UNIVERSITY OF TECHNOLOGY SYDNEY

Nutritional Status Among Adolescents Living with Human Immuno-deficiency Virus on Anti-Retroviral Therapy Follow-up Living in Selected Regions of Ethiopia: A Mixed Methods Study

By Meless Gebrie Bore

Thesis submitted in fulfilment of the requirements for the degree of

Doctor of Philosophy

Under the supervision of Professor Marilyn Cruickshank (Principal Supervisor), Professor Lin Perry (co-supervisor), Dr Xiaoyue Xu (co-supervisor), and Associate Professor Andargachew Kassa (co-supervisor)

University of Technology Sydney
Faculty of Health
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Certificate of Original Authorship

I, Meless Gebrie Bore, hereby declare that this thesis is submitted in fulfilment of the requirements for the award of the Doctor of Philosophy, in the Faculty of Health at the University of Technology Sydney.

This thesis is entirely my own work, except where due acknowledgment has been made. I certify that all sources of information and literature used are appropriately cited in the thesis.

This document has not been submitted for any other qualification at any academic institution.

This research is supported by the Australian Government Research Training Program.

Signature: Date:25/09/2024

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Meless Gebrie Bore

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[1] Dr Aitken has conducted research on the epidemiology of HIV and other infectious diseases, mostly among people who inject drugs, but has not been active in this field for many years.

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Impacts of COVID-19 Pandemic on thesis work

The COVID-19 pandemic has significantly impacted my thesis work by restricting my access to campus resources and limiting opportunities for in-person collaboration with peers and faculty. These restrictions delayed my thesis and hindered my ability to actively conduct my research in a timely manner. Additionally, the shift to remote learning, coupled with political instability and internet connectivity issues in Ethiopia, posed challenges in accessing necessary materials, ultimately slowing my progress and affecting my overall timeline.

Travel was also severely limited during this period, restricting my ability to attend conferences that could have enhanced my research and networking opportunities. However, after the pandemic, I became an on-campus student and worked diligently to meet the requirements, successfully completing my thesis despite these circumstances.

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Glossary

Body mass index (BMI) indicates body size and is used to identify and classify weight for height, calculated as weight in kilograms divided by height in metres squared: Weight (kg)/height (m^2). BMI values can be categorised as underweight, normal and overweight: underweight refers to adults and adolescents whose BMI is < 18.5 kg/m^2; BMI values > 25 kg/m^2 are considered overweight (with values > 30 kg/m^2 designated obese); BMI values between 18.5 kg/m^2 and 25 kg/m^2 are considered within normal range (WHO, 2006).

Dietary diversity: the variety of different foods or food groups consumed by an adolescent living with HIV (ALHIV) over a specific period (Gibson, 2005; Meng et al., 2018).

Dietary habits: the regular patterns and behaviours related to an ALHIV's consumption of food and beverages. These habits encompass what, when, how, and why people eat, including the types of food they prefer, their meal timings, portion sizes, frequency of meals, and the social and cultural contexts of their eating behaviours (De Hoogh et al., 2021; Koneru et al., 2020).

Dietary intake: the quantity and quality of food and beverages consumed by an ALHIV over a specific period. This includes the types and amounts of nutrients ingested, which are critical for assessing nutritional adequacy and identifying potential dietary deficiencies or excesses (Dötsch-Klerk et al., 2023; Gibson, 2005).

Food security is defined as all ALHIV, at all times, having physical, social, and economic access to sufficient, safe, and nutritious food that meets dietary requirements and preferences for maintaining an active and healthy lifestyle. This includes food availability from production, storage, and distribution; the utilisation of food through adequate dietary intake; and access to food through income, social support, and infrastructure (FAO, 2020).

Low- and Middle-Income Countries are classified according to the World Bank criteria and listed in Appendix I (World-Bank, 2021).

Malnutrition includes undernutrition, micronutrient deficiencies, and overweight/obesity. Malnutrition was assessed using various measurement indices, each featuring specific cutoff points tailored to different age groups, thereby delineating distinct levels of malnutrition among adolescents living with HIV. Accordingly, two separate mid-upper arm circumference

(MUAC) cutoff points were employed to categorise malnutrition levels in this study. For ALHIV aged 10–14 years, severe acute malnutrition was defined as MUAC < 16 cm, moderate acute malnutrition as MUAC of 16–18.49 cm, and normal status as MUAC ≥ 18.5 cm. Conversely, for ALHIV aged 15–19 years, severe acute malnutrition was identified as MUAC < 18.5 cm, moderate acute malnutrition as MUAC of 18.5–21 cm, and normal status as MUAC ≥ 21 cm (Kristen & Lesley, 2018).

Nutritional assessment is a comprehensive evaluation of the nutrition needs of the individual or a patient based upon appropriate data to determine nutrient needs or nutritional status and the nature and cause of nutrition-related health issues, allowing development of appropriate recommendations for nutrient intake and tackling the underlying cause of nutritional deficiencies. Assessment includes gathering information from the person's medical history, dietary history, physical examination, anthropometric measurements, laboratory tests, and lifestyle data indicating behavioural and environmental influences. The data for a nutritional assessment commonly falls into four categories: anthropometric, biochemical, clinical, and dietary intake (Gibson, 2005; Reber et al., 2019).

- Anthropometric measurements include weight, percentage weight loss, height, BMI), mid upper arm circumference (MUAC), skinfold thickness, mid-arm muscle circumference, fat-free mass/lean body mass, body fat (BF), and percentage body fat (PBF).
- Biochemical assessments include serum analysis of macro and micronutrient levels such as measurements of albumin, pre-albumin, haemoglobin, serum iron, total iron-binding capacity, magnesium, vitamin levels, trace elements, cholesterol, triglycerides, fasting glucose, CD4, CD8, virus load of HIV, renal function, and liver enzyme levels.
- Clinical presumptive features, such as symptoms and signs of infection that can increase nutrient needs (e.g., fever) and nutrient loss (e.g., diarrhea and vomiting), as well as opportunistic infections related to HIV that impair digestion and nutrient absorption and increase the risk of developing malnutrition. In addition, the common signs and symptoms of malnutrition and sarcopenia are low energy, low mood, difficulty performing activities of daily living, poor balance and falls, muscle wasting, constipation, loss of appetite, bilateral pitting oedema, severe palmar pallor, dehydration, shock (lethargic or unconscious with cold hands, slow capillary refill, or weak /low volume, rapid pulse and low blood pressure), eye sign (dry conjunctiva or cornea, Bitot spots, corneal cloudiness, corneal ulceration). Other relevant data may include co-morbid metabolic disease, hospitalisations, and medications that can affect nutritional status, such as certain protease

inhibitors, such as ritonavir and nelfinavir, which can cause changes in the metabolism of lipids (fats), resulting in an elevation in blood cholesterol and triglyceride levels.

- Dietary intake, measured by, for example, 24-hour recall, food frequency questionnaires and records, and food diaries.

Nutrition assessment, counselling, and management practice: the provision of an integrated nutrition intervention for ALHIV during ART follow-up by health professionals working in ART clinics. The integrated nutrition intervention includes:

- Performing systematic evaluation of the nutritional status of ALHIV during their ART follow-up using several methods of assessment, such as anthropometric, biochemical, dietary, clinical, and food security assessment.
- Conducting an interactive dialogue with the ALHIV regarding the identification, management, and prevention of dietary problems by following GALIDRAA (greet, ask, listen, identify, discuss, recommend, agree, and appoint) and ORPA (Observe, Reflect, Personalize and Act) approaches.
- Providing nutrition care and support to ALHIV (i.e., adopting standardised acute malnutrition management from admission to discharge, nutrition supplementation and follow-up, setting minimum practice standards for the nutrition care and management).

Nutritional status is defined as the condition of the body in those respects influenced by diet; the levels of nutrients in the body and the ability of those levels to maintain normal metabolic integrity; the degree of balance between nutrient intake and requirements (FANTA, 2016; Kennedy et al., 2011).

Stunting refers to children and adolescents whose height-for-age (HFA) Z-score is below minus 2 (−2) standard deviations (SD) according to the 2007 WHO growth reference. **Severe stunting** is defined as children and adolescents whose HFA Z-score lies below −3 SD (De Onis et al., 2007; FANTA-III, 2013; WHO, 2006, 2007).

Thinness refers to children and adolescents whose BMI-for-age Z-score (BAZ) is < -2 SD below the 2007 WHO Growth Reference Standard. **Severe thinness** is defined as children and adolescents whose BAZ lies below −3 SD (FANTA-III, 2013; WHO, 2007).

Ready-to-use Supplementary Food (RUSF**)** is a specialised food supplement intended to be used as part of a nutritional program, to treat moderate acute malnutrition (MAM) or prevent

severe acute malnutrition (SAM). RUSF is an energy-dense, mineral- and vitamin-enriched formulation specifically designed to treat MAM. The composition of RUSF is different to that of RUTF, which is designed to treat SAM. RUSF is soft and can be consumed easily by children from the age of six months without adding water. The ready-to-eat supplementary diet includes nutritious oil seeds/ cereals/ pulses, vegetable oils, milk powder, sugar, vitamins, and minerals (Fetriyuna et al., 2023).

Ready-to-Use Therapeutic Food (RUTF) – a specialised food product designed to treat SAM. It is energy-dense, highly nutritious, and requires no additional preparation, making it suitable for use in resource-limited settings where access to clean water and cooking facilities may be poor. RUTF typically contains a blend of ingredients such as peanuts, milk powder, vegetable oil, sugar, and added vitamins and minerals to meet the nutritional needs of malnourished children (Fetriyuna et al., 2023; Manary, 2006).

Abbreviations

ADP	Air Displacement Plethysmography
AIDS	Acquired Immunodeficiency Syndrome
ALHIV	Adolescent Living with HIV
ALT	Alanine Aminotransferase
ANOVA	Analysis of Variance
AOR	Adjusted Odds Ratio
ART	Anti-Retroviral Therapy
AST	Aspartate Aminotransferase
AUDIT-C	Alcohol Use Disorders Identification Test
BAZ	BMI-for-Age Z-score
BF	Body Fat
BFP	Body Fat Percentage
BAI	Body Adiposity Index
BIA	Bioelectrical Impedance Analysis
BMI	Body Mass Index
CDC	Centers for Disease Control and Prevention
CI	Confidence Interval
COR	Crude Odds Ratio
DDS	Dietary Diversity Score
DXA	Dual-energy X-Ray absorptiometry
EPHI	Ethiopian Public Health Institute
FANTA	Food and Nutrition Technical Assistance
FAO	Food and Agriculture Organization
FDRE-MOH	Federal Democratic Republic of Ethiopia-Ministry of Health
FFQ	Food Frequency Questionnaire
FGD	Focus Group Discussion
FMOH	Federal Ministry of Health
GAD	Generalised Anxiety Disorder
GAD-7	Generalized Anxiety Disorder 7-item scale
GALIDRAA	Greet, Ask, Listen, Identify, Discuss, Recommend, Agree, and Appoint
HAART	Highly Active Anti-Retroviral Therapy
HAZ	Height-for-age Z score

HFA	Height-for-Age
HIV	Human Immunodeficiency Virus
ICC	Intraclass Correlation Coefficient
I-CVI	Item Level Content Validity Index
IDI	In-Depth Interview
IFPRI	International Food Policy Research Institute
LMICs	Low and Middle-Income Countries
MAM	Moderate Acute Malnutrition
MDG	Millennium Development Goal
MOH	Ministry of Health
MUAC	Mid-Upper Arm Circumference
NACS	Nutrition Assessment, Counselling and Support
NCD	Non-Communicable Disease
NGO	Non-Governmental Organisation
OR	Odds Ratio
ORPA	Observe, Reflect, Personalize and Act
OTZ	Operation Triple Zero
PHQ-9	Patient Health Questionnaire-9
PMTCT	Prevention of Mother-to-Child Transmission
RBP	Retinol-Binding Protein
RDA	Recommended Daily Allowance
RUSF	Ready-to-Use Supplementary Food
RUTF	Ready-to-Use Therapeutic Food
SAM	Severe Acute Malnutrition
S-CVI	Scale Level Content Validity Index
SD	Standard Deviation
SDG	Sustainable Development Goal
SDI	Social Development Index
SGPT	Serum Glutamic Pyruvic Transaminase
SGOT	Serum Glutamic Oxaloacetic Transaminase
SOP	Standard Operating Procedure
SPSS	Statistical Package for the Social Sciences
SRH	Sexual and Reproductive Health

S_4SKT	Sum of four skinfold thicknesses (biceps, triceps, subscapular, and supra-iliac SKT)
STI	Sexually Transmitted Infection
STROBE-Nut	Strengthening the Reporting of Observational Studies in Epidemiology-Nutritional Epidemiology
UNAIDS	United Nations Programme on HIV/AIDS
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations International Children's Emergency Fund
UNSCN	United Nations System Standing Committee on Nutrition
WBC	white blood count
WHO	World Health Organization
WHR	Waist-to-Height Ratio

Abstract

Background: In Ethiopia, despite a decline in overall HIV prevalence, adolescents, particularly those living with HIV (ALHIV) on antiretroviral therapy (ART), remain at high risk of malnutrition. A systematic review revealed stunting and wasting among ALHIV in low- and middle-income countries. Due to rapid growth and low status, these adolescents face significant nutritional risks that increase their vulnerability to infections. Integrated nutritional interventions are crucial for improving health outcomes, yet comprehensive information to guide these efforts is lacking. This study aims to identify gaps in practices and provide recommendations for enhancing the nutritional status and care of ALHIV.

Methods: The study comprised three interrelated sub-studies focused on nutritional assessment and management practices for ALHIV. The first sub-study employed a quantitative prospective design to assess how healthcare workers in Ethiopian ART units manage the nutritional status of ALHIV, concentrating on existing practices and protocols. The second sub-study utilized a predominantly quantitative approach, supplemented by a small qualitative component, to evaluate nutritional status including 24-hour dietary recalls and identifying influencing factors. The third sub-study adopted a qualitative descriptive design to explore challenges and experiences of ALHIV aged 16–19 years, including their perceptions of support from ART clinics. Data were analysed using descriptive statistics, regression models, and reflexive thematic analysis.

Results: The study highlighted significant challenges in the nutritional management of ALHIV on ART in Ethiopia. Key findings included high levels of thinness, acute malnutrition, and stunting among ALHIV. Although nutritional supplementation helped reduce thinness, persistent issues such as food insecurity and psychosocial problems remained. Factors like delayed ART initiation, food insecurity, and psychosocial challenges negatively impacted nutritional status. Male adolescents, older age groups, and those with opportunistic infections were at higher risk of poor nutritional outcomes. Qualitative data revealed gaps in nutritional screening and education, compounded by economic hardships and psychological barriers faced by participants.

Conclusion and Recommendations: This study highlights critical issues in the nutritional care of ALHIV on ART in Ethiopia, revealing significant malnutrition and disparities in care practices. To improve outcomes, it is essential to implement advanced nutritional assessment tools, standardize nutritional counselling, and enhance training for healthcare workers.

Addressing socio-economic barriers like food insecurity is vital, as is integrating mental health services into the care framework. Promoting dietary diversity, fostering collaboration among community and policy stakeholders, and conducting further research on nutritional practices will help meet the complex needs of ALHIV on ART, ultimately improving their health and well-being.

Summary

In Ethiopia, despite overall decline in HIV rates, adolescents living with HIV (ALHIV) remain a high-risk, high-prevalence group for malnutrition. Examining the nutritional challenges and healthcare support available to ALHIV in Ethiopia, this study revealed significant malnutrition, including thinness, stunting and acute malnutrition, and disparities in nutritional assessment and intervention practices including nutritional counselling and supplement usage. Dietary analysis revealed deficiencies in essential nutrients like fibre, vitamins, and minerals. Qualitative data highlighted economic and ecological difficulties, psychological problems and social stigma as significant barriers to adequate nutrition. These insights stress the need for improved, integrated nutritional care and targeted interventions to meet the multifaceted needs of ALHIV. To improve outcomes, it will be essential to implement advanced assessments, enhance nutritional counselling, standardise practice and improve training for healthcare workers. Overcoming socio-economic barriers such as food insecurity will be crucial, and improving dietary diversity, engaging community and policy stakeholders, and integrating mental health services into care plans. A multi-faceted approach, including government action, is essential to overcome these complex problems and improve the health and well-being of ALHIV.

Publications based on the research

Journal article

Gebrie M, Perry L, Xu X, Kassa A, Cruickshank M. Nutritional status and its determinants among adolescents with HIV on anti-retroviral treatment in low- and middle-income countries: a systematic review and meta-analysis. *BMC Nutrition*. 2023 Mar 28;9(1):60. DOI: 10.1186/s40795-023-00714-z. https://doi.org/10.1186/ s40795-023- 00714-z

Conference presentations

Nutritional status and its determinants among adolescents with HIV on anti-retroviral treatment in low- and middle-income countries: a systematic review and meta-analysis. Australian Association for Adolescent Health (AAAH). Youth Health Conference November 8–10, 2023 Adelaide.

Nutritional status and its determinants among adolescents with HIV on anti-retroviral treatment in low- and middle-income countries: a systematic review and meta-analysis. Research Student Forum at UTS and won **Runner up** Prize in November 2022.

Additional publications during candidature

During my candidacy, I authored or co-authored over 15 articles that were not based on this thesis but contributed significantly to the field. Some of these publications are listed below.

- Abel F Dadi, Kedir Y Ahmed, Yemane Berhane, Habtamu M Bizuayehu, Getayeneh A Tesema, Tahir A Hassen, Getiye D Kibret, Daniel B Ketema, **Meless G Bore**, ….. and Allen G Ross, (2024). Intimate partner violence and childhood health outcomes in 37 sub-Saharan African countries: an analysis of demographic health survey data from 2011 to 2022. *The Lancet Global Health*. https://doi.org/10.1016/S2214-109X(24)00313-9
- Seid, A., Cumpston, M. S., Ahmed, K. Y., Bizuayehu, H. M., …….., **Bore, M. G**., & Hassen, T. A. (2024). The intergenerational association of preterm birth: A systematic review and meta-analysis. *BJOG : An International Journal of Obstetrics and Gynaecology*. https://doi.org/10.1111/1471-0528.17924
- Ahmed, K. Y., Thapa, S., Hassen, T. A., ……, **Bore, M. G**., Ross, A. G. (2024). Population modifiable risk factors associated with neonatal mortality in 35 sub-Saharan Africa countries: analysis of data from demographic and health surveys. *EClinicalMedicine*, *73*, 102682. https://doi.org/10.1016/j.eclinm.2024.102682
- Ahmed, K. Y., Dadi, A. F., Kibret, G. D., Bizuayehu, H. M., …. **Bore, M. G**., & Ross, A. G. (2024). Population modifiable risk factors associated with under-5 acute respiratory tract infections and diarrhoea in 25 countries in sub-Saharan Africa (2014–2021): an analysis of data from demographic and health surveys. *EClinicalMedicine*, *68*, 102444–102444. https://doi.org/10.1016/j.eclinm.2024.102444
- Gebre, B. B., **Gebrie, M**., Bedru, M., & Bennat, V. (2024). Magnitude and associated factors of benign prostatic hyperplasia among male patients admitted at surgical ward of selected governmental hospitals in Sidamma region, Ethiopia 2021. *International Journal of Africa Nursing Sciences*, *20*, 100688. https://doi.org/10.1016/j.ijans.2024.100688
- **Bore, M. G**., Dadi, A. F., Ahmed, K. Y., Hassen, T. A, …., Perry, Lin, Leshargie, C. T., & Bizuayehu, H. M. (2024). Unmet supportive care needs among cancer patients in sub-Saharan African countries: A mixed method systematic review and meta-

analysis. *Journal of Pain and Symptom Management*, *67*(3), e211–e227. https://doi.org/10.1016/j.jpainsymman.2023.11.023

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- Amenu, A., Aynalem, A., Borie, Y. A., Jemebere, W., Molla, E., Samuel, B., Israel, E., Yeheyis, T., Assefa, D. G., & **Gebrie, M**. (2023). Determinants of unmet physical and psychological supportive care needs among adult cancer patients in Southern Ethiopia. *BMJ Supportive & Palliative Care*, spcare-2023-004606-. https://doi.org/10.1136/spcare-2023-004606
- Edeo Berarti, A., **Gebrie, M.,** & Beyene, B. (2023). Adherence to iron folic acid supplementation and associated factors among antenatal CARE attending women in Sire district primary health care units, South-East Ethiopia: A facility based cross-sectional study. *International Journal of Africa Nursing Sciences*, *18*, 100526-. https://doi.org/10.1016/j.ijans.2023.100526
- Samuel, B., Tsegaye, B., Dulla, D., Aynalem, A., Israel, E., & **Gebrie, M.** (2023). Informed choice and its associated factors among women received immediate postpartum long-acting reversible contraceptives at public hospitals in Sidama Regional State, Ethiopia, 2022. *Contraception and Reproductive Medicine*, *8*(1), 32–32. https://doi.org/10.1186/s40834-023-00229-9

Chapter One: Introduction

Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome (HIV/AIDS) remains a major global public health challenge. Adolescents, in particular, are highly vulnerable to HIV due to the significant physical, mental, social, emotional, and sexual changes that occur during this developmental period. During adolescence, individuals undergo rapid growth and development, making them susceptible to various health challenges at a time that is a pivotal period for establishing lifelong health and behavioural patterns. In addition, adolescents begin to form their identities and make independent decisions, which can often include engaging in high-risk behaviours such as alcohol consumption, drug use, and unsafe sexual practices. These behaviours can lead to severe health consequences, including sexually transmitted infections (STIs), unplanned pregnancies, and mental illnesses such as eating disorders and depression. While many of these health issues are preventable with proper education and intervention, the prevention services and infrastructure may not exist in areas of high need (Balocchini et al., 2013).

My experience as a public health professional and nutritionist has informed my understanding of adolescent health challenges, particularly in areas such as sexual and reproductive health (SRH), adolescent nutrition, and the management of malnutrition. Through facilitating training sessions and observing outcomes, I have seen the positive impact of such interventions on adolescent well-being. This background has motivated my research into identifying effective solutions for improving adolescent health in low- and middle-income countries.

Health and nutrition professionals are expected to analyse problems, conduct community-based and problem-oriented research, and propose evidence-based solutions. I studied the vulnerability to malnutrition of Ethiopian adolescents living with HIV, and the role of nutritional nutrition in improving their quality of life and survival, generating novel findings and recommendations for improved nutritional practice.

1.1 An Overview of the Ethiopian health system

1.1.1 HIV in Ethiopia

In Ethiopia, HIV prevalence has been falling gradually over the last two decades, from 2.3% in 2002 to 0.8% in 2021 (World Data Atlas Ethiopia Health, 2021). Despite this progress, the HIV burden

remains concentrated in regions such as Amhara, Oromia, and Addis Ababa, which account for 75% of the cases. According to the 2023 Ethiopian Public Health Institute (EPHI) HIV report, 603,537 people in Ethiopia were living with HIV, 7,194 people were newly infected with HIV, and 9,984 people were facing HIV-related death in 2022 (EPHI, 2023). In 2020–21, of all people living with HIV an estimated 77% were receiving anti-retroviral therapy (ART); of those living with HIV on ART, 96.7% were aged 15 years or older (MOH, 2021). There are no recent data on the number of adolescents living with HIV (ALHIV) in Ethiopia.

Adolescents are disproportionately affected by HIV (UNICEF, 2021b) due to two main factors (UNICEF, 2021b). Firstly, they are at high risk of perinatal infection, with many acquiring HIV from their mothers during childbirth or during breastfeeding. Secondly, many adolescents contract HIV as a result of engaging in high-risk behaviours. HIV-related health problems, most of which are preventable, can cause significant morbidity and mortality. In addition, several cultural and social factors in Sub-Saharan Africa not only increase the risk of infection but limit their ability to respond effectively (UNICEF, 2023a), as described below.

Many adolescents and young people in Sub-Saharan Africa are affected by gender-based and other forms of violence, as well as harmful social norms, social, economic and gender inequalities, prejudice/stigma, discrimination and harmful laws and practices that hamper the development of adolescent girls and young women and their ability to protect themselves from HIV (UNAIDS, 2023; WHO, 2023a). Early and forced marriage, unequal access to information, lack of bargaining power and economic autonomy all contribute to an increased risk of HIV transmission in women and adolescent girls. Public health initiatives for adolescents predominantly target SRH, largely driven by concerns about the reproductive health needs of the many adolescent girls who are subject to child marriage, of whom over a quarter are already pregnant or mothers by 19 years of age (Ahinkorah et al., 2021).

In Ethiopia, political instability has exacerbated these challenges by severely impacting healthcare service delivery and food security. Ongoing conflict has damaged infrastructure, created staff shortages, and diverted resources, leading to disruptions in access and quality of care. Additionally, political unrest has hindered agricultural production and supply chains, contributing to food instability and malnutrition, which further compromise health outcomes for vulnerable populations.

This unrest has diminished trust in health systems, causing many to seek informal care that often lacks quality assurance. The combination of social vulnerabilities faced by young people and the destabilizing effect of political conflict significantly undermines public health outcomes in the country, particularly for those most at risk (Arage et al., 2023; Gutema et al., 2023).

A total of 441,464 adults and children were receiving ART in Ethiopia (excluding the Tigray Region) in June 2022. About half of all Ethiopian children (<15 years) and adults (≥15 years) living with HIV were resident in these two regions (49.3%, n=217,528) and receiving ART services: 100,714 in Addis Ababa Region, and 116,814 in Oromia Region (MOH, 2021).

1.1.2 National programs and policies relevant to HIV services

To meet the health needs of people living with HIV, in recent decades the Ministry of Health of Ethiopia has developed and implemented adolescent and youth health programs and strategies (FDRE-MOH, 2006; FMOH, 2020; Oljira, 2016). However, adolescents and young adults aged 10–24 years in Ethiopia continue to face a high burden of morbidity and mortality from multiple factors, including teenage pregnancy, unplanned pregnancy, compromised nutrition, HIV and STIs, unsafe abortion, early and child marriage, substance abuse, lack of access to and utilisation of youth-friendly services, and unmet family planning needs (Admassu et al., 2022; FMOH, 2020).

Ethiopia has implemented various national programs and policies specifically targeting HIV services for adolescents. The National HIV/AIDS Strategic Plan aims to reduce new infections, increase access to treatment, and improve the quality of life for adolescents living with HIV (MOH, 2023). Additionally, the Health Sector Development Program integrates HIV/AIDS services into the broader health system, emphasising health infrastructure and equitable access for all, including adolescents (MOH, 2010).

The Adolescent and Youth Health Strategy focuses on SRH, HIV prevention, and youth-friendly health services (FMOH, 2016). National guidelines for comprehensive HIV prevention, care, and treatment include protocols for adolescents covering testing, counselling, ART, and nutritional support (MOH, 2018, 2022). To improve service access, the Community-Based Health Insurance scheme, implemented in 2011, reduces financial barriers, particularly benefitting adolescents from low-income families (Alemayehu et al., 2023; Mulat et al., 2022).

School-based HIV prevention programs integrate HIV education into curricula to increase awareness, promote safe practices, and reduce stigma among young people (UNESCO, 2021). These efforts reflect Ethiopia's commitment to combating the HIV epidemic and aim to enhance the effectiveness and sustainability of its response among adolescents.

However, significant gaps remain in policy implementation. Although policy documents identify adolescents and young people aged 10–24 years as a priority population, the strategies often combine adolescents with adults (individuals aged 15 years and above). This approach neglects the specific needs of younger adolescents (10–14 years), highlighting the need for more targeted interventions (MOH, 2016b).

Challenges to improving care for ALHIV include limited access to adolescent-friendly health services, inadequate training for healthcare providers on adolescent-specific needs, and persistent stigma and discrimination hindering care. Additionally, the lack of comprehensive data on HIV prevalence and specific needs of adolescents hampers effective policy planning and implementation (MOH, 2016b). Filling these gaps requires a multifaceted approach, including improving the accessibility and quality of adolescent-focused HIV services, enhancing community engagement and education to reduce stigma, and strengthening data collection and monitoring systems (UNAIDS, 2020).

1.2 Adolescent health, nutrition, and HIV/AIDS policy

Nutrition was central to achieving the Millennium Development Goals (MDGs) and was directly or indirectly linked to all of them. However, countries made uneven progress in achieving the MDGs (United Nation, 2012), and most, especially African countries, did not fully achieved them. Approximately 15.5% of the world's population still suffered from hunger, and a narrow focus on undernourishment, along with lack of coordinated multi-sectoral action on nutrition, acted as nutrition-specific limitations of the MDG framework (FDRE, 2016; United Nation, 2012, 2023). In 2015, the United Nations announced 17 Sustainable Development Goals (SDGs) for 2030 in a new universal agenda to further develop and complete the unachieved MDGs (UNSCN, 2015).

According to the Global Nutrition Report and the International Food Policy Research Institute (IFPRI), good nutrition is crucial for achieving 12 of the 17 SDGs (International Food Policy Research Institute(IFPRI), 2015). Therefore, nutrition is at the core of sustainable development.

Nutritional insufficiency hinders healthy growth and development, and is driven by factors including hunger, disease, poverty, disempowerment, and unhealthy environments. To solve these problems, strong, multi-sectoral and multi-stakeholder efforts are required that encompass nutrition-specific, nutrition-sensitive, and environmentally friendly actions at all levels (Global Nutrition Report, 2015; International Food Policy Research Institute(IFPRI), 2015).

A report from the Ministry of Health of Ethiopia in 2016 assessed the country's policies and strategies for HIV care and prevention of mother-to-child transmission (PMTCT) in relation to the SDGs for ending AIDS by 2030. The report noted strong policies and implementation strategies in place but identified several gaps in HIV care for adolescents in Ethiopia. Major issues included the lack of a clear strategy for retaining adolescents in HIV care, and the absence of a minimum care package that includes nutrition and psychosocial support. There were also discrepancies between HIV testing guidelines and national laws and regulations. There was no third-line ART regimen, and no specific PMTCT strategy for underserved areas. Health worker skills and attitudes were also found to need improvement, with the Ministry of Health identifying a lack of confidence in managing paediatric and adolescent patients with HIV and a high attrition rate among trained staff. Collaboration between the Ministries of Health, Education, and Women and Children's Affairs were also lacking, as were HIV testing and treatment targets specific to paediatric and adolescent populations (Ministry of Health of Ethiopia, 2016).

For adolescents living with HIV/AIDS, nutrition counselling, care and support interventions should be tailored to their nutritional status and extent of disease progression (WHO, 2003). Nutrition Assessment, Counselling and Support (NACS) is an organising framework designed for integrating nutrition into the continuum of care for clients and into national HIV treatment, care and support programs. It includes the prevention, detection and treatment of acute malnutrition, maintenance of improved nutritional status to prevent relapse, and linkage to other nutrition-sensitive interventions provided by the health, agriculture, food security, social protection, education and rural development sectors (FANTA, 2012). Integrating nutrition assessment, care, and support into routine clinical services is essential to meet the nutritional requirements of individuals living with HIV/AIDS (FANTA, 2004). Numerous studies have indicated that the NACS program has been accepted and put into practice in several Sub-Saharan African nations with high HIV prevalence, including Ethiopia (FANTA, 2016, 2018b).

The NACS program in Ethiopia has been functional since 2009. However, a joint FANTA/Regional Health Bureau pilot performance quality evaluation of NACS found the quality of services at the health facility level was inconsistent and insufficient (FANTA, 2018b). For example, some facilities failed to screen the nutritional status of all HIV-positive individuals, improperly classified clients' nutritional status, and failed to treat all malnourished HIV-positive individuals according to the recommended nutrition care plan. Additionally, some facilities were not regularly employing the correct anthropometric measures, especially for paediatric patients (FANTA, 2018b). These quality failures could result in incorrect diagnosis of nutritional status, inadequate care and, in some situations, improper prescription of nutrition products to clients. The 2017 FANTA Pilot NACS Quality Improvement Activity report showed that the integration of nutritional assessment, counselling, care and support services in some resource-constrained clinical settings was inadequate, although the reasons for this were unclear. Further work is required to map any care deficits and determine the contributing factors to help clinicians, policymakers, health planners, researchers, and other stakeholders find solutions (FANTA, 2017).

1.3 The significance of adolescence

The World Health Organization (WHO) defines adolescence as the period between ages 10 and 19 years (WHO, 2014). It encompasses the critical transition from childhood to adulthood, a period of rapid growth and development involving physical, mental, social, emotional, and sexual changes. Adolescents form a significant proportion of the global population (16%), totaling 1.3 billion (UNICEF, 2022). While more than half of these young people live in Asia, sub-Saharan Africa is the region where this age group comprises the largest percentage of the population, accounting for 23% (UNICEF, 2021b; United Nation, 2019). Ethiopia has an even higher percentage of young people (33% of the total population), with about 41.8 million people aged 10–24 years in 2023 (UNFPA, 2023), a phenomenon often referred to as the youth bulge (EPHI, 2020).

Adolescents can face difficult challenges in deciding how they feel, think, make decisions, and interact with the world around them (WHO, 2023b). In addition, this is the time that many people receive their first exposure to high-risk behaviours such as alcohol consumption, use of other drugs, including tobacco, and sexual and other risk-taking behaviours; these can lead to multiple health issues, including STIs, adolescent pregnancy, and mental health problems such as eating disorders and depression. The propensity to partake in risk-taking behaviours can also make adolescents

vulnerable to HIV (UNICEF, 2021b; WHO, 2013b, 2023b). Additionally, accidental injury, homicide, and suicide are leading preventable causes of death among adolescents (Oinam, 2019), responsible for an estimated 1.2 million deaths every year worldwide (UNICEF, 2023a). In 2015, more than two-thirds of these deaths occurred in low- and middle-income countries (LMICs) in Africa and South-East Asia (UNICEF, 2023a).

In Ethiopia, the prevalence of high-risk behaviours among adolescents, such as unprotected sex and substance abuse, is a major contributor to the spread of HIV. Poor access to sexual education and healthcare services exacerbates these issues, making it essential to implement comprehensive sexual education, improve healthcare access, and strengthen community support to mitigate these risks and improve health outcomes for Ethiopian adolescents (Roba et al., 2021; Rudgard et al., 2023; Sifer & Getachew, 2024).

Adolescents are disproportionately affected by HIV yet often overlooked in national HIV programming and intervention strategies. Despite their heightened vulnerability, adolescents are rarely given specific priority in the development and implementation of national HIV prevention and treatment efforts (Pettifor et al., 2018). HIV in adolescence is a different epidemic from adult HIV because of the compounding effects of the disease. An adolescent who contracts HIV remains infected and affected for the rest of their lives (Naswa & Marfatia, 2010). Not only do adolescents often have difficulty accepting their HIV status, they require lifelong treatment. They may need to adjust to the effects of other HIV-positive family members and may have painful memories of losing their parents or other family members to the disease. They face unanswered questions about their future health, education, careers, and marriage. In common with other young adults, their likelihood of risky sexual behaviour is high, while at the same time, most have infrequent contact with the healthcare system.

Monitoring the spread of HIV in this demographic group is difficult but critical for long-term epidemic control, (EPHI, 2020). An estimated 1.65 million adolescents were living with HIV worldwide in 2022, of whom 85% were living in the WHO African Region. Equally concerning is the young age of the newly infected; of the 480,000 young people aged 10–24 years living with HIV in 2021, 140,000 were aged between 10 and 19 years (UNICEF, 2023a; WHO, 2023a).

In resource-constrained settings, HIV-related deaths continue to increase among young people. HIV/AIDS is one of the leading causes of preventable death among adolescents in Africa and the second most common cause of death among adolescents worldwide (UNAIDS, 2015). According to a UNICEF report, about 27,000 adolescents lost their lives to HIV/AIDS-related causes in 2022 (UNICEF, 2023a). The high mortality is due to the low priority of adolescents and young people in HIV programs; inadequate provision of accessible and acceptable HIV testing, counselling and treatment services; lack of support for adolescents and young people; and low adherence to ART (WHO, 2013a). HIV/AIDS is also responsible for substantial disability and morbidity among adolescents and young people, who increasingly report depression, stigma, violence, and suicidal behaviours(UNICEF, 2021b; United Nation, 2019; WHO, 2022).

HIV prevalence vary widely by gender and location. Adolescent girls accounted for four-fifths of all new HIV infections among adolescents worldwide in 2022 (UNICEF, 2023a), most of whom (75%) live in sub-Saharan Africa (UNAIDS, 2023; UNICEF, 2023a; WHO, 2023a). In 2021, two-thirds of HIV-infected adolescents living in Sub-Saharan Africa were in eastern and southern Africa (UNAIDS, 2022). It has been estimated that in 2021, an adolescent girl or young woman was newly infected with HIV every two minutes (UNAIDS, 2022). Although almost six times as many adolescent girls than adolescent boys were newly infected with HIV in 2022 worldwide (UNAIDS, 2023; UNICEF, 2023a).

Whilst effective treatment for HIV exists, it is not universally available nor accessible. Approximately 940,000 adolescents living with HIV worldwide receive ART (UNICEF, 2021b), with coverage at 53% among adolescent girls and slightly higher among boys (55%). To reach the 95-95-95 targets (i.e., 95% of people living with HIV know their HIV status; 95% of people who know their status are on treatment; and 95% of people on treatment have suppressed viral loads) by 2025, there is an urgent need to scale up treatment and care efforts among adolescents (UNICEF, 2021b). UNICEF states that combating HIV/AIDS requires a greater focus on adolescents and young people, with policymakers noting significant gaps in access to HIV/AIDS services among adolescents and young people, with many factors combining to limit the range of youth-friendly services in sub-Saharan Africa, including Ethiopia (UNAIDS, 2023; UNICEF, 2021c; WHO, 2022).

1.4 The role of nutrition in adolescent health

Adolescence has been called the second window of opportunity (after the first one thousand days of life) to prepare for a healthy, productive and reproductive adult life and to prevent the development of nutrition-related chronic diseases in adulthood (MOH, 2016a). It is the time when nutritional problems stemming from childhood should be corrected and interventions launched to solve nutritional problems (WHO, 2005).

Adolescence is also a critical time for the development of non-communicable diseases (NCDs) in adults, because many of the risk factors for disease develop at this age; malnutrition is a large contributor to many NCDs and thus remains a major public health concern (Reiner et al., 2019). Progress in reducing NCDs is inequitable, because countries with a low and low–middle social development index (SDI) bear a higher burden of morbidity amongst children and adolescents than middle-, high–middle-, and high-SDI countries (Reiner et al., 2019). Targeting adolescents with health interventions, such as comprehensive education programs, regular health screenings, and access to medical care, can have significant positive ripple effects. These interventions can lead to improved physical growth, a reduced risk of both communicable and non-communicable diseases, better adherence to medical treatments, fewer distressing symptoms, enhanced quality of life, and higher survival rates. Additionally, they can raise awareness about risk behaviours and prevention strategies, support better cognitive development, boost productivity in adulthood, and contribute to overall economic growth for the nation.

A focus on adolescent growth and development can be transformative, bringing about profound changes that improve health in adult life (Norris et al., 2022; Wrottesley et al., 2020). In LMICs, including in sub-Saharan Africa, adolescent generations are growing up in an era of unprecedented changes in the nutrition landscape such as rising rates of overweight and obesity, alongside continuing problems such as micronutrient deficiencies and food insecurity (Christian & Smith, 2018; Norris et al., 2022).

Nutrition and the adolescent transition are closely linked. As noted already, adolescence is a period of rapid growth and change, and proper nutrition is crucial for optimal physical and cognitive development. Adolescents have greater nutrient needs than children and adults, and poor nutrition during this period can have long-term negative consequences for health and well-being (Soliman et

al., 2022). Additionally, adolescent eating patterns and behaviours, nutritional intake and adequacy are influenced by many factors, including peer pressure, parental modelling, food availability, food preferences, cost, convenience, personal and cultural beliefs, mass and social media, and body image (Salam et al., 2019).

Nutrition has a profound impact on the current and future health adolescents (WHO, 2018b). It is an important public health issue for adolescent populations due to rapid growth spurt and increased physiological demands typical of this period (MOH, 2016a). Adolescent nutrition plays an important role in the timing and progression of puberty, during which adolescents gain up to 50% of adult weight, more than 20% of adult height, and 50% of adult skeletal mass, with significant influence exerted on later risks for NCDs (Norris et al., 2022).

Adolescence is a nutritionally vulnerable period of life due to the high nutrient and calorie demands of physical growth and maturation and changes in body composition (WHO, 2018b). Energy and protein requirements are maximal during puberty (WHO, 2005) and nutritional effects during adolescent development extend beyond musculoskeletal growth to cardiorespiratory fitness, neurodevelopment and immune function (Norris et al., 2022).

Adolescent populations worldwide are affected by many nutritional problems, including undernutrition and overweight/obesity, iron deficiency anaemia, and deficiencies in iodine, vitamin A, calcium, zinc and folate (MOH, 2016a; WHO, 2005, 2023a). The nutritional status of adolescents and young people is crucial for the health and well-being of future generations, whether they are HIV-positive or not (Wrottesley et al., 2020). The current generation is facing significant changes in food environments, marked by persistent issues such as micronutrient deficiencies, food insecurity, and a rising prevalence of overweight and obesity (Norris et al., 2022).

As noted earlier, both undernutrition and overweight are prevalent, especially in LMICs, where food insecurity, nutritional deficiencies and undernutrition coexist and interact with obesity, unhealthy diets and environments that foster sedentary and unhealthy behaviour (Caleyachetty et al., 2018; Wells et al., 2021).

Malnutrition refers to deficiencies, excesses or imbalanced intake of energy and/or nutrients (WHO, 2018b). Malnutrition often starts prenatally in individuals, continues through childhood and adolescence, and even extends to adulthood (Norris et al., 2022). This creates a vicious circle of

malnutrition contributing to adverse intergenerational effects, such as low birth weight, which in turn has lifelong effects on health, physical and cognitive development (MOH, 2016a; WHO, 2005). The lack of proper nutrition among adolescent girls and pregnant women is a particular issue that can have long-term consequences both for them and their offspring (Marshall et al., 2022). In addition (as noted earlier), micronutrient deficiencies, anaemia and food insecurity are major concerns. These factors, combined with gender inequality and discrimination, increase the risks of stillbirths, miscarriages, preterm delivery, low birth weight, impaired foetal growth and development, and increased risk of maternal and neonatal mortality. These effects can have lifelong consequences for the nutrition, growth and development, learning, future earning capacity and economic productivity of future generations (Marshall et al., 2022; UNICEF, 2023b; WHO, 2005). Nutrition interventions targeting adolescents, especially adolescent girls, play a key role in breaking intergenerational cycles of malnutrition, poverty and chronic disease (WHO, 2005, 2023b).

The relationship between nutritional status and HIV outcomes is significantly influenced by social determinants of health such as poverty, access to healthcare, and social support (Borkowski & Borkowska, 2024). Individuals living in poverty often face barriers to accessing nutritious food, which can exacerbate the negative effects of HIV. Malnutrition can impair immune function, making it harder to manage HIV and increasing susceptibility to opportunistic infections (Borkowski & Borkowska, 2024; Duggal et al., 2012; Ivers et al., 2009; Wahyu Wibowo et al., 2021). Additionally, poverty can restrict access to healthcare services, including HIV testing, ART, and regular medical follow-ups. This lack of access can result in delayed diagnosis and inadequate treatment, ultimately leading to poorer health outcomes (Hlongwa et al., 2023). Comprehensive healthcare access not only facilitates early diagnosis and effective management of HIV but provides essential nutritional support, which is crucial for optimising ART efficacy and overall health (Kitahata et al., 2002). Moreover, social support networks can play a vital role in improving health outcomes by offering emotional support and practical assistance, thereby helping individuals adhere to treatment and navigate healthcare systems (Qiao et al., 2014; Tam et al., 2023). Conversely, inadequate housing and employment opportunities, often linked to poverty, can further diminish an individual's ability to maintain a healthy diet and access necessary healthcare services (Rajabiun et al., 2018). Thus, addressing these social determinants is crucial for improving both nutritional status and HIV outcomes.

1.4.1 Nutritional issues affecting the health of adolescents living with HIV

Malnutrition both compounds the risks of HIV infection and results from it (FANTA, 2004; UNICEF, 2021b; WHO, 2022). HIV infection causes excess nutrient loss and malabsorption (De Pee & Semba, 2010), increasing nutritional requirements beyond those needed for the rapid growth and development that should occur during puberty (De Pee & Semba, 2010; FANTA, 2016). Nutritional requirements can be even higher if the HIV-infected adolescent has secondary infections or is pregnant or lactating (FANTA, 2016). Food insecurity at home, lack of access to information on health and nutrition, poor eating habits, unbalanced energy expenditure, early pregnancy in girls and malnutrition in utero are among contributing factors to undernutrition in HIV-infected adolescents (Christian & Smith, 2018; UNICEF, 2021a, 2021b).

For adolescents living with HIV, adequate nutrition is critical for managing health and preventing complications (Borkowski & Borkowska, 2024). Nutrition interventions for adolescents, especially in the presence of co-morbid conditions like HIV, are rare in low-resource and less developed countries, such as Ethiopia (Ivers et al., 2009; Wahyu Wibowo et al., 2021). Trialling and assessing the effects of nutritional interventions on health outcomes and priorities informs the community, policymakers, and researchers, supporting further investigation and development of effective implementation strategies (Duggal et al., 2012; Tam et al., 2023).

Many adolescents and young adults living with HIV in sub-Saharan Africa struggle with nutrition-related issues due to their chronic illness (Darshit D, 2020). Acute malnutrition or wasting syndrome has been the most frequently observed form of malnutrition in HIV-infected children and adolescents worldwide for many years. This condition is characterised by significant decreases in body fat, lean mass, and bone mass, which can lead to a variety of health problems, including growth retardation or stunting, a weakened immune system, and even death in severe cases (Darshit D, 2020) .

The immune status of an individual depends on their nutritional status, which can be influenced by their choice of nutrient intake (Neufeld et al., 2022). A noted already, malnutrition and HIV progression are linked (Duggal et al., 2012), and treatment requires active cooperation between infectious disease physicians and nutritionists. Patients with HIV patients receiving ART have been found to experience significant weight loss, which necessitates dietary modification (Duda et al., 2020; Wrottesley et al., 2014). Oxidative stress represents an important etiological factor in diseases

of immune deficiency, so antioxidant agents (vitamin A, vitamin E, vitamin B12 and certain minerals, such as zinc and selenium) are crucial factors in HIV diet therapy (Stojanovic et al., 2011).

Poor nutrition poses major threats to the health of HIV-infected adolescents, as it can impair the immune system and increase the risks of morbidity and mortality (Naswa & Marfatia, 2010). In turn, HIV infection worsens the burden of malnutrition by increasing the body's need for nutrients and interfering with nutrient absorption and retention causing malabsorption and loss of nutrients. This creates a vicious cycle of malnutrition and HIV (Shiferaw & Gebremedhin, 2020; WHO, 2013a). However, improved nutrition and body mass index (BMI) of adolescents with HIV are associated with improved quality of life and also with improved immune markers (Duggal et al., 2012; Evans et al., 2013).

Dietary intake during adolescence can set a foundation for a healthy life. However, every adolescent is different when it comes to eating habits and the factors that influence their food choices (Neufeld et al., 2022). Taste, price, convenience, limited autonomy, social desirability and social norms about food, and hunger and cravings are commonly noted factors influencing adolescents' food choices (Daly et al., 2022). Additionally, lifestyle changes, growing independence, peer acceptance, and appearance concerns or body image can affect dietary habits (Norris et al., 2022). Due to these factors, many children and adolescents consume cheap, processed foods that are high in energy, fat and salt content but low in nutrient quality. As mentioned earlier, this can lead to the double burden of malnutrition, in which undernutrition accompanies overweight or obesity. Studies conducted in sub-Saharan countries have shown that adolescents with HIV/AIDS have similar eating habits to the general population, including high consumption of added sugar, saturated fat, and sodium, which can lead to both undernutrition and overweight or obesity (Tanaka et al., 2015).

Adolescents living with HIV/AIDS require adequate amounts, in appropriate proportions, of macronutrients (e.g., proteins, carbohydrates, fats) and micronutrients (e.g., vitamins, minerals). The nutritional needs and intake of HIV-infected persons depend on the stage of the disease and the absence or presence of symptoms such as fever, diarrhea, weight loss and wasting (FANTA, 2004; Francis et al., 2015). The following nutritional requirements have been proposed for adolescents living with HIV/AIDS.

1.4.1.1. Energy requirements

Adolescents living with HIV/AIDS have increased energy needs (FANTA, 2004) due to the increased energy expenditure caused by HIV and opportunistic infections, as well as nutrient malabsorption and altered metabolism (Duggal et al., 2012). Energy requirements in children and adolescents can vary depending on the type and duration of HIV-related infections and weight loss during acute infection (WHO, 2003).

Asymptomatic children and adolescents living with HIV /AIDS need 10% more energy to maintain growth, body weight and physical activity. During symptomatic HIV, and subsequently during AIDS, energy requirements increase by approximately 20% to 30% per day. Energy intakes need to increase by 50% to 100% per day over normal requirements in children experiencing weight loss and severe malnutrition (FANTA, 2004; WHO, 2003).

1.4.1.2. Protein requirements

The WHO indicates that there is insufficient evidence to support the need for increased protein intake in HIV-infected individuals compared to healthy non-HIV-infected individuals of the same age, sex, and physical activity level. According to the Food and Nutrition Technical Assistance (FANTA) report (2004), HIV-infected individuals do not require more protein than their non-infected peers, unless they are experiencing specific health conditions that necessitate increased nutritional support (FANTA, 2004).

During the onset of opportunistic infections, the body loses nitrogen, which suggests a need for increased protein intake if such infections are left untreated (FANTA, 2004, 2016). However, studies have not shown that increasing protein intake leads to improved clinical outcomes for HIV-infected individuals (Sattler et al., 2008). More research is needed to determine the optimal protein requirements for those with HIV during the disease.

1.4.1.3. Fat and micronutrient requirements

There are currently no data showing that fat and micronutrient requirements differ because of HIV infection. However, certain ART regimens and symptoms of infection (such as diarrhea) may require changes in the timing or quantity of fat intake. ART drugs can influence fat metabolism, leading to altered fat distribution and increased risk of metabolic complications like lipodystrophy, which may require dietary modifications (FANTA, 2004; WHO, 2003). Additionally,

gastrointestinal issues such as diarrhea can affect nutrient absorption and may require adjustments in fat intake to ensure adequate energy provision and nutrient absorption (Rezazadeh et al., 2023).

Micronutrient deficiencies are common in areas where HIV is prevalent. Vitamins A, B-complex, C, E, iron, selenium, and zinc are needed to bolster the immune system and fight infections, especially for people living with HIV. Deficiencies of antioxidant vitamins and minerals contribute to oxidative stress, leading to accelerated cell death and higher rates of HIV replication (FANTA, 2004; WHO, 2003). To counter this, it is crucial to prioritise nutrition and give adolescents living with HIV the micronutrients they need to stay as healthy as possible.

Nutrition management is an integral part of comprehensive HIV care and treatment. Improving dietary diversity and caloric intake will improve nutritional status and weight gain, in turn improving resilience, fitness and quality of life for people living with HIV/AIDS (Mehta S, 2018). As noted already, health and nutritional needs are higher in HIV-infected individuals, which poses challenges on top of the broader health vulnerabilities that affect adolescents generally (Duggal et al., 2012; Shiferaw & Gebremedhin, 2020). Undernutrition in Africa is complicated by HIV, which compromises nutritional status and increases vulnerability to infection. Adequate nutrition can help delay HIV disease progression, but improving the diet and hence nutritional status of adolescents, who are rarely a priority group for nutrition interventions, is a challenge for policymakers, service providers and caregivers (WHO, 2013a, 2023b).

Improving the availability and coverage of ART should be the primary focus for HIV-infected people, but improving nutritional status plays a complementary role in the management of HIV infection. Nutritional interventions for adolescents with or without HIV are frequently neglected, especially in Sub-Saharan Africa, including Ethiopia. Addressing their food intake and improving their nutritional status pose significant challenges for policymakers, service providers, and caregivers (Shiferaw & Gebremedhin, 2020; Wrottesley et al., 2020).

1.4.2 Nutrition assessment, care and support for adolescents living with HIV

The HIV/AIDS epidemic has had a devastating impact on health, nutrition, food security and overall socioeconomic development in many countries (WHO, 2003; WHO et al., 2009). Infection with HIV, and co-infection with endemic diseases (such as tuberculosis, malaria, and diarrheal diseases), is common in sub-Saharan Africa (Kharsany & Karim, 2016; Raiten et al., 2011; Trehan et al., 2012)

and complicates the care of severely malnourished children and adolescents. HIV-related infections such as tuberculosis and diarrhoea can lead to appetite loss, weight loss and wasting (Kharsany & Karim, 2016). Prompt diagnosis and treatment of these conditions, along with the use of ART when necessary, can help improve overall nutrition and health. It is also essential to continue to improve understanding of nutrition–drug interactions to inform effective HIV/AIDS treatment programs (WHO, 2003).

Superimposed infections and a lack of up-to-date evidence-based guidelines hinder clinicians' ability to care for malnourished children and adolescents (Trehan et al., 2012). Although interventions have been developed for many common causes of child mortality worldwide over the past decade (Black et al., 2003; Kharsany & Karim, 2016), the management of severe wasting and malnutrition in children, especially those with HIV and/or tuberculosis, is still poorly understood. These conditions often coexist and have significant nutritional implications, necessitating a comprehensive approach to nutritional assessment and care.

Nutritional care and support depend on the availability and utilization of food, which are influenced by a range of factors including household-level social, economic, and cultural conditions, as well as broader community and policy-level influences (FANTA, 2016). Effective management of HIV-infected individuals with nutritional assessment, care and support can result in fewer secondary infections and hospital admissions, better clinical outcomes and lower healthcare costs (Keithley et al., 2000; Raiten et al., 2011).

1.5 Statement of problem

The care and support of people living with HIV has evolved rapidly with the widespread introduction of effective ART. However, despite substantial improvements in morbidity and mortality, ART alone has not eliminated the nutritional problems of people living with HIV/AIDS (Keithley et al., 2000; Tang et al., 2015). Malnutrition is common among children and adolescents living with HIV and is linked to treatment failure that increases morbidity and mortality (Tsegaye et al., 2016). Priority for clinical assessment and treatment initiation should be given to people with advanced HIV disease (WHO, 2017). Many studies have shown that clinical undernutrition (indicated by low BMI) or weight loss at the time of ART initiation is strongly predictive of mortality.

Adolescent nutrition, particularly related to HIV status, has received less research than nutrition in other age groups, hindering the development of adolescent-responsive nutritional policies and adolescent-friendly implementation guidelines (Mehta S, 2018; Norris et al., 2022). Research is hampered by a lack of data on the prevalence of undernutrition among adolescents living with HIV in many developing nations, including Ethiopia. It remains unclear whether nutritional interventions at or before ART initiation can improve health and nutritional outcomes (Christian & Smith, 2018; Shiferaw & Gebremedhin, 2020). Further investigation is warranted to explore the impact of nutritional assessment and support to contribute to the formation of evidence-based recommendations, which will help inform current practice and meet the ongoing healthcare needs of HIV-infected adolescents.

1.6 Rationale and research questions

The rationale for this study was as follows.

- Given the high prevalence of HIV in the Addis Ababa and Oromia regions of Ethiopia, in-depth analysis of the nutrition assessment and support given to adolescents living with HIV is essential to provide information crucial to improve nutritional care and support in HIV care settings in these regions and to inform national policies in Ethiopia.

- Research on adolescent nutrition and nutritional programs in HIV care in Ethiopia is scarce. Insufficient information is available to guide adolescent nutritional screening, care and support programs in HIV care settings. The factors that determine the effectiveness of

nutritional programs designed to improve health outcomes in resource-poor settings are not well understood.

  - Evidence about the programmatic health system and sociocultural obstacles for nutritional care and support programs in HIV care for adolescents in Ethiopia is lacking.
  - No previous research sought the perspectives of program stakeholders about the barriers and facilitators of utilisation of adolescent nutritional care and support programs in HIV care settings in Ethiopia.
  - Real-world evidence about the multifaceted challenges of nutritional care and support programs in HIV care settings in Ethiopia, in addition to routine clinical care, is lacking

- This information is needed to guide future policies and programmes to ensure optimal nutritional and health outcomes for adolescents living with HIV.

Consequently, the study's research questions were:

1. What are the nutritional assessment, counselling, and management practices for ALHIV among healthcare workers in Ethiopia?
2. What is the nutritional status of ALHIV on ART living in Ethiopia?
3. What are the perceptions and experiences of ALHIV on ART in Ethiopia in relation to the available nutritional situation and nutritional care?
4. What factors are associated with the nutritional status of ALHIV on ART living in Ethiopia? Are the nutritional care practices delivered to ALHIV reflected in their nutritional status?
5. How do the food consumption, dietary patterns, and eating habits of ALHIV in Ethiopia relate to the WHO/FAO-recommended levels of energy and nutrient intake?

1.7 Significance of the study

This study was significant for several compelling reasons. Firstly, it addressed critical gaps in the existing literature on adolescent nutrition and HIV, particularly in Sub-Saharan Africa. While previous research explored various aspects of HIV and nutritional health, no comprehensive studies focused on ALHIV in Ethiopia or the broader Eastern and Sub-Saharan Africa regions. This study was designed to fill this gap by generating evidence that is directly applicable to clinical settings in Ethiopia and relevant to other countries in the region.

Current literature underscores the importance of rectifying nutritional deficiencies in ALHIV, because these deficiencies can harm treatment outcomes and overall health (Duggal et al., 2012; Ivers et al., 2009). However, there remains a need for localised data that can inform tailored interventions and policy decisions (Borkowski & Borkowska, 2024; Wahyu Wibowo et al., 2021). By focusing on the nutritional status of ALHIV, this study was intended to generate valuable insights that will be useful for clinicians in developing individualised treatment plans and promoting healthier living strategies for this group. The findings can guide government and non-governmental organisations (NGOs) to prioritise integrative nutrition policies and programs. As highlighted in existing literature, integrating nutritional support with routine clinical care is crucial for mitigating undernutrition among adolescents (Hlongwa et al., 2023; Kitahata et al., 2002). The study's recommendations are expected to influence future policy, implementation strategies, and research directions, with a specific focus on adolescent nutrition in Ethiopia and similar contexts. Thus, this study not only fills a significant gap in the literature but provides actionable insights that could lead to improved health outcomes for ALHIV.

In summary, this study filled substantial evidence gaps and is anticipated to be clinically relevant and directly applicable in the study areas, more widely in Ethiopia, and potentially for other countries in sub-Saharan Africa. The findings will inform clinicians about the nutritional status of ALHIV, whether on ART or not, supporting the development of treatment plans and healthier living strategies. Additionally, the study will encourage government and non-governmental organizations to prioritize integrative nutrition policies and programs to combat adolescent undernutrition. The recommendations from this study will offer direction for future policy, implementation strategies, and research, with an emphasis on improving adolescent nutrition and health outcomes in Ethiopia and similar contexts.

1.8 Research objectives and thesis structure

The research conducted during this PhD program included a systematic review and three related research projects. The systematic review explores what is currently known about nutritional status and associated factors among ALHIV receiving ART while living in LMICs. The three related studies (henceforth referred to as sub-studies 1–3) were a survey of healthcare workers working in ART clinics, a mixed-method survey and qualitative study of adolescents living with HIV undergoing ART follow-up, and a small-scale qualitative study of ALHIV aged 16-19 years.

These studies had five objectives – to:

1) determine the methods by which nutritional status is assessed, and counselling and any other nutritional support practices are planned and delivered, for adolescents living with HIV on ART follow-up by healthcare workers in ART units in selected regions of Ethiopia.
2) assess the nutritional status of ALHIV on ART follow-up in selected regions of Ethiopia.
3) explore the nutritional problems, dietary situations, and perceptions and experiences of ALHIV regarding the nutritional support provided in ART clinics and recommend actions for improvement.
4) identify the determinants of the nutritional status of ALHIV on ART follow-up living in selected regions of Ethiopia.
5) determine the level of food consumption, dietary patterns, and eating habits of ALHIV on ART follow-up to compare their energy, protein, and nutrient intake with WHO/FAO standard minimum requirements.

How the PhD candidate met these objectives and answered the research questions (section 1.6) is described in the seven chapters of the thesis, outlined below.

Chapter One provides the introduction to the study, setting out the background in terms of the burden of HIV in adolescents, the burden of undernutrition/malnutrition in ALHIV, nutrition in the context of HIV/AIDS, and nutrition screening, counselling and support policy and practices for adolescents living with HIV worldwide and in LMIC settings, with a focus on Ethiopia.

Chapter Two presents a systematic review of the current evidence about nutritional status and associated factors among ALHIV on ART follow-up in LMICs. The review outlines knowledge

about the provision of nutritional care for ALHIV, identifies key questions, and provides a rationale for the need for further research.

Chapter Three provides an overview of the methods of the three sub-studies, including their research questions and objectives, setting, design, variables, statistical analysis, and ethical considerations. The methods for the three sub-studies are described, each designed to answer a specific research question. Sub-study 1 examined the methods by which nutritional status is assessed, and counselling and any other nutritional support practices planned and delivered for ALHIV on ART follow-up by healthcare workers in ART units in selected regions of Ethiopia. Sub-study 2 assessed the level of nutritional status, food and eating practices, and determinants of the nutritional status of this population. Sub-study three explored the perceptions and experiences of ALHIV regarding their nutritional challenges, dietary intake, and the factors influencing these aspects.

Chapter Four presents the results of sub-study 1 – the methods health professionals use to assess nutritional status, conduct counselling, and manage nutritional-related problems of ALHIV on ART follow-up living in the selected regions of Ethiopia.

Chapters Five and Six present the results of sub-study 2. It identifies the determinants of the nutritional status of ALHIV on ART follow-up in the selected regions of Ethiopia, including how nutritional care practices are reflected in nutritional status, and the levels of food consumption, dietary patterns, and eating habits of ALHIV compared to the WHO/FAO-recommended levels of energy and nutrient intake.

Chapter Seven presents the results of the qualitative study components of sub-study 3, which explored the nutritional challenges of and factors influencing the care and support provided to ALHIV in ART clinics in selected regions of Ethiopia.

Chapter Eight offers a discussion of the research results in relation to the wider literature and their implications for clinical nutrition practice and policy, education for healthcare professionals, ALHIV and their families and carers, and future research.

Chapter Nine presents the conclusions from the study and recommendations for clinical nutrition practice and policy, education for healthcare professionals, ALHIV and their families and carers, and future research.

1.9 My background, motivation, and aims

I am a nutritionist and a registered nurse with many years of academic and clinical work experience in various governmental and non-governmental organisations. Throughout my professional career, I have had the privilege of working with various community service organisations, including Save the Children Ethiopia South Region, WHO Gedio Zone, Oromia Region Health Bureau, South Nation National People Regional Health Office, and other local NGOs. I have been involved in facilitating training sessions on important topics such as SRH, youth-friendly services, adolescent nutrition, and severe acute malnutrition management. I have gained valuable experience through my involvement in several health and nutrition research projects, providing care and support to individuals affected by HIV/AIDS, malnutrition case management, and monitoring and evaluating the performance of health facilities. I also observed how these improved the outcomes of the children when implemented, and conversely, how the children's health deteriorated when support was inadequate. These experiences helped me to identify high-priority areas in Ethiopia and motivated me to continue working to bolster HIV care and support in the community and country.

I have critically analysed public health problems, including the increased vulnerability to malnutrition of HIV-infected adolescents, and queried the role of nutrition in improving the quality of life and survival of ALHIV. In Ethiopia and other Sub-Saharan African countries, clinical nutrition screening and management for adolescents does not receive as much attention as other adolescent reproductive health strategies. However, it is crucial for healthcare services to meet the nutritional needs of adolescent patients to reduce their risk of mortality and improve healthy living with HIV. When healthcare providers are familiar with basic principles of nutritional management for common diseases, mortality is reduced, and quality of life is improved.

My professional work inspired me to assess the nutritional status, dietary intake and practices and determinants of malnutrition among ALHIV on ART follow-up in Ethiopia. My broad aim was to gather and develop knowledge on the prevalence of malnutrition, the factors that contribute to malnutrition, and the relationship between malnutrition and the HIV cycle (how malnutrition worsens the HIV/AIDS disease progression and how HIV contributes to malnutrition). I was also interested in how malnutrition was treated, and in demonstrating that effective screening and management of malnutrition can be established for ALHIV.

My specific aims for this study were to determine the prevalence of malnutrition, identify its determinants, and assess the contribution of nutrition services to the health of ALHIV in Ethiopia. My ultimate purpose was to provide information for policymakers and planners to help them design and implement strategies and guidelines for effective nutritional interventions for ALHIV. The research presented in this thesis contributes to global and national knowledge by filling important gaps in scientific understanding and public health practice with respect to nutrition for ALHIV.

Chapter Two: Literature Review

Nutritional Status and its Determinants among Adolescents with HIV on Anti-Retroviral Treatment in Low- and Middle-Income Countries: A Systematic Review and Meta-Analysis

Chapter One describes the need for an understanding of the nutritional aspects of adolescents with HIV in the Ethiopian context. It provides background to the research and presents the research question and the study's aims.

Chapter Two contains a published review of the literature relevant to nutritional status and related factors for adolescents living with HIV and undergoing ART follow-up in LMICs. The literature review confirmed the relevance of the research questions and established the rationale and justification for the methodology used in the study. The article begins with a detailed description of the search strategies, databases, article screening process, quality appraisal techniques, data extraction, and synthesis approaches used in the review. This is followed by the review's findings and discussion of the epidemiology of HIV in adolescents, the vulnerability of adolescents with HIV to undernutrition, the magnitude of undernutrition in LMICs, and the significance of nutrition in HIV for healthy growth and development. The chapter concludes with recommendations for further research.

The review was published in BMC Nutrition and can be referenced as:

> Gebrie M, Perry L, Xu X, Kassa A, Cruickshank M. Nutritional status and its determinants among adolescents with HIV on anti-retroviral treatment in low- and middle-income countries: a systematic review and meta-analysis. BMC Nutrition. 2023 Mar 28;9(1):60. Doi: 10.1186/s40795-023-00714-z.

The published version of this manuscript is available in Appendix II.

2.1 Abstract

Purpose: This review aimed to determine what methods are used to assess nutritional status, the levels of nutritional status, determinants of undernutrition, and nutritional interventions employed for adolescents with HIV on Anti-Retroviral Therapy follow-up in Low- and Middle-Income countries.

Methods: Established methods were used to systematically identify and retrieve studies published in five databases between January 2000 to May 2021, and citation searching. Quality was appraised and findings were synthesized using narrative analysis and meta-analysis.

Result: Body Mass Index is the major indicator of nutritional status. The pooled prevalence of stunting, wasting, and overweight were 28.0%, 17.0%, and 5.0%, respectively. Adolescent males are 1.85 and 2.55 times more likely than female adolescents to suffer from both stunting and wasting at AOR = 1.85 (95%:1.47, 2.31) and AOR = 2.55 (95%:1.88, 3.48), respectively. Similarly, adolescents with a history of opportunistic infections were 2.97 times more likely to be stunted than uninfected adolescents, AOR = 2.97 (95%:1.73, 5.12). One single intervention study found significant improvements in anthropometric status after nutritional supplementation.

Conclusion and recommendation: The few studies that have been conducted on nutritional status in adolescents living with HIV in low- and middle-income countries indicate that stunting and wasting are common in this population. Avoiding opportunistic infections is an important protective factor but the review highlighted the generally inadequate and fragmented nature of nutritional screening and support programs. Development of comprehensive and integrated systems for nutritional assessment and intervention services during ART follow-up should be prioritized to improve adolescent clinical outcomes and survival.

2.2 Introduction

Adolescence (ages 10 to 19 years (WHO, 2014)) is a critical time period since many of the risk factors for adult diseases develop during this age (Reiner et al., 2019). This age group provides a second window of opportunity for positive life cycle development and aids in mitigating adult problems (UNICEF, 2021c). Adolescents account for 16% of the global population but comprise a quarter of the population in some countries. Numbers are expected to rise through 2050, particularly in low- and middle-income countries (LMICs). More than half of all adolescents live in Asia but in sub-Saharan Africa they make up the greatest proportion of the population, at 23% (United Nation, 2019; WHO, 2014).

Adolescents are disproportionately affected by the human immunodeficiency virus (HIV) (UNICEF, 2021c; WHO, 2014). In 2020, about 1.75 million adolescents worldwide were living with HIV, representing approximately 5% of all people with HIV, 11% of new HIV infections, and 5% of all AIDS-related deaths. In the same year, approximately 940,000 adolescents, 54% of adolescents living with HIV worldwide, received antiretroviral therapy (ART) (UNICEF, 2021c; United Nation, 2019). More than 1.5 million adolescents and young adults aged 10 -24 years die each year, nearly 5000 every day, from largely preventable causes; three-fourths occur in LMICs (WHO, 2022). HIV is a preventable cause of disability, morbidity, and mortality among adolescents and young people, with an increasing proportion reporting depression, stigma, violence, and suicidal behaviour (UNICEF, 2021c; United Nation, 2019; WHO, 2022).

Adolescents living with HIV are vulnerable to undernutrition due to their elevated nutritional needs imposed by a puberty growth spurt and HIV infection. Malnutrition is a major threat to the health of HIV-infected individuals and is associated with increased risks of morbidity and mortality (Naswa & Marfatia, 2010). Despite the introduction by the United Nations of Sustainable Development Goals (SDG), designed to safeguard the most vulnerable (United Nation, 2023), and the decreasing trends seen in many communicable and nutritional disorders, malnutrition remains a major public health concern (Reiner et al., 2019). Moreover, progress has been inequitable with countries with a low and low–middle social development index (SDI) bearing a higher burden of morbidity amongst children and adolescents compared to middle-, high–middle-, and high-SDI countries (Reiner et al., 2019). About 88% (1.5 million) of all HIV-infected adolescents live in sub-

Saharan Africa and although health-related initiatives have been instigated through SDG-aligned legislation, these adolescents still face severe health vulnerabilities (Cluver et al., 2018).

In many LMICs, the targets for adolescents' physical health predominantly focus on the sexual and reproductive health (SRH) behaviors of young people aged over 15. However, nutrition plays a critical role not just for SRH but also in the life cycle, transitioning from adolescence to healthy adults. Malnutrition among children and adolescents is associated with delayed growth, impaired cognitive maturation, lower intellectual quotient, behavioral problems and increased risk of contracting communicable disease (Dick & Ferguson, 2015; Onyango, 2013; WHO, 2014). Further, younger adolescents with HIV have greater nutritional and health demands because they face extra challenges beyond those caused by the general health vulnerabilities affecting adolescents in LMICs, such as cultural/norm-based practices, gender-based violence, and heavy workloads (Ahinkorah et al., 2021). Due to their increased nutritional requirements, those living with HIV are particularly susceptible to undernutrition. Adequate and proper nutrition for well-nourished patients with HIV leads to slower disease progression than experienced by those who are malnourished, but teenagers are rarely given priority in nutrition initiatives and there is little research on the epidemiology of undernutrition and its causes among adolescents living with HIV in LMICs. This review, therefore, aimed to determine how nutritional status is assessed and to evaluate the nutritional status of HIV-positive adolescents and its determinant factors in LMICs.

2.3 Methods and materials

2.3.1 Study design

An integrative review design was used as it was anticipated that evidence would derive from a variety of quantitative and qualitative studies that would support the topic under study. The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guideline was followed to report results (Page et al., 2021) (see Supplementary Table 1) to answer the following questions.

2.3.2 Research questions

1. What methods are used to assess the nutritional status of adolescents who are HIV positive on ART follow-up living in LMICs?

2. What is the nutritional status of adolescents who are HIV positive on ART follow-up living in LMICs?
3. What are the determinant factors associated with the nutritional status of adolescents who are HIV positive and on ART follow-up living in LMICs?
4. What nutritional interventions, if any, have a significant improvement on the nutritional status of adolescents who are HIV positive and on ART follow-up living in LMICs?

2.3.3 Search strategy and sources of information

The review used a structured approach using the "Population, Intervention, Comparator, Outcomes (PICO)" and "Population, Exposure, Outcomes (PEO)" frameworks to develop a robust literature search strategy. A search strategy was developed after a preliminary assessment of the appropriate Medical Subject Heading terms (Title-Abstract-Keywords), keywords and synonyms. As the terms nutrition screening and assessment were often used interchangeably in studies, synonyms of malnutrition and nutritional status were combined with synonyms of screening and assessment (see Supplementary Table 1).

The PICO/PEO framework was applied for research questions 1 & 2 as follows:

- In adolescents who are HIV positive and on ART follow-up living in LMICs (P), what methods of assessment were used (I) to determine the level of nutritional status (O) compared with WHO standards (C)?
- In adolescents who are HIV positive on ART follow-up living in LMICs (P), what levels of nutritional status (O) were reported compared with WHO standards (C)?

To address research question 3:

- In adolescents who are HIV positive and on ART follow-up living in LMICs (P), what determinant factors (I or E) lead to a changed (increased/decreased) risk of malnutrition/ undernutrition (O)?

To address research question 4, effectiveness studies were sought to determine:

- What nutritional interventions (I) affect the nutritional status outcomes (O) of adolescents who are HIV positive on ART follow-up living in LMICs (P) compared to comparison group (C) outcomes?

The search strategy was applied, with individual modifications, to the electronic databases: Medline (Ovid), Pub-Med, ProQuest, EMBASE (Ovid), and Cochrane Library of Databases. Records were

systematically searched for publications from January 2000 to May 2021 for materials that met the inclusion criteria. In addition, citations/reference lists of retrieved relevant articles were searched. Additional articles were advance searched from Web of Science and Google Scholar.

2.4 Inclusion and exclusion criteria

2.4.1 Inclusion criteria

Study setting: Studies conducted in LMICs, classified according to the World Bank criteria (Serajuddin U, 2020; World-Bank, 2021).

Population: The target population was adolescents who were HIV positive and on ART follow-up. For this review, participants were required to be specified as:

- Aged between 10—19 years of age, or
- If age was not specified, participants were referred to as older children OR young adults OR teenagers OR young person's OR young people whose age was 10 – 24 years, or
- If the sample was of mixed age (children/ adolescent/ young adult), the mean or median age or most of the sample (> 50%) must lie between 10–19 years

Type of publication: Primary studies, both published and grey literature in the English language

Study design: To address the first three questions, prospective studies, retrospective studies, cross-sectional studies, descriptive/quantitative and experimental studies, qualitative studies, and mixed-methods studies were sought

To address the fourth question, effectiveness designs, such as experimental studies, randomised controlled trials (RCT), controlled clinical trials, quasi-experimental studies, or other interventional study designs were required.

2.4.2 Exclusion criteria

- Conference abstracts and other studies which did not have the full text available
- Reviews and other forms of report using secondary analysis.

Study screening, selection, and data extraction

The search results were exported to an Endnote library Version 20 after which duplicate items were automatically eliminated. Article titles, abstracts, and keywords were reviewed by two independent

reviewers (MG & AK) for evaluation against the inclusion and exclusion criteria for eligibility. The complete texts of all potentially relevant papers were retrieved, and their citations were uploaded to the Joanna Briggs Institute System for the Unified Management, Assessment, and Review of Information (JBI SUMARI) for full-text screening (JBI, Adelaide, Australia). For articles that did not have full details, authors were contacted to obtain the full-text report at the corresponding author addresses. Papers were retained for full-text evaluation in cases where eligibility was ambiguous. Ineligible studies were excluded, with reasons noted. At each level of the selection process, any discrepancies between the reviewers were settled through conversation or by consulting a third reviewer (MC, LP). The search and screening procedure outcomes were displayed in a PRISMA flow diagram (Figure 1).

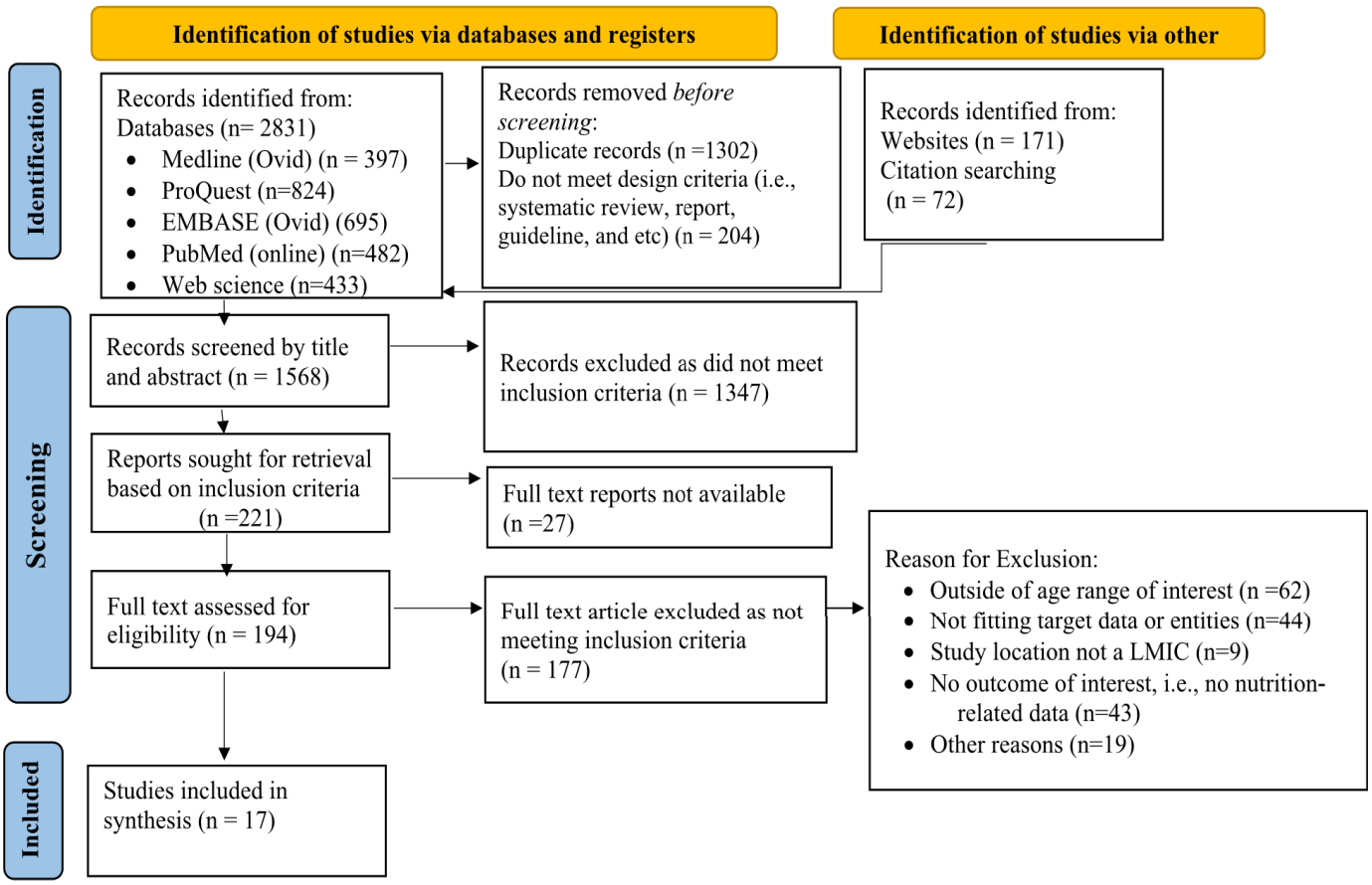

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram of the review (Page et al., 2021) (see Supplementary Tables 2 and 3)

Data were extracted by MG, AK, and AC/MC, and verified by LP and XX. Two reviewers extracted data for the quantitative component from the quantitative and mixed methods (quantitative component only) studies related to study contexts and participants, research techniques, interventions, and outcomes relevant to review questions. Data were taken verbatim where possible and any discrepancies between the reviewers were settled through conversation or consulting a third reviewer. When necessary, data were requested from the study authors.

Quality appraisal

The selected studies were critically evaluated by two independent reviewers for methodological quality using the JBI appraisal instruments (Lockwood et al., 2015; Tufanaru C, 2020). Reviewers used the appropriate JBI quality assessment tool for each individual study design. Any disagreements between reviewers were resolved through discussions or with a third reviewer (see Supplementary Table 4).

Data synthesis and analysis

Extracted data were exported from Microsoft Excel to STATA Version 17.0 (software) for analysis. The characteristics of the included studies and descriptive results were presented using tables and graphs. A random effects meta-analysis model was used, and the pooled effect size was employed. Forest plots were used to show the pooled estimates with 95% confidence intervals (CIs). The strategy for meta-analysis was based on the guidance of the Campbell systematic review model (Maier et al., 2022). Publication bias and heterogeneity of the studies was assessed. Publication bias was assessed by examining a funnel plot of the data and performing Egger's test (Egger et al., 1997) to determine whether the effect size correlated with their standard errors. A sign of publication bias was considered in this study when studies with larger standard errors lead to larger effect sizes. Sub-group analysis was conducted to examine data heterogeneity and Cochran's Q-test and I2 statistics were calculated to estimate the level of heterogeneity.

2.5 Results

After duplicates were removed, a total of 1568 articles remained for Title-Abstract screening. Of these, 1347 articles were excluded as they did not meet inclusion criteria, and 221 articles remained for full-text screening. Of these 221 articles, 27 were excluded because the full report was not

available and 177 were excluded for not meeting the inclusion criteria. In total, 17 articles were retained for data extraction and synthesis (Figure 1).

2.5.1 Characteristics of included studies

The 17 primary articles recruited a total of 2873 study participants in LMICs. The majority of articles (n = 11, 64.7%) were cross-sectional studies (Bissigo Pereira et al., 2016; Castro et al., 2018; Darshit D, 2020; Dos Reis et al., 2015; Francis et al., 2015; Jesson et al., 2015; Schtscherbyna et al., 2012; Shiferaw & Gebremedhin, 2020; Junko Yasuoka et al., 2020), whilst the remainder (n = 6, 35.3%) comprised: observational studies (n = 3) (Alves Junior et al., 2019; Hillesheim et al., 2014; Muddana Narasimha & Ashish, 2020); case–control study (n = 1) (Chelo et al., 2020)); mixed-method study (n = 1) (Murray et al., 2020), and one clinical trial (Niasse et al., 2020) (Table 1).

Studies were conducted in seven LMIC countries in South American, Asian and African continents. The majority (n = 7, 41.2%) took place in upper-middle-income countries (Alves Junior et al., 2019; Bissigo Pereira et al., 2016; Castro et al., 2018; Dos Reis et al., 2015; Hillesheim et al., 2014; Ramalho et al., 2011; Schtscherbyna et al., 2012), followed by low-middle-income countries (n = 5, 29.4%) (Muddana Narasimha & Ashish, 2020; Murray et al., 2020; Niasse et al., 2020; Junko Yasuoka et al., 2020) and low- income countries (29.4%) (Darshit D, 2020; Francis et al., 2015; Jesson et al., 2015; Sewale et al., 2018; Shiferaw & Gebremedhin, 2020) (Table 1).

Table 1. Summary of study characteristics (n=17)

Variable with Category	Number of studies	Percentage (%)
Study setting by region		
African countries [Cambodia (n= 1), Cameroon (n = 1), central and west Africa (n = 1), Ethiopia (n = 2), Senegal (n = 1), Uganda (n = 2)]	8	47.1
Asian countries [India (n = 1) and Myanmar (n = 1)]	2	11.8
South America [Brazil (n = 7)]	7	41.2
Country Income		
Low-Income country	5	29.4
Low-Middle Income Country	5	29.4
Upper-Middle Income Country	7	41.2
Study Design		
Case-Control Studies	1	5.9
Clinical trial-based interventional study	1	5.9
Cross-sectional study	11	64.7
Mixed Method Study	1	5.9
Observational Study	3	17.6
Sample size		
< 100 participants	7	41.2
≥ 100—200 participants	5	29.4
> 200 Participants	5	29.4

2.5.2 Outcome 1, review question 1: nutritional assessments

The review findings describe the methods of nutritional assessment. The majority of studies (n = 13, 76.5%) used BMI as an indicator of nutritional status, followed by height for age (n = 7, 41.2%). Six (35.3%) studies assessed dietary intakes and estimated energy and nutrient intakes, and three studies (17.6%) assessed body fat composition using standardized fat measurement (Table 2).

Table 2. Methods of nutritional assessment used in included studies (n = 17)

Indices	Types of Nutritional Assessment	Studies (n)	Percentage (%)
Anthropometric indices	Height-for-age (HAZ)	7	41.2
	Body mass index (BMI) Z-score	13	76.5
	Weight-for-height Z-score	1	5.9
	Weight-for-Age Z-score	1	5.9
Body Composition/ Body Fat Assessment	Skin-folds thickness (abdominal, triceps, sub-scapular, calf)	3	17.6
	Waist-to-height ratio (WHR)	1	5.9
	Waist and hip circumferences (WHC)	3	17.6
	Perimeter relaxed arm (PRA)	1	5.9
	Perimeter neck / Neck circumference-for-age	2	11.8
	Air displacement plethysmography (ADP)	1	5.9
	Body adiposity index (BAI)	1	5.9
	Dual-energy X-Ray absorptiometry (DXA)	1	5.9
	Conicity index	1	5.9
	Lipodystrophy physical diagnosis for abnormal fat distribution	1	5.9
	Bone Mineral Density (BMD)/ Bone mineral content (BMC)	2	11.8
	Body fat percentage	3	17.6
	Lean mass	1	5.9
	Upper-arm fat area	1	5.9
	Upper-arm muscle area	1	5.9
Dietary assessment	Food frequency questionnaires (FFQ) for dietary assessment to estimate total energy intake (TEI) and nutrient intake	1	5.9
	24-h recall Dietary Intake Assessment to estimate Energy and nutrient intake	4	23.5
	Individual Dietary Diversity status	1	5.9

2.5.3 Outcome 2, review question 2: nutritional status of study participants

The majority of studies reported nutritional status in terms of stunting (n = 10, 58.8%) and wasting (n = 9, 52.9%); while only six studies (n = 6, 35.3%) reported overweight status. In most studies, BMI-for-age Z-score and Height-for-Age Z-score (HAZ) below -2 Z score were used to determine nutritional status (under-weight, wasting, stunting and overweight), although a few articles used Weight-for-Age Z-score (WAZ) and Weight-for-Height Z-scores (WHZ) below − 2 Z- scores (WHO standard).

Prevalence of stunting

Studies that reported stunting demonstrated that it occurred in between one-fifth and one-third of the participants (n = 7 of 9, ranging 20.9 – 36.6%). The highest prevalence of stunting, at 46.6%, was reported from Cambodia (Junko Yasuoka et al., 2020) and the lowest, at 6.1%, from Brazil (Hillesheim et al., 2014) (Table 3).

Table 3. The prevalence of stunting among adolescents living with HIV and on ART follow-up in LMICs (n = 9)

Author Name	Year	Country	Sample size	Stunting n (%)
Darshit D., et al., (Darshit D, 2020)	2020	Uganda	132	31(23.7)
David Chelo, et al., (Chelo et al., 2020)	2020	Cameroon	75	15(36.6)
Dos Reis, et al., (Dos Reis et al., 2015)	2015	Brazil	115	24(20.9)
Hillesheim, et al., (Hillesheim et al., 2014)	2014	Brazil	49	3(6.1)
Jesson, et al., (Jesson et al., 2015)	2015	Central and West African	684	163(23.8)
Lwanga F, et al., (Francis et al., 2015)	2015	Uganda	200	72(36.2)
Ramalho, et al., (Ramalho et al., 2011)	2011	Brazil	94	24(25.5)
Shiferaw & Gebremedhin (Shiferaw & Gebremedhin, 2020)	2020	Ethiopia	260	86(33.1)
Yasuoka, et al., (Junko Yasuoka et al., 2020)	2020	Cambodia	298	139(46.6)

Prevalence of wasting

More than half the studies reported wasting between one-tenth and one-fourth of the samples (n = 5 of 9, ranging from 10 – 22.3%). The highest prevalence of wasting was reported from Ethiopia (60.2%) (Sewale et al., 2018), and the lowest from Brazil (2.2%) (Hillesheim et al., 2014) (Table 4).

Table 4. The prevalence of wasting among adolescents living with HIV and on ART follow-up in LMICs

Author Name	Year	Country	Sample size	Wasting n (%)
Darshit, et al., (Darshit D, 2020)	2020	Uganda	132	10(7.6)
Dos Reis, et al., (Dos Reis et al., 2015)	2015	Brazil	115	4(3.5)
Hillesheim, et al., (Hillesheim et al., 2014)	2014	Brazil	49	1(2.0)
Jesson, et al., (Jesson et al., 2015)	2015	Central and West African	684	69(10.0)
Lwanga F., et al., (Francis et al., 2015)	2015	Uganda	200	36(18.0)
Ramalho, et al., (Ramalho et al., 2011)	2011	Brazil	94	21(22.3)
Sewale, et al., (Sewale et al., 2018)	2018	Ethiopia	372	224(60.2)
Shiferaw & Gebremedhin (Shiferaw & Gebremedhin, 2020)	2020	Ethiopia	260	52(20.0)
Yasuoka, et al., (Junko Yasuoka et al., 2020)	2020	Cambodia	298	39(13.1)

Prevalence of overweight

Most studies demonstrated that being overweight was the least common finding of nutritional assessment (n = 4 of 6, ranging from 6.1%—15.6%). The highest (15.6%) and lowest (1.9%) prevalence of overweight were reported from studies conducted in Brazil (Dos Reis et al., 2015) and Ethiopia (Shiferaw & Gebremedhin, 2020), respectively (Table 5).

Table 5. The prevalence of overweight among adolescents living with HIV and on ART follow-up in LMICs (n = 6)

Author Name	Year	Country	Sample size	Overweight n (%)
Darshit D, et al, (Darshit D, 2020)	2020	Uganda	132	4(3.8)
David Chelo, et al., (Chelo et al., 2020)	2020	Cameroon	75	3(7.3)
Dos Reis, et al., (Dos Reis et al., 2015)	2015	Brazil	115	18(15.6)
Hillesheim, et al., (Hillesheim et al., 2014)	2014	Brazil	49	3(6.1)
Ramalho, et al., (Ramalho et al., 2011)	2011	Brazil	94	6(6.4)
Shiferaw and Gebremedhin (Shiferaw & Gebremedhin, 2020)	2020	Ethiopia	260	5(1.9)

2.5.4 Outcome 3, review question 3: factors associated with undernutrition among adolescents living with HIV

Variables reported as significantly associated with stunting and wasting in at least two primary studies were included in this meta-analysis. Accordingly, being male and having opportunistic infection were found to be significantly associated with stunting (Francis et al., 2015; Jesson et al., 2015; Sewale et al., 2018; Shiferaw & Gebremedhin, 2020). Only being male was a significant factor for wasting /thinness (Jesson et al., 2015; J. Yasuoka et al., 2020) (Table 2.6).

A total of 1261 participants were included to analyse the association between sex and stunting. The pooled odds ratio showed that male adolescents were 1.847 times at greater odds of stunting than their female counterparts (AOR = 1.847 (95%CI: 1.474, 2.313), I^2 = 72.6%, P = 0.026) (Francis et al., 2015; Jesson et al., 2015; Sewale et al., 2018). Six hundred and thirty-two participants were included in the analysis of the association between a history of opportunistic infection and stunting. This analysis demonstrated that adolescents who had an opportunistic infection were 2.97 times more likely to develop stunting than non-infected counterparts (AOR = 2.97 (95%CI: 1.73, 5.12), I^2 = 31.9%, P = 0.225) (Sewale et al., 2018; Shiferaw & Gebremedhin, 2020) (Table 6).

A total of 1354 participants were included in the analysis of the association between sex and wasting among adolescents living with HIV in LMIC. The pooled odds ratio showed that male adolescents were 2.55 times more likely to become wasted / thin compared to their female counterparts (AOR = 2.55 (95%CI: 1.88, 3.48) I^2 = 34.9%, P = 0.215) (Jesson et al., 2015; Sewale et al., 2018; Junko Yasuoka et al., 2020) (Table 6).

Table 6. Factors associated with undernutrition among adolescents living with HIV in LMICs

Types of Undernutrition	Variable	Number of studies	Studies included in the analysis	Pooled Odds Ratio with 95%CI	Heterogeneity	
					(I^2)	P-Value
Stunting	Sex (male Sex)	3	(Jesson et al., 2015) (Francis et al., 2015) (Sewale et al., 2018)	1.847(1.474, 2.313)	72.60%	P = 0.026
	Opportunistic infection	2	(Sewale et al., 2018) (Shiferaw & Gebremedhin, 2020)	2.97(1.73, 5.12)	31.90%	p = 0.225
Wasting/ thinness	Sex (Male Sex)	3	(Jesson et al., 2015) (Sewale et al., 2018) (Junko Yasuoka et al., 2020)	2.55(1.88, 3.48)	34.90%	p = 0.215
	Opportunistic infection	2	(Sewale et al., 2018) (Shiferaw & Gebremedhin, 2020)	3.70(2.12, 6.45)	0.00%	p = 0.569

2.5.5 Outcome 4, review question 4: nutritional interventions, outcomes and the magnitude of effect

Only one interventional study was found. This study examined the trial of nutritional supplementation of 360 kcal energy and 32.2gm protein in food made from Peanut Chikki and another source. The study reported that after one year of daily supplementation, participants showed a significant improvement in their Height-for-Age, Weight-for-Age and BMI-for-Age indices (Muddana Narasimha & Ashish, 2020).

2.6 Meta-analysis

A random effect meta-analysis model was used to estimate the pooled prevalence of under-nutrition among adolescents living with HIV in LMIC. To estimate the prevalence of stunting, nine studies were included in the analysis and the overall pooled prevalence of stunting was 28.0% (95% CI; 20.0–36.00, $I^2 = 92.89\%$, $p < 0.01$), (Figure 2).

Similarly, nine studies were included in the analysis to estimate the pooled prevalence of wasting /thinness, which was demonstrated as 17.0% (95% CI; 0.06– 0.29, $I^2 = 98.65\%$ $p < 0.01$), (Figure 3
).

Regarding overweight, a fixed effect model was used to estimate the pooled prevalence of overweight. Six studies were included in this analysis and the overall pooled.

Sub-group meta-analysis and heterogeneity summary

prevalence of overweight amongst the adolescents was Subgroup analysis was performed using country and 5.0% (95% CI; -0.13 – 0.22, $I^2 = 0.00$, $p = 0.6$), (Figure 4). Study design to identify the source of heterogeneity.

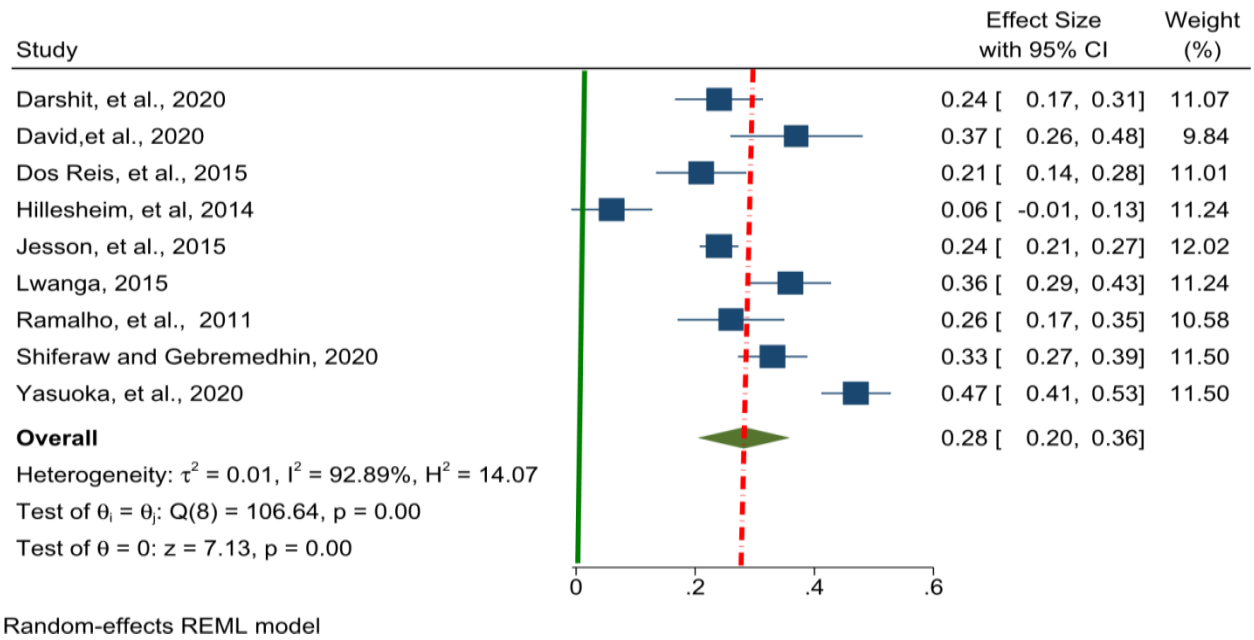

Figure 2. Forest plot for the pooled prevalence of stunting among adolescents living with HIV in LMICs (n = 9)

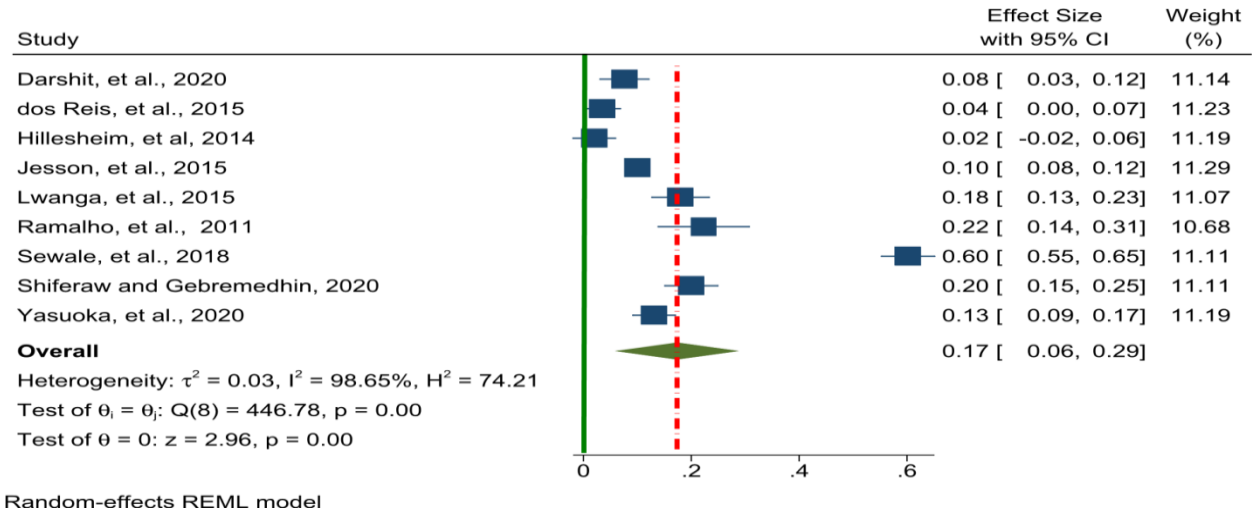

Figure 3. Forest plot for the pooled prevalence of wasting among adolescents living with HIV in LMICs (n = 9)

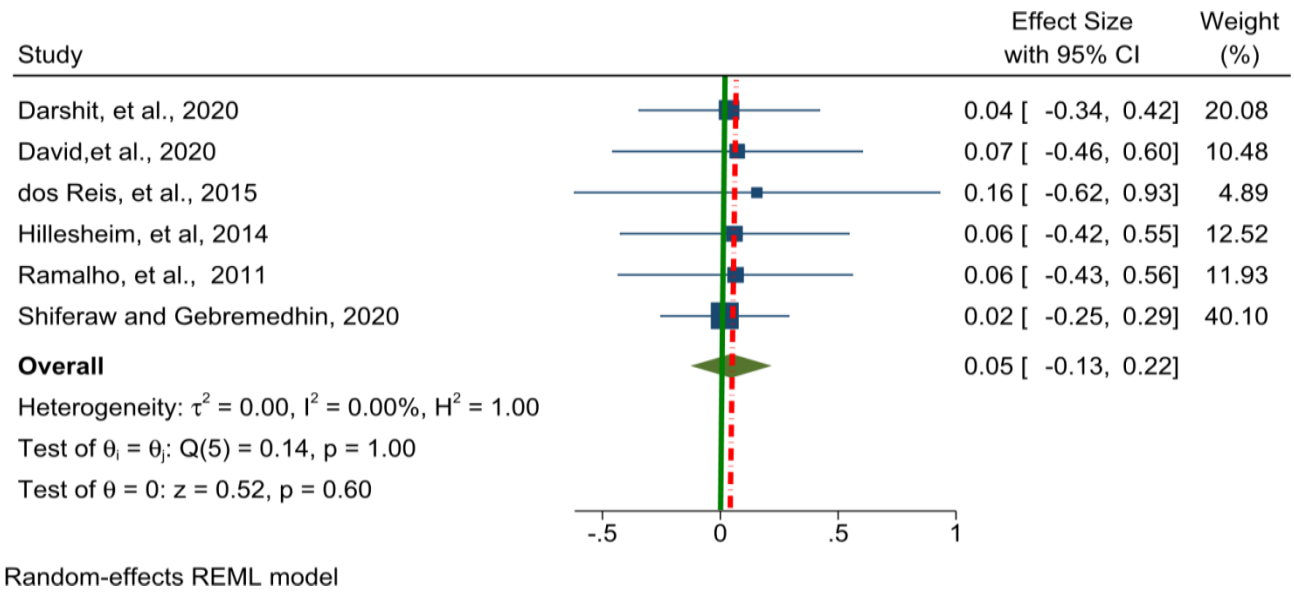

Figure 4. Forest plot for the pooled prevalence of overweight among adolescents living with HIV in LMICs (n = 6)

Sub-group meta-analysis and heterogeneity summary for stunting

Subgroup analyses were conducted for Brazil (Dos Reis et al., 2015; Hillesheim et al., 2014; Ramalho et al., 2011) and Uganda (Darshit D, 2020; Francis et al., 2015). From these studies, the highest pooled prevalence estimate of stunting was in Uganda, at 30.1% (95% CI: 18.3–41.8, I^2 = 82.47%, P < 0.001) and the lowest was in Brazil, at 17.40% (95% CI: 5.50–29.30, I^2 = 86.35, P = 0.004).

Sub-group analysis was also conducted by study design for cross-sectional studies, and the pooled prevalence estimates of stunting by this design was 30.03% (95% CI: 23.4–37.10, I^2 = 89.58, P < 0.001) (Darshit D, 2020; Dos Reis et al., 2015; Francis et al., 2015; Jesson et al., 2015; Ramalho et al., 2011; Shiferaw & Gebremedhin, 2020; Junko Yasuoka et al., 2020) (Table 2.7).

When sub-group analysis was conducted by the study population, the pooled prevalence estimate of stunting for only the adolescent age study population was 32.0% (95%CI:25.0, 38.0; I^2 = 78.47, p < 0.001) (Chelo et al., 2020; Francis et al., 2015; Jesson et al., 2015; Shiferaw & Gebremedhin, 2020), whereas the pooled prevalence estimate of stunting for mixed-age study population was 25.0% (95% CI:12.0, 38.0; I^2 = 88.87, P < 0.001) (Darshit D, 2020; Dos Reis et al., 2015; Hillesheim et al., 2014; Ramalho et al., 2011). Regarding the test of difference within each subgroup analysis, there is significant heterogeneity within each sub-group based on the statistical significance of I^2 statistics, Cochran's 'Q' result and p-values, as indicated in Table 7 below.

Table 7. Sub-group meta-analysis for the percentage of prevalence effect size of stunting among adolescents living with HIV in LMICs

Sub-group by category type	Studies (n)	Pooled prevalence % ES (95%CI) with Test of Differences					
		% ES (95% CI)	P-Value	Q	I2	Tau^2	H^2
Sub-group by country							
Brazil	3	17.4 (5.5, 29.3)	0.004	15.32	86.35	0.009	7.33
Cambodia [a]	1	47.0 (41.0, 53.0)	< 0.001				
Cameroon [a]	1	37.0 (26.0, 48.0)	< 0.001				
Central and West-African[a]	1	24.0 (21.0, 27.0)	< 0.001				
Ethiopia [a]	1	33.0 (27.0, 39.0)	< 0.001				
Uganda	2	30.1 (18.3, 41.8)	< 0.001	5.7	82.47	0.006	7.30
Sub-Group by study design							
Case-control study [a]	1	37.0 (26.0, 48.0)	< 0.001			0.000	
Cross-sectional study	7	30.3 (23.4, 37.1)	< 0.001	61.09	89.58	0.008	9.60
Observational study [a]	1	6.0 (-7.0, 12.7)	0.078			0.000	
Study Population							
Only the Adolescent age population	4	32 (25.0, 38.0)	< 0.001	17.34	78.47	0.00	4.64
Mixed age population	5	25 (12.0, 38.0)	< 0.001	88.87	94.22	0.02	17.3

CI - Confidence Intervals, ES -Effect Size; [a] Countries and study designs having single study

Sub-group meta-analysis and heterogeneity summary for wasting

Subgroup analyses were conducted for Brazil (Dos Reis et al., 2015; Hillesheim et al., 2014; Ramalho et al., 2011), Ethiopia (Sewale et al., 2018; Shiferaw & Gebremedhin, 2020) and Uganda (Darshit D, 2020; Francis et al., 2015). Only the pooled estimate for Uganda provided evidence of significant heterogeneity, at 12.7% ((95% CI: 2.5–22.9), $I^2 = 88.37\%$, $P < 0.001$).

Sub-group analysis was also conducted by study design for cross-sectional studies, and the pooled prevalence estimates of wasting by this design were 19.3% ((95% CI: 7.0–31.60), $I^2 = 98.66$, $P < 0.01$) (Darshit D, 2020; Dos Reis et al., 2015; Francis et al., 2015; Jesson et al., 2015; Ramalho et al., 2011; Sewale et al., 2018; Shiferaw & Gebremedhin, 2020; Junko Yasuoka et al., 2020) (Table 8).

When sub-group analysis was conducted by the study population, the pooled prevalence estimate of wasting for only-adolescent age study population was 15.6% (95%CI:9.3, 22.0, $I^2 = 86.34$, $p < 0.0001$) (Francis et al., 2015; Jesson et al., 2015; Shiferaw & Gebremedhin, 2020), whereas the pooled prevalence estimate of wasting for mixed-age study population was 18.1% (95%CI:1.0, 35.6, $I^2 = 98.96$, $P < 0.0001$) (Darshit D, 2020; Dos Reis et al., 2015; Hillesheim et al., 2014; Ramalho et al., 2011; Sewale et al., 2018; Junko Yasuoka et al., 2020).

Tests of differences within each subgroup analysis demonstrated evidence of significant heterogeneity observed within each sub-group based on the statistical significance of I^2 statistics, Cochran's 'Q' results and the p-values indicated in Table 8 below, but no significant difference was observed on pooled estimates for Brazil and Ethiopia.

Table 8. Subgroup meta-analysis for the percentage of prevalence effect size of wasting among adolescents living with HIV in LMICs

Sub-group by category type	Studies (n)	Pooled prevalence % ES (95%CI) with Test of Differences within each subgroup					
		%ES (95% CI)	P-Value	Q	I2	Tau^2	H2
Sub-group by country							
Brazil	3	8.7 (-3.5, 21.0)	0.162	19.04	95.22	0.011	20.91
Cambodia [a]	1	13.1 (9.2, 17.0)	< 0.001				
Central and West-African[a]	1	10.0 (7.8, 12.2)	< 0.001				
Ethiopia [a]	2	40.1 (0.7, 79.5)	0.045	129.28	99.23	0.08	129.28
Uganda	2	12.7 (2.5, 22.9)	0.015	8.6	88.37	0.005	8.6
Sub-Group by study design							
Cross-sectional study	8	19.3(7.0, 31.6)	0.002	412.0	98.66	0.031	74.41
Observational study [a]	1	2.0 (-1.9, 5.9)	0.317			0.000	
Study population							
Only adolescent age population	3	15.6(9.3, 22.0)	0.000	18.3	86.34	0.003	7.32
Mixed Age Population	6	18.1(1.0, 35.6)	0.000	427.29	98.96	0.047	96.14

CI - Confidence Interval, ES- Effect Size, [a] Countries and study designs having single study

Quality of included studies

The average JBI quality score of studies was 6.76 (95% confidence interval 6.2- 7.5); the minimum was 5 and the maximum was 10 (the maximum possible quality score). A score of 7 and above was described as indicative of good quality, with 10 (58.8%) of the articles scoring at this level (see Supplementary Table 2.4).

Publication bias was checked using Egger's test; the results showed no significant publication bias, as evidenced by p = 0.865, 0.055, and 0.735 for stunting, wasting, and overweight, respectively. The symmetrical distribution of the funnel plots indicated that publication bias was not a significant problem in this meta-analysis (Figures. 5, 6, and 7).

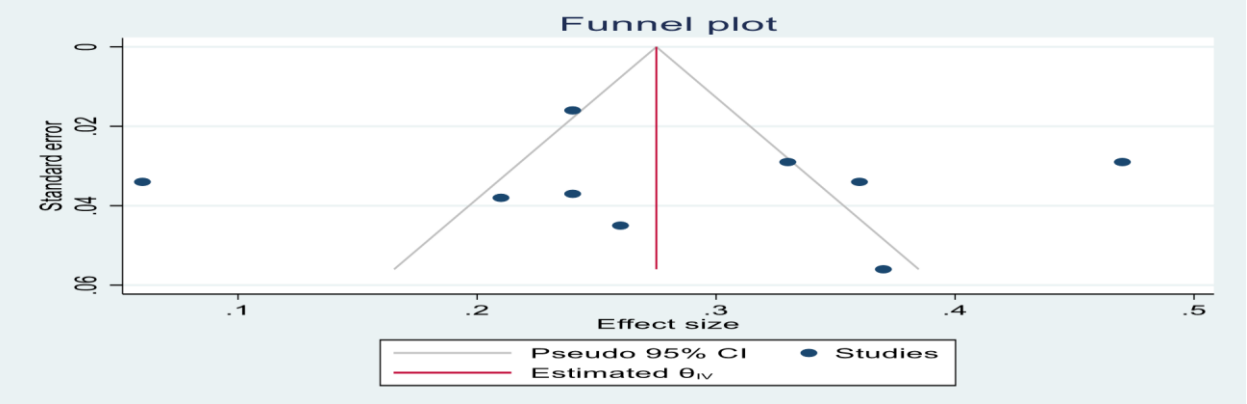

Figure 5. Funnel plot showing the symmetric distribution of articles analyzed for pooled prevalence of stunting among adolescents living with HIV in LMICs

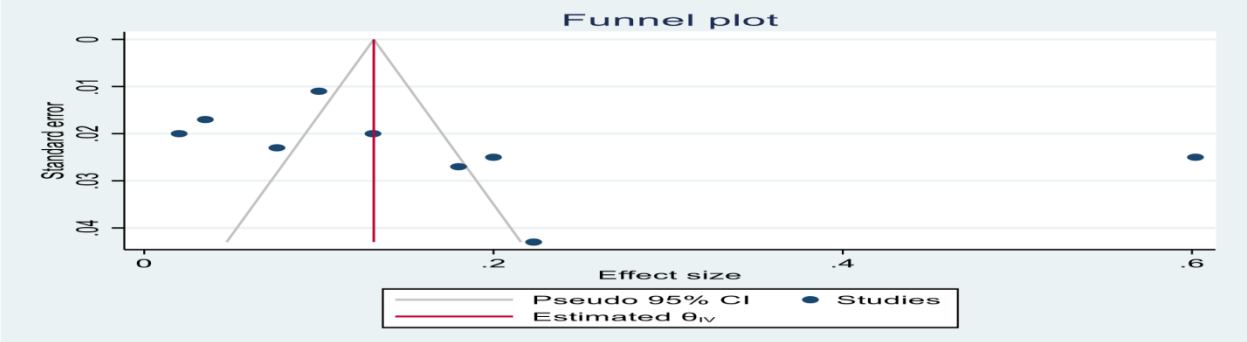

Figure 6. Funnel plot showing the symmetric distribution of articles analysed for pooled prevalence of wasting among adolescents living with HIV in LMICs

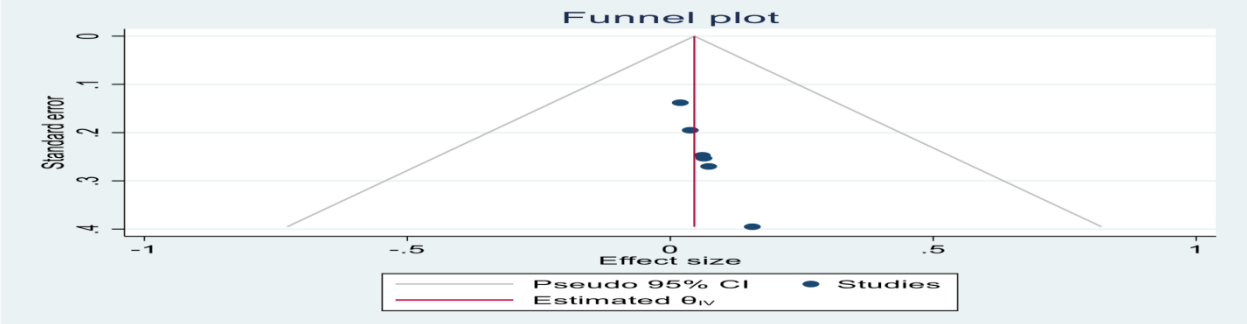

Figure 7. Funnel plot showing the symmetric distribution of articles analysed for pooled prevalence of overweight among adolescents living with HIV in LMICs

2.7 Discussion

The findings from the reviewed studies found that evidence of undernutrition among adolescents living with HIV in LMICs is scarce. The few studies that have been conducted on nutritional status in adolescents living with HIV in low- and middle-income countries indicate that stunting and wasting are common in this population. Avoiding opportunistic infections is an important protective factor but the review highlighted the generally inadequate and fragmented nature of nutritional screening and support programs. Development of comprehensive and integrated systems for nutritional assessment and intervention services during ART follow-up should be prioritized to improve adolescent clinical outcomes and survival.

This is an important omission because most such adolescents are at risk of undernutrition secondary to an elevated nutritional need imposed by their age-related growth spurt and HIV infection. Further, undernutrition may predict disease progression in HIV-infected individuals and result in a higher risk of morbidity and mortality in both HIV-infected adolescents and adults. Consequently, efforts to treat HIV infection are less likely to achieve good outcomes for the individual (and their community) if underlying malnutrition is not also addressed (Duggal et al., 2012). While no study has examined the cost-effectiveness of HIV treatment in detail, it is likely that this effectiveness could be severely impacted if underlying vulnerability factors, such as malnutrition, are not addressed.

This review revealed the narrow variety of nutritional assessment techniques in use for the population under study. The most commonly used anthropometric assessments were BMI-for-Age (76.5%) and height-for-Age (41.2%). These anthropometric tools are inexpensive, portable, simple to use, and require minimal training; however, are less sensitive and specific indicators of nutritional status. body fat composition measurements were used in a few studies (17.6%) using various standardized tools, such as skin-fold thickness, circumference measurement (Waist/hip circumference), Bioelectrical Impendence Analysis (BIA), Dual-energy X-ray Absorptiometry and Air Displacement Plethysmography (ADP) (Castro et al., 2018; Dos Reis et al., 2015; Schtscherbyna et al., 2012). These measurement tools have a better ability to determine nutritional status and to differentiate fat from fat-free mass, but are used less often in LMICs, based on the review findings. One possible reason might be the scarcity of such resources and personnel trained to use them.

Dietary intake was evaluated by some studies (35.3%), using a one-time 24-hour dietary review (n = 4), FFQ (n = 1) and individual assessment of dietary diversity (n = 1) to identify energy and nutrient intake. There are significant challenges in obtaining accurate diet histories as the tools are arduous to complete and of little value unless there is a high degree of completeness and accuracy. The use of such limited methods in the determination of nutritional status results in limited information and difficulty in differentiating whether apparent undernutrition was a result of disease effects, inadequate food intake or other predisposing factors.

The findings from this review revealed a high pooled prevalence of stunting and wasting and a low prevalence of overweight in this population. Among the seventeen studies included in this meta-analysis, nine reported the prevalence of stunting ranging from 6.1% to 46.6%. This significant discrepancy in the studies may be caused by a varied but generally limited emphasis on nutrition treatment and support for undernourished children and adolescents, lack of standardised and integrated service provision for HIV-positive individuals and poor screening in clinical and nutrition-related conditions during ART follow-up at health facilities (Naswa & Marfatia, 2010) . Further, the variety of research methods used in these studies may have contributed to variability in findings. The overall pooled prevalence of stunting in this systematic review meta-analysis was 28.0% among adolescents living with HIV in LMIC. This finding was lower than that seen in the large-scale study conducted among HIV-infected adolescents (41%) in sub-Saharan Africa, the Asia–Pacific, Caribbean, Central and South America regions of the world (Jesson et al., 2019). Discrepancies may result from differences in samples and sample sizes, study design and settings, and socio-cultural differences (e.g. socio-economic status, dietary habits and health services) between studies.

The prevalence of wasting, ranged from 2% to 60.2%. In many LMICs, including Ethiopia, with the highest reported prevalence of wasting, integrated HIV care and support services are recent developments for adolescents living with HIV during ART follow-up. Weak policy implementation, resulting in inadequate provision of nutrition screening, counselling and supplementation, may all contribute to the high rates of wasting seen amongst this population in many LMICs. Discrepancies between studies and countries might be related to differences in sociocultural and/or socioeconomic characteristics, health care providers' knowledge, attitudes and skills, health facilities and health systems, and study methods and settings. However, the

pooled prevalence of wasting, 12.0% in this meta-analysis, is similar to that in another study from less developed regions of the world (14.5%) (Jesson et al., 2019).

Six of these seventeen studies revealed the prevalence of overweight, with a pooled prevalence of 5.0% and the highest and lowest frequencies reversing the findings for wasting. A study in Brazil found the highest frequency of overweight young people (15.6%), with Ethiopia providing the lowest prevalence (1.9%) (Shiferaw & Gebremedhin, 2020). This variation may be caused by genetic differences, disparities in socioeconomic status, and cultural norms that affect how people perceive their bodies and what they eat. Even though study findings varied, the meta-analysis did not find any statistically significant differences among descriptive studies.

Being male predisposed participants to both stunting and wasting, occurring at 1.85 and 2.55 times higher than for their female adolescent counterparts, respectively. This might be a consequence of the generally greater growth spurt and energy requirements of males compared to female adolescents (Alves Junior et al., 2019; Dangour, 2006; Kennedy-Hagan, 2006). It may also reflect a socio-cultural bias where males are expected to undertake high physical activities to support family subsistence (Murray et al., 2020).

Similarly, the odds of stunting among adolescents with a history of opportunistic infection was 2.97 times higher than their noninfected counterparts. This finding is consistent with the vicious circle concept of malnutrition and HIV infection, i.e. infection predisposes to malnutrition, and malnutrition predisposes to infection (Duggal et al., 2012). Reasons for this may be that as the disease advances, appetite reduces and disease-related malabsorption problems increase, leading to further vulnerability to opportunistic infection which worsens under-nutrition. Worryingly, only a single trial examined supplementation, showing that one year of intervention improved nutritional indices in adolescents with HIV.

Adolescent nutrition has been largely overlooked in intervention and policy research. Most intervention studies have focused on micronutrient supplementation, and few have considered multiple factors in adolescent nutrition (Norris et al., 2022). It may indicate that implementation is not progressing as expected. However, there is evidence that nutrition interventions result in beneficial effects (Muddana Narasimha & Ashish, 2020; Niasse et al., 2020). Effective interventions and strategies, therefore, are needed to address multiple challenges in communities and sectors, supported by a multifaceted and multi-level policy.

Sustainable nutrition care and support for adolescents with HIV are used to provide adequate nutrient intake to promote normal growth and development during puberty, maintain adequate nutritional status to promote health and prevent disease after physiological growth is complete, promote optimal nutrition and prevention of malnutrition, manage or reduce symptoms of HIV disease, enhance drug compliance and efficacy through diet counselling, prevent food-borne illness, and manage complications associated with HIV and antiretroviral therapy (ART) (FANTA, 2013, 2014, 2015, 2018a). Integration of nutrition care and support with the national HIV care and treatment implementation guideline is crucial for effective prevention, building the ART pipeline, ensuring the continuum of care and quality service, and healthy living with HIV.

Strengths and limitations of the review

The strengths of this review include an extensive search strategy, with data analysed using a rigorous methodology. Explicit inclusion and exclusion criteria related to population and comprehensive outcomes were assessed. Four authors were involved in the quality assessment. As the included studies showed considerable heterogeneity, we performed advanced statistical analysis using as meta-regression to identify possible sources of heterogeneity.

Despite the above strengths, this review has some limitations that should be considered before interpreting the results. Since most of the primary studies included in this systematic review and meta-analysis are cross-sectional, no analyses could be undertaken to pool intervention effects as only one single eligible intervention study was found. In addition, the limited number of published studies from low-middle-income countries that were retrieved and used for the pooled effect size may have yielded an underrepresentation of data from other low-middle-income countries. Other limitations of this study included significant heterogeneity between the primary studies, with review methods limited to those published in the English language. This may have resulted in the exclusion of some essential studies.

2.8 Conclusion and recommendations

This review highlights the scarcity of evidence on undernutrition among adolescents living with HIV in low- and middle-income countries (LMICs). This gap is critical as adolescents are particularly vulnerable to undernutrition due to their growth spurts and HIV infection, which together increase their nutritional needs. Undernutrition in these individuals may accelerate disease progression and heighten the risk of morbidity and mortality, impacting the effectiveness of HIV

treatment (Duggal et al., 2012). Moreover, the cost-effectiveness of HIV treatment could be compromised if underlying malnutrition is not addressed.

The review also notes the limited variety of nutritional assessment techniques used for adolescents on antiretroviral therapy (ART). Most studies relied on anthropometric assessments, primarily BMI-for-Age (76.5%) and height-for-Age (41.2%), which, although easy to use and cost-effective, are less sensitive indicators of nutritional status. More accurate body fat composition measurements were used in only a few studies (17.6%) due to resource and training constraints in LMICs (Castro et al., 2018; Dos Reis et al., 2015; Schtscherbyna et al., 2012).

The prevalence of stunting and wasting was notably high, while overweight was less common among this population. Variations in these findings across studies may be due to differences in nutrition support, health services, and research methodologies (Jesson et al., 2019; Naswa & Marfatia, 2010). Factors such as male sex and history of opportunistic infections were significantly associated with higher risks of stunting and wasting, aligning with the concept that malnutrition and HIV infection are mutually reinforcing (Duggal et al., 2012).

Few intervention studies have focused on adolescent nutrition, often overlooking the multifaceted nature of nutritional needs. Effective nutrition interventions are essential for promoting growth, managing symptoms, enhancing ART efficacy, and preventing food-borne illnesses (FANTA, 2013, 2014, 2015, 2018a). The integration of nutrition care with national HIV treatment guidelines is crucial for ensuring comprehensive and effective care.

Despite the strengths of this review, such as a rigorous methodology and extensive search strategy, limitations include the predominance of cross-sectional studies and significant heterogeneity among primary studies. Additionally, the limited number of studies from LMICs and language restrictions may have resulted in underrepresentation and exclusion of relevant data.

In conclusion, the review demonstrates the inadequate and fragmented nutritional screening and support programs used by government and NGOs for this population in clinical settings were highlighted.

Review findings have implications for improving the healthy living of adolescents infected with HIV in LMIC through acting on the demonstrated prevalence and identified determinants of

undernutrition by integrating rigorous nutritional screening and assessment modalities into routine services and developing and evaluating nutritional interventions.

Review findings indicate that comprehensive systems of nutritional assessment and intervention should be integrated within HIV services to be delivered during routine follow-up of adolescents in the ART clinic. Despite its limitations, review findings provide evidence that can be used by policymakers, health planners and managers, researchers, and planners in LMICs to create an evidence-informed strategy supporting Sustainable Development Goal 1–3.

2.9 Summary of key finding

This systematic review was vital for the thesis work as it offered a comprehensive and unbiased synthesis of existing research on undernutrition among adolescents living with HIV (ALHIV) in low- and middle-income countries (LMICs), highlighting the existing evidence. By systematically analysing and summarizing the literature, it identified research gaps, guiding the formulation of novel research questions and objectives. The rigorous methodology enhanced the credibility and reliability of the findings, providing a solid foundation for the thesis. Additionally, it synthesized evidence from various studies, offering a more robust understanding of the topic and highlighting critical gaps, which informed future research directions and practical applications. It also ensured that the thesis addressed pertinent issues, aligned with current knowledge, and contributed valuable insights for improving integrated nutrition care and health outcomes for ALHIV.

Chapter Three: Study Methods

This chapter describes the methods used in the study, the study setting, and methods of data collection, including sampling, recruitment, sources of data, and data analysis strategies. Firstly, the study methodology and its philosophical foundations are presented in detail, including the choice of study design, comprising a dominant quantitative component and a small qualitative component, and how they were used to achieve the research objectives 1–5 (see section 1.8). Secondly, the research setting, including the geographic and service-related characteristics of the study sites, is described. Thirdly, the methods employed are outlined: sampling and sample size, recruitment, data collection procedures, variables, and methods of data management and analysis. Finally, the researcher's reflexivity, ethical considerations and approvals for the study, and methods employed to ensure study rigour are described.

3.1 Research questions and objectives Study design

The study's research questions were:

1. What were the nutritional assessment, counselling, and management practices for ALHIV among healthcare workers?
2. What was the level of nutritional status of ALHIV on ART follow-up living in the selected regions of Ethiopia?
3. What are the perceptions and experiences of ALHIV on ART follow-up living in the selected regions of Ethiopia in relation to their nutritional situation and nutritional care available to them?
4. What factors were associated with the nutritional status of ALHIV on ART follow-up living in the selected regions of Ethiopia? Are nutritional care practices delivered for ALHIV reflected in their nutritional status?
5. What was the level of food consumption, dietary pattern, and eating habits of ALHIV in relation to the recommended levels of energy and nutrient intake from the WHO/FAO?

To answer these questions, the researcher sought to achieve the following objectives:

1. To determine the methods by which nutritional status is assessed, and counselling and any other nutritional support practices are planned and delivered for adolescents living with

HIV on ART follow-up by healthcare workers in ART units in selected regions of Ethiopia. This objective seeks to describe the nutrition-related assessment and support practices of healthcare workers for ALHIV on ART follow-up.

2. To assess the level of nutritional status of ALHIV on ART follow-up in selected regions of Ethiopia. This objective seeks to demonstrate the level of undernutrition and overnutrition in these young people.
3. To explore the nutritional challenges, dietary situation and perceptions and experiences of ALHIV regarding the nutritional support provided in ART clinics and make recommendations on potential areas for improvement.
4. To identify determinant factors for the nutritional status of adolescents living with HIV on ART follow-up living in selected regions of Ethiopia. This objective seeks to identify those factors or variables shown to be significant influences on the nutritional status of adolescents living with HIV on ART in selected regions of Ethiopia, including whether nutritional care practices delivered for ALHIV were reflected in their nutritional status.
5. To determine the level of food consumption, dietary patterns, and eating habits of ALHIV on ART follow-up to compare their energy, protein and nutrient intake with WHO/FAO standard minimum requirements. This objective seeks to identify the adequacy and the level of any inadequacy of energy, protein, and nutrient consumption in these young people.

To meet these objectives, three sub-studies were conducted.

Sub-study 1 determined the methods by which nutritional status was assessed, and counselling and any other nutritional support practices planned and delivered to ALHIV on ART follow-up provided by healthcare workers in ART units in selected regions of Ethiopia (research question 1, objective 1).

Sub-study 2 assessed the nutritional status, food consumption, dietary patterns, and eating practices of adolescents living with HIV on ART in selected regions of Ethiopia. It also examined the determinants affecting nutritional status, including nutritional care practices (research questions 2, 4, and 5, objectives 2, 4, and 5).

Sub-study 3 assessed the nutritional challenges, dietary situation and perceptions and experiences of ALHIV aged 16 to 19 years regarding the nutritional support provided in ART clinics and culminated in recommendations for improvement (research question 3, objective 3).

3.2 Study design

This research used a mixed methods study design comprising three prospective sub-studies, involving a dominant quantitative descriptive approach and a small qualitative inquiry. The mixed methods approach was identified as an important way to allow contextualisation and triangulation of the findings using convergence and transformational models. Convergence was used to integrate findings from different methods to validate insights, thereby enhancing the reliability of results. In contrast, transformational models were used to synthesise diverse data sources to reveal new perspectives and deeper insight than was available from individual methods. This comprehensive approach facilitated a detailed examination of the research problem and yielded credible and valid conclusions for policymakers and implementers with respect to prioritising nutritional care in clinical settings (Creswell & Creswell, 2018).

Sub-study 1 used a survey design with a predominantly quantitative approach and a small-scale qualitative component to achieve objective 1, focusing on health professionals' practices in routine clinical nutritional assessment and support (Figure 8). The survey efficiently gathered data from a wide range of professionals, providing a representative sample and precise measurements of practices and adherence to guidelines. To add depth, open-ended questions were included to explore motivations, challenges and contextual factors influencing these practices. While the survey offered a broad overview, the qualitative insights from open-ended questions revealed underlying reasons for practice patterns, offering a more nuanced understanding. This combination of quantitative and qualitative methods ensured a comprehensive assessment of the professionals' nutritional assessment practices.

Sub-study 2 used a survey design with a predominantly quantitative component supplemented by clinical assessments and extraction of clinical data from health records, and a small-scale qualitative component to achieve objectives 2, 4 and 5, determining the nutritional status of ALHIV at ART follow-up, identifying the determinants of nutritional status, and demonstrating the food and eating practices these young people, with their contributing or hindering factors (Figure 8). The survey collected extensive quantitative data, providing a broad, generalisable view

of nutritional status and related factors across a large sample. Clinical assessments and health record data offered precise, objective measurements, enhancing the validity of the findings. The small-scale qualitative component explored personal experiences and contextual factors affecting food and eating practices, adding depth to the quantitative data. This mixed methods design was chosen for its ability to integrate comprehensive quantitative data with detailed qualitative insights, ensuring a robust and nuanced understanding of ALHIVs' nutritional status and behaviours.

Sub-study 3 employed a qualitative descriptive design (Sandelowski, 2010) to achieve objective 3, which investigated ALHIVs' perceptions and experiences of specific nutritional challenges, dietary intake, and the factors influencing these aspects. The study also offered recommendations for improvement in relation to their experience in ART follow-up clinics. In-depth interviews (IDIs) and focus group discussions (FGDs) were the primary data collection methods. The qualitative component was used to explore ALHIVs' food and eating practices in detail, capturing personal experiences and contextual factors that influenced their nutritional behaviours. This approach provided a deeper understanding of the qualitative aspects of nutrition, revealing personal and contextual factors not fully captured by the survey. By examining ALHIVs' experiences, the study identified key factors affecting their nutritional status and provided valuable context for interpreting the quantitative findings.

The Strengthening the Reporting of Observational Studies in Epidemiology-Nutritional Epidemiology (STROBE-Nut) guidelines were used to inform the reportage of these sub-studies (Elm et al., 2007; Lachat et al., 2016; Vandenbroucke et al., 2014).

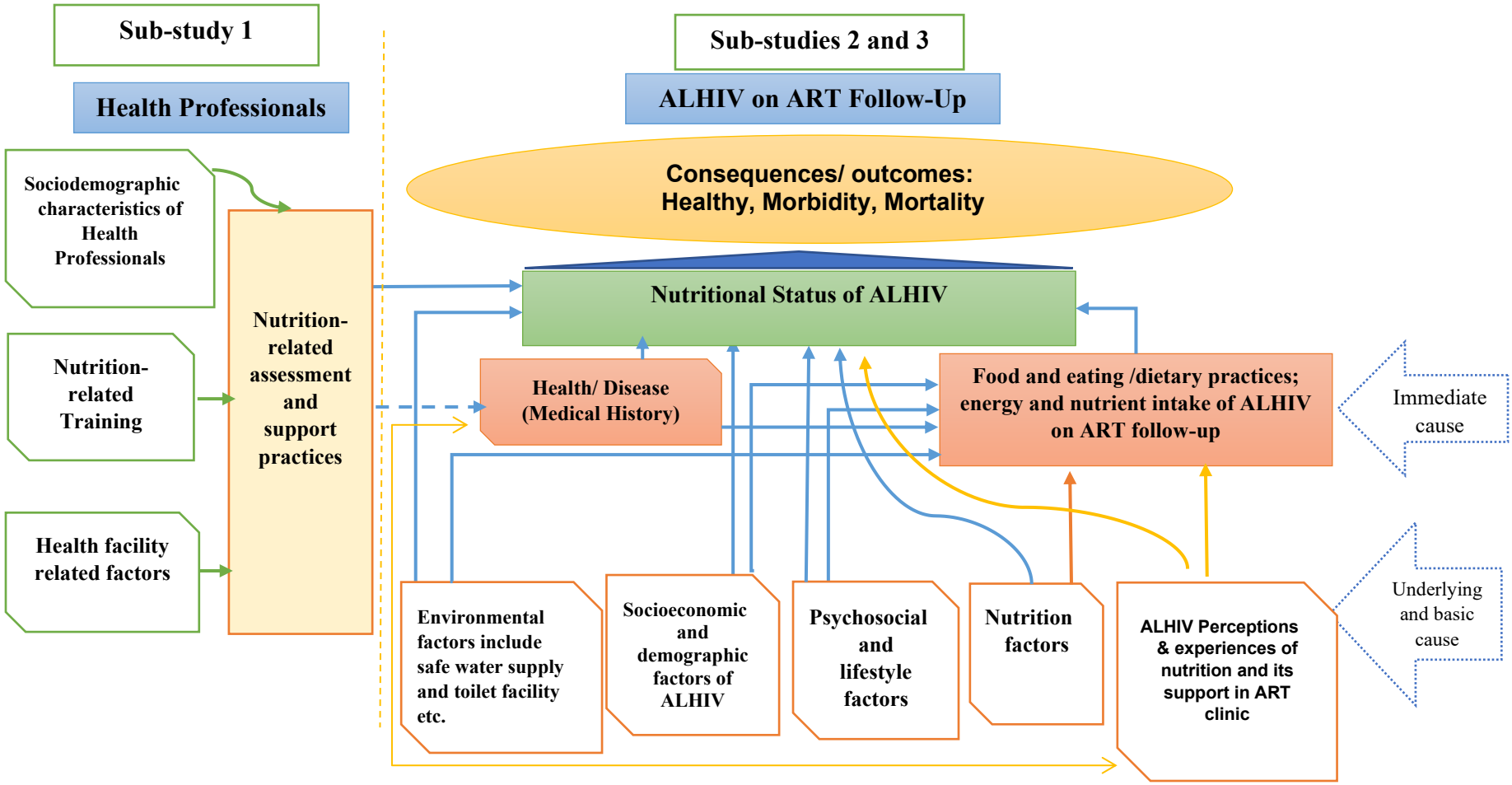

Figure 8. Conceptual framework of the factors associated with nutrition-related assessment and support practice of health professionals, and determinants of nutritional status, food and eating practice among ALHIV on ART follow-up. Source: UNICEF (2013)

3.3 Study setting and period

This study was conducted at selected public health facilities that deliver ART services for ALHIV in Ethiopia (specifically the Addis Ababa and Oromia Regions – see Figure 9). The study was undertaken in 10 selected hospitals in the two regions from August to December 2023. These regions were chosen due to their high HIV prevalence and substantial number of adults and children receiving ART services, making them valuable locations for understanding the needs of ALHIV. Although the study focuses on these specific regions, the sociocultural and healthcare contexts in Ethiopia are relatively similar across regions. Therefore, while the findings are particularly relevant to Addis Ababa and Oromia, they are likely to be applicable to other regions within Ethiopia with comparable HIV prevalence and ART service infrastructure.

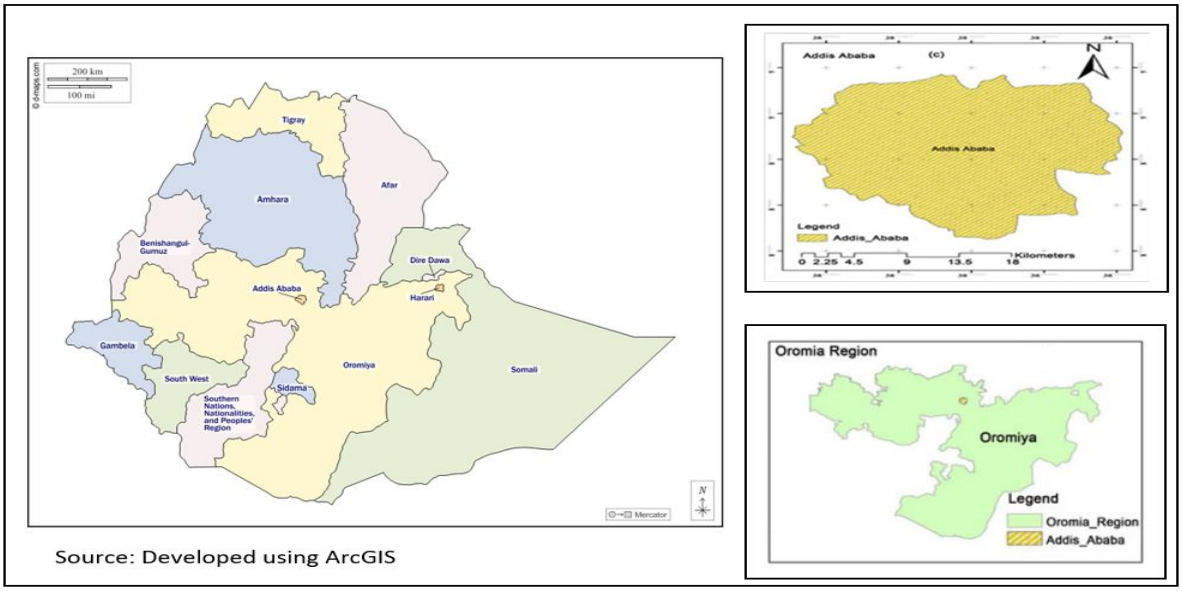

Figure 9. Map of Ethiopia, showing the study regions.

3.4 Sampling and study population

3.4.1 Sub-study one: methods of data collection

This sub-study employed a survey design. A pre-tested, interviewer-administered structured questionnaire containing closed-ended and open-ended questions was used to collect the data. The questionnaire was administered using the Survey Electronic Kobo Toolbox program by trained data collectors, all of whom were healthcare workers (nurses, health officers, public health professionals, and nutritionists), five with bachelor's and two with master's degrees.

Before data collection, the data collectors and supervisors were trained for three days on the study's purpose and relevant data collection techniques, including how to conduct the interview using the Toolbox program and recording data using smartphones and personal computers. Data were collected under the control of the supervisor and principal investigator. In the case of device problems, printed questionnaires were used, and data were uploaded later to the platform. The data were checked for completeness by data collection supervisors.

3.4.2 Sub-study 1: sampling and recruitment

Sampling strategies and sample sizes were chosen based on the type of sub-study and specific objectives. Sub-study 1 sampled health professionals currently working in the ART units of selected hospitals in Addis Ababa and Oromia regions of Ethiopia.

From the population of all healthcare professionals working in clinics providing ART to ALHIV in Ethiopia, a purposive sampling technique was used to select 10 public health hospitals, with high patient loads, in Addis Ababa and Oromia regions. All healthcare professionals working in each ART clinic were invited to participate, because the number of health professionals working in each ART clinic was small.

It was estimated that 50 health professionals working in the 10 hospital ART units in these regions (approximately five per facility) would be eligible to participate. Hospitals with a high prevalence of HIV patients and effective ART services for adolescents were identified, and the number of healthcare workers actively working in the ART clinics of each of the 10 selected hospitals was determined with the assistance of a research assistant. Forty-six potential participants were invited to take part in the study by research assistant: ultimately, 44 consented to participate.

3.4.3 Sub-study 1: data collection instrument

The interviewer-administered structured questionnaire consisted of four sections (See Appendix III). The sections are described in order below:

Section 1 included questions on sociodemographic characteristics, such as age, sex, marital status, education level, qualifications, job title, duration of experience in this role, monthly income, and other employment benefits.

Section 2 sought details of individuals' nutritional assessment practice and related factors in routine use at the study sites, such as methods of nutritional assessment, types of body measurement tools used, and timing and frequency of nutritional assessments.

Section 3 included questions on nutritional care, support practices and related factors in routine use at the study sites, such as admission and discharge criteria, types of nutritional care and support given, availability of nutrition education/counselling, nutrition counselling practices, and quantities and qualities of supplementation provided.

Section 4 included questions on facility-related elements of nutritional care and support in routine use at the study sites, such as updated staff nutrition training, nutrition monitoring, and availability of measurement standard operating procedures; professional resources such as standards of practice, guidelines and job aids; patient information and education materials; treatment regimens for undernutrition; food and supplementation contracts and availability; and referrals to others/outside agencies for additional support.

Finally, two open-ended questions asked for participants' perceptions of what worked well and what did not work well in their units with respect to nutrition support for their patients, and why they thought this was.

The questionnaire was created in English and translated into local language (Amharic language), then the translated versions were back-translated into English by a language expert, and the original and back-translated versions were compared and verified by the team (Sidani et al., 2010).

Local ART unit staff (senior clinicians not employed at study sites) reviewed both the English and translated versions of the questionnaire and assessed content validity based on research relevance and the appropriateness of language for the intended audience. The Content Validity Index (consisting of the I-CVI – Item Level Content Validity Index and S-CVI – Scale Level Content Validity Index) was used to check the validity of the items in this customised tools (Polit et al., 2007; Yusoff, 2019). An S-CVI for three or more experts of above 0.78 was set as a threshold for good content relevance (Yusoff, 2019). Six experts were invited to establish content validity – two from academia, two from clinical practice, and two from a regional health office. Each expert rated item relevance and clarity using a four-point scale (1 = Not at all relevant/clear, 2 = Slightly relevant/clear, 3 = Moderately relevant/clear, 4 = Highly relevant/clear). The mean S-CVI was

0.981, indicating that, on average, 98.1% of experts rated the items as moderately or highly relevant/clear, suggesting robust initial content validity.

In addition, consistency between raters was evaluated for each questionnaire item using Cohen's Kappa coefficient. A coefficient of 0.71 or higher was taken to indicate substantial agreement among raters (McHugh, 2012). The experts also provided qualitative feedback to improve the clarity of items as part of the questionnaire refinement process.

3.5 Sub-study 2

This sub-study employed a survey design. A pre-tested, interviewer-administered structured questionnaire with predominantly quantitative items and a small qualitative component was used to achieve objectives 2, 4 and 5.

3.5.1 Sub-study 2: sampling and recruitment

Sub-study 2 sampled ALHIV (aged 10–19 years) on ART follow-up and attending ART services in the clinics of the selected hospitals in Addis Ababa and Oromia regions of Ethiopia.

Inclusion criteria: ALHIV aged 10–19 years on ART and attending ART units of hospitals in the Addis Ababa and Oromia regions.

Exclusion criteria: Adolescents who had recently become aware of their HIV status and been on ART follow-up for less than three months were excluded, because they may not have stabilised on treatment, potentially leading to variable outcomes. Those with cognitive or communication deficits were excluded to ensure accurate data collection and reporting. Adolescents under 18 without parental or guardian consent were excluded to comply with ethical and legal standards. Additionally, those without a medical registration number or unique ART number, or who could not provide their name and date of birth, were excluded due to this difficulty this presented for data reconciliation and verification.

To achieve objectives 2, 4, and 5 of sub-study 2, a proportionate random sampling approach was employed. The total number of ALHIV on ART follow-up was initially obtained from each hospital through collaboration with the ART data clerk. A sampling frame was created using ART registration codes, with each participant assigned a unique research code to ensure confidentiality

and facilitate organization. Sample sizes were allocated proportionally to the population distribution across the 10 selected hospitals.

Participants were randomly selected from these hospitals by first assigning a unique registration number to each eligible individual in the hospital's records. Statistical software (SPSS version 26) was then used to randomly select participants from these registration numbers, ensuring representativeness and minimizing the risk of bias. The recruitment process was conducted in accordance with ethical guidelines, ensuring that all selected participants met the inclusion criteria and that their confidentiality was maintained throughout.

Recruitment was carried out in collaboration with the clinical staff at each hospital by the principal investigator and trained data collectors. Eligible participants were approached by trained research assistants or hospital staff, who explained the study's objectives, procedures, and potential risks. Information about the study was provided both verbally and in writing to ensure participants fully understood their involvement.

Informed consent was obtained from all participants, or their guardians in the case of minors, prior to participation. The consent process took place in a private setting to ensure confidentiality and minimize undue influence. Research assistants, trained to answer any questions and ensure participants' comfort, obtained the consent. Informed consent was documented by having both the participant (or their guardian) and the research assistant sign the consent form, which was securely stored to ensure confidentiality. The consent form outlined the voluntary nature of participation, the ability to withdraw at any time without consequence, and the protection of participants' privacy. Ethical guidelines were strictly adhered to throughout both the recruitment and consent processes.

Sample sizes were calculated based on sample sizes required to address objectives 2, 4 and 5, as follows:

a) Sample size for objective 2 (prevalence of nutritional status)

For objective 2, the sample size was calculated using a single population proportion formula $n = \frac{(z_{\alpha/2})^2 \cdot pq}{d^2}$ with a 5% marginal error (d) and CI of 95% (Z α/2= 1.96) based on the estimated

proportion with undernutrition of 33.1% seen in 2020 in southern Ethiopia (Shiferaw & Gebremedhin, 2020). Based on these assumptions, the calculated sample size was 340.

b) Sample size for objective 4 (determinants of nutritional status)

The sample size was determined based on variables shown to be significant using unmatched cohort and cross-sectional studies reporting determined predictors of undernutrition. It was calculated using the two-population proportion formula, based on the following assumptions: type one error of 5%, power of 80%, and 1:1 ratio of exposed to non-exposed and taking the adjusted odds ratios and percentages of an unexposed group from previous studies (Sewale et al., 2018; Shiferaw & Gebremedhin, 2020; Junko Yasuoka et al., 2020). Applying the assumptions outlined above to the data shown in Table 9, using Epi Info version 7 software, gave the following sample size outcomes.

Table 9. Sample size determination using multiple variables as predictors of undernutrition.

Variables	CI	Power	Ratio	Percent of outcome in an unexposed group	AOR	Total sample size for both groups	Reference
Sex Female (unexposed) Male (exposed)	95	80	1:1	32.3	2.37	196	(Sewale et al., 2018)
Opportunistic Infection (Diarrhea) No (unexposed) Yes (exposed)	95	80	1:1	34.1	3.3	106	
Dietary Diversity Good Poor/Fair	95	80	1:1	41.8	0.47	292	
Social support Yes (unexposed) No (exposed)	95	80	1:1	43.5	2.71	148	(Shiferaw & Gebremedhin, 2020)
Meal Skipping No (unexposed) Yes (exposed)	95	80	1:1	16.5	2.13	352	
Disclosure of HIV status Not Disclosed Disclosed	96	80	1:1	45.7	1.88	346	
Sex Female (unexposed) Male (exposed)	95	80	1:1	46.3	5.3	66	(Junko Yasuoka et al., 2020)

The largest sample size required to measure these variables ("meal skipping") was calculated to be 352.

c) Sample size for objective 5 (food consumption, dietary pattern, and eating habits)

For objective 5, sample size was calculated using a single population proportion formula $n = \frac{(z_{\alpha/2})^2 \cdot pq}{d^2}$ with 5% marginal error (d) and a CI of 95% (Z α/2= 1.96) based on the estimated

proportion of 50%, because no prior similar studies exist. Based on these assumptions, the required sample size was 384.

The largest of the calculated sample sizes needed to achieve objectives 2 and 4 of sub-study 2 was selected: 384.

For objective 5 of sub-study 2, comprising 24-hour energy and nutrient intake assessment, due to the time and budget constraints, 15% of the sample size of 384 was selected (n=58). This sub-sample was also selected using proportionate random sampling from the total ALHIV survey sampling frame (see above).

3.5.2 Sub-study 2: methods and instruments for data collection

This sub-study employed multiple methods to collect quantitative and qualitative data:

- newly researcher-developed questionnaire items
- clinical assessments
- established data collection instruments
- extraction of routinely collected health record data
- established methods to describe dietary practice, energy and nutrient intake-related data.

The quantitative elements were collected using a pre-tested, interviewer-administered structured questionnaire (see Appendix IV). Data were collected face to face using the Survey Electronic Kobo Toolbox program by trained data collectors who were healthcare workers (nurses, health officers, public health professionals, and nutritionists), five with bachelor's and two with master's degrees.

Before data collection, the data collectors and supervisors were trained for three days. They were trained on the study's purpose, the structured questionnaire used, how to conduct the interview using the Toolbox program, and how to record data using smartphones and personal computers. Additionally, they were trained in anthropometric measurement, clinical assessment, dietary intake assessment including portion size estimation, and how to extract secondary data from records. Data were collected under the control of the supervisor and principal investigator (the PhD candidate). Printed questionnaires were supplied should any device problem occur (none did). Data were uploaded to the platform after collection, and their completeness checked by data collection supervisors.

New researcher-developed survey items included questions on sociodemographic characteristics, such as age, sex, education level, marital status, domiciliary arrangements, occupational status, monthly income, and other benefits. A section on nutrition-related factors included nutrition screening at ART enrolment, including weight/height at this time point, household food security, presence of any eating or appetite problem, meal intake, skipping meals, environmental characteristics like safe water supply and toilet facilities, feeding-related complications like re-feeding syndrome and nutritional supplementation.

Clinical assessments: it is widely acknowledged that no single nutritional assessment method provides a completely valid and reliable index of nutritional status (Gibson, 2005; Thompson & Subar, 2013). Rather, various assessments offer complementary perspectives on this complex issue. Anthropometric measures constitute one such group of assessments, each with its limitations. Multiple anthropometric measures were collected. Three specific measures were chosen to assess nutritional status based on their complementary strengths. BMI and MUAC are well-established indicators of bodily proportions but do not differentiate between fat mass and fat-free mass (Bhattacharya et al., 2019; Gómez-Campos et al., 2021), so were not used. Conversely, skinfold thickness measurements, waist circumference, and body fat percentage assessment provide insights into body composition by distinguishing between fat mass and fat-free mass (Duren et al., 2008; Ma et al., 2016; Peterson et al., 2003).

Multiple anthropometric assessments were conducted, including standard measurements such as weight, height, arm circumference, waist circumference, hip circumference, waist-to-hip ratio percentage, skinfold thickness, body fat percentage, and muscle strength. These measurements were conducted using locally available instruments regularly maintained for accuracy to determine nutritional status. The following instruments/devices were used for these measurements:

- digital weight scale for weight measurement
- portable stadiometer for height
- MUAC tape for arm circumference tape
- non-fabric measuring tape for waist and hip circumference
- Harpenden skin fold callipers for skinfold thickness or body composition
- Hammacher Schlemmer handheld body fat analyser for body composition
- hand dynamometer for measuring hand grip strength.

For clinical measurement processes: to ensure consistency across observers and measurement times, standardised measurement protocols were established and followed.

1. Participants were asked to remove heavy clothes prior to weight measurement.
2. Digital weight scales were calibrated and checked for accuracy before each measurement was taken (Gibson, 2005).
3. The weight scale was adjusted to zero level before each measurement.
4. Participants' weight was recorded to the nearest 0.1 kg.
5. At the time of height measurement (Gibson, 2005), study participants were asked to remove their shoes and stand erect with their heels on the floor, buttocks, shoulder blades, and occipital bone against the wall and eyes facing straight forward.
6. After measuring weight and height, BMI was calculated by dividing weight in kilograms by height in metres squared (kg/m^2) (Gibson, 2005).
7. Arm circumference, waist circumference, and hip circumference were measured using a non-fabric measuring tape to assess body composition and health risks associated with fat distribution (Gibson, 2005). Arm circumference was measured by locating the midpoint between the acromion and olecranon processes, where a non-stretchable tape was wrapped snugly around the relaxed arm and recorded to the nearest 0.1 cm. Waist circumference was measured at the midpoint between the lower rib and the top of the iliac crest during normal expiration, with the tape snug but not tight. Hip circumference was measured around the widest part of the buttocks, with the tape snug and horizontal. Then, waist-to-height ratio and waist-to-hip ratio were calculated.
8. Skin folds: Systematic and standardised approaches were applied to measure skin folds using Harpenden callipers to estimate body fat percentage (Amaral et al., 2011; Gibson, 2005; Norton, 2018). Before use, the callipers were calibrated according to manufacturer guidelines. Participants were positioned comfortably, and anatomical landmarks were marked for consistency: triceps (midway between the acromion and olecranon process on the posterior midline of the upper arm), biceps (over the belly of the biceps muscle on the anterior midline of the upper arm), subscapular (diagonally, 1–2cm below the inferior angle of the

scapula), and supra iliac (at the iliac crest at the anterior axillary line). Each skinfold was gently lifted and held between the thumb and index finger to isolate skin and subcutaneous fat. The calliper's jaws were applied perpendicular to the skinfold, and measurements were recorded in millimetres after stabilization. Two measurements were taken per site and the average was recorded.

9. Body composition was also assessed using a Hammacher Schlemmer handheld body fat analyser, a portable device designed for estimating body composition using BIA (Aldobali & Pal, 2021; Gibson, 2005). Participants were instructed to avoid vigorous exercise and ingesting a large meal or excessive fluids 2 hours before measurement. The device was calibrated before each use as per manufacturer guidelines. The participant's age, gender, and height were entered into the device for generating the body composition analysis. Participants were instructed by the data collector on how to hold the device properly and maintain a stable position during the measurement. Two measurements were taken per participant and average values were recorded.

10. Hand grip strength was assessed to indicate overall muscular strength and provide insights about the participant's physical health and functional capabilities (Bohannon, 2003). We used a hand dynamometer to measure the maximum force participants can generate when squeezing the instrument. During measurement, the participants were instructed to hold the dynamometer in one hand with their arm at their side and elbow bent at a 90-degree angle. We measured dominant and non-dominant hand grip. Participants were instructed to squeeze the device as hard as possible for a few seconds while maintaining a steady grip. The highest reading on the dynamometer was recorded as the maximum grip strength for that hand. Two measurements were taken per participant and the highest value recorded.

Reliability tests were conducted to assess the consistency of anthropometric measurements used in the study – height, weight, MUAC, BMI, hip circumference, waist circumference, skinfold thickness, body fat percentage, and handgrip strength. Statistical analysis, specifically using the Intraclass Correlation Coefficient (ICC) with a two-way mixed-effects model, was employed to quantify the level of agreement among these measurements. The obtained ICC value of 0.856 indicated good agreement, highlighting robust agreement in the anthropometric data (Koo & Li, 2016; McHugh, 2012).

Clinical assessment methods also included direct observation. Clinical assessments primarily involved thorough physical examinations to identify common signs of malnutrition such as wasting, stunting, bilateral pitting oedema, severe wasting, recent weight loss, dermatosis, and specific eye signs like Bitot spots, corneal cloudiness, and corneal ulceration. Additionally, pallor in the palms, mucous membranes, and nail beds was evaluated.

Established data collection instruments

- Psychosocial factors including anxiety and depression were assessed using the Generalised Anxiety Disorder Questionnaire (GAD-7) and Patient Health Questionnaire-9 (PHQ-9) (Kroenke et al., 2001; Swinson, 2006).

  The GAD-7 is a reliable and valid tool for assessing generalised anxiety disorder (GAD), demonstrating high internal consistency and good test-retest reliability across various settings and populations (Dhira et al., 2021). With a Cronbach's α coefficient of 0.891, it exhibits a high level of reliability. The instrument was chosen for this study because of its brevity and efficiency, comprising only seven items that allow for quick administration and completion. It shows high sensitivity and specificity in diagnosing GAD, utilising a standardised scoring system that effectively categorises symptom severity. Moreover, the GAD-7 has been translated into multiple languages (Mills et al., 2014), and validated across diverse cultural contexts, ensuring its reliability and applicability in many populations. These attributes make it an ideal choice for routine screening and monitoring of anxiety symptoms in clinical settings. The Cronbach's α coefficient of 0.758 in this study indicates the high reliability of the measurement instrument used.

  The PHQ-9 is a simple, rapid, effective, and reliable tool for screening and evaluating depression. It is useful for assessing Major Depressive Disorder (MDD), as demonstrated by the principal component factor analysis which showed good reliability, validity, and high adaptability. The Cronbach's α coefficient of PHQ-9 was 0.892, indicating strong internal consistency. Correlation coefficients between each item score and the total score ranged from 0.567 to 0.789 ($P < 0.01$), and the correlation coefficient between various item scores ranged from 0.233 to 0.747. The test-retest correlation coefficient for the total score was 0.737,

indicating that the test is stable over time (Sun et al., 2020). Like the GAD-7, the PHQ-9 instrument was selected for this study because of its concise format (nine items), which facilitates efficient screening for depression. It provides distinct thresholds for categorising severity levels and has been validated across diverse populations and languages, including in Amharic. Its straightforward administration and scoring process, alongside its capability to monitor treatment outcomes, render it a valuable asset for the comprehensive assessment and management of depression. The Cronbach's α coefficient of 0.799 in this study indicated the high reliability of the instrument.

- Lifestyle factors included alcohol consumption, assessed using the Alcohol Use Disorders Identification Test (AUDIT-C) screening tool (Babor et al., 2001; WHO, 2001) The AUDIT-C has a Cronbach's α coefficient of 0.80, highlighting its high internal consistency and reliability in measuring alcohol use disorders (Moussas et al., 2009). The Cronbach's α coefficient of 0.847 in this study indicated the high reliability of the measurement instrument used, a finding consistent with previous research.

Extraction of routinely collected health data

The extraction of data from health records and patient ART follow-up databases involved systematically retrieving pertinent medical history information using a structured approach. A structured tool was employed to extract variables such as the time/duration since HIV diagnosis, partner status, initial and current CD4 status, recent viral load, pre-ART clinical stage, current clinical stage, history of any opportunistic or chronic infections, history of any intercurrent illness during the last three months, types of ART prescribed, and time/duration enrolled on ART.

The health data extraction tool also collected data about clinical variables such as infective complications and standard haematological and biochemical test values. These included haemoglobin, alanine aminotransferase (ALT), aspartate aminotransferase (AST), creatinine, urea, total protein, retinol-binding protein (RBP), C-reactive protein, albumin, pre-albumin, transferrin, glucose, interleukin-6, white blood cell count (WBC), total lymphocyte count, and differential WBC count. For these variables, standardised biochemistry analysis output results were used to ensure the reliability of the data (See Appendix IV, Part II).

To maintain compliance with confidentiality standards, permissions and approvals were obtained from the Health Management Information System (HMIS) record office prior to accessing patient records patient records for the survey. Data collectors retrieved relevant records immediately after administering the participant's survey questionnaire, following the participant consent for record review. Relevant records were identified and retrieved manually from patient charts. Data extraction focused on retrieving key information such as clinical assessments, laboratory results, HIV status, and nutritional assessments.

Laboratory assessments retrieved from patient records included biochemical and haematological assessments conducted as routine hospital procedures. Results extracted included haemoglobin levels and biochemical markers that were pivotal in assessing nutritional adequacy and evaluating the metabolic impact of HIV infection. Data on HIV disease status, including CD4 count and viral load, were also reviewed to understand immune status and inform tailored management strategies. Throughout the data extraction process, strict adherence to data security protocols was maintained to protect patient privacy.

Dietary practice, energy, and nutrient intake-related factors

Data on quantities, frequency and diversity of food eaten were assessed using structured questionnaires adopted from FAO guidelines for measuring individual dietary diversity (see Appendix IV, Part III) (Gibson, 2005; Kennedy et al., 2011). The study participants were asked about the consumption of 17 food items (cereals, white tubers and roots, vegetables, fruits, meats, eggs, fish and other seafood, legumes, nuts and seed, milk and milk products, oils and fat, sweets, spices, condiments and beverages) in the 24 hours before the day of assessment, and their dietary diversity score (DDS) and dietary intake adequacy was determined (Gibson, 2005; Kennedy et al., 2011).

Portion size was estimated to determine the amount of each food item consumed. This was done by using predetermined standard portion sizes and common household measures (e.g., cups, tablespoons, ladles, plates, bowls) as well as a photographic food model representing different portion sizes to aid in visually estimating the amount of food eaten. The photographic food model was created by measuring typical Ethiopian food items and preparing them under controlled conditions to ensure accurate representation. During dietary recall, data collectors used prompts to

assist participants in remembering and reporting all food and drink consumed within the past 24 hours, including any items they might have omitted.

Before data collection, the validity and reliability of the questionnaire were assessed using the Content Validity Index (Polit et al., 2007; Yusoff, 2019). To establish content validity, four experts took part, two from academia and two from clinical practice sites. Each expert rated item relevance and clarity using a four-point scale (1 = Not at all relevant/clear, 2 = Slightly relevant/clear, 3 = Moderately relevant/clear, 4 = Highly relevant/clear). The S-CVI was computed in an Excel spreadsheet, resulting in an average proportion of 0.988, indicating that, on average, 98.8% of experts rated the items as highly relevant/clear, suggesting robust initial content validity. Additionally, internal consistency was evaluated between raters for each questionnaire item using Cohen's Kappa coefficient. A coefficient of 0.741 and above indicated substantial agreement among raters (McHugh, 2012). Additionally, experts provided qualitative feedback to improve the clarity of items as part of the questionnaire refinement process.

3.6 Sub-study 3

Sub-study 3 employed a qualitative descriptive design to achieve objective 3.

3.6.1 Sub-study 3: sampling and recruitment

Adolescents aged 16 and older who participated in the initial survey were invited to take part in either an IDI or FGD during the survey period. Initially, eligible participants willing to engage in IDIs and FGDs were identified from each hospital. Subsequently, eight hospitals (four in each region) were selected for the qualitative study due to the availability of eligible study participants (ALHIV aged 16 years and above who expressed willingness to participate in the qualitative sub-study). As above, proportional sampling was employed based on population distribution to determine the number of participants per site for IDIs and FGDs.

Purposive sampling techniques were then employed to select participants for both IDIs and FGDs based on specific criteria. Participants were selected if they were aged 16 years and above, not severely ill or sick, easily accessible, available during the study period, and willing to participate. The sample size was determined based on data saturation (Saunders et al., 2018), which occurred when no new information or insights relevant to the research question were obtained from additional data collection. The sampling process continued until reaching the saturation point,

ensuring capture of the breadth and depth of perspectives and experiences related to the research topic of interest. Thus, the sample size in qualitative research was not predetermined but emerged through the iterative data collection and analysis process until saturation was achieved. Specifically, 12 participants were selected for IDIs and 75 participants were recruited for eight FGDs, with 6–12 participants per FGD.

3.6.2 Sub-study 3: methods of data collection and instruments

For the qualitative component, local research assistants from each selected hospital conducted the IDIs and FGDs. To facilitate the accessibility of selected participants according to schedule, one week before the planned interview and focus group dates, the data collectors and principal supervisor (PhD candidate) informed the assistants to arrange the schedule, contact participants and prepare a suitable private setting for the interviews and discussions.

In this sub-study, qualitative data were collected through IDIs and FGDs, scheduled after the participants completed the questionnaire. Twelve one-to-one IDIs and eight FGDs were conducted with ALHIV on ART follow-up, with or without family and/or caregivers. The IDIs and FGDs related to objective 3, which was about the nutritional challenges, dietary situation and perceptions and experiences of ALHIV regarding the nutritional support provided in ART clinics, to enable recommendations on areas for improvement. For the collection of these data, one trained data collector or the principal investigator conducted the IDIs, with an additional moderator present for the FGDs.

For IDIs and FGDs, a semi-structured open-ended interview schedule was developed to provide flexibility to delve into specific topics while maintaining a degree of consistency across interviews (See Appendix IV, IDI and FGD Guide for Sub-study 3). The questions focused on factors contributing to undernutrition, including themes such as HIV status and experiences with HIV medications, dietary habits and their impact on HIV, factors influencing nutritional status in both HIV-positive and HIV-negative individuals, and the nutritional care and support services provided by hospital ART units.

In-depth interviews gathered data from individual participants, in an environment where the confidentiality allowed by being interviewed alone would enable participants to disclose information that they might be discouraged from raising by the presence of others (Kvale & Brinkmann, 2015). The FGDs gathered data through group interactions and were facilitated by a

moderator using an open-ended semi-structured discussion guide as described above. These discussions aimed to capture collective perspectives, group dynamics, and shared experiences related to the study objectives (Krueger et al., 2007), and had the advantage that individuals' information might prompt others to recall experiences and opinions.

Content validity of the interview and FGD guides was established by aligning the questions and prompts with the theoretical constructs and themes of the study, ensuring they accurately reflected the research goals. Peer debriefing was conducted to confirm that the instruments were relevant and comprehensive in addressing the research objectives and capturing the intended information. Peer debriefing involved soliciting feedback from colleagues and experts to refine the instruments for clarity and effectiveness in data collection.

See Table 10 for a summary of the study's design, study populations, data collection techniques and methods of analysis.

Table 10. Summary of the research design, study populations, data collection techniques and methods of analysis of this study.

Studies	Design	Study population	Sampling Technique	Recruitment and consent process	Data collection Technique	Method of analysis
Sub-study 1 (objective 1): To describe the nutrition-related assessment and support practices of healthcare workers for ALHIV on ART follow-up	Quantitative Prospective Study	All health professionals working in the ART units of the selected hospitals	Purposive sampling	- Healthcare workers (HCWs) were invited to participate voluntarily. - HCWs provided an information sheet detailing the study's purpose, procedures, and potential risks and written informed consent was obtained before participation	Interviewer-administered questionnaire	Descriptive statistics
Sub-study 2 (objective 2): To assess the nutritional status of ALHIV on ART follow-up in selected regions of Ethiopia	Descriptive cross-sectional study	All ALHIV aged 10–19 years on ART follow-up in the selected public health facilities	Proportional random sampling	- Recruitment was conducted with hospital staff, led by the principal investigator (PI) and trained data collectors. Eligible participants were approached by research assistants or staff, who provided verbal and written information about the study's objectives, procedures, and risks to ensure full understanding.	Interviewer-administered structured questionnaire Anthropometric measurements	Descriptive statistics

				- Consent obtained from ALHIV aged ≥ 16 years and Assent taken from guardian for ALHIV < 16 years		
Sub-study 2 (objective 4): To identify determinant factors for the nutritional status of adolescents living with HIV on ART follow-up living in selected regions of Ethiopia	Quantitative and small-scale qualitative cross-sectional study	All ALHIV aged 10–19 years on ART follow-up in the selected public health facilities	Proportional random sampling for the quantitative component	- Recruitment was conducted with hospital staff, led by the principal investigator (PI) and trained data collectors. Eligible participants were approached by research assistants or staff, who provided verbal and written information about the study's objectives, procedures, and risks to ensure full understanding. - Consent obtained from ALHIV aged ≥ 16 years and Assent taken from guardian for ALHIV < 16 years	Interviewer-administered questionnaire Routinely collected health record data extracted from patient records and patient ART follow-up databases	Descriptive statistics, linear regression, logistic regression and content analysis
Sub-study 2 (objective 5): To determine the level of food consumption, dietary patterns, and eating habits of ALHIV on	Quantitative cross-sectional study and	All ALHIV aged 10–19 years on ART follow-up in the selected	Proportional random sampling for	- Recruitment was conducted with hospital staff, led by the principal investigator (PI) and trained data collectors. Eligible participants were	An interviewer-administered questionnaire including a 24-	Descriptive statistics, mean difference,

ART follow-up; and compare their energy, protein, and nutrient intake with WHO/FAO standard minimum requirements	small-scale qualitative study	public health facilities	both dietary assessments	approached by research assistants or staff, who provided verbal and written information about the study's objectives, procedures, and risks to ensure full understanding. - Consent obtained from ALHIV aged ≥ 16 years and Assent taken from guardian for ALHIV < 16 years	hour dietary recall	DDS, energy and nutrient intake compared with WHO recommend ations
Sub-study 3 (objective 3): To explore the nutritional challenges, dietary situation and perceptions and experiences of ALHIV regarding the nutritional support provided in ART clinics, and recommend areas for improvement	Qualitative descriptive study	All ALHIV aged 16 -19 years on ART follow-up in the selected public health facilities	Purposive sampling	Adolescents aged ≥ 16 years from the initial survey who consented were invited to participate in IDIs or FGDs.	One-to-one IDIs and FGDs were conducted using an interview guide and a discussion guide, respectively	Reflexive thematic analysis using six steps outlined by Braun and Clarke

3.7 Data management plan

After extraction of data from routine health databases, collection of study data and transcription of qualitative data, the data were entered into data files which were then stored in a data folder created in STASH (UTS research data management platform). Three folders were used to store the data (two for the survey data collected from ALHIV on ART follow-up and health care professionals, and one for the qualitative recorded and transcribed data). To ensure the security of the data, both the computer and the STASH account were secured with passwords, which were known only to the research team (see Appendix V).

Supervisors oversaw data collection, ensuring its quality and adherence to protocols. Quantitative data collected by trained data collectors using the Survey Electronic Kobo Toolbox program were checked for completeness before data were processed, cleaned, coded, and stored by supervisors and principal investigators. Qualitative data were collected by the principal investigator.

In case of device problems, printed questionnaires were available, and if used, their data were uploaded later to the platform prior to their destruction. All data were securely stored on the Kobo Toolbox storage platform and Google Cloud. Supervisors checked data completeness to maintain data quality and integrity.

3.8 Data processing and analysis

Quantitative data analysis was undertaken using SPSS version 28. All collected data were checked and exported from the Kobo toolbox program to SPSS version 28 for cleaning, coding, categorisation, and analysis.

To achieve objective 1, sub-study 1, descriptive statistics were generated to determine nutrition-related assessment, counselling, management, and support practices. Frequency tables and figures were generated to display the distribution of each variable, ensuring accuracy and identifying any outliers or inconsistencies. Continuous variables were assessed for normality using Kolmogorov-Smirnov and Shapiro-Wilk tests, with a significance level set at $p > 0.05$, and checked against Q-Q plots. Data quality was assessed for missing values.

To achieve objective 2, sub-study 2, descriptive statistics were generated to determine nutritional status. The frequency of each variable was calculated and checked for accuracy, outliers, consistency, and missing values. For continuous variables, statistical tests for normality were

employed, including the Kolmogorov-Smirnov and Shapiro-Wilk tests. Descriptive findings were presented through frequency tables and figures. Nutritional status was assessed using BAZ and HFA indicators as measures of thinness and stunting, respectively. Standard deviation scores (Z scores) were applied to determine nutritional status, with WHO Growth Reference 2007 standard Z-score cut-offs applied to classify the nutrition status. In addition, the MUAC-for-age indicator was used to assess acute malnutrition/wasting status.

To achieve objective 4, sub-study 2, descriptive statistics were generated to identify the determinants of nutritional status. This included calculating frequencies for each variable and checking for accuracy, outliers, consistency, and missing values. Correlation analysis was conducted to explore relationships between anthropometric variables.

- Both linear and logistic regression models were used in this study. A linear regression analysis model was employed to investigate how various anthropometric measurements contribute to determining nutritional status. These analyses were crucial for understanding the interrelationships among different measures and their impact on overall nutritional assessment. Bivariate and multivariate logistic regression models were used to identify predictors of undernutrition/malnutrition. Outputs comprised crude (COR) and adjusted (AOR) odds ratios with their respective 95% CIs for the logistic regression model, along with Beta coefficients and their respective 95% CIs for the linear regression model. Each independent variable that demonstrated a bivariable test p-value below 0.25 was considered eligible for inclusion in the multivariable logistic regression model. The final model was constructed using backward elimination. A significance level of $p < 0.05$ was considered statistically significant.
- Tests for normality, such as the Kolmogorov-Smirnov and Shapiro-Wilk tests, were conducted on continuous variables. Additionally, the absence of multicollinearity was verified using the variance inflation factor index, with no evidence found. Goodness-of-fit for the models was assessed using the Hosmer-Lemeshow statistic.

To achieve objective 5, sub-study 2, descriptive statistics were used to analyse the types and quantities of food consumed, dietary patterns, and eating habits among ALHIV in Ethiopia. A DDS was calculated based on the number of food groups consumed in the 24 hours preceding the

assessment. Additionally, dietary intake and the adequacy of energy and nutrient levels were assessed using WHO recommendations in a sub-sample of the study. The Food Composition Table developed by Abebe et al. (2007) was employed to compare average nutrient intakes to FAO/WHO reference values and estimate the percentage of recommended intake. Energy and nutrient intake calculations were performed using an Excel spreadsheet tailored to the Ethiopian context and the Nutri Survey 2007 program (Abebe et al., 2007).

Food items were standardised to nutrient values using Excel in accordance with the Nutri Survey 2007and Ethiopian and world food composition tables. Sample characteristics and nutrient intake distributions were summarised using descriptive statistics. Independent sample t-tests and analysis of variance (ANOVA) were conducted to compare nutrient intake between groups within the study population. This comprehensive approach provided a detailed examination of dietary patterns and nutrient intake among ALHIV in Ethiopia.

To achieve objective 3, sub-study 3, the following steps were used: verbatim transcription, translation, back translation, and uploading of the translated script into NVivo version 12 for analysis. The data were analysed following a conventional thematic analysis approach using the six phases of thematic analysis proposed by Braun and Clarke (2006): familiarisation, generating initial codes, generating /searching themes, reviewing themes, defining and naming themes, and producing reports (Braun & Clarke, 2014; Clarke & Braun, 2013; Clarke, 2006).

Initially, the researcher immersed himself in the qualitative data, reading and re-reading to become familiar with its content. Then the data were systematically coded, enabling identification of emerging patterns and themes directly from the texts. Themes were subsequently refined and defined through iterative review and discussion among the research team. Finally, findings were synthesised into a narrative format, providing a coherent and detailed account that illuminated the underlying patterns and meanings discovered within the data. Lastly, triangulation of quantitative and qualitative findings was undertaken using a process of contrast and comparison.

The analysis was anchored in a theoretical or conceptual framework (Figure 8) that describes healthcare workers' practices in nutritional assessment, counselling, and management, along with the determinants of nutritional status, dietary intake, and food consumption among ALHIV. This framework guided the evaluation of how healthcare practices affected nutritional outcomes and how various determinants, including dietary intake and socio-economic factors, influenced

ALHIVs' health. By applying this framework, the study systematically explored the relationships between healthcare practices, levels of nutritional status, dietary intake, and food consumption, ensuring a comprehensive and consistent analysis.

In the context of the qualitative study, the conceptual framework (Figure 8) played a critical role in contextualizing participants' experiences and perceptions of nutritional care and dietary practices. It allowed for a deeper understanding of how ALHIV perceived the nutritional support they received within their broader healthcare environment, which includes the availability of services, the attitudes of healthcare workers, and the social and cultural factors that influence dietary practices. This framework helped guide the interpretation of qualitative data by framing participants' narratives in relation to key themes such as healthcare access, nutrition counselling, and the impact of socio-economic conditions on food choices. By situating participants' experiences within this framework, the study was able to identify how various levels of influence—ranging from individual factors to healthcare practices and social structures—interact to shape nutritional outcomes for ALHIV on ART.

3.9 Ethics

This study was conducted in line with the Declaration of Helsinki (World-Medical-Association, 2001). Ethical approval was obtained from the Human Research Ethics Committee at the University of Technology Sydney, Australia (Ref. Number: ETH23-7873), the Institutional Review Board of the College of Medicine and Health Sciences of Hawassa University, Ethiopia (Ref Number: IRB/321/15), the Addis Ababa and Oromia Regional Health Bureau Ethics Review Committee, Addis Ababa, Ethiopia, and the selected hospitals' Ethics Review Committees (See Annex VII). Permission was secured from all health institutions involved in the study.

Informed consent was obtained from ALHIV aged 18 years and older. Participants were informed of the purpose of the study, its procedures, and potential risks. Consent was recorded on the consent form. For ALHIV aged <18 years, consent was sought from their adult partner (if married) or parents/guardians for the adolescent to participate in the study, as well as the young person's informed consent.

Illiterate participants provided consent by witnessed verbal consent or by writing on the consent form with the assistance of a witness. Participants who were <18 years old provided witnessed

verbal assent. All participants were informed that they had the right to refuse participation without consequences and without giving any reason.

Participants were assured of confidentiality and privacy. Data were collected using study codes rather than names to safeguard the anonymity of the participants. No participant's name was identified in the study material. Respondents were assured that the information they provided was used solely for the research and was not provided to third parties. When reporting the results, project code numbers were used to protect the identities of participants. Data were stored separately from identifiable information, such as consent forms and participant code lists.

The researcher implemented strategies to mitigate any perceived power imbalance, obligation, or coercion during IDIs and FGDs. Firstly, sessions were conducted at locations chosen by participants to enhance their comfort in responding to questions. Secondly, a trained research assistant facilitated FGDs to ensure impartial moderation. Thirdly, the researcher sought to build trust by reassuring participants that they were free to express themselves openly. Consent was obtained from all participants, who received clear instructions emphasising confidentiality, voluntariness, and the study's objectives, including the expected duration and the necessity of audio recording. Refreshments like soft drinks and locally available snacks were offered during face-to-face interactions; travel expenses were not reimbursed.

3.10 Rigour of the research

Rigour was established in various ways related to the methods used for the quantitative and qualitative components. For quantitative components, internal and external validity, reliability and objectivity were established. For qualitative components, trustworthiness was established by assessing credibility, transferability, dependability and confirmability.

3.10.1 Quantitative research

Validity

The internal and external validity of this study were addressed by controlling for research bias, ensuring transparency and integrity in data collection and reporting, development and testing of appropriate research tools, selecting locations and times for interviews that suited participants, use of validated instruments and appropriate sampling techniques, controlling confounding variables, and use of appropriate statistical techniques (Heffner, 2004; Shuttleworth, 2008; Trochim, 2006).

Reliability

Reliability in research means high reproducibility and consistency'. Instrumentation reliability is essential for sound research results. The researcher ensured that the instruments were reliable by performing pilot testing outside the study area in < 10% of the sample size. Cronbach's alpha(α) statistical analysis was performed to measure internal consistency (Gobezie et al., 1997; Trochim, 2006; Wilson, 2014). Inter-rater and intra-rater reliability of anthropometric measurement and 24-hour dietary intake estimation were maximised via standard protocols, training and close supervision, and testing before data collection, including comparing food portion size estimation to actual consumption.

Promotion of objectivity/ management of potential bias

For the quantitative component of this study, objectivity was promoted via the following strategies:

- focusing on the data when determining the findings
- ensuring that the research was value-free by eliminating, as far as possible, personal or situational biases from the research, and presenting the impartial, objective truth
- ensuring that the instruments used for research were reliable and valid (Sprenger, 2014), including those measuring personal values, beliefs, biases and behaviours. Participant and researcher bias was minimised by:
    - framing open-ended questions to prevent the participant from simply agreeing or disagreeing, and providing an environment conducive to the provision of honest answers
    - considering all the data obtained and analysing with a clear, neutral and unbiased mind; continually re-evaluating the impressions and responses, and recognising and suppressing pre-existing assumptions
    - asking general questions first, before moving to specific or sensitive questions to avoid question-ordered bias during the interviews
    - keeping the questions simple and being careful to avoid words that could introduce bias.

3.10.2 Qualitative research

Credibility

Credibility is the confidence that can be placed in the truth of the research findings. Credibility establishes whether the research findings represent plausible information drawn from the participants' original data and are a correct interpretation of their original views (Korstjens & Moser, 2018).

To ensure credibility (Bradshaw et al., 2017), the following methods were applied to the maximum possible extent:

- long-term involvement in all aspects of research data management. This means working in the research setting long enough to build rapport with participants, experience variations, and overcome the biases of researchers being in the field
- prolonged engagement in all aspects of research data management, which means building trust with participants, experiencing the breadth of variation in the data, and overcoming distortions due to the researcher's presence
- persistent observation and in-depth examination of the research phenomena
- use of multiple sources (i.e., interviewing and observation), methods, investigators, and theories for triangulation of findings (contextual validation)
- peer debriefing to avoid biased opinions
- systematic storage of all raw data and records to ensure referential adequacy, allowing for future examination and comparison with other studies.

Likewise, in sub-study 3 (objective 3), after transcribing interviews with ALHIV, the research team reviewed the de-identified transcripts to ensure that the data accurately reflected the participants' responses. The transcripts were also compared with notes taken during the interviews, and multiple reviewers were involved to ensure a comprehensive and accurate reflection of all relevant information. Peer debriefing occurred through ongoing dialogue with supervisors via e-mail. Transcripts of interviews were shared with all supervisors on team account and e-mail so they could read, comment, discuss coding, and contribute to the development of conceptual categories and the generation of themes.

Dependability

Dependability is the qualitative equivalent of reliability in quantitative research. It is about the consistency of the findings, and involves evaluating study results, interpretations, and recommendations based on the participants' data. Research dependability includes how research is accessed, how errors and surprises are handled, how data are collected and recorded, and how data are coded, analysed and interpreted (Anney, 2014; Bazeley, 2013). In this research, dependability was maintained by comparison of data from questionnaires, interviews and FGDs.

Transferability

Transferability means the external validity or generalisation of qualitative research results. Transferability can be achieved via a thorough description of the research context and underlying assumptions (Trochim, 2006). By providing this information, the research results can be transferred from the original research situation to a similar situation.

Confirmability

Confirmability in qualitative research means the degree to which other researchers can confirm or corroborate the outcomes. Confirmability is the qualitative investigator's version of objectivity and requires the researcher's neutrality in interpretation. This can be achieved using a confirmability audit that includes an audit trail of raw data, analysis notes, reconstruction, and synthesis products, process notes, personal notes, as well as preliminary developmental information (Forero et al., 2018). In this study, the researcher documented all data foe checking and rechecking to ensure confirmability.

Chapter Four: Nutritional Assessment, Counselling and Management Practices of ART Clinic Healthcare Workers During Antiretroviral Therapy Follow-Up for ALHIV

This chapter presents findings about the nutritional practices of ART clinic healthcare workers in two regions of Ethiopia, with respect to nutritional assessment, advanced nutritional counselling and education, and nutritional management and support for ALHIV.

4.1 Specific objectives

The objectives of the work that produced the results outlined in this chapter were to:

1. evaluate the extent to which healthcare workers utilise holistic methods for assessing the nutritional status of ALHIV during ART follow-up
2. assess the provision of advanced and evidence-based nutrition counselling and education by healthcare workers, tailored to the unique needs of ALHIV during ART follow-up
3. examine the nutritional management and support provided by healthcare workers to ALHIV, including regular monitoring, follow-up, and provision of necessary care and support services.

4.2 Results

4.2.1 Socio-demographic characteristics

We recruited 44 healthcare workers who provided health and nutrition care services for ALHIV on ART follow-up in 10 hospitals located in Addis Ababa and Oromia regions (95.6% of those eligible to participate). Nearly half of these healthcare workers (n=21; 47.7%) were aged between 24 and 34 years, with a mean age of 35.4 ± 6.99 years. Over half (n=25; 56.8%) of the participants were recruited from Addis Ababa regional hospitals, with the highest numbers coming from St. Paul's Comprehensive Specialized Hospital (n=7; 15.9%) and ALERT General Hospital (n=7; 15.9%). Most participants held bachelor's degrees (n=34; 77.3%) and were registered nurses (n=28; 63.6%). Most respondents had less than 10 years of professional work experience (n=26;

59.1%) and work experience in an ART clinic (n=36; 81.9%). Approximately 36.4% of the participants (n=16) received a monthly income of 10,000 EBR[2] or more (Table 11)

4.2.2 Nutritional assessment practice

Most healthcare workers reported utilising various methods of nutritional assessment for ALHIV. These methods included body measurements (100%, n=44), clinical assessments (93.3%, n=41), and biochemical assessments (77.3%, n=34). However, only 36.4% (n=16) (n=12) of the study participants assessed their ALHIV patient's dietary intake, and only 27.3% (n=12) assessed their food security status. Only 25% (n=11) of the healthcare workers utilised all methods to determine the nutritional status of ALHIV (Figure 10).

All study participants had access to standardised weight scales and height/length boards to measure the weight and height of ALHIV during clinic attendance. Additionally, more than half of the participants (63.6%) used arm circumference measuring tapes to determine the nutritional status of ALHIV. However, only a few participants had access to waist circumference measuring tapes (9.1%, n=4) or skinfold thickness callipers (4.5%, n=2) to determine the body composition of their clients. None of the study participants reported access to underwater weighing dual-energy X-ray absorptiometry (DXA) to measure body fat and/or hand grip dynamometers to measure sarcopenia and frailty (Figure 11).

All participants reported that they regularly assessed weight-for-age, HFA, and weight-for-height Z-score indices along with weight loss status. Additionally, many participants (95.5%, n=42 and more than half (56.8%, n=25) regularly evaluated the BMI and MUAC indices of ALHIV (Table 12). Few participants regularly assessed the waist circumference or waist-to-hip ratio indices of ALHIV. None of the participants reported using body composition assessments such as skinfold thickness, lean body mass, body fat, and grip strength assessment to determine body fat distribution and muscle strength.

[2] Ethiopian Birr; 1 EBR = 0.008734 US dollars on September 15, 2024

Table 11. Socio-demographic characteristics of the participating ART clinic healthcare workers in the selected hospitals of two regions of Ethiopia, 2024

Variables	Description	Frequency n (%)
Age (year)	24–34 years	21 (47.7)
	35–44 years	16 (36.4)
	≥ 45 years	7 (15.9)
	Mean ± SD =35.4 ± 6.99 years	
Sex	Male	17 (38.6)
	Female	27 (61.4)
Region	Addis Ababa	25 (56.8)
	Oromia	19 (43.2)
Hospitals	Shashemene Referral Hospital	3 (6.8)
	Asella Referral and Teaching Hospital	5 (11.4)
	Adama Referral Hospital	5 (11.4)
	Bishoftu Hospital	5 (11.4)
	Batu Hospital	1 (2.3)
	Yekatit 12 Hospital	3 (6.8)
	St Paul's Comprehensive Specialized Hospital	7 (15.9)
	ALERT General Hospital	7 (15.9)
	Zewditu Hospital	4 (9.1)
	Ras Desta Damtew Hospital	4 (9.1)
Educational status	Diploma	4 (9.1)
	Bachelor's degree	34 (77.3)
	Master's degree	6 (13.6)
Profession	Registered nurse	28 (63.6)
	Public health officer	6 (13.6)
	General practitioner	10 (22.7)
Length of work experience	< 10 years	26 (59.1)
	10–20 years	14 (31.8)
	≥ 21 years	4 (9.1)
Mean ± SD =	10.7 ± 6.61 year	
Length of work experience in ART unit/clinic	< 10 years	36 (81.9)
	≥ 10 years	8 (18.2)
Mean ± SD =	5.45 ± 4.23 year	
Monthly income	5000–7500 EBR	9 (20.5)
	7501–10000 EBR	19 (43.2)
	> 10000 EBR	16 (36.4)

SD = Standard Deviation; EBR = Ethiopian Birr

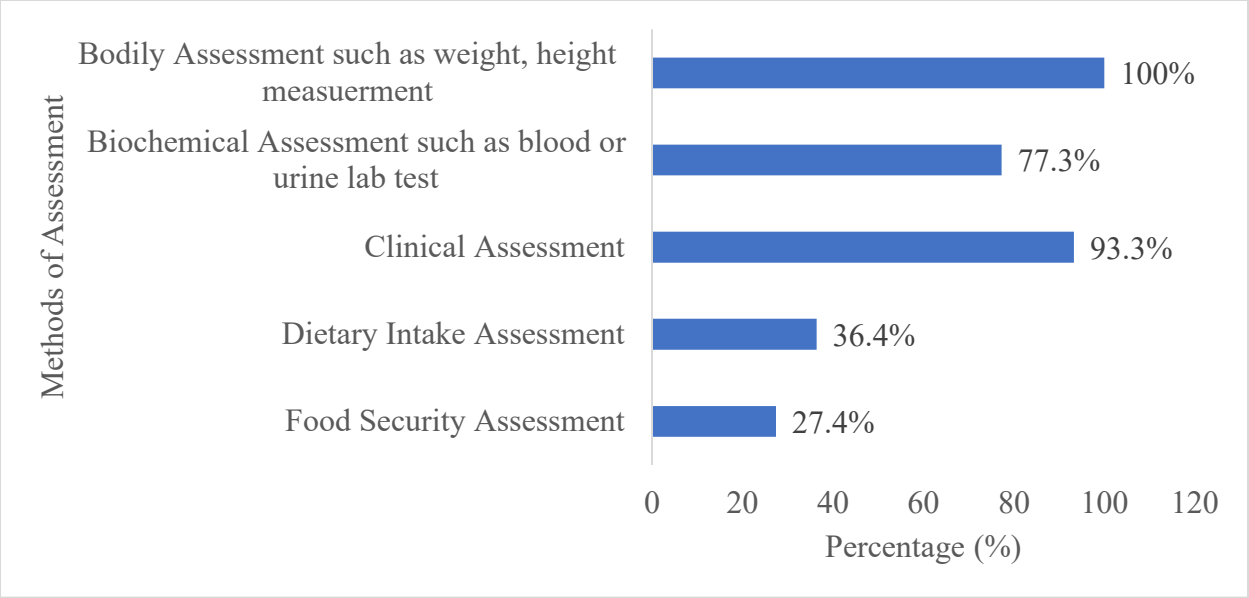

Figure 10. Nutritional assessment methods used by ART clinic healthcare workers in selected hospitals in two regions of Ethiopia, 2024.

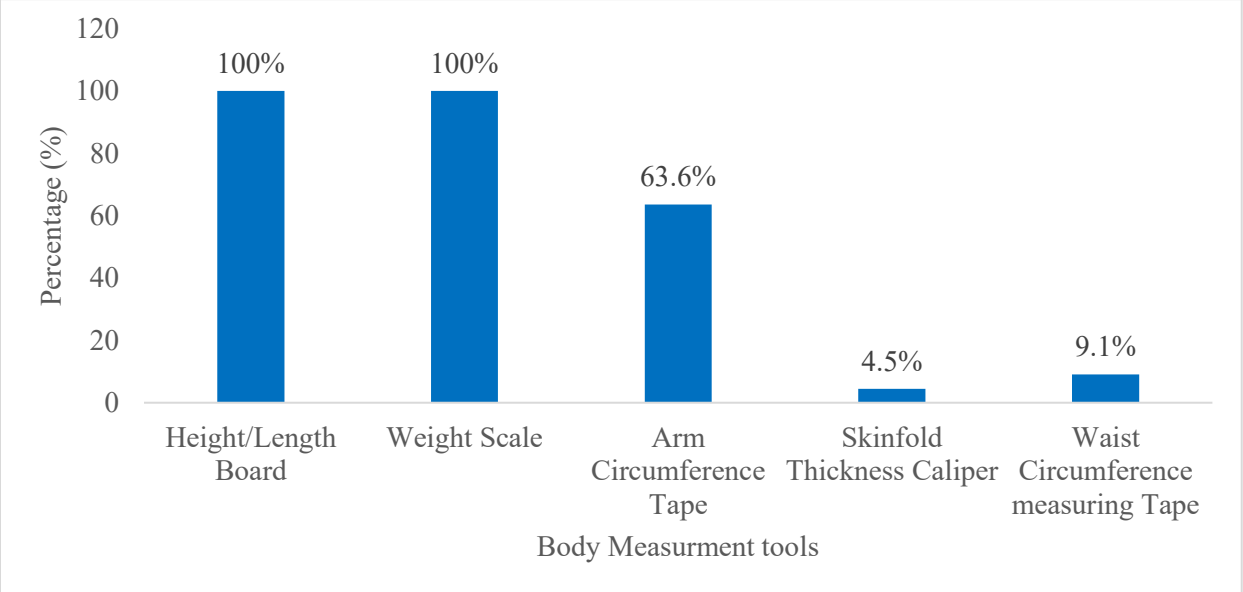

Figure 11. Availability of body assessment measuring tools for anthropometric measurements in selected hospitals of two regions of Ethiopia reported by ART clinic healthcare workers, 2024.

Most participants reported conducting biochemical assessments of ALHIV during their attendance at ART follow-up clinics. However, not all tests were performed routinely (e.g., total protein test and calcium level test). Most ALHIV were assessed for bilateral pitting oedema, visible severe

wasting, recent weight loss, and pallor of palms, mucus membranes, and nail bed loss. Less than half of the participants routinely assessed dermatosis and eye signs (Table 12).

Table 12. Nutritional assessment practices reported by clinic healthcare workers for attendees at the ART clinics of selected hospitals in two regions of Ethiopia, 2024

Variables	Description	Frequency n (%)
Anthropometric measurements used in ART clinics	Height	44 (100)
	Weight	44 (100)
	Body mass index	42 (95.5)
	Mid-upper arm circumference	25 (56.8)
	Skinfold thickness	0 (0.0)
	Waist circumference	3 (6.8)
	Waist-to-hip ratio	2 (4.5)
	Lean body mass	0 (0.0)
	Body fat	0 (0.0)
	Grip strength	0 (0.0)
Biochemical Assessments undertaken for ALHIV in ART clinics	Glucose test	32 (72.7)
	Blood urea and nitrogen test	33 (75.0)
	Creatinine test	32 (72.7)
	BUN to creatinine ratio	16 (36.4)
	Calcium	4 (9.1)
	Total protein	3 (6.8)
	Albumin	20 (45.5)
	Alkaline phosphatase	21(47.7)
	Alanine aminotransferase	22 (50.0)
	White blood cell count	35 (79.5)
	Red blood cell count	39 (88.6)
	Haemoglobin	39 (88.6)
	Haematocrit	39 (88.6)
	Mean corpuscular volume	38 (86.4)
	Mean corpuscular haemoglobin	38 (86.4)
	Platelet count	25 (56.8)
	Helminth infection (hookworm and ascaris)	17 (38.6)
Clinical Assessment conducted at the ART clinic	Bilateral pitting oedema	40 (90.9)
	Visible wasting	41 (93.2)
	Recent weight loss	41 (93.2)
	Dermatosis	18 (40.9)
	Eye signs (Bitot spot, corneal cloudiness, conjunctivitis, corneal ulceration)	17 (38.6)
	Pallor of palms, mucus membranes, and nail bed loss	35 (79.5)

4.2.3 Nutritional counselling and education practice

Just over one third (38.6%, n=17) of the interviewed workers provided nutrition counselling and education services to ALHIV. Of those who did (n=17), more than half (58.8%, n=10) provided the service regularly. Only 23.5% of the participants (n=4) used the GALIDRAA approach, in line with the nutrition counselling and education recommendations of the WHO (FANTA, 2016; MOH, 2016a; WHO, 2013a). Additionally, during the discussion component of nutrition counselling in the GALIDRAA approach, only 11.8% of participants (n=2) used the Observe, Reflect, Personalize and Act (ORPA) approach (Table 13).

Table 13. Nutritional counselling and education practices reported by clinic healthcare workers for ALHIV at the ART clinics of selected hospitals in two regions of Ethiopia, 2024

Variables	Value	Frequency n (%)
Availability of nutrition counselling and education for ALHIV at ART clinic (n=44)	Yes	17 (38.6)
Regular practice of nutritional counselling and education to ALHIV during ART follow-up (n=17)	Yes	10 (58.8)
Use GALIDRAA approach to nutrition counselling and education for ALHIV (n=17)	Yes	4 (23.5)
Use ORPA approach during discussion time for nutrition counselling and education for ALHIV (n=17)	Yes	2 (11.8)

ALHIV – Adolescent Living with HIV; GALIDRAA –Greet, Ask, Listen, Identify, Discuss, Recommend, Agree, and Appoint; ORPA – Observe, Reflect, Personalise, and Act

4.2.4 Nutrition management and care/support practice

Nearly half the study participants (47.7%, n=21) reported that their clinics had admission criteria for nutrition care and support services for ALHIV, whereas only 36.4% (n=16) reported their clinics had discharge criteria. About 81% of the study participants (n=17) used only BMI <18.5kg/m^2 as the standard admission criterion for nutrition care.

Most study participants performed nutrition screening (81.8%, n=36), nutrition case management (81.8%, n=36), and supplementation (72.7%, n=32) for ALHIV during ART follow-up clinic attendance. They reported that all undernourished ALHIV were given ready-to-use therapeutic food (RUTF) supplementation, but only a small percentage (15.6%, n=5) were given ready-to-use

supplementary food (RUSF). Most study participants (84%, n=27) provided monthly supplementation to malnourished clients, but only 40.6% had a strategy to detect sharing of the supplementation between siblings (Table 14).

Table 14. Nutritional management and care/support practices of the study participants in selected hospitals of two regions, Ethiopia, 2024

Variables	Description	Frequency n (%)
Has standard admission criteria for nutrition care and support	Yes	21 (47.7)
Types of standard admission criteria used (n=21)	Anthropometric measurement (i.e., only BMI < 18.5 kg/m^2)	17 (80.9)
	Combined method (i.e., anthropometric* and clinical findings**)	4 (19.1)
Nutrition screening	Yes	36 (81.8)
Nutrition case management	Yes	36 (81.8)
Nutrition supplementation	Yes	32 (72.7)
Type of supplementation provided [multiple responses] (n=32)	Ready to use therapeutic food	32 (100)
	Ready to use supplementary food	5 (15.6)
	Others***	2 (6.25)
Supplementation delivery period (n=32)	Every 2 weeks	5 (15.6)
	Every month	27 (84.4)
Availability of a strategy to detect sharing supplementation e.g. with a sibling (n=32)	Yes	13(40.6)
Strategies used to detect sharing (n=13)	Progress assessment	3 (23.1)
	Weight change/gain assessment	10 (76.9)
Has standard discharge criteria for nutrition care and support program	Yes	16 (36.4)

* such as MUAC < 16 cm, BMI < 18.5 kg/m^2, Weight-for-height Z-Score < -2 or -3
** Clinical signs like visible severe wasting, recent weight loss, bilateral pitting oedema
*** Oil, teff flour, and/or wheat flour

4.2.5 Implementation support for nutrition care

Most study participants reported a lack of implementation documents in their hospitals' ART clinics, such as standard operating procedures (SOPs) and nutrition guidelines. Similarly,

implementation aids – such as patient information and education materials, monitoring checklists or cards, or standardised reporting formats and systems that enable regional health bureaus and other organisational bodies to monitor care – were largely unavailable. Additionally, most of the participants lacked access to staff training in nutrition care and support, or to treatment facilities for undernourished ALHIV in their hospitals. However, more than half (54.5%, n=24) of the participants reported having access to referral and linkage systems to support ALHIV (Table 15).

Table 15. Resources and activities to support staff in providing nutrition care and support for ALHIV on ART follow-up

Variables	Frequency n (%)
Nutrition care and support training available for ALHIV for ART staff	5 (11.4)
SOPs available for nutritional care	3 (6.8)
Nutrition support guidelines provided by the hospital	4 (9.1)
Job aids available, such as algorithms, anthropometric reference cards, brochures, posters, pictures	3 (6.8)
Patient information and education resources available	3 (6.8)
Treatment for undernourished patients	8 (18.2)
Referral and linkage system available to support ALHIV	24 (54.5)
Monitoring checklist/multi-chart/card/ audit tools available	0 (0.0)
Reporting format and system to regional health bureau and others for monitoring purposes	9 (20.5)

4.2.6 Healthcare workers' perspectives on nutrition assessment, counselling, care, and support practices

Exploring healthcare workers' opinions on nutrition care and support for adolescents living with HIV revealed significant concerns about current practices. More than half of the respondents (n=24; 54.5%) expressed dissatisfaction with the nutrition assessment, counselling, care, and support services provided for ALHIV. According to their feedback:

> *Nutrition assessment, counselling, care, and support services for ALHIV were perceived as inadequately performed activities due to lack of integration of nutrition services and the absence of specific training on HIV and nutrition for ART clinic staff.*

This feedback underscores critical concerns about the integration of nutrition services and highlights the need for targeted training initiatives among ART clinic staff to enhance the quality of care provided to ALHIV.

Only 36.4% (n=16) of healthcare workers reported that they regularly and effectively performed weight, height, and BMI measurements as part of anthropometric assessments in their hospital ART clinics. Additionally, only 13.6% (n=6) indicated that they believed they conducted clinical assessments well.

Respondents highlighted the importance of nutritional assessments in monitoring patient health and guiding appropriate care interventions. Some healthcare workers expressed concern about the inadequacy of methods used for assessing the nutritional status of ALHIV. One participant (a registered nurse) stated that:

> "Nutritional assessments are crucial, but we use limited methods. Given the complexity of malnutrition, it is challenging to determine the nutritional status accurately."

Only 11.4% (n=5) of the healthcare workers reported that nutritional supplementation and monitoring services provided to ALHIV in their hospital performed well. Similarly, only 4.5% (n=2) of the healthcare workers reported performing psychosocial services well.

The research found that 34.0% (n=15) of healthcare workers' opinions expressed dissatisfaction with nutrition assessment, counselling, care, and support activities in their hospital. They also bemoaned the lack of integration of nutrition services in HIV/AIDS clinical care settings, absence of comprehensive nutritional screening, lack of nutrition training and supportive guidelines, and discontinuous or inadequate supplementation. These findings highlight the need for improved integration of nutrition services within the clinical care framework for HIV/AIDS patients in Ethiopia.

4.3 Summary of key findings

The findings of this study underscore the importance of a multi-method approach to nutritional assessment, counselling and education in managing undernutrition among ALHIV. Nutritional assessments, essential for monitoring patient health and guiding care interventions, were found to be used infrequently or ineffectively in the selected ART clinics. Basic methods such as body

measurements and clinical evaluations were conducted widely, but more comprehensive assessments of factors like dietary intake and body composition were performed infrequently due to poor access to the necessary tools.

Few healthcare workers reported that nutritional supplementation and monitoring services were performed well, and even fewer felt that psychosocial services for ALHIV were adequate. Just over half of respondents expressed dissatisfaction with the overall nutrition assessment, counselling, care, and support services. Key concerns included the inadequate integration of nutrition services and the lack of specific training on HIV and nutrition for ART Clinic staff.

A large minority of respondents felt they performed anthropometric assessments (weight, height, and BMI) effectively, and about one in seven believed they conducted clinical assessments well. These and other results highlight the need for improved integration of nutrition services, comprehensive screening, targeted training, supportive guidelines, and consistent supplementation to improve the quality of care and health outcomes for ALHIV receiving ART in Ethiopia.

Chapter Five: Nutritional Status and its Determinants among Adolescents Living with HIV on ART Follow-Up in Selected Hospitals of Two Regions of Ethiopia

This chapter presents results that answer research questions 2 and 4, namely, findings about the level of nutritional status and associated factors in ALHIV on ART follow-up in selected hospitals in Ethiopia.

5.1 Specific objectives

The objectives of this component of the study were to:

1. characterise ALHIV based on socio-demographic, anthropometric measures, psychosocial, environmental and lifestyle factors, and HIV-related medical and clinical data
2. compare various metrics/measures that can be used to determine the nutritional status of ALHIV and identify the prevalence rates reported for malnutrition in ALHIV
3. determine what socio-demographic, psychosocial, environmental, lifestyle and HIV-related medical and clinical factors may be significantly associated with the nutritional status of ALHIV.

5.2 Objective 1: Participants' characteristics

The study enrolled 384 ALHIV who were attending ART follow-up at 10 hospitals in Addis Ababa and Oromia regions. The response rate among eligible ALHIV invited to participate was 100%.

5.2.1 Socio-demographic characteristics

Of the 384 participants, the mean age was 15.9 ± 2.19 years; the largest group (n=227, 59.1%) was aged between 14 and 17 years, the middle adolescent age group (Allen, 2024; Sawyer et al., 2018). More than half (n=207, n=54%) were female. Three quarters (n=281, 73%) were recorded as orthodox religious followers. Over half the participants (n=254, 66.1%) were recruited from Addis Ababa Regional Hospitals, with the single largest groups coming from St. Paul's Comprehensive Specialized Hospital (n=73, 19.0%) and ALERT General Hospital (n=71, 18.5%). Most of the participants (n=379, 98.7%) were students, and 46.6% (n=179) were in grades 1–8.

The largest segment of participants resided in households earning 1000-3000 EBR monthly (n=175, 45.6%). More than half of the participants resided in a household with 4–5 members (n=198, 51.6%). About one third of participants belonged to households with three members or fewer (Table 16).

Table 16. Socio-demographic characteristics of 384 ALHIV attending ART follow-up across 10 selected hospitals in Addis Ababa and Oromia regions, Ethiopia

Variables	Description	Frequency n (%)
Age (years)	10–13 years (early adolescent)	55 (14.3)
	14–17 years (mid-age adolescent)	227 (59.1)
	18–19 years (late adolescent)	102 (26.6)
Mean age ± SD	15.9 ± 2.19 years	
Sex	Male	177 (46.1)
	Female	207 (53.9)
Region	Addis Ababa	254 (66.1)
	Oromia	130 (33.9)
Hospitals	Shashemene Referral Hospital	14 (3.6)
	Asella Referral and Teaching Hospital	24 (6.3)
	Bishoftu General Hospital	40 (10.4)
	Adama Referral Hospital	50 (13.0)
	Batu Hospital	2 (0.5)
	Yekatit 12 Hospital	53 (13.8)
	St Paul's Comprehensive Specialized Hospital	73 (19.0)
	ALERT General Hospital	71(18.5)
	Zewditu Hospital	55 (14.3)
	Ras Desta Damtew Hospital	2 (0.5)
Religion	Orthodox	281 (73.2)
	Muslim	49 (12.8)
	Protestant	48 (12.5)
	Others *	6 (1.5)
Highest educational grade	Grade 1–8	179 (46.6)
	Grade 9–10	111(28.9)
	Grade 11 and above	94 (24.5)
Occupation	Student	379 (98.7)
	Daily labourer	3 (0.8)
	Others (industry employees, begging)	2 (0.5)
Family monthly income	<1000 EBR	41(10.7)
	1000–<3000 EBR	175 (45.6)
	≥3000–5000 EBR	94 (24.5)
	≥ 5000 EBR	74 (19.3)
Family size	< 4	130 (33.9)
	4 – 5	198 (51.6)
	≥ 6	56 (14.6)
Living situation	Living with parents/responsible adult	369 (96.1)
	Living alone or with peers	15(3.9)

Others* - Catholic, Jehovah's Witness; SD = Standard Deviation; EBR = Ethiopian Birr

5.2.2 Anthropometric measurements

Participants' mean height was 155.7 ± 10.3 cm and mean weight 44.5 ± 8.6 kg. The mean BMI and MUAC values of study participants were 16.8 ± 2.5 kg/m^2 and 21 ± 2.8 cm, respectively. Statistical disparities were observed in nearly all anthropometric variables across age groups (Table 17).

Table 17. Descriptive analysis of ALHIVs' anthropometric variables by age category.

Description	Mean ± SD by age (years)				Test result (F-statistics value, df, p-value)
	10–13 (n=55)	14–17 (n=227)	18–19 (n=102)	10–19 (n=384)	
Height (cm)	143.3 ± 8.6	157.2 ± 9.1	159.3 ± 8.9	155.7 ± 10.3	F = 64.3, df =2, P < 0.001
Weight (kg)	34.8 ± 7.1	44.7 ± 7.2	49.0 ± 8.2	44.5 ± 8.6	F = 65.6, df = 2, p < 0.001
BMI (kg/m^2)	16.8 ± 2.5	18.1 ± 2.7	19.4 ± 3.2	18.3 ± 2.9	F = 15.2, df = 2, p < 0.001
MUAC (cm)	18.8 ± 1.9	21.0 ± 2.5	22.4 ± 2.9	21.1 ± 2.8	F = 37.3, df =2, p < 0.001
Skinfold thickness					
Biceps (mm)	4.35 ± 2.0	4.85 ± 2.16	4.93 ± 2.7	4.8 ± 2.3	F = 1.29, df =2, p = 0.278
Triceps (mm)	6.13 ± 2.5	8.0 ± 4.1	8.24 ± 4.5	7.8 ± 4.1	F = 5.75, df = 2, p = 0.003
Subscapular (mm)	6.53 ± 2.7	8.9 ± 4.6	10.2 ± 6.6	8.9 ± 5.1	F = 9.70, df = 2, p < 0.001
Supra-iliac (mm)	4.9 ± 2.3	7.4 ± 3.9	8.3 ± 4.6	7.3 ± 4.0	F = 13.5, df = 2, p < 0.001
S_4SKT (mm)	21.9 ± 8.5	29.2 ± 13.1	31.7 ± 16.1	28.8 ± 13.7	F = 9.66, df = 2, p < 0.001
Waist circumference (cm)	56.1 ± 7.6	64.4 ± 6.6	66.8 ± 7.3	63.8 ± 7.7	F = 44.2, df = 2, P < 0.001
Hip circumference (cm)	68.8 ± 8.8	81.5 ± 7.6	84.9 ± 7.9	80.6 ± 9.3	F = 79.7, df = 2, p < 0.001
Waist-to-hip ratio	0.82 ± 0.05	0.79 ± 0.06	0.78 ± 0.1	0.79 ± 0.1	F = 3.86, df = 2, p = 0.022
Waist-to-height ratio	0.39 ± 0.05	0.41 ± 0.04	0.42 ± 0.1	0.41 ± 0.5	F = 6.1, df = 2, p = 0.002
Body fat percentage	20.3 ± 10.5	18.9 ± 8.4	19.5 ± 8.6	19.3 ± 8.7	F = 9.66, df = 2, p = 0.526
Grip strength					
Left hand (kg)	15.5 ± 4.8	21.3 ± 6.7	23.1 ± 8.0	20.9 ± 7.2	F = 22.5, df = 2, p < 0.001
Right hand (kg)	13.7 ± 4.5	19.6 ± 6.3	21.1 ± 7.8	19.1 ± 6.9	F = 24.5, df = 2, p < 0.001

ANOVA was used to compare anthropometric measurements of participants. *p ≤0.05, **p ≤0.01 and *** p ≤0.001. BMI = body mass index, MUAC – mid-upper arm circumference, S_4SKT= sum of skinfold thickness

5.2.3 Psychosocial characteristics

Prevalence of anxiety

Of the study participants, half (n=190, 49.5%) reported experiencing anxiety. Of these, only a few (n=41, 8.1%) generated GAD-7 scores suggesting moderate to severe anxiety; a large minority (n=159, 41.4%) had mild anxiety related to their disease and condition. More female than male participants experienced mild to severe anxiety (n=109, 28.4%, n=81, 21.1%), but this difference was not statistically significant (Figure 12).

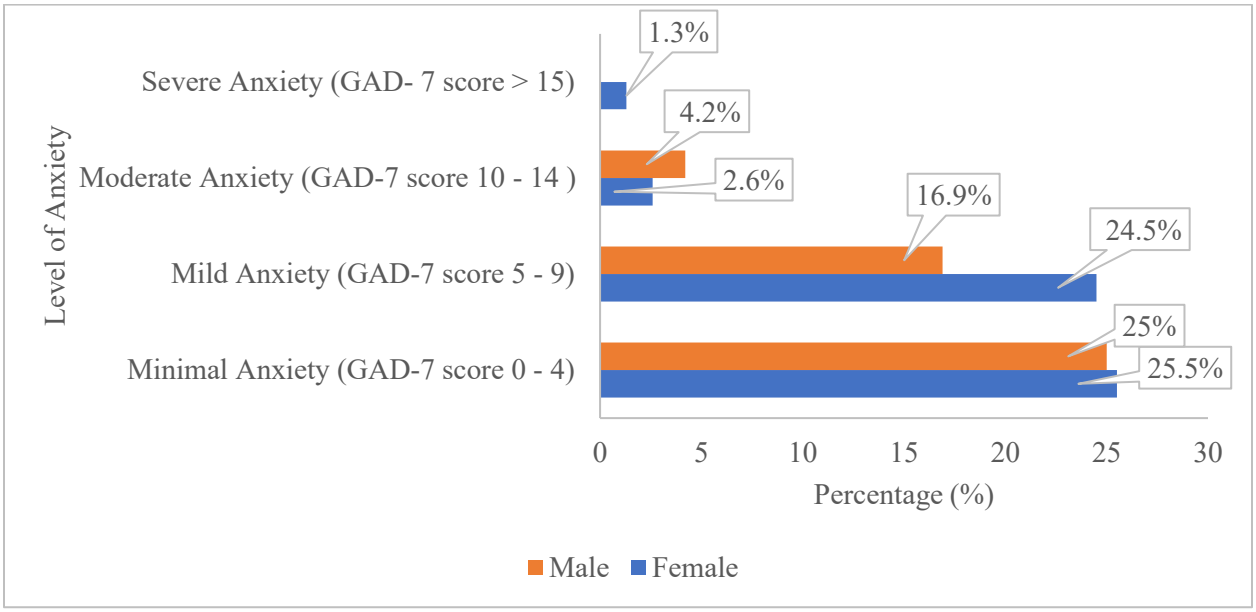

Figure 12. Prevalence of anxiety assessed using the Generalized Anxiety Disorder 7-item scale (GAD-7) among ALHIV on ART follow-up

Of mid-aged adolescent participants (14–17 years), 49.8% (n=113) reported mild to severe anxiety; 8.4% (n=19) were assessed as having moderate anxiety disorders, and 1.3% (n=3) reported severe anxiety disorders. In the late-age adolescent group (18–19 years) (n=102), 55.9% (n=57) of participants reported mild to severe anxiety. Within this group (n=102), 2.9% (n=3) had moderate anxiety disorders and 2.0% (n=2) had severe anxiety disorders. Among early-age adolescent participants (10–13 years) (n=55), 36.4% (n=20) reported mild to severe anxiety, and 7.3% (n=4) had moderate anxiety disorders, but none experienced severe anxiety (Figure 13).

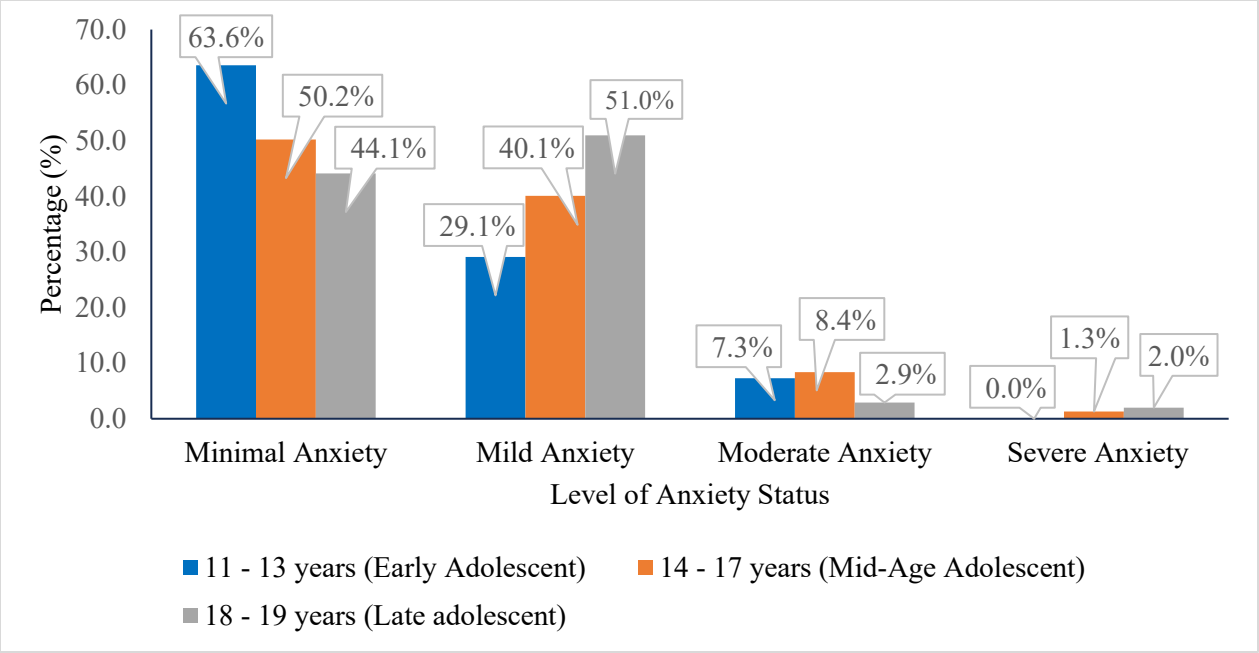

Figure 13. Prevalence of anxiety (GAD-7) by age category among ALHIV on ART follow-up

Prevalence of depression

Of the 384 study participants, 27.6% (n=106) reported experiencing depression. Of these, 6.8% (n=26) had moderate to severe depression. Regarding gender distribution, proportionately more female than male participants experienced mild to moderately severe depression (n=106, 27.6% versus n=76, 19.8%) (Figure 14).

The study found that 46.7% (n=106) of mid-age adolescent participants had mild to moderately severe depressive symptoms. Only 4.4% (n=10) had moderate depressive symptoms, and 1.3% (n=3) had moderately severe depressive symptoms. In the late-age adolescent group (n=102), 49.0% (n=50) of the participants experienced mild to moderately severe depressive symptoms. Within this group, 5.9% (n=6) had moderate depressive symptoms, and 2.0% (n=2) had moderately severe depressive symptoms. Among early-age adolescent participants (n=55), 47.3% (n=26) reported mild to moderately severe depressive symptoms. Of these early-age participants, 9.1% (n=5) had moderate depressive symptoms, but none experienced severe depressive symptoms (Figure 15).

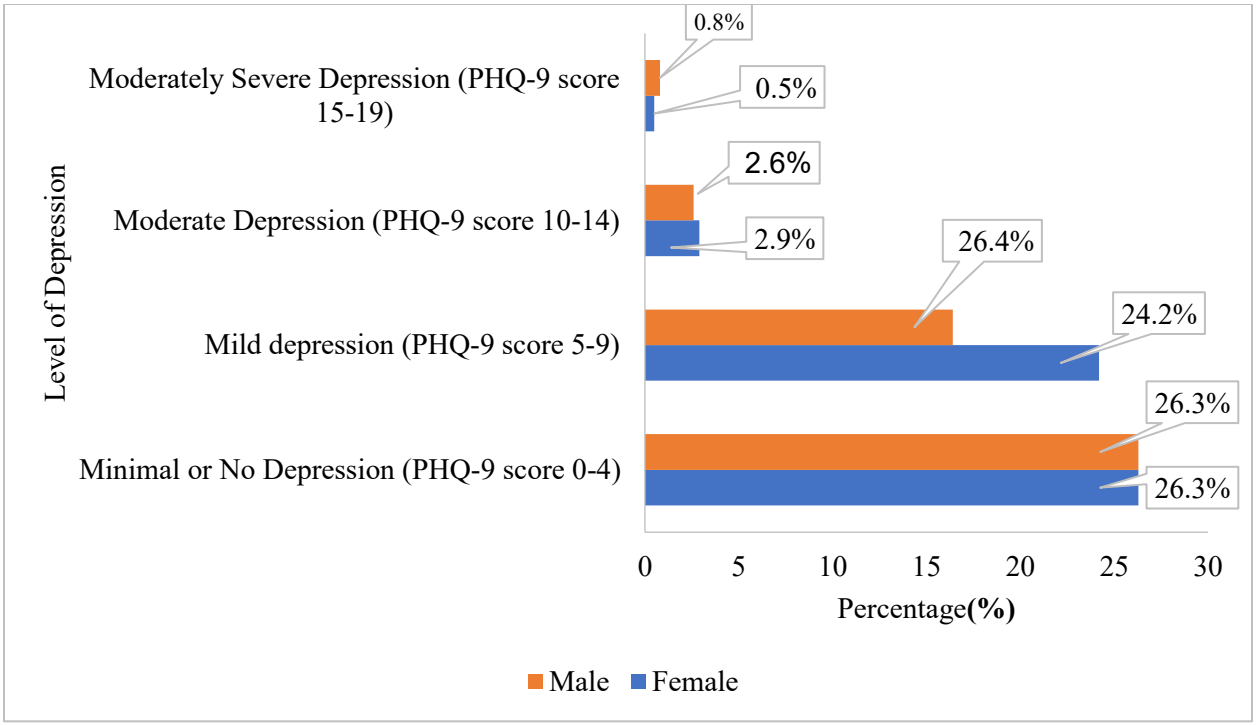

Figure 14. Distribution of depression assessed using a modified PHQ-9 among ALHIV on ART follow-up

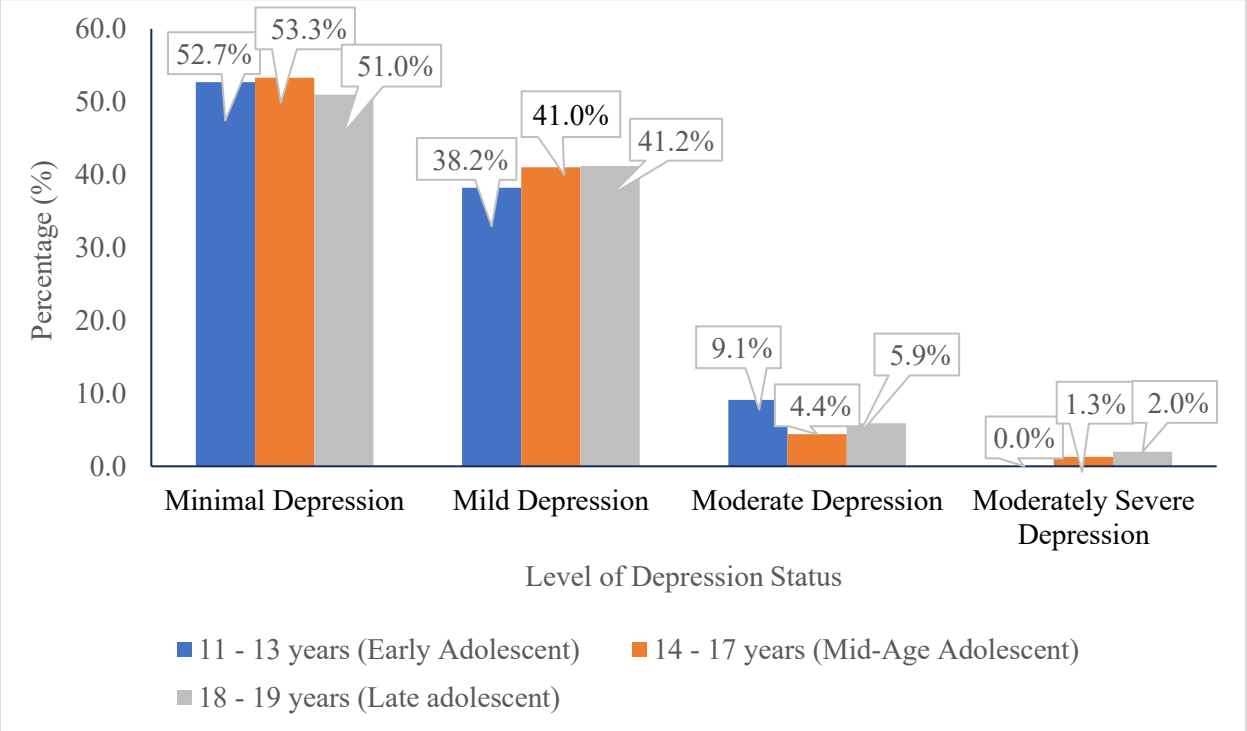

Figure 15. Distribution of depression assessed using a modified PHQ-9 by age category among ALHIV on ART follow-up

5.2.4 Environmental issues

Household food security, intake, supplementation and preservation

In total, 34.4 % (n=132) of the participants were worried about insufficient availability of food in their households. Additionally, 53.1% (n=204) of the participants ate an involuntarily restricted variety of foods, and 54.2% (n=208) were unable to consume their preferred foods. Moreover, 40.1% (n=154) of the study participants reported eating food they did not want and consuming smaller meals due to a lack of food in their households. Similarly, 44.8% (n=172) of the study participants had fewer meals than desired per day, and 25.8% (n=99) had no food to eat in their households due to resource constraints. Additionally, 55.3% (n=212) of the study participants went to bed hungry at least one to three times per week. However, only 15.4% (n=59) of the participants had gone a full day and night without eating due to lack of food. Most participants (83.6%, n=321) reported a history of skipping meals at some point in their lifetime. More than half of the participants (n=204, 53.1%) lived in food-insecure conditions (Appendix II, Supplementary Table 5).

Over a quarter of the participants (n=110, 28.6%) experienced feeding-related problems such as vomiting, diarrhea and loss of appetite. More than half (62%, n=238) of the participants took nutrition supplements (RUTF) from their ART clinic during their follow-up period. Among the participants who received supplementation (n=238), more than half received one sachet of 92 gm RUTF per day for two months or less (Appendix II, Supplementary Table 5).

Most study participants used canning (n=353, 91.9%) and drying (n=307, 79.9%) as household food preservation methods. About half also utilised refrigeration, freezing and salting (Figure 16).

Household water and toilet facilities

The study found that 77.3% (n=297) of the participants lived in households with access to clean water. Among the remaining 87 participants who did not have access to clean water, nearly half (n=42, 48.3%) treated their water to make it safe for drinking or other uses. Chlorine-based water treatment solution and water filters were the major methods of treating water. Most participants (82%, n=315) households had pit latrines, and 17.2% (n=66) had flush toilets; only 0.3% (n=1) of the participants practised open-field defecation (Appendix II, Supplementary Table 6).

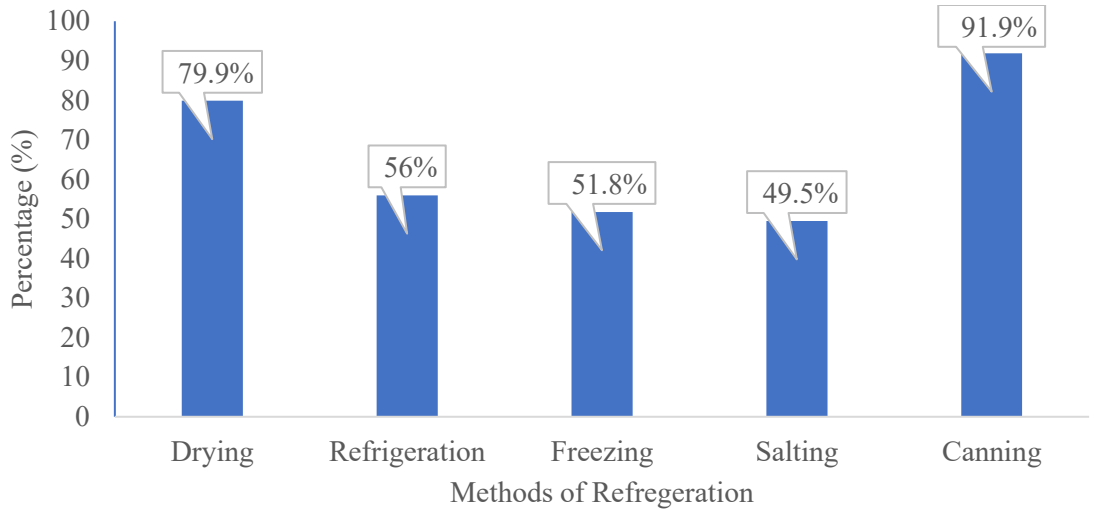

Figure 16. Distribution of food preservation methods used in households of ALHIV on ART follow-up in Addis Ababa and Oromia regions, Ethiopia, 2024

5.2.5 Lifestyle-related characteristics

About one-third of participants (n=115, 29.9%) had used alcohol at some point in their lifetime, while only 38 (9.9%) reported the current use of alcoholic drinks. On the AUDIT screening test, 13 of 38 participants (34.2%) reported risky, high-risk or addictive alcohol consumption patterns (Table 18). Of those who reported drinking alcohol, proportionately more male than female participants experienced medium risk to addictive alcohol consumption patterns (n=10, 26.4%, versus n=3, 7.9%). In terms of age distribution, 23.7% (n=9) of late-age adolescent participants (reported risky to addictive alcohol consumption patterns. Of these, 7.9% (n=3) had a high risk of addiction pattern. Only 10.5% (n=4) of mid-age adolescent participants had risky patterns of alcohol consumption (Table 18).

5.2.6 Health-related characteristics

HIV-related information

Overall, 79.9% (n=307) of the study participants had been aware of their HIV status for four or more years. Most (63%, n=242) of the study participants had started ART 15 years ago or more; however, 47.4% (n=182) had a history of missed ART clinic appointments (Appendix II, Supplementary Table 7).

Table 18. Alcohol consumption (AUDIT-C) of ALHIV on ART follow-up

Variables	Frequency N (%)
Alcohol consumption risk category as per AUDIT screening test (n=38)	
Low risk (AUDIT Score 1 – 7)	25 (65.8)
Risky (AUDIT Score 8 – 15)	10 (26.3)
High Risk (AUDIT Score 16 - 19)	1 (2.6)
Addiction Likely (AUDIT Score 20 - 40)	2 (5.3)

AUDIT - Alcohol Use Disorders Identification Test

Overall, most (81.8%, n=314) of the study participants had HIV-positive family members in their households. Of these, 52.9% (n=166) had only an HIV-positive mother in their families, whereas 24.6% (n=76), 13.9% (n=43) and 8.3% (n=26) of participants had both parent HIV-positive, nuclear family members HIV-positive (i.e., mother, father, brother and/or sister), and only an HIV positive father, respectively.

In total, 81.5% (n=313) of the participants had experienced opportunistic infections at some point in their lives. Of those, 57.5% (n=221) had chronic respiratory illnesses such as colds, pneumonia, and tuberculosis. One third (33.1%, n=127) of these participants had a history of tuberculosis and were being treated with an anti-tuberculosis regimen.

In addition to these common infections, study participants faced various other health problems, including gastrointestinal system problems (n=217, 56.5%) such as salmonellosis and gastritis/peptic ulcer disease), dermatologic problems (n=178, 46.4%), and central nervous system problems (n=128, 33.3%) such as headaches, meningitis, epilepsy and Guillain-Barré Syndrome. Furthermore, half of the participants had experienced some form of illness in the previous three months. Of these participants, 67.2% had experienced respiratory system problems, while 19.3% (n=74) had suffered gastrointestinal system problems.

Clinical characteristics recorded in medical record profiles

Of the 384 ALHIV participating in the study, 50.5% (n=194) had been diagnosed and commenced ART at the (median) age of 3.95 years or above, at a mean age of 4.66 ± 3.7 years.

Assessment of CD_4 levels at ART initiation provides valuable insights into the overall health status and nutritional well-being of individuals living with HIV/AIDS (Bhaskaran et al., 2008) . In this study, half of the participants had a CD_4 level of 500–1500 cells/mm^3 on ART enrolment and 36.7% (n=141) had a CD_4 level below 500 cells/mm^3 at this time.

The WHO and Centres for Disease Control and Prevention (CDC) (Pham et al., 2022; WHO, 2019) regard the assessment of viral load as an essential component of HIV/AIDS management that can improve treatment adherence, immune function, and nutritional status, ultimately improving health outcomes in this population. Accordingly, 98.7% (n=379) of the study participants had undergone viral load assessment within the previous three months. Of these participants, 97.7% had a viral load test result of less than 150 copies of viral load per ml of blood, and only 1% of the participants had 150 copies of viral load or more per ml of blood. Before starting ART, more than half of the participants were in clinical Stage I (n=247; 64.3%) and 29.4% (n=113) were in Stage III. After ART initiation, most participants (96.6%) were in clinical Stage I. This indicates a considerable improvement in the clinical status of the participants due to ART treatment. Most study participants (n=305; 79.4%) were taking first-line highly active anti-retroviral therapy (HAART) (Appendix II, Supplementary Table 8).

5.3 Objective 2: nutritional status

Participants' nutritional status was examined using three different measures: BAZ (indicating thinness), HFA (to indicate stunting) and MUAC.

5.3.1 Prevalence of malnutrition/thinness based on body mass index -for-age indices

Malnutrition among ALHIV was evaluated using the BAZ based on the 2007 WHO Growth Reference. Those with a BAZ of -2 SD were classified as thin, while severe thinness was defined by a BAZ of -3 SD below the mean. Adolescents with a BAZ above -2 SD were considered "normal" – not classified as thin (De Onis et al., 2007; FANTA, 2013; WHO, 2007).

According to WHO Growth Reference 2007 standards, less than one third (n=93; 24.2%) of the study participants were categorised as thin (Z-scores < -2 SD). Of this group, 26.9% (n=25) were severely thin (Z-Score < -3 SD) and 73.1% (n=68) were moderately thin (-3 SD < Z-score < -2 SD) (FANTA-III, 2013; Iheme et al., 2022; WHO, 2007). The prevalence of thinness varies by gender; more males than females were thin (Figure 17).

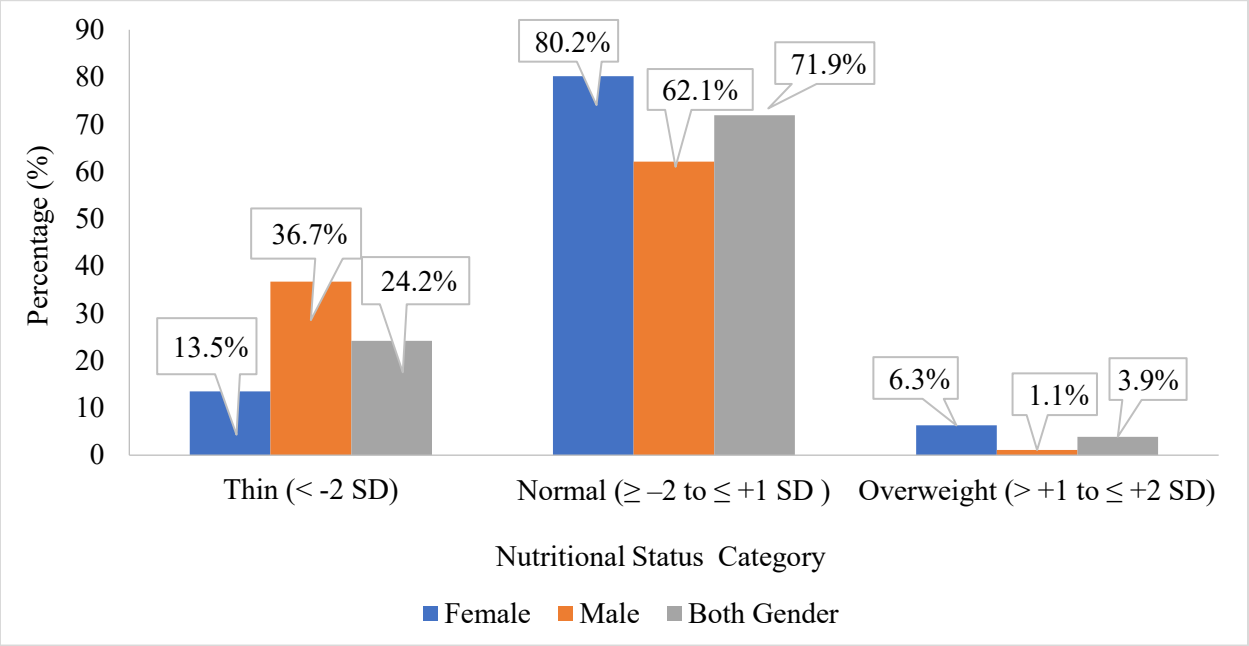

Figure 17. Level of undernutrition assessed as BMI-for-Age of ALHIV on ART follow-up.

The thinness, normal, and overweight status of the study participants according to age distribution is presented in Figure 18. The prevalence of thinness varied by age group. The highest prevalence was observed in the late adolescent group (n=102), with 27.5% (n=28) classified as thin. This was followed by the mid-age adolescent group (n=227), of whom 24.7% (n=56) were categorised as thin. The lowest prevalence was found among early adolescents (n=55), with 16.4% (n=9) classified as thin (Figure 18).

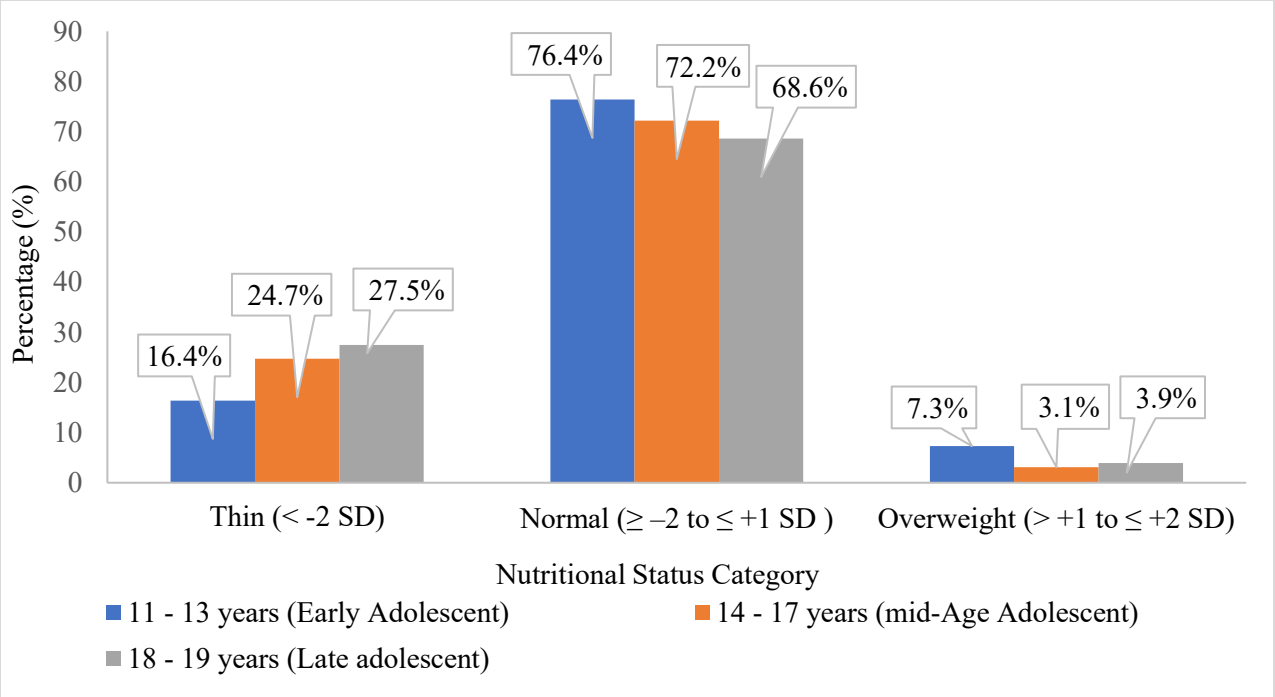

Figure 18. Distribution of nutritional status according to BMI-for-age by age category of ALHIV on ART follow-up.

5.3.2 Prevalence of stunting based on height-for-age indices

Malnutrition among ALHIV was evaluated using the HFA Z-score based on the 2007 WHO Growth Reference. Those with HFA Z-score of -2 SD to -3 SD were classified as stunted, while severe stunting was defined by an HFA Z-score below -3 SD. Adolescents with an HFA Z-score above -2 SD were considered "normal" – not classified as stunted (de Onis et al., 2007; FANTA-III, 2013; WHO, 2007).

Using the WHO Growth Reference 2007 standards, 21.7% (n=83) of the study participants had stunted growth (Z-Score <-2SD). Of this group (n=83), 28.9% (n=24) were severely stunted (Z-Score <-3SD) (WHO, 2006) (Figure 19).

The highest prevalence of stunting was observed among the late adolescent age group (n=102), with 26.4% (n=27) of the group being stunted and 8.8% (n=9) being severely thin. Among the mid-age adolescents (n=227), 19.8% (n=45) were stunted and 5.7% (n=13) were severely stunted. The early adolescent age group was the least affected by stunted growth (Figure 19).

Male ALHIV showed a slightly higher prevalence of stunting at 22.6% (n=40), with 7.3% (n=13) being severely stunted. In comparison, females had a stunting prevalence of 20.8% (n=43), with 5.3% (n=11) being severely stunted.

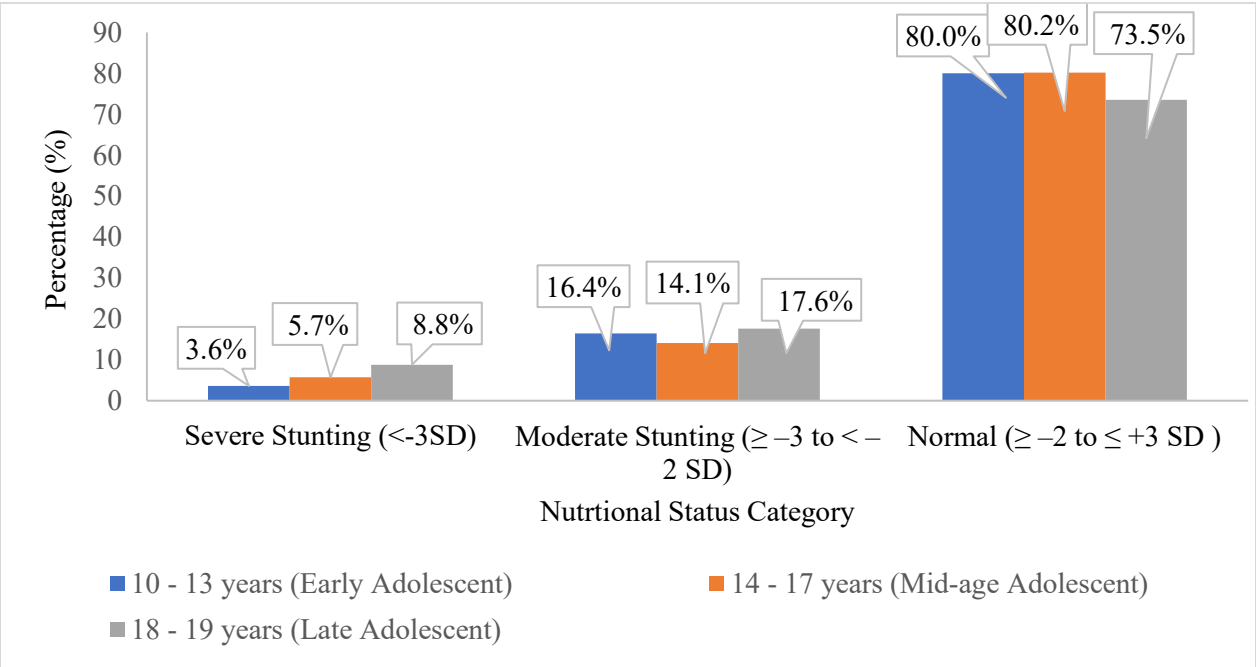

Figure 19. Distribution of stunting status related to age category of ALHIV on ART follow-up.

5.3.3 Prevalence of malnutrition based on MUAC-for-age indices

In this study, MUAC-for-age indices were used to categorise acute malnutrition levels based on age. Two distinct MUAC cutoff points were employed for this purpose. Severe acute malnutrition was defined as MUAC < 16 cm for ages 10–14 years and < 18.5 cm for ages 15–19 years. Moderate acute malnutrition was classified as MUAC measurements of 16–18.49 cm for ages 10–14 years and 18.5–21 cm for ages 15–19 years. Normal status was identified by MUAC measurements ≥ 18.5 cm for ages 10–14 years and ≥ 21 cm for ages 15–19 years (de Onis et al., 2007; Kristen & Lesley, 2018). In total, 34.9% (n=134) of the study participants were identified as malnourished based on MUAC measurements (Kristen & Lesley, 2018). Among the malnourished group (n=134), 80.6% (n=108) and 19.4% (n=26) of the study participants had moderate acute malnutrition and severe acute malnutrition, respectively (Figure 20).

Among the age groups, 37.4% (n=85) of mid-aged adolescents (n=227) experienced acute malnutrition, with 8.4% (n=19) classified as having severe acute malnutrition. In contrast, the

prevalence of severe acute malnutrition was lower in the early adolescent age group (n=55) and the late adolescent age group (n=102), comprising 3.6% (n=2) and 4.9% (n=5) of the total, respectively. This pattern was reversed for moderate acute malnutrition, which affected 34.5% (n=19) of early adolescent participants, compared to 29.1% (n=66) of mid-age adolescents and 22.5% (n=23) of late adolescent participants (Figure 20).

The prevalence of acute malnutrition was higher among male participants (n=73; 41.2%) than female participants (n=61; 29.4%). Among the male participants, 9.6% (n=17) had severe acute malnutrition, while 4.3% of female participants (n=9) were classified as having severe acute malnutrition.

5.4 Objective 3: Anthropometric parameters associated with malnutrition

5.4.1 Correlation analysis of anthropometric measurements

Anthropometric measurements revealed important insights into the nutritional status of ALHIV. The moderate positive correlations between the sum of four skinfold thickness measurements and both BFP ($r = 0.436$, $p < 0.001$) and BMI-for-age ($r = 0.335$, $p < 0.001$) indicate that increases in skinfold thickness are associated with higher BFP and BMI, suggesting that skinfold measurements are a reliable indicator of body fat and overall nutritional status. These correlations emphasise the utility of skinfold thickness and BFP in evaluating the effectiveness of nutritional interventions and monitoring growth in this population. However, the weaker correlation between skinfold thickness and MUAC-for-age ($r = 0.296$, $p < 0.001$) suggests that MUAC captures different aspects of body composition, such as muscle mass, which are less closely related to skinfold thickness (Table 19).

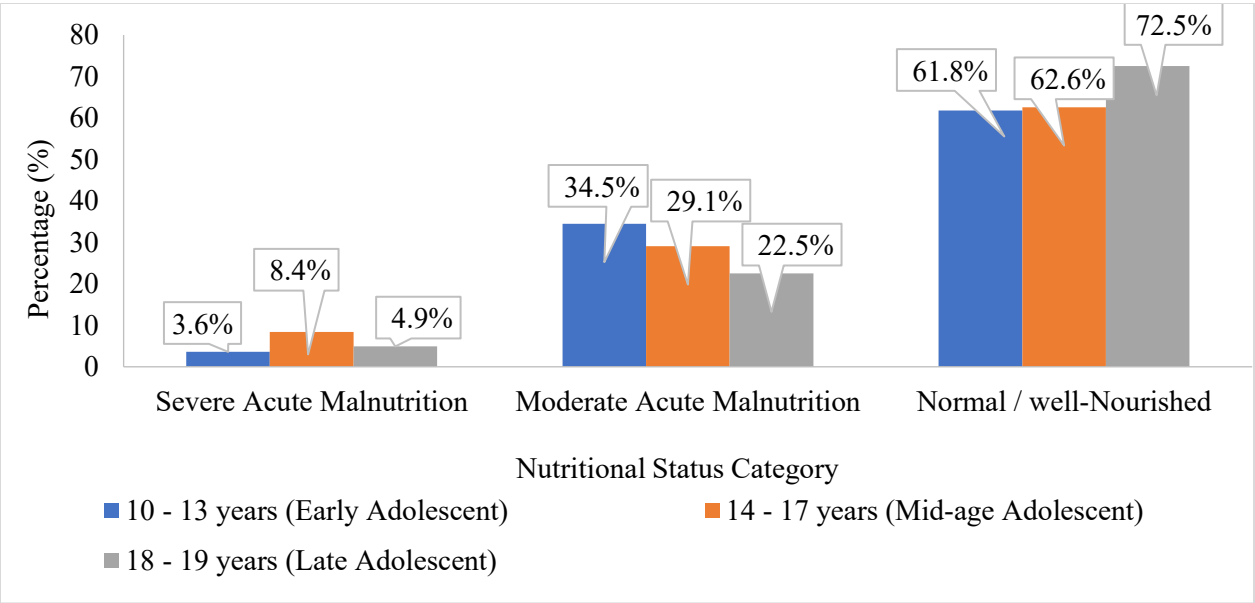

Figure 20. Distribution of malnutrition status according to MUAC measurement by age category for ALHIV on ART follow-up

These findings imply that a comprehensive approach to assessing nutritional status should incorporate multiple anthropometric measures. Clinicians should use a combination of skinfold thickness, BMI and MUAC to gain a fuller understanding of an adolescent's nutritional condition. This multidimensional assessment more accurately reflects the health status of ALHIV and can guide tailored nutritional interventions. For public health policy, integrating various anthropometric measures into routine evaluations can improve the identification and management of malnutrition among ALHIV. Overall, these correlations highlight the importance of a nuanced approach to nutritional assessment, which can enhance treatment plans and contribute to better health outcomes for ALHIV.

Table 19. Pearson correlation analysis for anthropometric indices

Variables	BFP	BMI-for-Age (BAZ)	MUAC-for-age (cm)	S_4SKT (mm)
BFP	-	0.264**	0.148**	0.436**
BMI-for-Age (BAZ)	0.264**	-	0.377**	0.335**
MUAC-for-age	0.148**	0.377**	-	0.298**
S_4SKT	0.436**	0.335**	0.298**	-

Data presented are r values.
Bold values indicate significant positive correlations.
**$p < 0.001$ (2-tailed)
BFP = body fat percentage; BMI = body mass index; MUAC = mid-upper arm circumference; S_4SKT = the sum of four skinfold thicknesses (biceps, triceps, subscapular, and supra-iliac SKT)

5.4.2 Anthropometric measures to assess nutritional status

This study adopted a comprehensive approach to assess the nutritional status of ALHIV by employing multiple anthropometric measures, notably BAZ, HAZ, and MUAC-for-age indices. These measures offer unique insights into various aspects of nutritional health, facilitating a nuanced understanding of the challenges ALHIV face. By comparing mean values to established WHO standards, the study determined rates of acute malnutrition, thinness, and stunting.

In nutritional assessment among ALHIV, the absence of a universally accepted single anthropometric measure necessitates use of multiple metrics. This study employed linear regression analysis to elucidate the relationship between various anthropometric measurements, including MUAC, S4SKT, hip circumference, and BFP, and thinness/malnutrition using BAZ. By revealing significant associations between these metrics and thinness/malnutrition, our analysis underscored the importance of adopting a holistic approach to nutritional assessment.

This regression analysis explored the relationship between several anthropometric indices and thinness among ALHIV receiving ART. While all anthropometric characteristics were examined, only five demonstrated significant associations with BMI-for-age indices in determining thinness. In simple linear regression, thinness growth standard/malnutrition was positively associated with measurements of MUAC < 21 cm (β = -0.38), S_4SKT < 25 cm (β = -0.34), hip circumference < 82 cm (β = -0.33), and waist circumference < 64 cm (β = -0.21) (Table 20).

Multivariable stepwise backward regression analysis revealed significant associations between various anthropometric measures and thinness or malnutrition in ALHIV, as indicated by BAZ scores. Specifically, a MUAC of less than 21 cm was associated with lower BAZ scores, with a β coefficient of -0.37 (95% CI -0.42–-0.26). This indicates that each 1 cm decrease in MUAC is linked to a 0.37 decrease in BAZ, reflecting a higher risk of thinness. Similarly, S4SKT below 25 cm was associated with a β coefficient of -0.25 (95% CI -0.29–-0.13), meaning each 1 cm decrease in S4SKT corresponds to a 0.25 decrease in BAZ, indicating an increased risk of malnutrition. Additionally, hip circumference measurements below 82 cm were associated with a β coefficient of -0.16 (95% CI -0.23–-0.06), where each 1 cm decrease in hip circumference reflects a 0.16 decrease in BAZ, signifying a higher likelihood of thinness. These results highlight the strong connection of low MUAC, skinfold thickness, and hip circumference and higher risks of thinness and malnutrition. They emphasise the importance of monitoring these anthropometric indicators to better identify ALHIV at heightened risk of malnutrition and to implement targeted nutritional interventions (Table 20).

Table 20. Anthropometric measurements associated with thinness among ALHIV on ART follow-up

Variable	Thinness (undernutrition with BMI-for-Age Z-score indicators)	
	Simple LR	Adjusted LR
	β coefficient (95%CI)	β coefficient (95% CI)
MUAC < 21 cm	-0.38 (-0.42, -0.26) ***	-0.37 (-0.42, -0.26) ***
(S4SKT < 25 cm	-0.34 (-0.37, -0.21) ***	-0.25 (-0.29, -0.13) ***
Hip circumference < 82 cm	-0.33 (-0.37, -0.20) ***	-0.16 (-0.23, -0.05) **
Waist circumference < 64 cm	-0.21 (-0.26, -0.10) ***	

Significant at *P value ≤ 0.05, **P value ≤ 0.01 and p*** value ≤ 0.001
Model fitness –
F-statistics – 35.09, PV < 0.001 Adjusted R^2=0.211; SE=0.381; Durbin Watson=1.935
Model 1 - Predictors MUAC
Model 2 -Predictors: MUAC, S4SKT
Model 3 -Predictors: MUAC, S4SKT, and hip circumference
Dependent Variable: Thinnes growth

5.4.3 Determinant factors for malnutrition

Standard criteria for malnutrition were applied using BAZ < -2 SD, HFA Z-score < -2 SD, and MUAC-for-age indices among ALHIV. Regression analysis explored a wide range of potential determinants indicated by the systematic review (see chapter 2): socio-demographic characteristics, anthropometric measures, psychosocial factors, environmental influences, lifestyle behaviors, and HIV-related medical indicators. Variables with a p-value below 0.25 were included in multivariate logistic regression models, with statistical significance determined at $p < 0.05$. Various factors showed significant associations with both BMI-for-age and MUAC-for-age indices.

First, the study sought to identify determinant factors for thinness/malnutrition (BAZ < -2SD) among ALHIV receiving ART in selected hospitals. Subsequently, the study investigated factors associated with acute malnutrition. Factors shown to determine thinness, defined using BAZ, were sociodemographic variables (age, sex, household monthly income), lifestyle and clinical variables (nutritional assessment during ART initiation, anxiety status, depression status, time of HIV status awareness, longstanding disease), and food security and supplementation-related factors (ever had food insecurity concern at household, ever had nutrition supplementation).

Socio-demographic variables

Among all the sociodemographic variables included in the regression model, only sex was significantly association with thinness. Female ALHIV were 73% less likely to be thin or malnourished than their male counterparts (AOR = 0.27; 95% CI: 0.16, 0.45) (Table 21).

Food security and supplementation-related factors

Adolescents living with HIV who experienced food insecurity were found to be 1.63 times more likely to be thin or malnourished than those who did not face food insecurity (AOR = 1.63; 95% CI: 1.02, 2.62). On the other hand, ALHIV who received nutritional supplementation had a 45% lower likelihood of being thin or malnourished than those who did not (AOR = 0.55; 95% CI: 0.32, 0.95) (Table 21).

Clinical variables

ALHIV who had never experienced chronic infections such as tuberculosis were 52% less likely to experience thinness or malnourishment than those who had suffered such infections (AOR = 0.48; 95% CI: 0.29, 0.80).

Similarly, ALHIV without symptoms of GAD (GAD scores < 5) were 47% less likely to be thin or malnourished than those scoring at levels suggesting GAD (AOR = 0.53; 95% CI: 0.32, 0.88).

Additionally, ALHIV experiencing minimal to mild symptoms of depression (PHQ-9 scores < 9) were 60% less likely to be thin or malnourished than those with moderate to moderately severe depression scores (AOR = 0.40; 95% CI: 0.17, 0.91) (Table 21).

Table 21. Factors associated with thinness/malnutrition (BAZ) among ALHIV on ART in Addis Ababa and Oromia Regions, 2024

Variables	Category	Nutritional status		COR (95% CI)	AOR (95% CI)
		Thin/ malnourished (BAZ<-2SD)	Normal (BAZ ≥-2 SD)		
		N (%)	N (%)		
Age	Early adolescent age	9 (2.3)	46 (15.8)	0.57 (0.27, 1.22)	
	Mid and late adolescent age	84 (21.3)	245 (63.8)	1	
Sex	Male	109 (28.4)	98 (25.5)	1	1
	Female	131 (34.1)	46 (12.0)	0.27 (0.16, 0.44)	0.27(0.16, 0.45) ***
Family monthly income	< 3000 EBR	128 (33.3)	51 (13.3)	1	
	≥ 3000 EBR	56 (14.6)	55 (14.3)	0.20 (0.74, 1.18)	
Ever had food insecurity concerns in the household	No	52 (13.5)	127 (33.1)	1	1
	Yes	41 (10.7)	164 (42.7)	1.64 (1.02, 2.62)	1.63 (1.02, 2.62) *
Ever had a nutritional assessment during ART initiation	No	24 (6.3%)	122 (31.8%)	1	
	Yes	69 (18.0%)	169 (44.0%)	0.63 (0.36, 1.10)	
Ever had nutrition supplementation intake	No	83 (21.6)	63 (16.4)	1	1
	Yes	157 (40.9)	81 (21.1)	0.48 (0.29, 0.81)	0.55 (0.32, 0.95) *
Duration aware of HIV status	≤ 3 years ago,	24 (6.3)	53 (13.8)	1.56 (0.9, 2.71)	
	≥ 4 years ago,	69 (18.0)	238 (62.0)	1	
	Yes	41 (10.7)	86 (22.4)	1	1

Ever had long-lasting infections such as tuberculosis	No	52 (13.5)	205 (53.4)	0.53 (0.33, 0.86)	0.48 (0.29, 0.80) **
GAD scores indicative of GAD	Yes	56 (14.6)	134 (34.9)	1	1
	No	37 (9.6)	157 (40.9)	0.56 (0.35, 0.91)	0.53 (0.32, 0.88) **
PHQ-9 scores indicative of depression	Moderate to moderately severe depression scores	111 (2.9)	15 (3.9)	1	1
	Minimal to mild depression scores	82 (21.4)	276 (71.9)	0.41 (0.18, 0.92)	0.40 (0.17, 0.91) *

Significant at *P-value <0.05, **P-value <0.01 and ***P-value<0.001; GAD: Generalized Anxiety Disorder; PHQ-9: Patient Health Questionnaire-9

5.4.4 Factors associated with acute malnutrition

Several factors were shown to be associated with acute malnutrition using MUAC-for-age indices in ALHIV patients receiving ART in the selected hospitals. They were sociodemographic variables (age, sex, family size), lifestyle and clinical variables (anxiety status, haemoglobin, alanine aminotransferase level (SGPT), time of HIV status awareness, longstanding disease), and food security and intake-related factors (ever had food insecurity in household, number of meals eaten in 24 hours, ever had nutrition supplementation).

Sociodemographic variables

Early and mid-aged ALHIV were more likely to suffer from malnutrition than late-age ALHIV. Malnutrition risks were 1.94 times higher in ALHIV aged 10–17 years (AOR = 1.94; 95% CI: 1.03, 3.64). Female adolescents with HIV were 42% less prone to being malnourished than their male counterparts (AOR = 0.58; 95% CI: 0.38, 0.88). ALHIV residing in households with three or fewer family members were 56% less likely to experience malnutrition than those living in households with four or more members (AOR = 0.44; 95% CI: 0.24, 0.81) (Table 22).

Lifestyle and clinical variables

Adolescents living with HIV without GAD (GAD-7 score < 5) were 50% less likely to develop malnutrition than those with GAD (GAD-score ≥5) (AOR = 0.50; 95% CI: 0.28, 0.89). ALHIV who had known their status for three years or less (AOR = 2.96; 95% CI: 1.62, 5.40) had a 2.96 times higher risk of malnutrition than those who became aware four or more years earlier.

Adolescents living with HIV with haemoglobin levels below 11.5 grams per decilitre were 7.29 times more likely to record malnutrition than those with haemoglobin levels exceeding 15 grams per decilitre (AOR = 7.29; 95% CI: 1.31, 40.5). ALHIV with SGPT levels between 0 and 50 U/L were 71% less likely to experience malnutrition (AOR = 0.29; 95% CI: 0.09, 0.99), than those with SGPT levels of 50 U/L or higher.

ALHIV who had never experienced a prolonged illness such as tuberculosis were 48% less likely to experience malnutrition than those who had (AOR = 0.52; 95% CI: 0.33, 0.81) (Table 22).

Food security and intake-related factors

ALHIV who had experienced food insecurity within their households ran a 1.8-fold higher risk of malnutrition (AOR = 1.85; 95% CI: 1.09, 2.14) than those who had never encountered such issues. In addition, malnutrition was more prevalent among ALHIV who consumed fewer meals per day than required. The odds of malnutrition were 1.86 times higher in ALHIV who had ever eaten two meals or fewer in a day than in those who had always consumed three or more meals daily (AOR = 1.86; 95% CI: 1.08, 3.19). Furthermore, ALHIV receiving nutritional supplementation were 55% less likely to experience malnutrition than those without supplementation (AOR = 0.45; 95% CI: 0.36, 0.79) (Table 22).

Table 22. Factors associated with acute malnutrition using MUAC-for-age indices among ALHIV on ART in Addis Ababa and Oromia Regions, 2024

Variables	Category	Nutritional Status using MUAC-for-Age indices		COR (95% CI)	AOR (95% CI)
		Acutely Malnourished	Not acutely Malnourished		
		N (%)	N (%)		
Age	Early and mid-adolescent age (10–17 years)	106 (27.6)	176 (45.8)	1.59 (0.97, 2.62)	1.94 (1.03, 3.64) *
	Late adolescent age (18–19 years)	28 (7.3)	74 (19.3)	1	1
Sex	Female	61 (15.9)	146 (38.0)	0.59 (0.39, 0.91)	0.58 (0.38, 0.88) *
	Male	73 (19.0)	104 (27.1)	1	1
Household monthly income	< 3000 EBR	82 (21.4)	134 (34.9)	1.36 (0.89, 2.09)	
	≥ 3000 EBR	52 (13.5)	116 (30.2)	1	
Family size	Less than or equal to three	35 (9.1)	95 (24.7)	0.58 (0.36, 0.92)	0.44 (0.24, 0.81) *
	Four and above	99 (25.8)	155 (40.4)	1	1
Ever had food insecurity concerns in households	Yes	64 (16.7)	141 (28.4)	1.46 (0.96, 2.22)	1.85 (1.09, 2.14) *
	No	70 (18.2)	109 (28.4)	1	1
Number of meals eaten in 24 hours (day and night)	≤ 2 meals	30 (7.8)	30 (7.8)	2.11 (1.21, 3.69)	1.86 (1.08, 3.19) *
	3–5 meals	104 (27.1)	220 (57.3)	1	1
Ever had nutrition supplementation intake	No	39 (10.2)	107 (27.9)	0.55 (0.35, 0.86)	0.45 (0.36, 0.79) **
	Yes	95 (24.7)	143 (37.2)	1	1
Duration aware of HIV status	≤ 3 years ago	42 (10.9)	35 (9.1)	2.80 (1.68, 4.67)	2.96 (1.62. 5.40) ***
	≥ 4 years ago	92 (24.0)	215 (56.0)	1	1

PHQ-9 scores indicative of depression	Minimal/no depression scores	64 (16.7)	138 (35.9)	0.74 (0.49, 1.13)	
	Mild to severe depression scores	70 (18.2)	112 (29.2)	1	
GAD scores indicative of GAD	No	58 (15.1)	136 (35.4)	0.64 (0.42, 0.98)	0.50 (0.28, 0.89) *
	Yes	76 (19.8)	114 (29.7)	1	1
Longstanding disease (e.g., tuberculosis)	No	57 (14.8)	70 (18.2)	0.53 (0.34, 0.82)	0.52 (0.33, 0.81) **
	Yes	77 (20.1)	180 (46.9)	1	1
Haemoglobin status	<11.5 gm/dl	26 (7.2)	29 (8.1)	3.59 (1.06, 12.12)	7.29 (1.31, 40.5) *
	11.5–15.0 gm/dl	98 (27.3)	186 (51.8)	1.70 (0.95, 3.05)	1.92 (0.83, 4.42)
	>15.0 gm/dl	4 (1.1)	16 (4.5)	1	1
Alanine transaminase (SGPT)	0–50 U/L	86 (36.8)	135 (57.7)	0.40 (0.13, 1.26)	0.29 (0.09, 0.99) *
	>50 U/L	8 (3.4)	5 (2.1)	1	1

Significant at *P-value <0.05, **P-value <0.01 and ***P-value<0.001; GAD: Generalized Anxiety Disorder; PHQ-9: Patient Health Questionnaire-9

5.5. Summary of key findings

In response to objective 1, the findings revealed that largest groups of ALHIV were those aged 14–17 years, female, from households with moderate incomes (1000–3000 EBR/month), and family sizes of 4–5 people. Food insecurity was common, despite the prevalent use of nutritional supplementation such as RUTF. Although there were statistical disparities in anthropometric variables among participants of different age groups, concerns remained about the limited application of diverse anthropometric measurements to assess nutritional status across these groups. Psychosocial challenges, including anxiety and depression, were common, especially among mid-aged adolescents. Substance use, particularly alcohol consumption, was prevalent, and more so among older adolescents and males. Participants reported delayed disclosure of their HIV status and ART initiation, incurring a substantial burden of opportunistic infections. However, improvements were seen post-ART initiation, particularly in viral load outcomes and clinical staging. These findings highlight the multifaceted challenges ALHIV face, and the need for comprehensive interventions tailored to their diverse needs for improved well-being and health outcomes.

In response to objective 2, the study revealed that ALHIV face significant nutritional challenges, as evidenced by the high prevalence of thinness, acute malnutrition and stunting. Approximately 24.2% of participants were thin, with a higher prevalence among late adolescent age groups. Moreover, 34.9% exhibited (primarily moderate) acute malnutrition. Stunting affected 21.7% of participants, with 6.3% severely stunted and males showing a slightly higher prevalence than females. These findings highlight the critical importance of employing comprehensive multi-method assessments to evaluate malnutrition among ALHIV, given the complex nature of malnutrition in this population.

In response to objective 3, findings revealed key determinants of both thinness and acute malnutrition among ALHIV receiving ART. Notably, females had lower prevalence of thinness than males, while food insecurity was associated with higher thinness prevalence. Conversely, nutritional supplementation was associated with reduced thinness prevalence. For acute malnutrition, significant variables included age, with early and mid-aged adolescents facing higher risks, and gender, with females exhibiting decreased prevalence. Additionally, factors such as household size, absence of GAD, shorter duration of HIV status awareness, lower hemoglobin

levels, absence of chronic illnesses like tuberculosis, food insecurity, and inadequate meal consumption were associated with increased malnutrition risks. These findings underscore the multifaceted nature of nutritional challenges among ALHIV, and the importance of targeted interventions across sociodemographic, clinical, and food security domains.

Chapter Six: Energy and Nutrient Intake and its Effect on the Nutritional Status of Adolescents Living with HIV

This chapter responds to research question 5 and presents the findings on food consumption and eating habits of ALHIV, and their implications for nutritional status. This component of the study compared Ethiopian ALHIVs' energy and nutrient intake to the WHO/FAO standard requirements. To understand these aspects, dietary data were collected using 24-hour dietary recall assessment.

6.1 Specific research question and objective

Research question:

> What was the level of food consumption, dietary patterns and eating habits of ALHIV in relation to the recommended levels of energy and nutrient intake from the WHO/FAO?

Research objective:

> To determine the level of food consumption, dietary patterns, and eating habits of ALHIV on ART follow-up and to compare findings in relation to their energy, protein, and nutrient intakes with WHO/FAO standard requirements.

By answering this question and achieving this objective, the study aimed to reveal any inadequacies in energy, protein, and nutrient consumption among ALHIV, thereby providing valuable insights into ways to enhance their nutritional well-being.

6.2 Sociodemographic characteristics

This study involved a randomly selected sub-sample of 58 ALHIV who were on ART follow-up in 10 hospitals located in Addis Ababa and Oromia regions, as detailed in chapter 5, section 5.2. Sample sizes were allocated to the 10 selected hospitals proportionate to the population distribution across the regions. Participants were then randomly selected from each hospital to create a diverse and representative sample.

Of the 58 participants, 42 (71.7%) were aged 14–17 years, the mean age was 16 years, 74.1% (n=43) were orthodox religious followers, and 50.0% (n=29) were female. Most of the participants (96.6%; n=56) were students, with 41.4% (n=24) in grades 1–8. Half of the participants (n=29)

resided in households earning 1000–3000 EBR per month with a family size of less than four (74.1%; n=43) (Table 23).

Table 23. Socio-demographic characteristics of the sub-sample of 58 ALHIV on ART follow-up in two regional hospitals of Ethiopia

Variables	Description	Frequency n (%)
Age (years)	10–13 (early adolescent)	11 (19.0)
	14–17 (middle adolescent)	30 (51.7)
	18–19 (late adolescent)	17 (29.3)
Sex	Male	29 (50.0)
	Female	29 (50.0)
Region	Addis Ababa	43 (74.1)
	Oromia	15 (25.9)
Hospitals	Shashemene Referral Hospital	2 (3.4)
	Asella Referral and Teaching Hospital	2 (3.4)
	Bishoftu General Hospital	3 (5.2)
	Adama Referral Hospital	8 (13.8)
	Yekatit 12 Hospital	11 (19.0)
	St Paul's Comprehensive Specialized Hospital	12 (20.7)
	ALERT General Hospital	12 (20.7)
	Zewditu Hospital	7 (12.1)
	Ras Desta Hospital	1(1.7)
Religion	Orthodox	43 (74.1)
	Protestant	6 (10.3)
	Muslim	8 (13.8)
	Catholic	1 (1.7)
Educational status	Grade 1–8	24 (41.4)
	Grade 9–10	15 (25.9)
	Grade 11 and above	19 (32.8)
Occupation	Student	56 (96.6)
	Daily labourer	2 (3.4)
Monthly income	<1000 EBR	4(6.9)
	1000–3000 EBR	29 (50.0)
	3000–5000 EBR	15 (25.9)
	≥ 5000 EBR	10 (17.2)
Family size	< 4	43 (74.1)
	4–5	12 (20.7)
	6 or more	3 (5.2)
Living situation	Living alone and/or with other peers	3 (3.4)
	Living with parents/responsible adult	56 (96.6)

6.3 24-hour recall of food consumption and eating habits

Almost one third (31%; n=18) of ALHIV reported they had skipped a meal in the 24 hours before interview. Most participants reported consuming three meals a day, while 12% (n=7) also ate snacks between meals (Table 24).

An analysis of the foods nominated by the participants indicated that while half of the sample (50%; n=29) consumed item(s) from the vitamin A-rich food group, which enhances immune function, just 20.7% (n=12) consumed animal product-based vitamin A-rich meals, which are the most bioavailable. More participants (36.2%; n=21) consumed plant-based vitamin A-rich foods, which are less bioavailable. Likewise, only a small percentage of the sub-sample of ALHIV (22.4%; n=13) consumed iron-rich foods during the previous 24 hours (Table 24).

Table 24. 24-hour food consumption, dietary patterns, and eating habits of 58 ALHIV on ART follow-up in two regional hospitals in Ethiopia

Variables	Description	Frequency n (%)
Eaten meal (*multiple responses)	Breakfast	50 (86.2)
	Lunch	52 (89.7)
	Dinner	53 (91.4)
	Snack	7 (12.1)
Meal frequency	≤ 2 times per day	16 (27.6)
	3 times per day	36 (62.1)
	≥ 4 times per day	6 (10.3)
Had skipped a meal in the previous 24 hours	No	40 (69.0)
	Yes	18 (31.0)
Plant-based vitamin A-rich food group intake	No	37 (63.8)
	Yes	21 (36.2)
Animal-based vitamin A-rich food group intake	No	46 (79.3)
	Yes	12 (20.7)
Vitamin A-rich food group intake	No	29 (50.0)
	Yes	29 (50.0)
Iron-rich food group intake	No	45 (77.6)
	Yes	13 (22.4)

During the 24-hour recall period, ALHIV primarily reported consuming starchy staples such as cereals. Vegetables, legumes, nuts, and seeds were also commonly consumed, contributing to their overall intake of essential nutrients. Oils and fats, along with sweets and spices, were included in

their diets, adding variety and flavor to their meals. However, consumption of fruit and animal-based food products (e.g., eggs, meat, milk, and dairy products) was not sufficient. This dietary pattern is illustrated in Figure 21, highlighting gaps in intake of essential vitamins and proteins.

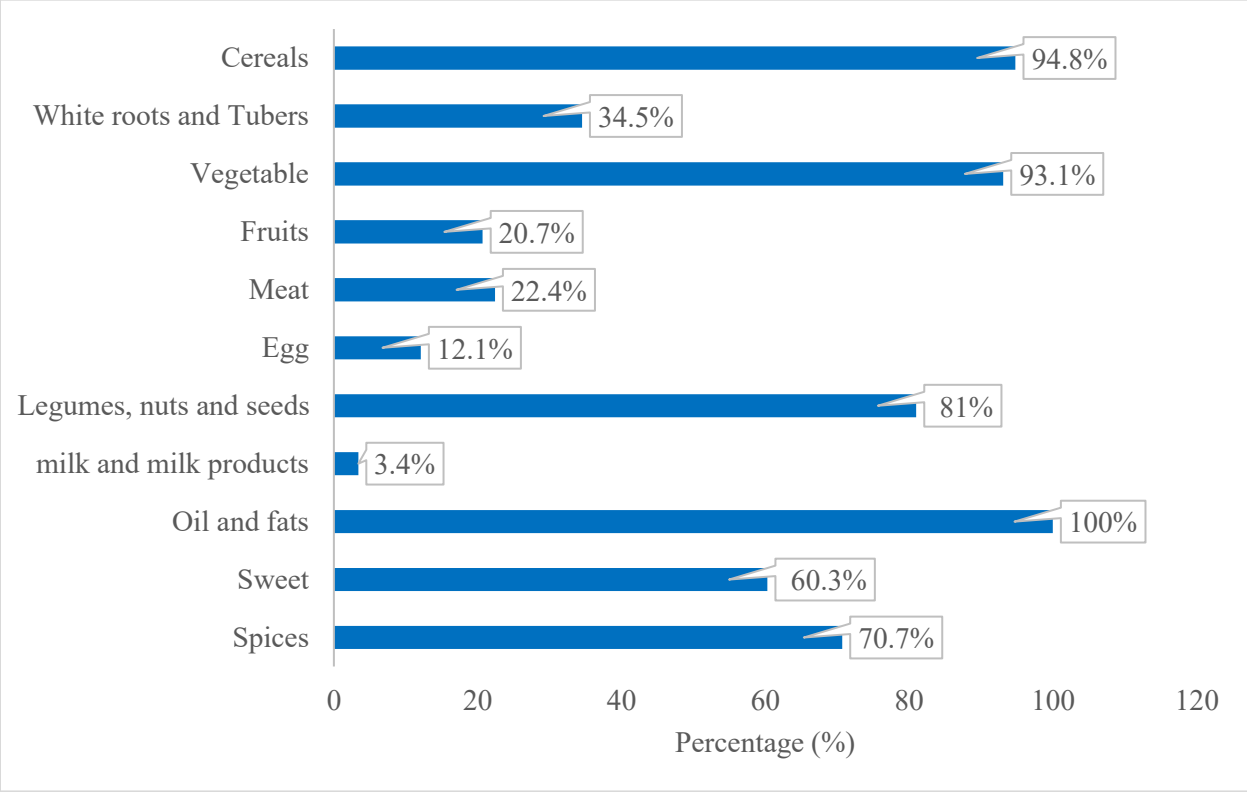

Figure 21. Consumption of food groups within 24 hours of interview among 58 ALHIV on ART follow-up in selected hospitals of Addis Ababa and Oromia regions, Ethiopia, 2024

More than half of these sub-study participants (65.5%; n=38) recorded high dietary diversity, with only a few (3.4%; n=2) reporting very low diversity of dietary intake in the 24 hours prior to interview (Figure 22).

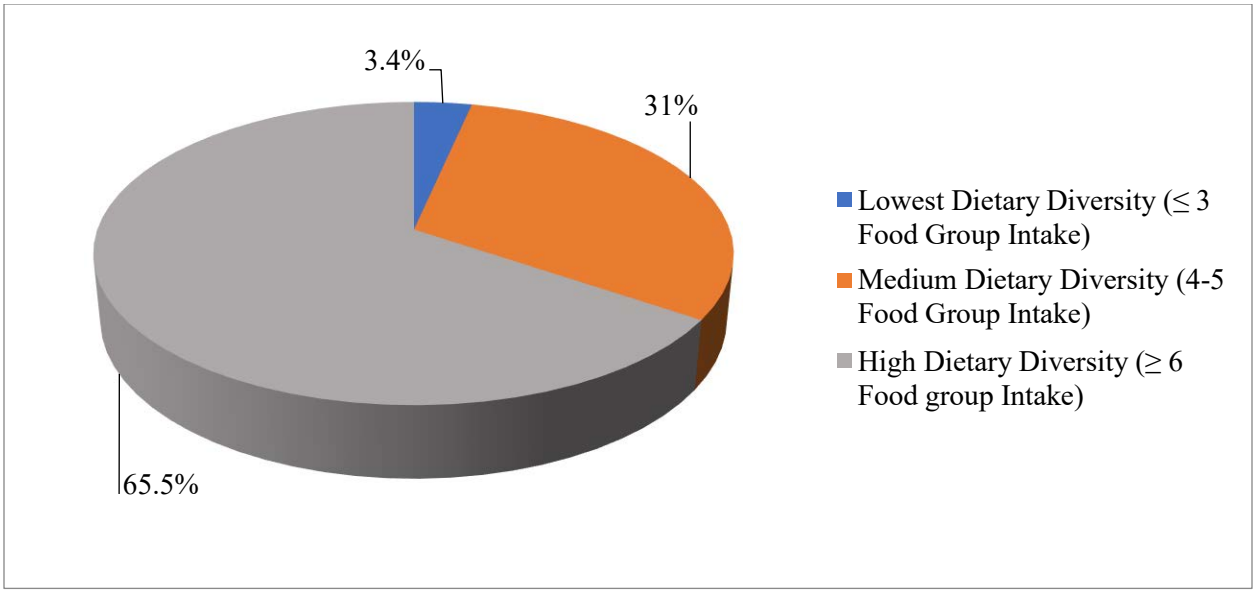

Figure 22. Dietary diversity among 58 ALHIV on ART follow-up in selected hospitals of Addis Ababa and Oromia regions, Ethiopia, 2024

6.3.1 Energy and nutrient intake

Overall, the sub-study participants' reported intake met over 75% of the daily requirements for calories, protein, total carbohydrates, and fats recommended in FAO/WHO standards. Notably, their estimated intake of dietary phosphorus and riboflavin approached or exceeded 100% of the recommended levels (FAO/WHO, 2004). Additionally, their intakes of thiamine and iron were found to surpass the dietary recommendations.

However, intake of several other key nutrients fell short of the FAO/WHO recommendations. Participants did not consume the recommended levels of dietary fiber, retinol equivalent (vitamin A), niacin, vitamin C, calcium, or zinc. Furthermore, reported consumption of phytate – a compound that can inhibit the absorption of certain minerals – was high (see Table 25).

Table 25. 24-hour mean energy and nutrient intake of ALHIV on ART compared to FAO/WHO recommended daily allowance (RDA), 2024

Nutrient	Mean nutrient intake value	FAO/WHO RDA	Achievement (% met)
Energy (Kcal)	1586.7	2036.3	77.9
Total carbohydrate (g)	258.2	290.7	88.8
Protein (g)	44.1	60.1	73.4
Fat (g)	49.8	69.1	72.1
Dietary fibre (g)	16.6	30	55.3
Retinol A Equivalent (µg)	92.3	800	11.5
Thiamine /vitamin B1 (mg)	1.6	1	160.0
Riboflavin/vitamin B2 (mg)	1.1	1.2	91.7
Niacin/vitamin B3 (mg)	6.6	14	47.1
Vitamin C (mg)	28.9	100	28.9
Calcium (mg)	581.2	1000	58.1
Iron (mg)	75.9	15	506.0
Phosphorous (mg)	1215.8	1250	97.3
Zinc (mg)	2	7	28.6

A t-test revealed no statistically significant difference in energy and nutrient intake between the sexes in this sub-sample (p-value > 0.05) (Table 26).

Table 26. Average 24-hour energy and nutrient intake of ALHIV on ART follow-up by sex, 2024

Variables	Male (mean ± SD) (n=29)	Female (mean ± SD) (n=29)	Test result [t-value, df, p-value]
Energy (Kcal)	1643.1 ± 320.6	1530.5 ± 400.0	t = 1.183; df = 56; p = 0.242
Carbohydrate (gm)	264 ± 52.3	252.4 ± 64.8	t = 0.746; df = 56; p = 0.229
Protein (gm)	43.6 ± 13.5	44.6 ± 21.5	t = -0.202; df = 56; p = 0.420
Fat (gm)	54.0 ± 43.9	45.5 + 20.8	t = 0.944; df = 56; p = 0.175
Dietary fibre	17.9 + 9.4	15.3 ± 6.7	t = 1.195; df = 56; p = 0.237
Retinol Equivalent (RAE) (µgm)	96.6 ± 117.1	87.8 ± 138.6	t = 0.235; df = 56; p = 0.815
Thiamine (Vitamin B1) (mg)	1.5 ± 0.4	1.6 ± 0.9	t = -0.517; df = 56; p = 0.607
Riboflavin (Vitamin B2) (mg)	1.0 ± 0.6	1.1 ± 0.9	t = -0.244; df = 56; p = 0.404
Niacin (Vitamin B3) (mg)	7.9 ± 7.8	5.3 ± 2.1	t = 1.759; df = 56; p = 0.084
Ascorbic Acid (Vitamin C) (mg)	31.6 ± 29.9	26.4 ± 18.3	t = 0.186; df = 56; p = 0.214
Calcium (mg)	540.1 ± 211.8	622.4 ± 630.2	t = -0.666; df = 56; p = 0.254
Iron (mg)	77.2 ± 25.2	74.7 ± 26.5	t = 0.380; df = 56; p = 0.706
Phosphorus (mg)	1190 ± 311	1241.7 ± 433.9	t = -0.522; df = 56; p = 0.302
Zinc (mg)	2.2 ± 3.3	1.8 ± 2.3	t = 0.557; df = 56; p = 0.580
Phytate (mg)	2522.7 ± 824.7	2539.7 ± 1047.0	t = 0.235; df = 56; p = 0.815

Significant at *P value ≤ 0.05(2-tailed). Kcal = Kilo calorie, SD = Standard Deviation.
Assumptions for the independent samples t-test were evaluated:

- Equality of means was assumed based on random assignment.
- Equality of variances was confirmed using Levene's test, showing no significant difference between groups.

Nutrient intakes were described by age group (Appendix II Supplementary Table 6.1a). ANOVA was conducted to assess variations in nutrient intake as a percentage of the RDA met across age groups (Appendix II Supplementary Table 6.1b). The results revealed that among all nutrients analysed, only mean iron intake (F-statistic = 6.05, p = 0.004) and phosphorus intake (F-statistic = 5.754, p = 0.005) differed significantly in RDA met across their age groups.

Comparative analysis of 24-hour mean nutrient intake as percentage of RDA met with nutritional status

Using BMI-for-age, HFA, and MUAC-for-age as the criteria to distinguish malnourished from adequately nourished ALHIV (see section 5.2.2 for more detail), dietary intakes as a percentage of RDA met of the two groups were compared using independent samples t-tests.

Comparison of mean % RDA met with thinness

Among the nutrient intake variables analysed, only the mean RDA met, and phosphorus intake differed significantly between thin and non-thin adolescents (Table 27).

Table 27. Comparison of average 24-hour energy and nutrient intake as percentage RDA met for malnourished and not malnourished ALHIV on ART follow-up: independent sample t-test

Nutrient	Mean RDA met (%)		Test result [t-value, df, p-value (2-tailed)]
	Thin (n=11)	Not thin (n=47)	
Energy (Kcal)	73.1	79	t = 0.998, df = 56, p = 0.332
Carbohydrate (gm)	80.6	90.7	t = 1.523, df = 56, p = 0.133
Protein (gm)	59.9	76.5	t = 1.695, df = 56, p = 0.096
Fat (gm)	59.9	74.8	t = 0.893, df = 56, p = 0.376
Dietary fibre (gm)	47.8	57.1	t = 1.022, df = 56, p = 0.311
Retinol equivalent (µgm)	10.6	9.1	t = -0.310, df = 56, p = 0.758
Thiamine (vitamin B1) (mg)	168.1	154.7	t = -0.588, df = 56, p = 0.559
Riboflavin (vitamin B2) (mg)	66.9	93.9	t = 1.259, df = 56, p = 0.213
Niacin (vitamin B3) (mg)	32.6	50.4	t = 1.283, df = 56, p = 0.205
Ascorbic Acid (vitamin C) (mg)	19.9	31	t = 1.354, df = 56, p = 0.181
Calcium (mg)	46.3	60.8	t = 0.932, df = 56, p = 0.355
Iron (mg)	441.7	521.5	t = 1.404, df = 56, p = 0.166
Phosphorus (mg)	81.2	101	t = 2.024, df = 56, p = 0.048*
Zinc (mg)	15.5	32.1	t = 1.214, df = 56, p = 0.230

*$p \leq 0.05$

Comparison of mean % RDA met with stunting

None of the mean RDA met percentages for nutrient intake differed significantly for stunted and non-stunted adolescents (Table 28).

Table 28. Comparison of average 24-hour energy and nutrient intake as percentage RDA met between stunted and not stunted ALHIV on ART follow-up: independent sample t-test.

Nutrient	Mean RDA Met (%) ± SD		Test result
	Stunted (n=13)	Not stunted (n=45)	[t-value, df, p-value (2-tailed)]
Energy (Kcal)	78.6	77.7	t = 0.164, df = 56, p = 0.870
Carbohydrate (gm)	85.6	89.7	t = -0.646, df = 56, p = 521
Protein (gm)	69.9	74.3	t = -0.474, df = 56, p = 0.637
Fat (gm)	74.0	71.5	t = 0.163, df = 56, p = 0.871
Dietary fibre (gm)	50.3	56.9	t = -0.762, df = 56, p = 0.449
Retinol equivalent (µgm)	7.4	9.9	t = -0.529, df = 56, p = 0.599
Thiamine (vitamin B1) (mg)	150.4	159.3	t = -0.415, df = 56, p = 0.679
Riboflavin (vitamin B2) (mg)	109.7	82.8	t = 1.338, df = 56, p = 0.186
Niacin (vitamin B3) (mg)	38.1	49.7	t = -0.882, df = 56, p = 0.381
Ascorbic Acid (vitamin C) (mg)	30.5	28.5	t = 0.259, df = 56, p = 0.797
Calcium (mg)	74.9	53.3	t = 1.482, df = 56, p = 0.144
Iron (mg)	483.5	512.9	t = -0.543, df = 56, p = 0.589
Phosphorus (mg)	107.3	94.4	t = 1.375, df = 56, p = 0.175
Zinc (mg)	25.8	29.8	t = -0.307, df = 56, p = 0.760

*$p \leq 0.05$

Comparison of mean % RDA met with acute malnutrition

Among the nutrient intake variables analysed, only the mean RDA met percentage of carbohydrate intake differed significantly for malnourished and non-malnourished adolescents (Table 29).

Table 29. Comparison of average 24-hour energy and nutrient intake as percentage RDA met for malnourished and not malnourished ALHIV on ART follow-up: independent sample t-test.

Nutrient	Mean RDA met (%)		Test result [t-value, df, P-value (2-tailed)]
	Malnourished (n=16)	Not malnourished (n=42)	
Energy (Kcal)	72.1	80.1	t = 1.549, df = 56, p = 0.127
Carbohydrate (gm)	79.8	92.2	t = 2.156, df = 56, p = 0.035 *
Protein (gm)	64.2	76.8	t = 1.467, df = 56, p = 0.148
Fat (gm)	75.3	70.8	t = -0.305, df = 56, p = 0.761
Dietary fibre (gm)	52.6	56.5	t = 0.479, df = 56, p = 0.634
Retinol equivalent (µgm)	12.6	8.1	t = -1.008, df = 56, p = 0.318
Thiamine (vitamin B1) (mg)	137.2	164.9	t = 1.405, df = 56, p = 0.165
Riboflavin (vitamin B2) (mg)	75.0	94.1	t = 1.011, df = 56, p = 0.316
Niacin (vitamin B3) (mg)	32.9	52.5	t = 1.629, df = 56, p = 0.109
Ascorbic acid (vitamin C) (mg)	27.1	29.7	t = 0.358, df = 56, p = 0.722
Calcium (mg)	71.3	53.1	t = -1.331, df = 56, p = 0.189
Iron (mg)	478.5	516.9	t = 0.763, df = 56, p = 0.449
Phosphorus (mg)	91.4	99.5	t = 0.914, df = 56, p = 0.364
Zinc (mg)	20.5	32.2	t = 0.970, df = 56, p = 0.336

*$p \leq 0.05$

6.4 Summary

The findings of this study provide valuable insights into the dietary intake and nutrient adequacy of ALHIV in Ethiopia. Participants met RDAs for calories, protein, total carbohydrate, and fat consumption, as well as dietary phosphorus intake. However, there were notable deficiencies in intakes of dietary fiber, retinol equivalent, niacin, vitamin C, calcium, and zinc that could be harming their health.

While mean thiamine, riboflavin and iron consumption exceeded the FAO/WHO RDAs, high consumption of phytate raises concerns about nutrient bioavailability. Notably, ANOVA revealed significant differences in iron and phosphorus intake across age groups, highlighting the influence of participants' age on nutrient intake patterns. Additionally, the significant difference in mean carbohydrate intake between malnourished and non-malnourished ALHIV suggests that carbohydrate and phosphorus intake are important determinants of nutritional status in this population.

Chapter Seven: The Perceptions and Experiences of ALHIV on ART Follow-up About Their Nutritional Situation and Nutritional Care Available to Them

This chapter responds to research question 3, presenting findings about the perceptions and experiences of ALHIV with respect to their nutritional situation and their implications for nutritional status.

HIV exerts a large healthcare and social burden in Ethiopia, particularly in the regions of Addis Ababa and Oromia, where prevalences are high. Within these regions, ALHIV face unique hurdles, especially regarding nutritional health. This qualitative component of the PhD project explored the perceptions and experiences of ALHIV on ART follow-up living in the selected regions of Ethiopia in relation to their nutritional situation and the nutritional care available to them.

7.1 Specific objectives

The specific objectives of this component of the study were to:

1. identify the specific nutritional challenges faced by ALHIV in ART clinics
2. describe the dietary situations of ALHIV and factors perceived to influence this
3. explore the perceptions and experiences of ALHIV regarding the nutritional support provided in ART clinics
4. identify potential areas for improvement in the nutritional care and support services for ALHIV in ART clinic.

7.2 Findings

7.2.1 Participants' demographic characteristics

Eighty-seven participants aged 16 years and older agreed to participate in this component of the study. Of these participants, 54% (n=47) were in the late adolescent age group (18–19 years), and 57.5% (n=50) were female. Most participants (51.7%, n=45) reported living with a single parent, with or without siblings. Another 17.2% (n=15) of participants lived with their grandparents, adopted family, or peer groups due to the loss of a parent, while only 28.7% (n=25) of the

participants lived with both parents, with or without siblings. Most participants reported living with HIV-positive parents – mother only (n=38; 43.7%), father only (n=13; 14.9%), or both (n=24; 28.2%). Other participants (n=10; 11.5%) lived with HIV-negative grandparents or adopted family members.

Most participants stated, and the ART registration book confirmed, that they had begun taking ART medication during childhood (age < 10 years) following their HIV diagnosis. However, most participants only found out about their HIV status in late childhood or early adolescence, typically between the ages of 10 and 12 years. Healthcare workers most commonly informed the participants about their HIV status, followed by their mothers.

The qualitative analysis identified five key themes, which are outlined below and illustrated with quotes.

7.2.2 Theme 1: HIV care and support services

Participants highlighted a variety of effective and supportive services at their HIV care clinics, claiming that they contributed to their overall well-being and quality of life. These services included provision of medications and supplementation, psychosocial support, nutritional guidance, education and counselling. Each of these services helped them to manage HIV and improve their daily lives. This theme is about how participants perceived these services, the positive impacts they experienced, and how these services collectively contributed to a comprehensive care approach. These insights were essential to identify key strengths in care practices and to support ongoing improvements to enhance the well-being of individuals living with HIV.

Many participants received both ART medication and supplementation, with healthcare workers providing valuable advice on the advantages and side effects of the medication. For instance, a 17-year-old female participant shared that:

> *The healthcare workers advised about the ART medication advantages and the side effects before taking medicine.* (P6)

Psychosocial services played a vital role in enhancing sociability and alleviating loneliness, particularly through programs such as Operation Triple Zero (OTZ)[3]. Many participants praised OTZ for its confidentiality and supportive environment, which utilises an assets-based approach to empower adolescents and young people living with HIV. A 16-year-old female participant highlighted that:

> *The main thing is that it helped us to get treatment, have close friends, and feel less lonely using the OTZ program.* (P8)

Nutritional guidance and support were regarded as significant aspects of the care provided. The participants emphasised the importance of balanced diet education. A 17-year-old female participant shared:

> *They told me to eat foods like meat and milk products to build my body. And I see the changes in my body build.* (P3)

The clinic also proactively tackled malnutrition by offering supplements like plumpy-nut to those in need. As a 19-year-old male participant explained:

> *They give supplements for people who face such a problem. Not for all persons, but for those malnourished, they give them plumpy-nut. Regarding its sufficiency, they provide based on his/her demand.* (P11)

Many participants highly appreciated the educational and counselling services. They received comprehensive education on their health, medication, and lifestyle choices. A 16-year-old male participant said:

> *Here we have got a lot of services like education, measurement of weight and height, and CD4 count.* (P2)

Healthcare workers' private counselling sessions addressed specific concerns, helping ALHIV make informed decisions about their health. A 19-year-old female participant explained:

[3] Operation Triple Zero means focusing on empowering ALHIV to commit to the "triple zero outcomes": zero missed appointments, zero missed doses, and zero viral load.

They gather girls together and give private counselling services; they also advise us concerning sexual practices and unnecessary violence and consider us like a family. (P9)

Participants highlighted the importance of support programs and workshops, particularly those related to HIV, as essential for personal development and capacity building. They noted that these workshops not only provided crucial information and skills but increased their understanding and awareness of available services, making it easier to navigate the healthcare system. The workshops were seen as instrumental in reducing stigma and empowering them to seek and access the services they needed more confidently. Additionally, participants appreciated the provision of transportation support during ART follow-ups, which alleviated the difficulty of accessing care. Other support provided, such as school uniforms and learning materials, was also acknowledged as beneficial. The participants valued the clinics' comprehensive approach highly, including treatment for co-morbid conditions, viral load and CD4 screening, and peer education. Guidance from healthcare workers and peers on ART and nutrition improved their quality of life significantly. An 18-year-old female participant shared:

The advice I got from health workers and peers regarding ART and nutrition helped me follow healthy nutrition. (P12)

A 16-year-old female participant also expressed gratitude for the healthcare workers' compassionate care, saying that:

They treat us without any discrimination and stigma. (P7)

7.2.3 Theme 2: ART clinic experience

Participants provided a variety of insights into their experiences at the ART clinics, focusing on communication about difficulties, interactions with healthcare providers, nutritional assessments, preparedness and willingness to provide support, and punctuality of healthcare appointments and the overall clinic experience.

Most participants generally felt supported in discussing their personal and medical issues. A 16-year-old female participant noted:

I faced a stressful issue, consulted the nurse, and found a solution. (P42)

However, an 18-year-old male participant reported that experiences varied, with some participants feeling discriminated against:

> *Sometimes some healthcare workers discriminate one [patient] from the other.* (P4)

Most participants reported positive interactions with healthcare providers. For example, a 19-year-old male participant shared:

> *They advised me personally and are willing to hear my private questions.* (P32)

Similarly, an 18-year-old female participant noted that the relationship was often familial:

> *They share my interests. We have a family relationship. I freely ask for advice about my private life.* (P39)

However, there were inconsistencies, as a 17-year-old male participant noted:

> *Some healthcare workers did not always treat patients well.* (P65)

Nutritional assessments and the communication of their results were important elements of patient care at the ART clinics. One 16-year-old female participant's experience was that:

> *When we came here to take the medicine, the doctors checked our weight, compared it with the previous one, and asked us if we lost weight.* (P39)

However, other similar-age female participants indicated that not all patients received these regular screenings. Additionally, some participants noted a lack of follow-up about the results of their assessments, leading to uncertainty about their nutritional status.

> *The healthcare workers did not conduct nutritional screening regularly.* (P28)

Many participants praised healthcare workers for their readiness and willingness to support patients. For example, a 16-year-old female participant said:

> *They are ready any time to welcome us.* (P23)

Timely service was mentioned frequently, and punctuality was valued. Patients appreciated the healthcare workers' adherence to schedules, and a 19-year-old male participant highlighted the efficiency of clinic operations:

They don't let us wait too much. (P46)

The overall experience was positive, with patients feeling welcomed and cared for and many feeling like they were part of a family. A 17-year-old male participant stated:

> *The healthcare worker's reception is welcoming. They give the service on time. They welcome us with joy; they are also willing and ready. Our relationship is like a family.* (P55)

In summary, the participants' experiences at ART clinics were marked by supportive and effective communication, useful nutritional assessments, a welcoming and respectful overall clinic environment, readiness to support patients upon arrival, and punctual healthcare appointments. Despite some areas needing improvement, such as consistency in nutritional screening and occasional unprofessional behaviour, the general feedback was positive, highlighting the commitment of Ethiopian healthcare providers to patient care.

7.2.4 Theme 3: medication experiences

Participants reported a range of experiences with their HIV medication, reflecting both long-term adherence and significant challenges, such as managing side effects, navigating healthcare access, and maintaining consistent routines. Many had been on HIV medication since childhood, demonstrating a deep familiarity with their treatment regimens. For example, a 16-year-old female participant and a 19-year-old male participant (respectively) stated:

> *I started the medicine when I was 5 years old (about 13 years ago).* (P12)

> *I've been taking medicine since childhood (I was diagnosed and started ART 18 years ago).* (P32)

Despite often long-term ART use, participants faced various challenges and side effects. Two 18-year-old male participants described severe side effects that included diarrhea and vomiting:

> *The drug in the second stage was severe and had diarrhea and vomiting.* (P67)

> *When I was a child, I had no appetite because I was taking it in syrup form, and it was bitter.* (P40)

Emotional and psychological factors reduced adherence significantly for some participants. A 19-year-old female participant admitted:

> *There are days when I just leave the medicine and go to sleep (skipping medicine) as a result of psychological trauma related to HIV and loss of family.* (P28)

One 17-year-old female reported often skipping doses without informing her healthcare providers:

> *I don't tell any healthcare workers. As I usually skip, I say I am taking the medication daily when they ask me and continue the regular treatment by skipping the missed medication.* (P32)

Anger and forgetfulness also played a role in low adherence, as a 19-year-old female participant explained:

> *I sometimes forget to take a daily dose. But I also do not take it if I feel angry.* (P28)

Initial resistance to taking medication was common among participants. An 18-year-old male participant stated:

> *I used to hate it. I pretended to take it and put it in my mouth and spit it out; I did not like it.* (P46)

Over time, some participants developed a more positive outlook on their medication regimen. A 17-year-old female participant said that:

> *When I take the pills, I feel happy, but if I don't, I feel frustrated.* (P25)

She had initially struggled with adherence, but by the time of the interview, was taking her medication properly.

In summary, participants reported both long-term adherence and significant difficulties with their HIV medication, with many having started treatment in childhood. Despite their familiarity with the regimen, many struggled with severe side effects such as diarrhea and vomiting and experienced trauma, anger and forgetfulness. Stigma led some participants to hide non-adherence from healthcare providers, underscoring the need for a more supportive environment. While initial resistance to medication was common, some participants eventually adopted a more positive approach, highlighting the importance of tailored interventions to maximise adherence.

7.2.5 Theme 4: unmet needs at the hospital clinic

Despite many positive aspects of ART clinic care, participants highlighted several unmet needs, particularly in nutritional services. Many participants reported a lack of consistent and detailed nutritional screening and counselling. Issues such as inconsistent nutritional assessments, inadequate nutritional education, and supply problems with nutritional support (like plump-nut) were common. Participants also shared negative feelings and difficulties in utilising HIV care and support services, including initial reluctance due to fear of stigma and discrimination. This theme covers these unmet needs, providing crucial insights for improving the quality and consistency of care and services at ART clinics.

Many participants reported a lack of consistent and detailed nutritional screening and counselling services. For example, an 18-year-old male participant shared:

> *They did nothing special related to nutrition screening, nutrition counselling, measuring body weight, height and BMI assessment, dietary counselling, supplementation.* (P6)

Similarly, a 17-year-old female participant noted:

> *They said nothing, but they often provide plumpy-nut when we become underweight and sick.* (P21)

However, a 16-year-old female participant had a different experience:

> *Earlier they used to screen and provide us plumpy-nut, but now there is no supply.* (P22)

About supply issues, participants mentioned limited or no regular nutritional supplementation in the ART clinic, with a 16-year-old female participant stating:

> *There wasn't strong nutrition supplementation service given.* (P33)

These accounts highlighted the irregularity and lack of comprehensive nutritional support. This inconsistency in providing essential nutritional supplements exacerbated the challenges faced by those in need. The need for better nutritional education was emphasized, with participants noting the lack of guidance on balanced diets. A 17-year-old male participant remarked:

> *They teach us about diet, but the nutrition counselling is not as good.* (P25)

Similarly, a 19-year-old male participant said:

Nobody told me about balanced nutritional content. (P27)

These statements suggest nutrition education in Ethiopian ART clinics needs improvement.

Participants reported various negative feelings and difficulties when utilising HIV care and support services. Initial reluctance to attend was common due to fear of stigma and discrimination. A 16-year-old female participant stated:

> *Before I got enough awareness, I was not happy to come here. I felt I was the only person who had HIV.* (P12)

Increased awareness and education eventually helped alleviate these fears, but the initial hesitation highlights the importance of reducing stigma in healthcare setting.

In summary, participants identified significant unmet needs in the hospital clinic, particularly with respect to nutritional services. They reported inconsistent nutritional screening, inadequate education, and irregular supply of nutritional support like plump-nut. These service gaps exacerbate the challenges ALHIV face. Many experienced negative emotions and initial reluctance to access HIV care due to fear of stigma and discrimination, although increased awareness eventually mitigated these fears. These findings underscore the need for improved consistency in care and comprehensive nutritional education within the clinic.

7.2.6 Theme 5: factors perceived as influencing nutrition

Understanding the multifaceted factors influencing nutrition is crucial for improving the health and well-being of people living with HIV. Investigation of malnutrition in this population revealed a complex web of interconnected factors that affect their nutritional status. These factors spanned economic, psychological, social, and medical domains, each contributing to a cycle of malnutrition and compromised health. This theme deals with the various dimensions influencing nutrition, including the economic challenges of poverty and unemployment, the psychological burdens of depression and anxiety, the social impacts of discrimination and isolation, and issues related to infections and medication side effects. The theme provides a comprehensive understanding of the perceived barriers to proper nutrition faced by ALHIV in Ethiopia.

Many participants stated that individuals are affected by poverty, unemployment, low income, and political instability, all of which led to food insecurity and influence dietary habits. For example, two participants, males aged 18 and 17 years, said:

> *Poverty and unemployment limit access to nutritious food, resulting in food insecurity and poor diet.* (P71)

> *Economic problems and lack of supply affect our nutrition.* (P62)

Participants reported that depression, anxiety, stress, and psychological trauma significantly reduce individuals' motivation to seek and consume nutritious food. These mental health issues also increase susceptibility to infections and illnesses. For instance, two 17-year-old female participants noted that:

> *Depression and anxiety can lead to neglect of nutritional needs, exacerbating health problems.* (P18)

Many participants believed that discrimination, stigma, isolation, and lack of social support exacerbate malnutrition. There was widespread agreement that discrimination and stigma reduce access to necessary social services, while isolation and lack of support lead to poor mental health. As 19- and 17-year-old male participants noted:

> *Social stigma and discrimination contribute to isolation, worsening both mental and nutritional health.* (P81, P44)

Further, participants highlighted the role of government in stabilising food supply, controlling inflation, and supporting nutritional programs. Security issues such as armed conflict and political instability were identified as significant disruptors of food production and supply. One 16-year-old female participant noted that:

> *When there is war, farmers cannot produce, causing a lack of food supply.* (P59)

Hence there was widespread awareness that food insecurity followed from a wide range of factors affecting food production, processing, transportation and purchase price, all perceived as tending to result in greater malnutrition risk for ALHIV.

Participants noted that infections, illnesses, and medication side effects are critical factors in nutritional deficiencies. These issues were seen as intertwined with psychological and social aspects of living with HIV, creating a vicious circle. One 18-year-old male participant explained:

> *The interconnected nature of economic, psychological, social, and medical factors creates a complex cycle of malnutrition and health problems.* (P76)

7.2.7 Theme 6: food security and nutrition issues and solutions

Findings revealed that the nutritional challenges for ALHIV in Ethiopia were intricate and multifaceted. These challenges encompassed economic, psychological, social and political, and medical factors that collectively degraded food security and nutrition. This theme is about how these diverse issues affect food security and nutrition and participants' suggestions about how to resolve them.

Participants identified economic barriers, such as poverty and unemployment, as major obstacles to food security and proper nutrition. They suggested that government initiatives to create job opportunities and stabilise the economy could improve access to nutritious foods. As two (18- and 17-year-old) participants noted:

> *The government needs to create job opportunities and stabilise inflation.* (P27, P58)

Participants also highlighted the role of government and the need for government policies to stabilise food supply, control inflation, and support nutritional programs. As a 19-year-old male participant noted:

> *The government should work on issues related to the economy and supply.* (P4)

Recommendations emphasised the importance of ensuring stable food resources, and included activities such as:

> *Encouraging home gardening and agricultural development.* (P28, P36)

Psychological challenges, such as depression and anxiety, were frequently mentioned as barriers to maintaining proper nutrition, diminishing motivation and ability to seek and consume nutritious food. Strengthening psychosocial support services and counselling was seen as a key solution by many participants. For instance, one 18-year-old female participant noted that:

Psychosocial service should be strengthened to increase medication adherence and social integration. (P42)

Many participants stated that social factors such as social exclusion, discrimination and stigma can lead to mental illness, which in turn affect dietary habits and harm the nutritional status of ALHIV. Participants called for community education to reduce stigma and promote acceptance through:

Creating awareness in the community about HIV and avoiding discrimination. (P76)

Security issues, such as armed conflict and political instability, were identified as significant disruptors of food production and supply. Ongoing conflicts hinder farmers' ability to produce food, leading to shortages.

War, political instability, and lack of rain […] lead to lack of food production. (P73)

Peace and security is essential for stable food production; participants called for conflict resolution and creation of a secure environment, as a 16-year-old female participant noted:

The government should work to sustain peace and manage supply issues. (26)

7.3 Study Limitations:

In conducting this qualitative research on the experiences of adolescents living with HIV in Ethiopia, several limitations were identified that may influence the findings and their interpretations. These limitations underscore the challenges inherent in qualitative studies, particularly regarding the depth of understanding and the context-specific nature of the insights gathered. Below are the key limitations encountered during the research:

1. **Sampling Bias**: The use of purposive and proportional sampling may have introduced selection bias, as participants were selected based on their availability, willingness, and accessibility. This could limit the representativeness of the sample and may not fully capture the experiences of all adolescents living with HIV (ALHIV) in Ethiopia, particularly those who were severely ill or unavailable during the study period.
2. **Limited Generalisability**: Given that the study was conducted in only eight hospitals across two regions of Ethiopia, the findings may not be generalisable to other regions or countries with different healthcare systems, socio-political environments, or populations of adolescents living with HIV.

3. **Dependence on Local Research Assistants**: While local research assistants helped facilitate data collection, variability in their training and experience could have influenced the depth and quality of the data collected during IDIs and FGDs. Potential inconsistencies in interview techniques or moderation could have affected the richness of participant responses.
4. **Recall Bias**: As participants reflected on their experiences during treatment, the potential for recall bias may have impacted the accuracy of their responses, particularly regarding past nutritional challenges and healthcare services.
5. **External Factors**: The complex socio-political and economic challenges highlighted by participants, such as food insecurity, economic instability, and political unrest, are significant variables that may have influenced the study outcomes. These factors could limit the focus on healthcare-related aspects of nutritional care.
6. **Small Sample Size for IDIs**: Although data saturation was achieved, the sample size for individual interviews (12 participants) may limit the breadth of perspectives, particularly when discussing personal and in-depth experiences related to nutritional challenges.
7. **Exclusion of Caregiver Perspectives**: While the focus was on ALHIV, excluding a detailed exploration of the perspectives of caregivers and families may have missed important insights related to familial support, nutritional care, and adherence to HIV treatment in adolescence.
8. **Context-Specific Findings**: The study findings are heavily influenced by the local context of ART clinics in Ethiopia, which may not reflect the experiences of adolescents living with HIV in different healthcare settings, cultures, or regions where socio-political and economic factors differ.
9. **Limited Exploration of Program Effectiveness**: Although participants noted positive aspects of healthcare programs like OTZ, the study did not fully evaluate the long-term effectiveness of these programs in improving nutritional outcomes for ALHIV.

In qualitative research, effective communication of findings is crucial for ensuring that insights are accurately conveyed and understood across different contexts. However, there are inherent

risks associated with translation, particularly when translating qualitative data and findings into different languages or cultural frameworks. Below are the potential translation risks that may impact the interpretation and application of the study results:

Potential Translation Risk	Description
1. **Loss of Nuance**	During translation from local languages to English and vice versa, subtle nuances in participant responses may have been lost. Important cultural or emotional expressions related to the participants' experiences with HIV care and nutrition may not have been fully captured, potentially affecting the depth of the findings.
2. **Translation Accuracy**	Variations in the quality and accuracy of translation, particularly in complex or technical discussions around nutrition and healthcare, may have led to misinterpretations or simplifications of participant responses. This could impact the reliability of the data
3. **Cultural Context**	Certain cultural concepts or terms related to health, nutrition, or psychosocial experiences may not have direct equivalents in English, making it challenging to fully convey participants' perspectives. This could result in an incomplete or skewed representation of the data.
5. **Back-Translation Challenges**	The process of translating interviews back and forth between languages may have introduced errors or misinterpretations, particularly if back-translation was not rigorously employed to check for discrepancies. This could affect the overall validity of the qualitative data.
6. **Participant Clarity**	Some participants may have altered or simplified their responses during interviews conducted in a language other than their first language, limiting the richness of the data collected and potentially affecting the study's conclusions.

7. **Delay in Data Collection**	The need for translation may have lengthened the interview or focus group process, potentially causing fatigue or rushed responses from participants, which could impact the quality and depth of the data collected.

To mitigate the translation risks in the study, the following steps were taken:

1. Employed translators who were fluent in both the local language(s) and English, and familiar with medical terminology and cultural nuances. This can improve the accuracy and consistency of translations.
2. Implemented a rigorous back-translation process, where after translating from the local language to English, a different translator translated the English version back to the original language. Comparing both versions helps identify discrepancies and ensures that the original meaning is preserved.
3. Provided training for translators and interpreters on the specific medical and cultural context of the study, as well as on the goals of the research. This ensured they were prepared to translate nuanced or sensitive topics accurately.
4. Conducted pilot interviews or focus groups to test the translation process. This allowed the research team to identify any translation issues and make necessary adjustments before the full data collection began.
5. Engaged local translators who could identify concepts that may not translate directly, to find culturally appropriate equivalents or explanations for terms or phrases.
6. Developed a glossary of key medical and research terms to ensure consistency in translation across different translators and regions. This standardisation helped to reduce variability in how terms are understood and used.
7. After data collection, collaborative sessions were held between researchers and translators to discuss difficult or unclear segments of the text. This allowed for collective decision-making about the most accurate translation of challenging sections.

8. When feasible, allowed participants to review their translated responses and clarify any points that may have been misunderstood or lost in translation. This step helped ensure that their views were accurately represented.

9. Data collectors who were native speakers of the local language(s) and understood the cultural context. This minimised the need for translation during interviews and improved the authenticity of the data.

10. Encouraged the use of clear, simple language during data collection to minimise the risk of misinterpretation or loss of meaning during translation. Avoided overly technical or ambiguous terminology when possible.

7.4 Summary

This qualitative component of the study explored the nutritional challenges and influences in HIV care perceived by ALHIV receiving treatment at ART clinics in Ethiopia. In interviews, 87 participants highlighted the comprehensive care that was provided to them, including medication, psychosocial support, and nutritional guidance. Despite positive experiences with healthcare services and programs such as OTZ, participants reported unmet needs, including inconsistent nutritional screening and assessment, and inadequate nutrition education. They identified the complexity of the nutritional issues that faced them, describing economic hardships, psychological issues, social stigma and political instability, as well as medical factors, that pose major barriers to proper nutrition.

These factors and their complex interactions are shown in Figure 23, which underscores the need for a multifaceted approach to reducing malnutrition among people living with HIV. Participants suggested solutions for many of these issues, notably government initiatives to improve job opportunities and economic stability and reduce stigma. Improving security was deemed essential for stable food production, and participants rightly saw this as a responsibility of government. Overall, the findings emphasise the need for a holistic approach to improving the nutritional status and well-being of ALHIV.

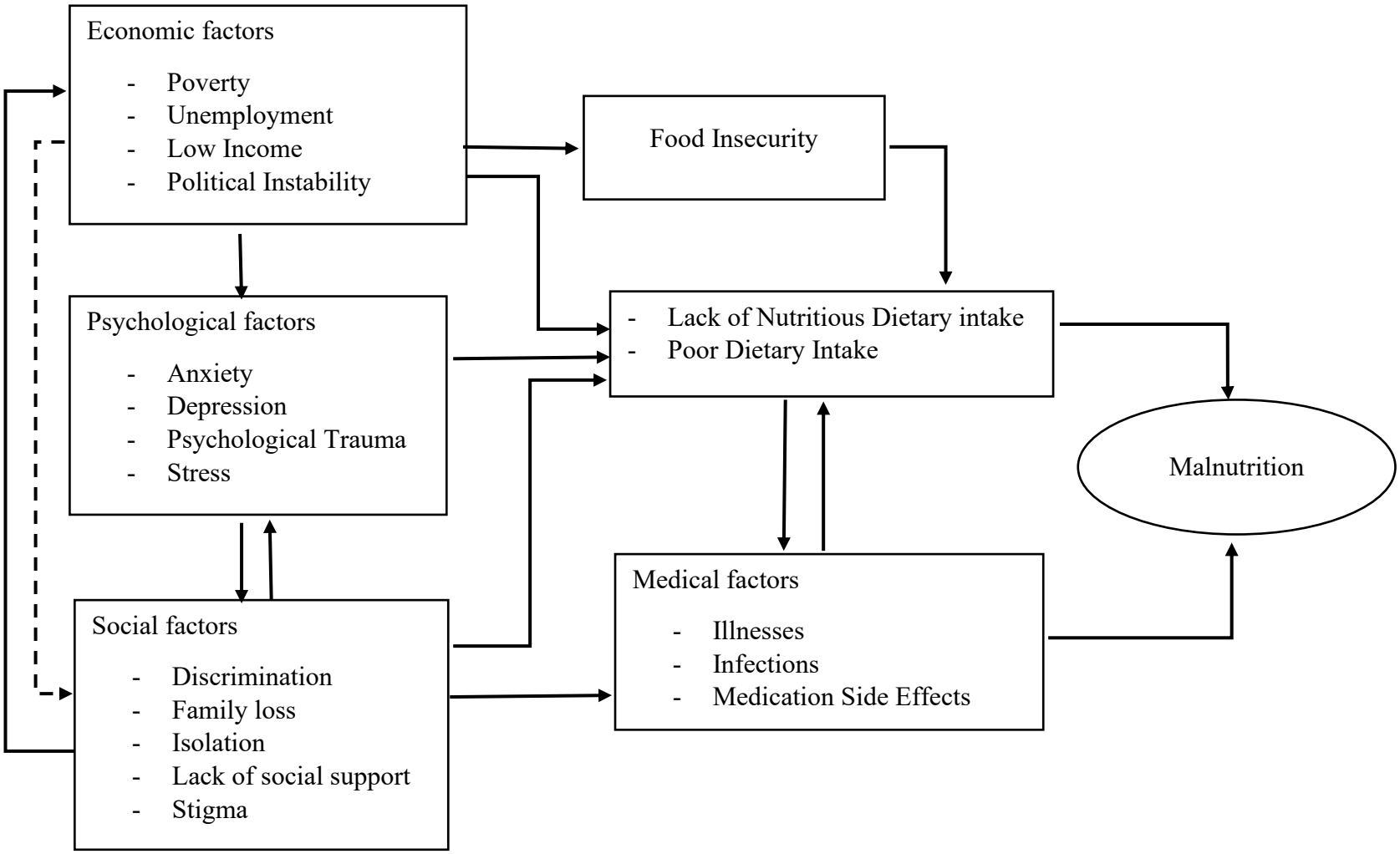

Figure 23: Factors contributing to malnutrition among ALHIV

Chapter 8: Discussion

In this discussion chapter, the findings presented in previous chapters are interpreted within the context of the theoretical framework as illustrated in the conceptual framework, which examines healthcare workers' practices in nutritional assessment, counselling, and management, as well as the determinants of nutritional status, dietary intake, and food consumption among ALHIV on ART (see Figure 19). This framework guided the analysis and provided a structured approach to understanding how healthcare practices and various determinants influenced nutritional outcomes for ALHIV. By applying this framework, the relationships between healthcare practices, levels of nutritional status, dietary intake, and food consumption are explored, ensuring that the interpretations remain consistent with the theoretical underpinnings. This approach not only validates the findings but offers a coherent understanding of the complexities involved in managing nutritional care for ALHIV.

This study investigated the nutritional practices, status, and dietary behaviours of ALHIV undergoing ART in Ethiopian hospitals. This chapter presents a discussion of five key findings of the study, illustrating their interrelationships and implications for policy and practice in Ethiopia and beyond. It provides a contextual framework for understanding the challenges and opportunities in managing nutritional care for ALHIV and consolidates the novel insights emanating from this original study. Additionally, the chapter offers explanations for the major findings and outlines their significance. Finally, it details the strengths and limitations of the research.

8.1 Main study findings

8.1.1 The systematic review and meta-analysis

The systematic review and meta-analysis presented in Chapter Two showed that evidence about undernutrition among ALHIV on ART in LMICs was scarce, despite increasing research on HIV-related outcomes in these regions. Its conclusion was that more research is needed to understand and overcome the nutritional challenges facing this vulnerable population.

The elevated nutritional needs of ALHIV are due to their age-related growth requirements and the compounding impact of HIV infection, which can exacerbate undernutrition and disease progression (Duggal et al., 2012). Neglecting malnutrition during HIV treatment jeopardizes

treatment efficacy, leading to heightened morbidity and mortality risk (Naswa & Marfatia, 2010). Targeted interventions are needed to improve outcomes for ALHIV on ART in LMICs.

The review highlighted the use of a narrow range of nutritional assessment techniques in LMICs, predominantly basic anthropometric measures such as BMI-for-age and HFA. While these tools are accessible and require minimal training, they may lack sensitivity in accurately assessing nutritional status compared to more advanced methods like body composition analysis (Schtscherbyna et al., 2012). Limited use of comprehensive assessment tools in LMICs is likely due to resource scarcity and inadequate training (Castro et al., 2018).

The review identified significant disparities in the prevalence of stunting and wasting among ALHIV populations, underscoring inconsistent nutritional care and support provision across settings (Jesson et al., 2019). Factors contributing to these disparities include a varied emphasis on nutrition treatment, variation in integrated service provision, and socio-cultural differences affecting healthcare access and dietary habits (Shiferaw & Gebremedhin, 2020).

Gender disparities among ALHIV were evident in the literature, with males more likely to suffer stunting and wasting than females, possibly due to their greater energy requirements and socio-cultural expectations (Alves Junior et al., 2019; Murray et al., 2020). Additionally, ALHIV with a history of opportunistic infections had a significantly higher prevalence of stunting, illustrating the complex interplay between disease progression and nutritional status (Duggal et al., 2012).

The review concluded that there is an urgent need for integrated approaches that enhance both HIV treatment and nutritional support strategies tailored to the specific needs of ALHIV in LMICs. This integration is crucial for improving health outcomes and quality of life among ALHIV, ensuring effective disease management and reducing vulnerability to malnutrition-related complications.

8.1.2 Nutritional assessment, counselling and management practices of ART clinic healthcare workers

The research revealed important new knowledge about the nutritional assessment, counselling and management practices of healthcare workers in ART clinics in Ethiopia. While basic nutritional assessments, such as body weight and height measurements, are routine, more advanced nutritional assessment methods are underutilised. Tools such as waist circumference measuring tapes,

skinfold thickness callipers, and DXA are largely unavailable or unused, limiting the comprehensiveness of nutritional evaluations for ALHIV.

The study found that a minority of healthcare workers regularly provide advanced, evidence-based nutrition counselling. Structured approaches like the GALIDRAA method and the ORPA approach are used infrequently. There is a need for enhanced training and resources to improve the delivery of effective nutritional education.

Most healthcare workers reported engaging in essential practices such as nutrition screening, case management, and the provision of RUTF. However, the use of RUSF was less common, and despite concerns about the sharing of supplementation among siblings, workers reported that little effort was made to identify or prevent this occurrence. Additionally, the absence of standardised discharge criteria for nutritional care is likely to reduce the continuity and quality of care provided to ALHIV.

The study uncovered deficiencies in implementation support and resources. Many healthcare workers reported a lack of essential documents like SOPs and nutrition guidelines, as well as inadequate patient education materials and training resources. Despite these challenges, more than half of the participants had access to referral and linkage systems that offer additional support for ALHIV.

Healthcare workers' perspectives reveal significant dissatisfaction with nutrition assessment, counselling and support services for ALHIV. Concerns include the inadequate integration of nutrition services into HIV care, insufficient specific training on HIV and nutrition, and a lack of comprehensive tools and resources. This dissatisfaction underscores the urgent need for better integration of nutrition services, more comprehensive nutritional screening, targeted training, and supportive guidelines to enhance the quality of care and improve health outcomes for ALHIV.

Overall, the study indicates that while basic nutritional assessments and interventions are being carried out in Ethiopian ART clinics, advanced assessment methods and evidence-based counselling practices are used rarely. Better training, resource allocation, and integration of nutrition services will improve the nutritional management and their health of ALHIV.

8.1.3 Nutritional status of ALHIV and its determinants

Socio-demographic, anthropometric, psychosocial, environmental, lifestyle, and HIV-related characteristics

The 384 ALHIV who participated in this research had a mean age of 15.9 years; most were aged 14–17 years and were female. Most participants came from households earning 1000-3000 EBR monthly. Anthropometric measurements indicated variability in nutritional status across age groups, suggesting the need for age-specific nutritional interventions. Psychosocial assessments uncovered high levels of anxiety and depression, especially among females and older adolescents, highlighting the need for integrated mental health support. Food insecurity was common, with many participants reported experiencing restricted food variety and inadequate meal frequency, despite receiving some nutritional supplementation. Lifestyle factors included high alcohol use, particularly among older adolescents, which could reduce treatment adherence and effectiveness. HIV-related medical data showed most participants had received ART for more than 5 years and had achieved good viral load control, despite missed appointments being common. These findings underscore the multifaceted nature of ALHIVs' health needs and the importance of overcoming socio-economic challenges and mental health issues and lifting ART adherence to overall well-being.

Nutritional status metrics and prevalence of malnutrition in ALHIV

The study employed BAZ, HFA and MUAC to estimate prevalence rates of malnutrition. BAZ analysis identified 24.2% of participants as thin, with 26.9% of these classified as severely thin, with a higher rate among late adolescents than younger age groups and higher prevalence in males. HFA measurements revealed 21.7% of participants were stunted, with 28.9% experiencing severe stunting, again with a higher rate in late adolescents. MUAC data indicated that 34.9% of participants were malnourished, with MAM affecting 80.6% and SAM affecting 19.4% of this group. MUAC highlighted a higher prevalence of acute malnutrition in mid-aged adolescents, with higher prevalence among males. These findings underscore the need for multifaceted nutritional interventions targeted by age and gender to overcome the diverse nutritional challenges faced by ALHIV.

Factors affecting nutritional status in ALHIV: socio-demographic, psychosocial, environmental, and clinical variables

A key finding of this research was that multiple anthropometric measurements (MUAC, skinfold thickness, hip circumference and BFP) are significantly associated with the malnutrition status of ALHIV. These correlations underscore the importance of using a comprehensive set of anthropometric indicators for a thorough assessment of nutritional status. Socio-demographic factors also play a critical role: females were found to be 73% less likely to be malnourished than males, and younger adolescents (10–17 years) had a higher rate of malnutrition than their older peers (18–19 years). Psychosocial factors such as anxiety and depression were significant, with ALHIV experiencing lower levels of these conditions being less likely to be malnourished. Clinical variables like haemoglobin levels and chronic infections also affected nutritional outcomes, with higher haemoglobin and the absence of chronic infections correlating with a lower likelihood of malnutrition. Additionally, food security and lifestyle factors, such as experiencing food insecurity and consuming fewer meals per day, were strongly associated with malnutrition. Notably, ALHIV receiving nutritional supplementation had a reduced likelihood of being malnourished, highlighting the effectiveness of targeted nutritional support. Overall, these findings emphasise the need for a holistic approach to nutritional assessment to identify and mitigate malnutrition among ALHIV more effectively.

Energy and nutrient intake and its effect on the nutritional status of ALHIV

Although on average the surveyed ALHIV met over 75% of RDAs for calories, protein, carbohydrates, and fats, there were significant shortfalls in other essential nutrients. Mean intakes dietary fibre, retinol equivalent, niacin, vitamin C, calcium, and zinc were below the FAO/WHO recommendations, and the research revealed high intake of phytates, which can inhibit nutrient absorption. There were no significant differences in overall energy and nutrient intake between sexes, an interesting finding given the gendered differences in rates of malnutrition and stunting mentioned earlier. However, age-related differences in iron and phosphorus intakes were observed. Mean phosphorus intake for thin and non-thin adolescents differed significantly, as did carbohydrate intake for malnourished and non-malnourished adolescents. No significant differences were found in the nutrient intakes of stunted and non-stunted participants. These findings highlight the need for targeted nutritional interventions and supplementation to rectify specific deficiencies and improve the overall nutritional well-being of ALHIV.

Nutritional challenges and influences in HIV care and support

The study revealed a complex interplay of positive experiences and significant gaps in the nutritional care provided to ALHIV in Ethiopia. Participants appreciated the comprehensive support ART clinics provided, including medication, psychosocial services, and nutritional guidance. However, inconsistencies in nutritional screening and support, such as irregular availability of supplements, were significant concerns. The findings highlight that while Ethiopian healthcare services generally support ALHIV well, they do not provide consistent and comprehensive nutritional care. This inconsistency, combined with broader economic, psychological, social and medical problems, contributes to malnutrition among Ethiopian ALHIV. Economic issues, such as poverty and unemployment, and psychological problems, including depression and anxiety, exacerbate nutritional difficulties. Social stigma and discrimination further complicate the situation, affecting both access and adherence to nutritional care. Participants recommended greater government attention to economic stabilisation, job creation, and community education to reduce stigma, as well as improved stability in food supply and nutritional services, as ways to improve the overall health and well-being of individuals living with HIV. These findings call for a holistic approach that integrates healthcare improvements with broader socio-economic and policy interventions to meet the nutritional needs of Ethiopian ALHIV and improve their overall well-being.

8.2 Discussion of key findings

8.2.1 Nutritional assessment, counselling and management practices of ART clinic healthcare workers

HIV/AIDS has profoundly impacted health, nutrition and socioeconomic development in heavily affected regions, with adolescents being particularly vulnerable (WHO, 2003, 2018a). Comprehensive care and support in clinical settings are critical for improving the health and well-being of those affected (WHO, 2013a). Nutrition is a fundamental component of this care; its provision, and early prevention and detection of malnutrition, can reduce morbidity and mortality rates (Derose et al., 2015; FANTA-III, 2015; Tang et al., 2015).

Comprehensive nutritional assessment practices are vital for meeting ALHIVs' specific nutritional needs (FANTA, 2016). These practices include evaluating dietary intake, anthropometric measurements (weight, height, body composition), biochemical assessments (micronutrient

levels), clinical evaluations, and examination of socio-economic and environmental factors. Effective assessments allow healthcare providers to measure ALHIVs' nutritional status comprehensively and develop tailored nutritional interventions. Socio-economic and environmental factors, such as household income, access to nutritious food, living conditions and social support systems affect nutritional status significantly and should be considered to ensure that interventions are practical and address all factors affecting the adolescent's health.

The study found that while basic assessments such as body weight and height are routine in Ethiopian ART clinics, advanced methods like waist circumference measuring tapes, skinfold thickness callipers, and DXA are rarely utilised. This limited use of advanced assessment tools restricts the depth of nutritional evaluations for ALHIV, potentially affecting the effectiveness of nutritional interventions. This finding aligns with existing literature that emphasizes the necessity of comprehensive nutritional assessments for effective management of ALHIV, highlighting that advanced assessment techniques are crucial for tailoring interventions to individual needs (Tang et al., 2015).

Nutrition counselling and education services are crucial components of comprehensive care for ALHIV, enabling them to understand and manage their nutritional needs effectively and improve their quality of life, ultimately reducing disease-related mortality (MOH, 2014; WHO, 2013a).The research underscores that informed nutritional choices and practices enhance long-term health outcomes for this population (Alo et al., 2014; Derose et al., 2015). However, the study highlights significant disparities in the provision of these essential services in Ethiopian ART clinics.

Only a minority of healthcare workers in the clinics studied regularly provide advanced, evidence-based nutritional counselling. Structured approaches such as the GALIDRAA and ORPA frameworks are used infrequently. This suggests a need for improved training and resources to enhance the delivery of effective nutritional counselling and education to patients (MOH, 2014; WHO, 2013a). Insufficient or inadequate nutrition counselling may mean ALHIV misunderstand their nutritional needs, increasing their vulnerability to dietary and nutritional deficiencies.

Most healthcare workers engaged in essential practices like nutrition screening and providing RUTF. However, the use of RUSF was less common, and sharing of supplementation among siblings and the lack of standardised discharge criteria may reduce the continuity and quality of care provided to ALHIV.

The study highlighted significant gaps in implementation support and resources. Many healthcare workers reported a lack of essential documents, such as SOPs and nutrition guidelines, as well as inadequate patient education materials and training resources. Despite these deficiencies, over half of the participating ALHIV had access to referral and linkage systems for additional support.

The study revealed that almost half of all participating healthcare workers reported inadequate levels of nutritional assessment, counselling, and management practices. Contributing factors may include the complex nature of undernutrition in ALHIV, inadequate implementation of integrative nutrition services, a shortage of trained professionals, and insufficient resources (FANTA, 2016). Comprehensive evaluations of nutritional status should be conducted from the early stages of HIV infection to minimise deficiencies and related complications (WHO, 2017). The absence of comprehensive evaluations, such as dietary and food security assessments and body composition measures, could result in missing hidden hunger and ART-related complications. Despite these challenges, HIV-related medical data indicated that most participants had been receiving antiretroviral therapy (ART) for over five years and achieved good viral load control, even though missed appointments were common. This aligns with findings from a study in Uganda (Okoboi et al., 2016), which also highlighted the effectiveness of long-term ART in achieving viral suppression.

No consolidated framework for nutrition policy implementation in Ethiopian ART clinic exists. This study also identified significant disparities in nutritional practices across healthcare facilities and regions, likely due to variations in resource availability and knowledge. Ensuring an adequate supply of measurement tools and improving healthcare worker training are crucial steps in reducing these disparities.

The literature shows that healthcare workers who use anthropometric indices and have access to nutrition counselling services provide better nutritional assessment and management. This underscores the importance of using multiple anthropometric methods and providing appropriate resources for accurate nutritional care of ALHIV (FANTA, 2016).

Despite providing nutrition case management and supplementation services, many participants reported a lack of implementation frameworks and guidelines, suggesting that national and regional health bureaus in Ethiopia do not prioritise nutritional care. This deficiency may lead to lower-quality service provision and inadequate monitoring and support.

The study also found that while RUTF is commonly used for severely malnourished clients, RUSF and super-cereals are rarely provided for moderately malnourished individuals. This gap highlights the need for better support and supplies to improve care for ALHIV on ART (WHO, 2021).

In conclusion, while basic nutritional assessments and interventions are performed in Ethiopian ART clinics, advanced assessment methods and evidence-based counselling practices are rarely applied. Enhanced training, resource allocation, and better integration of nutrition services can optimise nutritional management and improve health outcomes for ALHIV.

8.2.2 Nutritional status of ALHIV and its determinants

Adolescence is a critical stage of growth and development in which individuals' nutritional requirements increase (Christian & Smith, 2018). This study involved a thorough examination of the multifaceted health and nutritional challenges experienced by ALHIV, integrating socio-demographic, psychosocial, environmental, and clinical factors. The characteristics of the cohort of the participants highlight the need for interventions tailored to both age and gender. Nearly all participants (98.7%) were students, so HIV management strategies within school health programs are appropriate; school-based interventions have been demonstrated to be effective in improving adolescent health outcomes (Sawyer et al., 2018; Suto et al., 2021; Xu et al., 2020).

Analysis of anthropometric measures (BAZ, HFA and MUAC) revealed malnutrition among the participating ALHIV, with notable disparities by age and gender. The data indicated that a substantial proportion of participants were affected by thinness and stunting, with 24.2% classified as thin (26.9% severely so), and 21.7% as stunted (28.9% severely so). Furthermore, 34.9% of the participants were identified as malnourished based on MUAC, including 19.4% with SAM. These patterns underscore the critical need for age and gender- specific nutritional interventions. The higher prevalence of malnutrition among mid-aged adolescents and males suggests that interventions should be tailored to the unique nutritional needs of these subgroups, thereby improving their overall health outcomes and supporting better management of HIV-related health challenges (DeBoer et al., 2012; Williams & Jesson, 2018).

The prevalence of thinness in this study (24.2%) aligns with the findings of studies conducted in Uganda in 2015 (26%) (Francis et al., 2015) and southern Ethiopia in 2020 (20%) (Shiferaw & Gebremedhin, 2020), but exceeds those measured in south-west Nigeria in 2015 (19%) (Fagbamigbe et al., 2019) and Uganda in 2022 (7.25%) (Dave et al., 2022). Possible reasons for

this high prevalence include poverty, inadequate access to healthcare, and prevailing cultural norms affecting dietary habits and nutritional practices in these regions. The discrepancies between regional prevalences may be attributed to socioeconomic and cultural variations, differences in political stability and insecurity, as well as differences in dietary habits, nutritional support facilities, and dietary practices.

Socio-economic factors are strongly associated with nutritional status. A high prevalence of food insecurity was reported by ALHIV in this study, including low food variety and meal frequency, exacerbating malnutrition risk. Participants facing food insecurity were more likely to experience thinness and malnutrition, reflecting the severe impact of socio-economic deprivation on nutritional health. These findings align with previous studies that link food insecurity to poor nutritional outcomes in HIV-positive populations (Martín-Cañavate et al., 2018; Shiferaw & Gebremedhin, 2020).

Nutritional supplementation emerged as a critical factor in improving nutritional status, with ALHIV receiving support having a lower rate of malnutrition. This underscores the importance of targeted nutritional interventions as part of comprehensive HIV care. Additionally, participants consuming three or more meals per day were less likely to be malnourished, highlighting the role of dietary adequacy in maintaining nutritional health (Holmes & Racette, 2021).

The psychosocial dimension is crucial, with high rates of generalised anxiety and depressive disorders observed among ALHIV. These mental health problems are associated with poorer nutritional outcomes, including thinness and malnutrition (Muscaritoli, 2021). This underscores the need for integrated mental health care within HIV management programs to meet both psychological and nutritional needs. Study findings reinforce the need for a holistic approach that combines psychological support with medical and nutritional care (Firth et al., 2020; Kris-Etherton et al., 2021; Remien et al., 2021).

Environmental factors, including inadequate access to clean water and poor sanitation, undermine the benefits of adequate nutrition. The association between poor sanitation and increased infection risk suggests that improvements in water and sanitation infrastructure are essential for good health outcomes among ALHIV (Bain et al., 2014; Hutton et al., 2007). In addition, chronic illnesses (e.g., tuberculosis) and conditions (e.g., anaemia) cause poor appetite and inadequate nutrient intake, emphasising the need for integrated clinical and nutritional management strategies.

Elevated SGPT levels, indicating liver dysfunction, also correlate with malnutrition, highlighting the importance of monitoring liver function in ALHIV management (Fan et al., 2022; Michel et al., 2023; Nikolaou et al., 2013; Oh et al., 2017; Price & Thio, 2010).

In conclusion, sub-study findings underscore the complex and multifaceted nature of the health and nutritional needs of ALHIV. Meeting these needs requires a comprehensive approach that integrates socio-demographic, psychosocial, environmental, and clinical factors. Tailoring interventions to specific age groups and genders, while working to improve mental health, food security and environmental conditions, is crucial for improving the overall well-being of ALHIV. Adopting an integrated approach will enhance management of the diverse challenges for this vulnerable population, ultimately leading to improved health outcomes and better quality of life.

8.2.3 Energy and nutrient intake and its effect on the nutritional status of ALHIV

Adolescents living with HIV require adequate energy and nutrient intake to support their growth, development and well-being. Understanding the dietary patterns and nutrient intake of ALHIV is crucial for optimising their health outcomes and mitigating the adverse effects of HIV infection and ART, and provides insights into their overall health and well-being, as well as areas for intervention. This section presents a discussion of the dietary intake and diversity of ALHIV in Ethiopia and their relationships with nutritional status.

Mean intakes of iron and phosphorus in some age groups were found to be lower than recommended levels, which is concerning given that adequate iron and phosphorus are vital for growth, bone health, and metabolism (Norris et al., 2022; Stefanache et al., 2023). Targeted interventions to rectify these deficiencies will promote optimal health during this critical stage of development. Additionally, the reliance on plant-based sources for vitamin A and iron, coupled with high consumption of phytic acid-rich foods, may compromise nutrient absorption and heighten the risk of deficiencies (Samtiya et al., 2021; Samtiya et al., 2020). Notably, phosphorus intake varied significantly between thin and non-thin adolescents, as well as carbohydrate intake among malnourished and non-malnourished individuals. Addressing these disparities is essential for improving overall nutritional status and health outcomes in this population.

Study findings reveal that most ALHIV ingested over 75% of the RDAs for calories, protein, carbohydrates, and fats, indicating baseline adequacy in energy provision. However, there were significant deficiencies in mean intake of essential nutrients such as dietary fibre, retinol

equivalent, niacin, vitamin C, calcium, and zinc relative to FAO/WHO recommendations (Bailey et al., 2012; Norris et al., 2022). High consumption of phytates, which can impair the absorption of critical minerals, exacerbates this issue (Nissar et al., 2017).

Half of the participants came from households with a monthly income of 1000–3000 Ethiopian Birr, well below the median household income in Ethiopia, and a two-third lived in families of 4 or more people. Low income and large families can mean individuals eat a restricted and non-nutritious diet (Penne & Goedemé, 2021).

Nearly one third of the participating adolescents reported skipping meals in the 24 hours before interview. This behaviour can retard health, immune function, and growth (Zeballos & Todd, 2020). These findings underscore the importance of adequate nutrient intake for maintaining optimal nutritional status and supporting growth and health in ALHIV. However, no significant differences were observed in nutrient intake related to stunting, suggesting that factors beyond diet contribute to stunting.

In summary, this study highlights the urgent need for targeted nutritional interventions to correct specific deficiencies exhibited by ALHIV in Ethiopia. While some energy and macronutrient needs were being met, there were notable shortfalls in micronutrient intake and concerns about nutrient absorption due to high phytate levels. Overcoming these deficiencies through supplementation and promoting dietary diversity (particularly to deliver more iron and phosphorus) will be essential for improving the nutritional well-being of ALHIV. Tailoring interventions to overcome age-related disparities and socioeconomic influences and more comprehensive measurement of nutritional status will improve the effectiveness of nutritional support and create better health outcomes for this vulnerable population.

8.2.4 Nutritional challenges and influences on HIV care and support

The qualitative findings from this study provided a comprehensive understanding of the experiences and perceptions of ALHIV in Ethiopia, particularly regarding their nutritional status and the care available to them in ART clinics. Participants reported that clinics offered a broad range of services, including medication, psychosocial support, and nutritional guidance, which were generally appreciated. These services, especially the OTZ program, were instrumental in providing emotional support and fostering a sense of community, reflecting the benefits of

integrated health services in enhancing quality of life for those with chronic conditions (French et al., 2019).

However, significant gaps in nutritional care were identified. Inconsistent nutritional screening and inadequate education highlighted a need for a more systematic approach to ensuring comprehensive and consistent nutritional support (Penne & Goedemé, 2021). Participants on long-term antiretroviral therapy (ART) reported severe side effects and psychological complications, consistent with research on mental health and medication side effects (Samtiya et al., 2020). The psychological impacts of living with HIV, including trauma and depression, were compounded by stigma and fear of discrimination, which reduced adherence further. Given these challenges, a comprehensive approach to patient care is essential. Regular monitoring of physical and mental health helps manage side effects effectively. Personalized treatment plans minimize adverse effects, while psychoeducation and counselling provide coping tools. Using reminder systems enhances adherence, and incorporating nutritional support can improve health outcomes. Exploring newer ART medications with fewer side effects and integrating mental health care into HIV treatment programs is crucial. Open communication with healthcare providers empowers individuals to address concerns proactively, ultimately improving overall quality of life.

The study also identified a complex interplay of economic, social and medical factors influencing nutritional status. Economic barriers like poverty and unemployment were significant, leading to food insecurity and inadequate nutrition. This aligns with broader literature that connects socioeconomic factors with poor nutrition (Penne & Goedemé, 2021). The cyclical nature of these issues – economic hardship leading to poor nutrition, which in turn affects mental health and medication adherence – emphasises the need for a holistic approach to malnutrition prevention (Zeballos & Todd, 2020).

Participants reported that the ART clinics were inconsistent in their provision of nutritional support and education. Participants suggested that government intervention could improve economic stability via direct healthcare improvements and broader socioeconomic and policy interventions (French et al., 2019; Penne & Goedemé, 2021). Improving security to ensure stable food production and availability were also advocated.

In addition to these broader systemic changes, community and social support initiatives are needed to improve ALHIVs' health and quality of life. Community-based programs could provide targeted

nutritional support and education tailored to ALHIVs' specific needs. Community organisations, local NGOs, and social service agencies could collaborate to offer supplementary nutrition programs, peer support groups, and educational workshops for ALHIV and their families. Similar efforts could be mounted to reduce stigma and increase community awareness about HIV and nutrition. Additionally, local community gardens, food banks, and partnerships with local businesses could enhance food security and availability. By strengthening community support networks and integrating social support initiatives, these local actions could effectively complement broader policy interventions and improve overall care for ALHIV.

In conclusion, the findings from this study reveal a complex web of factors affecting the nutritional health of ALHIV in Ethiopia. While ART clinics provide valuable services, there are critical areas for improvement, particularly in the consistency of nutritional care and overcoming the multifaceted barriers to adequate nutrition. A holistic approach that combines enhanced and integrated healthcare services, psychological support, economic and social interventions, and government policies is essential. Participants' insights highlight the need for continued efforts to improve both the direct care provided within ART clinics and the broader systemic factors influencing the nutritional status of ALHIV.

8.3 Implications of the findings

8.3.1 Clinical implications

The study's findings highlight critical areas for improvement in the clinical management of ALHIV. Healthcare providers should adopt a more comprehensive approach to nutritional assessment that goes beyond basic anthropometric measures. Incorporating advanced techniques such as body composition analysis can provide more accurate evaluation of nutritional status. This will enable better targeting of nutritional interventions and tracking of outcomes.

There is a clear need for enhanced training of ART clinic staff in evidence-based nutritional counselling methods, such as GALIDRAA and ORPA, to improve the effectiveness of nutritional education and support provided to ALHIV. This will support empowerment of ALHIV and their families to maximise individual and home-based nutrition.

The findings also indicate a need for consistent application of nutritional management practices, including the regular provision of RUSF and deterring the sharing of supplements. Ensuring that

supplements are provided to those in need and consumed by the designated recipients will create the most cost-effective use of resources and optimised nutritional outcomes.

Clinical guidelines should be updated to include standardised nutritional care protocols, ensuring that all ALHIV receive uniform and effective nutritional support. This will enable easy access to evidence-based recommendations for practice by all healthcare professionals. Creation of lay summaries worded appropriately for ALHIV and families will support consumer education that results in better-informed patients and families. Additionally, integrating mental health support into routine care is essential, because high levels of anxiety and depression among ALHIV can degrade their nutritional status and health outcomes significantly.

8.3.2 Public health implications

The study highlights the urgent need to improve the socio-economic and environmental conditions contributing to malnutrition among ALHIV in Ethiopia. Acting on the following recommendations, based on the evidence generated in this study, will improve the nutritional status of ALHIV in Ethiopia.

- Implement targeted food security programs to ensure ALHIV have consistent access to nutritious food. This could include subsidised food programs, community-based nutrition support initiatives, and distribution of essential nutritional supplements, particularly in underserved areas. Collaborations with local and international organisations could facilitate the provision of fortified foods and micronutrient supplements.

- Develop and support economic empowerment programs aimed at improving the financial stability of families with ALHIV. This could involve job creation initiatives, vocational training, and microfinance opportunities to alleviate poverty and reduce socio-economic barriers to adequate nutrition.

- Integrate nutritional support into HIV care: Establish integrated care models where nutritional support is a standard component of HIV treatment programs. This includes training healthcare providers to offer nutritional counselling and support as part of routine HIV care and developing protocols that incorporate dietary assessments and interventions into the care plans for ALHIV.

- Strengthen community-based efforts to support ALHIV. Engage local organisations and community groups in delivering nutritional education and support services. Promote grassroots initiatives that offer local solutions to food insecurity and provide community-driven nutritional programs tailored to the needs of ALHIV.
- Launch comprehensive public health campaigns to raise awareness about the nutritional needs of ALHIV. Provide educational resources and training for both healthcare workers and the public to ensure consistent and accurate nutritional care practices. Develop materials that correct common misconceptions about HIV and nutrition to combat stigma and improve adherence to nutritional guidelines.
- Implement community-based interventions aimed at reducing stigma and discrimination associated with HIV. Support initiatives that promote inclusivity and respect for ALHIV, such as advocacy campaigns and educational programs that foster understanding and acceptance within communities.

By adopting these recommendations, stakeholders can enhance the overall care and support systems for ALHIV in Ethiopia, thereby improving their nutritional status, health outcomes, and quality of life. The integration of these interventions into the healthcare system will create a more comprehensive approach to managing HIV and nutrition, ultimately contributing to better health and well-being for ALHIV.

8.3.3 **Policy implications**

The findings of this study underscore the critical need for a more integrated approach to nutritional interventions within HIV care frameworks. Policymakers at the central governmental and local community levels must enhance the integration of nutritional assessments and support into HIV care strategies.

- **Enhance nutritional assessment practices:** Policies should mandate the use of advanced nutritional assessment tools in ART clinics. Although basic assessments are performed, the study highlights a gap in utilising tools such as waist circumference measuring tapes, skinfold thickness callipers, and DXA. Ensuring that these tools are available and used will provide a more comprehensive evaluation of nutritional status.

Additionally, performing baseline assessments consistently and repeating them regularly is crucial for monitoring progress over time. This approach will lead to more tailored and effective interventions, thereby improving the overall management of nutritional health for ALHIV.

- **Standardise nutrition care protocols:** Developing and implementing standardised guidelines for nutritional care is essential. This includes integrating structured nutritional counselling approaches, such as the GALIDRAA and ORPA methods, into routine practice. Clear protocols should be established for the provision of RUSF and other nutritional support measures. These guidelines must be consistently applied across all services and locations to ensure universality in care. Addressing inconsistencies and gaps identified in current practices will lead to more equitable and effective nutritional support for ALHIV.

- **Lower Socio-Economic and Systemic Barriers to Nutritional Health:** The study revealed that poverty, food insecurity, and social stigma are associated with lower nutritional status for ALHIV. Policymakers should advocate for broad socio-economic initiatives to improve food security, support economic stability, and reduce stigma to promote the well-being of ALHIV and improve their nutritional health.

- **Strengthen training and resource allocation:** To enhance the effectiveness of nutritional interventions, policymakers should improve training for healthcare workers and ensure the availability of necessary resources. Comprehensive training programs should be paired with strategies to encourage and incentivise the adoption of evidence-based practices. Clear guidelines and integrating new practices into daily routines are essential. Additionally, implementing monitoring and audit systems will help ensure adherence to protocols and achievement of desired outcomes. These measures will improve the delivery of nutritional care and achievement of the needs of ALHIV.

- **Promoting collaboration and integration:** Effective integration of nutrition services within HIV care requires collaboration between healthcare providers, government agencies, and community organisations. Policymakers should facilitate better coordination among these stakeholders to ensure a holistic approach to meeting both

nutritional and medical needs. Key actions include establishing guidelines for nutrition integration, providing training for healthcare providers, organizing interagency meetings, securing funding for nutrition programs, and supporting data collection on health outcomes. Additionally, encouraging community engagement and advocating for food security initiatives are crucial to ensuring comprehensive support for individuals living with HIV

By actioning these recommendations, policymakers can create a more cohesive and effective framework for managing the nutritional needs of ALHIV. This integrated approach will help improve the quality of care, enhance health outcomes, and support the overall well-being of ALHIV.

8.3.4 **Research Implications:** Future research should seek to fill remaining gaps in knowledge about the best practices in nutritional care for ALHIV.

- Explore the effectiveness and feasibility of advanced nutritional assessment tools in LMIC settings to determine how best to integrate them into routine care.
- Undertake research on the unique nutritional needs of male and female ALHIV and develop interventions tailored by gender.
- Conduct research into specific nutrient deficiencies and effective supplementation strategies in order to develop dietary recommendations and improve the overall nutritional well-being of ALHIV.
- Conduct longitudinal studies to evaluate the long-term impact of nutritional interventions on ALHIV. This will provide valuable insights into their effectiveness and help refine future strategies.

8.3.5 Strengths and limitations of the study

This study offered a thorough assessment of the nutritional status of ALHIV and the management practices employed in ART clinics in Ethiopia. It utilised a combination of methods, including dietary intake assessments, anthropometric measurements, healthcare worker surveys, patient experience interviews and FGDs, and health record reviews. The integration of record reviews enhanced the robustness of the data by providing objective information on medical and nutritional

interventions, complementing the self-reported data from ALHIV and healthcare workers. This multifaceted approach allowed for a comprehensive evaluation of both nutritional status and healthcare practices. The study's methodological rigour was strengthened by the use of pilot studies to validate data collection instruments and adherence to standardised protocols, which helped to ensure the reliability of the findings.

A limitation of the study was the reliance on self-reported data from ALHIV and healthcare workers, which may have introduced response or social desirability bias. Despite efforts to mitigate these biases through method triangulation, instrument validation, and standardised protocols, their impact on data accuracy could not be eliminated entirely. Future research could enhance reliability by incorporating objective measures alongside self-reports and employing methods for cross-validation.

Another limitation was the small sample sizes for both dietary data and healthcare worker surveys, which restricted the generalizability of the findings. The limited sample size for individual interviews further constrains the diversity of perspectives and excluding caregiver insights may overlook critical support dynamics. To improve generalizability, future studies should include larger, more diverse samples and consider multi-center designs that capture variability across geographic and socio-economic contexts. Additionally, variability in local research assistants' training could impact data quality, while recall bias may affect the accuracy of participants' reflections on past experiences.

The cross-sectional design of the study limited the ability to establish causal relationships between nutritional practices and health outcomes. Longitudinal or interventional study designs could provide deeper insights into the long-term effects of nutritional practices on the health of ALHIV, offering a more comprehensive understanding of causality. Lastly, socio-political and economic challenges may influence results, and the study did not assess the long-term effectiveness of healthcare programs.

By overcoming these limitations using larger sample sizes, longitudinal or interventional approaches, and improved data collection methods, future research could offer more robust and generalisable findings on the impact of nutritional practices on ALHIV.

Chapter 9: Conclusions and recommendations

9.1 Conclusions

This study has presented a comprehensive overview of the nutritional care and status of adolescents living with HIV (ALHIV) in Ethiopia, integrating quantitative and qualitative data to identify key challenges and areas for improvement. The findings highlight several critical issues in the management of ALHIV's nutritional needs, including gaps in advanced nutritional assessment practices, inconsistencies in counseling and education, and significant socio-economic and psycho-social barriers affecting their health.

The study reveals that while basic nutritional assessments are routinely performed by healthcare workers in ART clinics, advanced methods such as waist circumference measurement, skinfold thickness assessment, and dual-energy X-ray absorptiometry (DXA) are rarely utilized. This limitation in assessment practices constrains the effectiveness of nutritional interventions. Similarly, despite the importance of evidence-based nutritional counseling frameworks like GALIDRAA and ORPA, their application remains limited, pointing to a need for enhanced training and resources.

The nutritional status of ALHIV, as assessed through anthropometric measures, shows concerning rates of malnutrition, with significant disparities based on age and gender. The prevalence of thinness, stunting, and overall malnutrition underscores the need for targeted, age- and gender-specific nutritional interventions. Socio-economic factors, including food insecurity and inadequate dietary variety, further exacerbate these issues, while psycho-social factors like anxiety and depression compound the nutritional challenges faced by ALHIV.

The study also highlights the significant role of dietary intake in nutritional status. While energy and macronutrient intake generally meet recommended levels, deficiencies in essential micronutrients such as iron, vitamin A, and zinc are prevalent. High phytate consumption, which impairs mineral absorption, adds to the complexity of addressing these deficiencies. The variability in nutrient intake by age and the impact of socioeconomic factors on food security suggest that tailored, context-specific interventions are necessary.

Qualitative insights reveal a need for more consistent and comprehensive nutritional care within ART clinics. Participants reported valuable support from programs like Operation Triple Zero

(OTZ) but also highlighted gaps in nutritional education and support. Socio-economic hardships, stigma, and psychological issues significantly impact nutritional health, emphasizing the need for a holistic approach that addresses both direct nutritional care and broader socio-economic and mental health challenges.

In summary, addressing the nutritional needs of ALHIV requires a multifaceted approach that integrates improved assessment practices, enhanced counseling and education, and targeted interventions to address socio-economic and psycho-social barriers. The insights from this study, combined with evidence from the systematic review, underscore the necessity of a coordinated effort to optimize nutritional management and improve overall health outcomes for ALHIV.

9.2 Recommendations

To address the identified gaps and enhance the nutritional management of ALHIV, several key recommendations are proposed.

1. Enhance nutritional assessment practices. Introduce and implement advanced nutritional assessment tools, such as waist circumference measurement, skinfold thickness callipers and DXA, to provide a comprehensive evaluation of nutritional status in ALHIV. While some of these tools are resource-intensive, simple and cost-effective measures such as mid-upper arm circumference (MUAC) and basic dietary assessments can still be highly effective. Integrate training for healthcare providers in the use of these tools into existing programs to ensure practicality and effectiveness. This approach will enable healthcare providers to more accurately identify and minimise hidden hunger and ART-related complications.

2. Standardise and strengthen nutritional counselling. Develop and implement standardised nutritional care protocols based on evidence-based frameworks like GALIDRAA and ORPA. Ensure training programs for healthcare workers incorporate culturally relevant dietary practices and practical guidelines, leveraging community health networks to maximise reach and impact.

3. Improve resource allocation and training. Equip Ethiopian healthcare facilities with up-to-date measurement tools and educational materials. Explore partnerships with local and international organisations for resource provision. Invest in training programs to build the

capacity of healthcare workers to provide comprehensive nutritional care, focusing on efficient use of available resources. Fill gaps in resources such as SOPs and nutrition guidelines.

4. Reduce socio-economic barriers. Develop and implement policies aimed at reducing food insecurity and poverty, such as community-driven initiatives and local support programs. Collaborate with governmental organizations and local and international NGOs focused on HIV and nutrition to provide targeted economic support, ensuring that interventions are tailored to meet the specific needs of ALHIV and promote sustainable solutions for their well-being.

5. Integrate psychosocial support. Incorporate mental health services into HIV care programs to reduce the severity and influence of psychological factors, such as anxiety and depression, on nutritional status. Develop community-based mental health initiatives and integrate them with existing healthcare services to provide accessible and holistic support for ALHIV.

6. Enhance environmental and clinical support. Improve access to clean water and sanitation through community-driven projects and partnerships with relevant agencies. Reduce the health harms of chronic conditions like tuberculosis and anaemia through targeted health campaigns and routine care protocols. Monitor and manage these conditions to mitigate their impact on nutritional health.

7. Promote dietary diversity and supplementation. Increase dietary diversity and reduce micronutrient deficiencies through targeted supplementation. Encourage ALHIV to consume affordable, nutrient-rich foods, including those high in iron, vitamin A, and zinc. Additionally, teach practical cooking and food preparation techniques to mitigate the impact of phytates and improve nutrient absorption.

8. Foster community and policy engagement. Engage communities and policymakers in efforts to reduce stigma and support ALHIV. Advocate for comprehensive policy changes to tackle barriers that affect access to nutrition and healthcare services. Collaborate with governments and NGOs to strengthen support systems for ALHIV, ensuring they receive the resources needed for better health outcomes.

9. Conduct further research. Prioritise longitudinal and interventional studies to explore the causal relationships between improved nutritional practices and health outcomes for ALHIV. Investigate barriers to implementing advanced nutritional assessments and counselling strategies to refine and optimise care practices.

By implementing these recommendations, stakeholders will improve the nutritional management of ALHIV in Ethiopia, ultimately leading to improved health outcomes and a better quality of life for this vulnerable population.

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Appendix I: World Bank Global Index LMIC List 2020

1.1. LOW-INCOME ECONOMIES

Afghanistan	Syrian Arab Republic	Mozambique
Guinea-Bissau	Central African Republic	Uganda
Sierra Leone	Madagascar	Ethiopia
Benin	Tajikistan	Nepal
Haiti	Chad	Yemen, Rep.
Somalia	Malawi	Gambia
Burkina Faso	Tanzania	Niger
Korea, Dem. People's Rep.	Congo, Dem. Rep	Guinea
South Sudan	Mali	Rwanda
Burundi	Togo	
Liberia	Eritrea	

1.2. LOWER-MIDDLE INCOME ECONOMIES

Angola	Solomon Islands	Moldova
India	Cambodia	Uzbekistan
Papua New Guinea	Lao PDR	Djibouti
Bangladesh	Sudan	Mongolia
Indonesia	Cameroon	Vanuatu
Philippines	Lesotho	Egypt, Arab Rep.
Bhutan	Timor-Leste	Morocco
Kenya	Comoros	Vietnam
São Tomé and Principe	Mauritania	El Salvador
Bolivia	Tunisia	Myanmar
Kiribati	Congo, Rep.	West Bank and Gaza
Senegal	Micronesia, Fed. Sts.	Eswatini
Cabo Verde	Ukraine	Nicaragua
Kyrgyz Republic	Côte d'Ivoire	Zambia

Ghana Nigeria Honduras
Zimbabwe Pakistan

1.3. UPPER-MIDDLE-INCOME ECONOMIES

Albania
Fiji
Namibia
Algeria
Gabon
Nauru
American Samoa
Georgia
North Macedonia
Argentina
Grenada
Paraguay
Armenia
Guatemala
Colombia
Libya
Suriname
Costa Rica
Malaysia
Thailand
Cuba
Maldives
Tonga
Dominica
Marshall Islands
Turkey
Dominican Republic
Peru
Azerbaijan
Guyana
Romania
Belarus
Iran, Islamic Rep.
Russian Federation
Belize
Iraq
Samoa
Bosnia and Herzegovina
Jamaica
Serbia
Botswana
Mauritius
Turkmenistan
Equatorial Guinea
Mexico
Tuvalu
Ecuador
Montenegro
Venezuela, RB
Jordan
Sri Lanka
Brazil
Kazakhstan
South Africa
Bulgaria
Kosovo
St. Lucia
China
Lebanon
St. Vincent and the Grenadines

Appendix II: Published Article presented in Chapter Two

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BMC Nutrition

RESEARCH Open Access

Nutritional status and its determinants among adolescents with HIV on anti-retroviral treatment in low- and middle-income countries: a systematic review and meta-analysis

Meless Gebrie[1,2*], Lin Perry[2,3], Xiaoyue Xu[4], Andargachew Kassa[1] and Marilyn Cruickshank[2,5]

Abstract

Purpose This review aimed to determine what methods are used to assess nutritional status, the levels of nutritional status, determinants of undernutrition, and nutritional interventions employed for adolescents with HIV on Anti-Retroviral Therapy follow-up in Low- and Middle-Income countries.

Methods Established methods were used to systematically identify and retrieve studies published in five databases between January 2000 to May 2021, and citation searching. Quality was appraised and findings were synthesized using narrative analysis and meta-analysis.

Result Body Mass Index is the major indicator of nutritional status. The pooled prevalence of stunting, wasting, and overweight were 28.0%, 17.0%, and 5.0%, respectively. Adolescent males are 1.85 and 2.55 times more likely than adolescent females to suffer from both stunting and wasting at AOR = 1.85 (95%:1.47, 2.31) and AOR = 2.55 (95%: 1.88, 3.48), respectively. Similarly, adolescents with a history of opportunistic infections were 2.97 times more likely to be stunted than uninfected adolescents, AOR = 2.97 (95%:1.73, 5.12). One single intervention study found significant improvements in anthropometric status after nutritional supplementation.

Conclusion and recommendation The few studies that have been conducted on nutritional status in adolescents living with HIV in low- and middle-income countries indicate that stunting and wasting are common in this population. Avoiding opportunistic infections is an important protective factor but the review highlighted the generally inadequate and fragmented nature of nutritional screening and support programs. Development of comprehensive and integrated systems for nutritional assessment and intervention services during ART follow-up should be prioritized to improve adolescent clinical outcomes and survival.

Keywords Adolescent, Nutrition, Anti-retroviral therapy, Human immunodeficiency virus, Low-middle-income countries, Malnutrition

*Correspondence:
Meless Gebrie
natanmeless@gmail.com; MelessGebrie.Bore@student.uts.edu.au
Full list of author information is available at the end of the article

Introduction

Adolescence (ages 10 to 19 years [1]) is a critical time period since many of the risk factors for adult diseases develop during this age [2]. This age group provides a second window of opportunity for positive life cycle development and aids in mitigating adult problems [3]. Adolescents account for 16% of the global population but comprise a quarter of the population in some countries. Numbers are expected to rise through 2050, particularly in low- and middle-income countries (LMICs). More than half of all adolescents live in Asia but in sub-Saharan Africa they make up the greatest proportion of the population, at 23% [1, 4].

Adolescents are disproportionately affected by the human immunodeficiency virus (HIV) [1, 3]. In 2020, about 1.75 million adolescents worldwide were living with HIV, representing approximately 5% of all people with HIV, 11% of new HIV infections, and 5% of all AIDS-related deaths. In the same year, approximately 940,000 adolescents, 54% of adolescents living with HIV worldwide, received antiretroviral therapy (ART) [3, 4]. More than 1.5 million adolescents and young adults aged 10 -24 years die each year, nearly 5000 every day, from largely preventable causes; three-fourths occur in LMICs [5]. HIV is a preventable cause of disability, morbidity, and mortality among adolescents and young people, with an increasing proportion reporting depression, stigma, violence, and suicidal behaviour [3–5].

Adolescents living with HIV are vulnerable to undernutrition due to their elevated nutritional needs imposed by a puberty growth spurt and HIV infection. Malnutrition is a major threat to the health of HIV-infected individuals and is associated with increased risks of morbidity and mortality [6]. Despite the introduction by the United Nations of Sustainable Development Goals (SDG), designed to safeguard the most vulnerable [7], and the decreasing trends seen in many communicable and nutritional disorders, malnutrition remains a major public health concern [2]. Moreover, progress has been inequitable with countries with a low and low–middle social development index (SDI) bearing a higher burden of morbidity amongst children and adolescents compared to middle-, high–middle-, and high-SDI countries [2]. About 88% (1.5 million) of all HIV-infected adolescents live in sub-Saharan Africa and although health-related initiatives have been instigated through SDG-aligned legislation, these adolescents still face severe health vulnerabilities [8].

In many LMICs, the targets for adolescents' physical health predominantly focuses on the sexual and reproductive health (SRH) behaviors of young people aged over 15. However, nutrition plays a critical role not just for SRH but also in the life cycle, transitioning from adolescence to healthy adults. Malnutrition among children and adolescents is associated with delayed growth, impaired cognitive maturation, lower intellectual quotient, behavioral problems and increased risk of contracting communicable disease [1, 9, 10]. Further, younger adolescents with HIV have greater nutritional and health demands because they face extra challenges beyond those caused by the general health vulnerabilities affecting adolescents in LMICs, such as cultural/norm-based practices, gender-based violence, and heavy workloads [11]. Due to their increased nutritional requirements, those living with HIV are particularly susceptible to undernutrition. Adequate and proper nutrition for well-nourished patients with HIV leads to slower disease progression than experienced by those who are malnourished but teenagers are rarely given priority in nutrition initiatives and there is little research on the epidemiology of undernutrition and its causes among adolescents living with HIV in LMICs. This review, therefore, aimed to determine how nutritional status is assessed and to evaluate the nutritional status of HIV-positive adolescents and its determinant factors in LMICs.

Methods and materials

Study design

An integrative review design was used as it was anticipated that evidence would derive from a variety of quantitative and qualitative studies.

The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guideline was followed to report results [12] (see Supplementary Table 1).

Research questions

1. What methods are used to assess nutritional status of adolescents who are HIV positive on ART follow-up living in LMICs?
2. What is the nutritional status of adolescents who are HIV positive on ART follow-up living in LMICs?
3. What are the determinant factors associated with the nutritional status of adolescents who are HIV positive and on ART follow-up living in LMICs?
4. What nutritional interventions, if any, have a significant improvement on the nutritional status of adolescents who are HIV positive and on ART follow-up living in LMICs?

Search strategy and sources of Information

The "Population, Intervention, Comparator, Outcomes (PICO)" and "Population, Exposure, Outcomes (PEO)" frameworks were used to develop robust literature search strategies. After a preliminary assessment of

the appropriate Medical Subject Heading terms (Title-Abstract-Keywords), keywords and synonyms, a search strategy was developed. As the terms nutrition screening and assessment were often used interchangeably in studies, synonyms of *malnutrition* and *nutritional status* were combined with synonyms of *screening* and *assessment* (see Supplementary Table 1).

The PICO/PEO framework was applied for research question 1 & 2 as follows:

- In adolescents who are HIV positive and on ART follow-up living in LMICs (P), what methods of assessment were used (I) to determine the level of nutritional status (O) compared with WHO standards (C)?
- In adolescents who are HIV positive on ART follow-up living in LMICs (P), what levels of nutritional status (O) were reported compared with WHO standards (C)?

To address research question 3:

- In adolescents who are HIV positive and on ART follow-up living in LMICs (P), what determinant factors (I or E) lead to a changed (increased/decreased) risk of malnutrition/undernutrition (O)?

To address research question 4 effectiveness studies were sought to determine:

- What nutritional interventions (I) affect the nutritional status outcomes (O) of adolescents who are HIV positive on ART follow-up living in LMICs (P) compared to comparison group (C) outcomes?

The search strategy was applied, with individual modifications, to the electronic databases: Medline (Ovid), PubMed, ProQuest, EMBASE (Ovid), and Cochrane Library of Databases. Records were systematically searched for publications from January 2000 to May 2021 for materials that met the inclusion criteria. In addition, citations/reference lists of retrieved relevant articles were searched. Additional articles were advance-searched from Web of Science and Google Scholar.

Inclusion criteria

Study setting Studies conducted in LMICs, classified according to the World Bank criteria [13, 14]

Population The target population was adolescents who were HIV positive and on ART follow-up. For this review, participants were required to be specified as:

- Aged between 10—19 years of age, or
- If age was not specified, participants were referred to as older children OR young adults OR teenagers OR young person's OR young people whose age was 10 – 24 years, or
- If the sample was of mixed age (children/ adolescent/ young adult) the mean or median age or most of the sample (> 50%) must lie between 10–19 years

Type of publication Primary studies, both published and grey literature in the English language

Study design To address the first three questions, prospective studies, retrospective studies, cross-sectional studies, descriptive/quantitative and experimental studies, qualitative studies, and mixed-methods studies were sought

To address the fourth question effectiveness designs, such as experimental studies, randomized controlled trials (RCT), controlled clinical trials, quasi-experimental studies, or other interventional study designs were required.

Exclusion criteria

- Conference abstracts and other studies which did not have the full text available
- Reviews and other forms of report using secondary analysis.

Study screening, selection, and data extraction

The results of the search were exported to an Endnote library Version 20 after which duplicate items were automatically eliminated. Article titles, abstracts, and keywords were reviewed by two independent reviewers (MG & AK) for evaluation against the inclusion and exclusion criteria for eligibility. The complete texts of all potentially relevant papers were retrieved, and their citations were uploaded to the Joanna Briggs Institute System for the Unified Management, Assessment, and Review of Information (JBI SUMARI) for full-text screening (JBI, Adelaide, Australia). For articles that did not have full details, authors were contacted to obtain the full-text report at the corresponding author addresses. Papers were retained for full-text evaluation in cases where eligibility was ambiguous. Studies that were ineligible were excluded, with reasons noted. At each level of the selection process, any discrepancies between the reviewers were settled through conversation or by consulting a third reviewer (MC, LP). The outcomes of the search and screening procedure were displayed in a PRISMA flow diagram (Fig. 1).

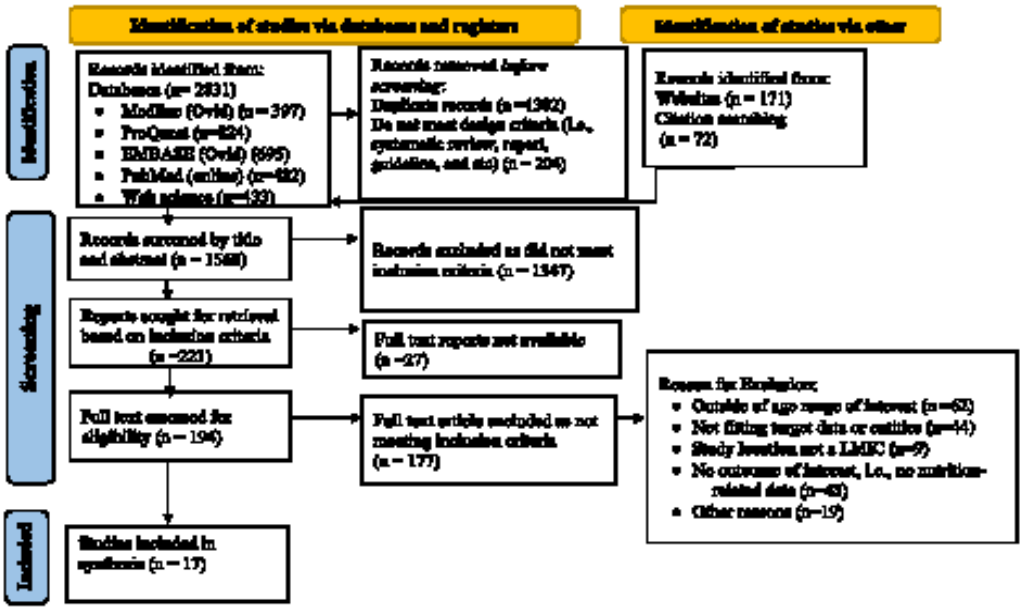

Fig. 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram of the review [12] (see Supplementary Tables 2 and 3)

Data were extracted by MG, AK, and AC/MC, and verified by LP and XX. Two reviewers extracted data for the quantitative component from the quantitative and mixed methods (quantitative component only) studies related to study contexts and participants, research techniques, interventions, and outcomes relevant to review questions. Data were taken verbatim where possible and any discrepancies between the reviewers were settled through conversation or by consulting a third reviewer. When necessary, data were requested from the study authors.

Quality appraisal

The selected studies were critically evaluated by two independent reviewers for methodological quality using the JBI appraisal instruments [15, 16]. Reviewers used the appropriate JBI quality assessment tool for each individual study design. Any disagreements between reviewers were resolved through discussions or with a third reviewer (see Supplementary Table 4).

Data synthesis and analysis

Extracted data were exported from Microsoft Excel to STATA Version 17.0 (software) for analysis. The characteristics of included studies and descriptive results were presented using tables and graphs. A random effects meta-analysis model was used and the pooled effect size was employed. Forest plots were used to show the pooled estimates with 95% confidence intervals (CI). The strategy for meta-analysis was based on the guidance of the Campbell systematic review model [17]. Publication bias and heterogeneity of the studies was assessed. Publication bias was assessed by examining a funnel plot of the data and performing Egger's test [18] to determine whether the effect size correlated with their standard errors. A sign of publication bias was considered in this study when studies with larger standard errors lead to larger effect sizes. Sub-group analysis was conducted to examine data heterogeneity and Cochran's Q-test and I2 statistics were calculated to estimate the level of heterogeneity.

Results

After duplicates were removed, a total of 1568 articles remained for Title-Abstract screening. Of these, 1347 articles were excluded as they did not meet inclusion criteria, and 221 articles remained for full-text screening. Of these 221 articles, 27 were removed because the full report was not available and 177 were excluded for not

meeting the inclusion criteria. In total, 17 articles were retained for data extraction and synthesis (Fig. 1).

Characteristics of included studies

These 17 primary articles recruited a total of 2873 study participants in LMICs. The majority of articles ($n=11$, 64.7%) were cross-sectional studies [19–27], whilst the remainder ($n=6$, 35.3%) comprised: observational studies ($n=3$) [28–30]; case–control study ($n=1$) [31]); mixed-method study ($n=1$) [32], and one clinical trial [33] (Table 1).

Studies were conducted in seven LMIC countries in South American, Asian and African continents. The majority ($n=7$, 41.2%) took place in upper-middle income countries [19, 21, 22, 27, 28, 30, 34], followed by low-middle income countries ($n=5$, 29.4%) [26, 29, 32, 33] and low- income countries (29.4%) [20, 23–25, 35] (Table 1).

Outcome 1, review question 1: nutritional assessments

Of the 17 included studies, the majority ($n=13$, 76.5%) used BMI as an indicator of nutritional status, followed by height for age ($n=7$, 41.2%). Six (35.3%) studies assessed dietary intakes and estimated energy and nutrient intakes, and three studies (17.6%) assessed body fat composition using standardized fat measurement (Table 2).

Outcome 2, review question 2: nutritional status of study participants

The majority of studies ($n=10$, 58.8% and $n=9$, 52.9%, respectively) reported nutritional status in terms of stunting and wasting; six studies ($n=6$, 35.3%) reported on overweight status. In most studies BMI-for-age Z-score and Height-for-Age Z-score (HAZ) below -2 Z score were used to determine nutritional status (under-weight, wasting, stunting and overweight) but a few articles used Weight-for-Age Z-score (WAZ) and Weight-for-Height Z-scores (WHZ) below − 2 Z- scores (WHO standard).

Prevalence of stunting

Most studies that reported stunting demonstrated that it occurred in between one fifth and one third of the participants ($n=7$ of 9, ranging 20.9 – 36.6%). The highest prevalence of stunting, at 46.6%, was reported from a study in Cambodia [26] and the lowest, at 6.1%, was from Brazil [30] (Table 3).

Prevalence of wasting

More than half the studies reported wasting in between one tenth and one fourth of the samples ($n=5$ of 9, ranging 10.0 – 22.3%). The highest prevalence of wasting was reported in a study conducted in Ethiopia (60.2%) [35], and the lowest was in Brazil (2.2%) [30] (Table 4).

Table 1 Summary of study characteristics ($n=17$)

Variable with Category	Number of studies	Percentage (%)
Study setting by region		
African countries *[Cambodia (n = 1), Cameroon (n = 1), central and west Africa (n = 1), Ethiopia (n = 2), Senegal(n = 1), Uganda(n = 2)]*	8	47.1
Asian countries *[India (n = 1) and Myanmar (n = 1)]*	2	11.8
South America *[Brazil (n = 7)]*	7	41.2
Country Income		
Low-Income country	5	29.4
Low-Middle Income Country	5	29.4
Upper-Middle Income Country	7	41.2
Study Design		
Case Control Studies	1	5.9
Clinical trial based interventional study	1	5.9
Cross-sectional study	11	64.7
Mixed Method study	1	5.9
Observational Study	3	17.6
Sample size		
< 100 participants	7	41.2
≥ 100—200 participants	5	29.4
> 200 Participants	5	29.4

Table 2 Methods of nutritional assessment used in included studies ($n=17$)

Indices	Types of Nutritional Assessment	Studies (n)	Percentage (%)
Anthropometric indices	Height-for-age (HAZ)	7	41.2
	Body mass index (BMI) Z-score	13	76.5
	Weight-for-height Z-score	1	5.9
	Weight-for-Age Z-score	1	5.9
Body composition / Body Fat assessment	Skinfolds thickness (abdominal, triceps, subscapular, calf)	3	17.6
	Waist-to-height ratio (WHR)	1	5.9
	Waist and hip circumferences (WHC)	3	17.6
	Perimeter relaxed arm (PRA)	1	5.9
	Perimeter neck / Neck circumference-for-age	2	11.8
	Air displacement plethysmography (ADP)	1	5.9
	Body adiposity index (BAI)	1	5.9
	Dual-energy X-Ray absorptiometry (DEXA)	1	5.9
	Conicity index	1	5.9
	Lipodystrophy physical diagnosis for abnormal fat distribution	1	5.9
	Bone Mineral Density (BMD)/ Bone mineral content (BMC)	2	11.8
	Body fat percentage	3	17.6
	Lean mass	1	5.9
	Upper-arm fat area	1	5.9
	Upper-arm muscle area	1	5.9
Dietary assessment	Food frequency questionnaires (FFQ) for dietary assessment to estimate total energy intake (TEI) and nutrient intake	1	5.9
	24-h recall Dietary Intake Assessment to estimate Energy and nutrient intake	4	23.5
	Individual Dietary Diversity status	1	5.9

Table 3 The prevalence of stunting among adolescents living with HIV and on ART follow-up in LMICs ($n=9$)

Author Name	Year	Country	Sample size	Stunting n (%)
Darshit, et al. [20]	2020	Uganda	132	31(23.7)
David, et al [31]	2020	Cameroon	75	15(36.6)
Dos Reis, et al [21]	2015	Brazil	115	24(20.9)
Hillesheim, et al [30]	2014	Brazil	49	3(6.1)
Jesson, et al [23]	2015	Central and West-African	684	163(23.8)
Lwanga, et al [25]	2015	Uganda	200	72(36.2)
Ramalho, et al [34]	2011	Brazil	94	24(25.5)
Shiferaw & Gebremedhin [24]	2020	Ethiopia	260	86(33.1)
Yasuoka, et al [26]	2020	Cambodia	298	139(46.6)

Table 4 The prevalence of wasting among adolescents living with HIV and on ART follow-up in LMICs ($n=9$)

Author Name	Year	Country	Sample size	Wasting n (%)
Darshit, et al [20]	2020	Uganda	132	10(7.6)
Dos Reis, et al [21]	2015	Brazil	115	4(3.5)
Hillesheim, et al [30]	2014	Brazil	49	1(2.0)
Jesson, et al [23]	2015	Central and West-African	684	69(10.0)
Lwanga, et al [25]	2015	Uganda	200	36(18.0)
Ramalho, et al [34]	2011	Brazil	94	21(22.3)
Sewale, et al., [35]	2018	Ethiopia	372	224(60.2)
Shiferaw & Gebremedhin [24]	2020	Ethiopia	260	52(20.0)
Yasuoka, et al [26]	2020	Cambodia	298	39(13.1)

Prevalence of overweight

Most of the studies demonstrated that overweight was the least common findings of nutritional assessment ($n=4$ of 6, ranging from 6.1%—15.6%). The highest (15.6%) and lowest (1.9%) prevalence of overweight were reported from studies conducted in Brazil [21] and Ethiopia [24], respectively (Table 5).

Outcome 3, review question 3: factors associated with undernutrition among adolescents living with HIV

Variables reported as significantly associated with stunting and wasting in at least two primary studies were included in this meta-analysis. Accordingly, being of male sex and having opportunistic infection were found to be significantly associated with stunting

Table 5 The prevalence of overweight among adolescents living with HIV and on ART follow-up in LMICs ($n=6$)

Author Name	Year	Country	Sample size	Overweight n (%)
Darshit, et al [20]	2020	Uganda	132	4(3.8)
David Chelo, et al [31]	2020	Cameroon	75	3(7.3)
Dos Reis, et al [21]	2015	Brazil	115	18(15.6)
Hillesheim, et al [30]	2014	Brazil	49	3(6.1)
Ramalho, et al [34]	2011	Brazil	94	6(6.4)
Shiferaw and Gebremedhin [24]	2020	Ethiopia	260	5(1.9)

[23–25, 35]. Only male sex was a significant factor for wasting /thinness [23, 26, 35] (Table 6).

A total of 1261 participants were included to analyze the association between sex and stunting among adolescents living with HIV in LMIC. The pooled odds ratio showed that male adolescents were 1.847 times at greater odds of stunting than their female counterparts (AOR = 1.847 (95%CI: 1.474, 2.313), $I^2=72.6\%$, $P=0.026$) [23, 25, 35]. Six hundred and thirty-two participants were included to analyze the association between a history of opportunistic infection and stunting, demonstrating adolescents who had an opportunistic infection were 2.97 times more likely to develop stunting than their non-infected counterparts (AOR = 2.97 (95%CI: 1.73, 5.12), $I^2=31.9\%$, $P=0.225$) [24, 35] (Table 6).

A total of 1354 participants were included to analyze the association between sex and wasting among adolescents living with HIV in LMIC. The pooled odds ratio showed that male adolescents were 2.55 times more likely to become wasted / thin compared to their female counterparts (AOR = 2.55(95%CI: 1.88, 3.48), $I^2=34.9\%$, $P=0.215$) [23, 26, 35] (Table 6).

Outcome 4, review question 4: nutritional interventions, outcomes and the magnitude of effect

Only one interventional study was found, trialling nutritional supplementation of 360 kcal energy and 32.2gm protein in food made from Peanut Chikki and another source. The study reported that after one year of supplementation on a daily basis the study participants showed a significant improvement in their Height-for-Age, Weight-for-Age and BMI-for-Age indices [29].

Meta-analysis

A random effect meta-analysis model was used to estimate the pooled prevalence of under-nutrition among adolescents living with HIV in LMIC. To estimate the prevalence of stunting, nine studies were included in the analysis and the overall pooled prevalence of stunting was 28.0% (95% CI; 20.0–36.00, $I^2=92.89\%$, $p<0.01$), (Fig. 2).

Similarly, nine studies were included in the analysis to estimate the pooled prevalence of wasting /thinness, which was demonstrated as 17.0% (95% CI; 0.06– 0.29, $I^2=98.65\%$ $p<0.01$), (Fig. 3).

Regarding overweight, a fixed effect model was used to estimate the pooled prevalence of overweight. Six studies

Table 6 Factors associated with undernutrition among adolescents living with HIV in LMICs

Types of Undernutrition	Variable	Number of studies	Studies included in the analysis	Pooled Odds Ratio with 95%CI	Heterogeneity	
					(I^2)	P-Value
Stunting	Sex (male Sex)	3	[23] [25] [35]	1.847(1.474, 2.313)	72.60%	$P=0.026$
	Opportunistic infection	2	[35] [24]	2.97(1.73, 5.12)	31.90%	$p=0.225$
Wasting / thinness	Sex (Male Sex)	3	[23] [35] [26]	2.55(1.88, 3.48)	34.90%	$p=0.215$
	Opportunistic infection	2	[35] [24]	3.70(2.12, 6.45)	0.00%	$p=0.569$

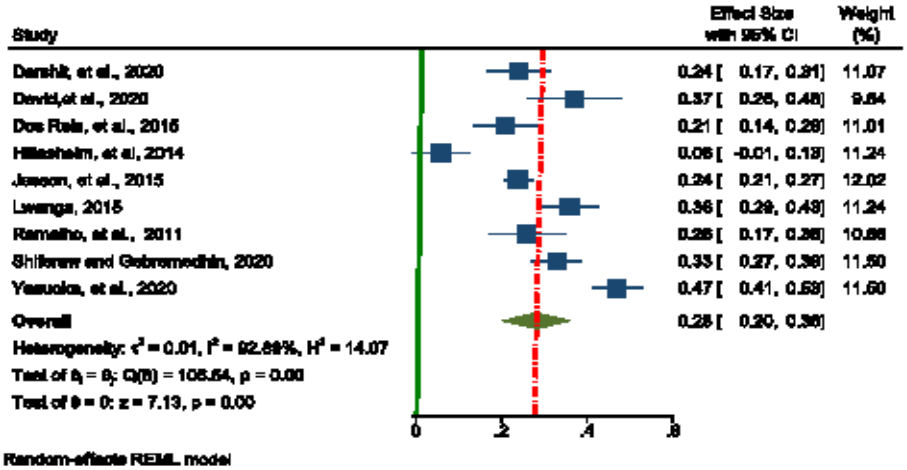

Fig. 2 Forest plot for the pooled prevalence of stunting among adolescents living with HIV in LMICs ($n=9$)

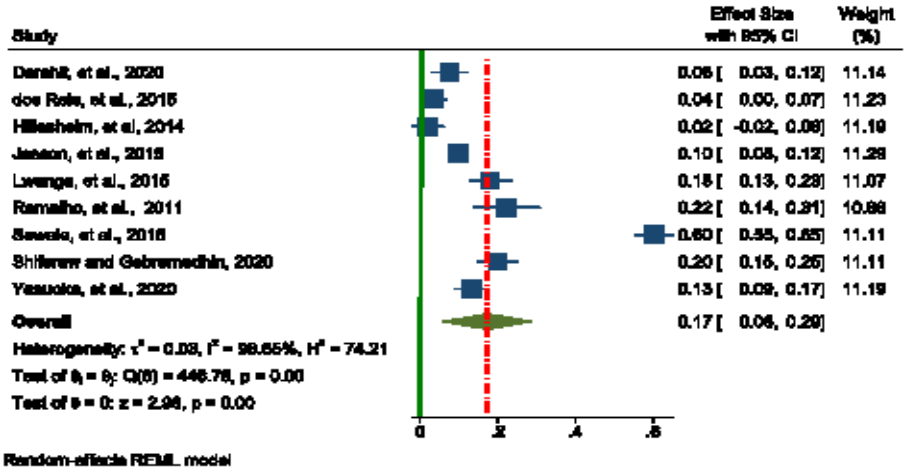

Fig. 3 Forest plot for the pooled prevalence of wasting among adolescents living with HIV in LMICs ($n=9$)

were included in this analysis and the overall pooled prevalence of overweight amongst the adolescents was 5.0% (95% CI; -0.13 – 0.22, $I^2=0.00$, $p=0.6$), (Fig. 4).

Sub-group meta-analysis and heterogeneity summary

Subgroup analysis was performed using country and study design to identify the source of heterogeneity.

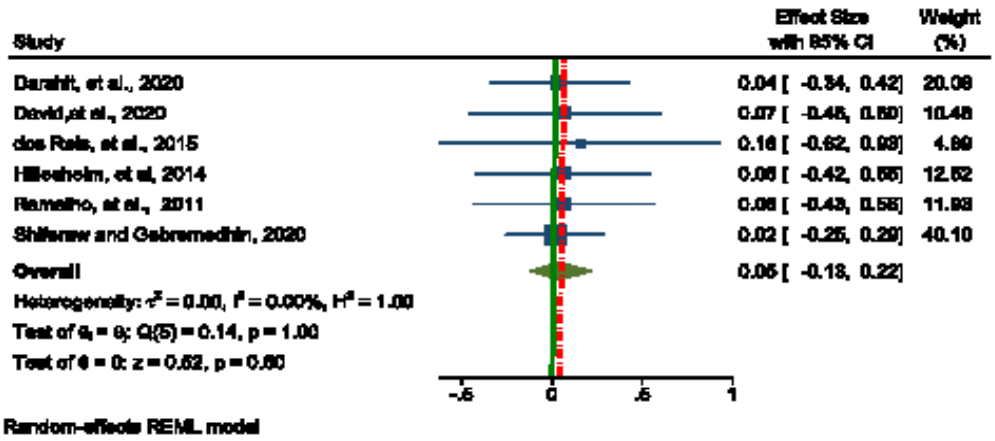

Fig. 4 Forest plot for the pooled prevalence of overweight among adolescents living with HIV in LMICs ($n=6$)

Sub-group meta-analysis and heterogeneity summary for stunting

Subgroup analyses were conducted by country for Brazil [21, 30, 34] and Uganda [20, 25]. From these studies, the highest pooled prevalence estimate of stunting was in Uganda, at 30.1% (95% CI: 18.3–41.8, $I^2=82.47\%$, $P<0.001$) and the lowest was in Brazil, at 17.40% (95% CI: 5.50–29.30, $I^2=86.35$, $P=0.004$).

Sub-group analysis was also conducted by study design for cross-sectional studies, and the pooled prevalence estimates of stunting by this design was 30.03% (95% CI: 23.4–37.10, $I^2=89.58$, $P<0.001$) [20, 21, 23–26, 34] (Table 7).

Furthermore, sub-group analysis was conducted by study population, and the pooled prevalence estimate of stunting for only adolescent age study population was 32.0% (95%CI:25.0, 38.0; $I^2=78.47$, $p<0.001$) [23–25,

Table 7 Subgroup meta-analysis for the percentage of prevalence effect size of stunting among adolescents living with HIV in LMICs

Sub-group by category type	Studies (n)	Pooled prevalence % ES (95%CI) with Test of Differences within each subgroup					
		% ES (95% CI)	P-Value	Q	I^2	Tau^2	H^2
Sub-group by country							
Brazil	3	17.4 (5.5, 29.3)	0.004	15.32	86.35	0.009	7.33
Cambodia[a]	1	47.0 (41.0, 53.0)	<0.001				
Cameroon[a]	1	37.0 (26.0, 48.0)	<0.001				
Central and West-African[a]	1	24.0 (21.0, 27.0)	<0.001				
Ethiopia[a]	1	33.0 (27.0, 39.0)	<0.001				
Uganda	2	30.1 (18.3, 41.8)	<0.001	5.7	82.47	0.006	7.30
Sub-Group by study design							
Case control study[a]	1	37.0 (26.0, 48.0)	<0.001			0.000	
Cross-sectional study	7	30.3 (23.4, 37.1)	<0.001	61.09	89.58	0.008	9.60
Observational study[a]	1	6.0 (-7.0, 12.7)	0.078			0.000	
Study Population							
Only Adolescent age population	4	32(25.0, 38.0)	<0.001	17.34	78.47	0.00	4.64
Mixed age population	5	25(12.0, 38.0)	<0.001	88.87	94.22	0.02	17.3

CI Confidence Intervals, *ES* Effect Size

[a] Countries and study designs having single study

31], whereas the pooled prevalence estimate of stunting for mixed age study population was 25.0% (95%CI:12.0, 38.0; $I^2 = 88.87$, $P < 0.001$) [20, 21, 26, 30, 34]. Regarding the test of difference within each subgroup analysis, there significant heterogeneity within each sub-group based on the statistical significance of I^2 statistics, the Cochran's'Q' result and *p*-values, as indicated in Table 7 below.

Sub-group meta-analysis and heterogeneity summary for wasting

Subgroup analyses were conducted by country for Brazil [21, 30, 34], Ethiopia [24, 35] and Uganda [20, 25]. From these studies, only the pooled estimate for Uganda provided evidence of significant heterogeneity, at 12.7% ((95% CI: 2.5–22.9), $I^2 = 88.37\%$, $P < 0.001$).

Sub-group analysis was also conducted by study design for cross-sectional studies, and the pooled prevalence estimates of wasting by this design was 19.3% ((95% CI: 7.0–31.60), $I^2 = 98.66$, $P < 0.01$) [20, 21, 23–26, 34, 35] (Table 8).

Furthermore, sub-group analysis was conducted by study population, and the pooled prevalence estimate of wasting for only adolescent age study population was 15.6% (95%CI:9.3, 22.0, $I^2 = 86.34$, $p < 0.0001$) [23–25], whereas the pooled prevalence estimate of wasting for mixed age study population was 18.1% (95%CI:1.0, 35.6, $I^2 = 98.96$, $P < 0.0001$) [20, 21, 26, 30, 34, 35].

Regarding the tests of differences within each subgroup analysis, there was evidence of significant heterogeneity observed within each sub-group based on the statistical significance of I^2 statistics, Cochran's'Q' results and the *p*-values indicated in Table 8 below, but no significant difference was observed on pooled estimates by country for Brazil and Ethiopia.

Quality of included studies

The average JBI quality score of included studies was 6.76 (95% confidence interval 6.2- 7.5); the minimum quality score was 5 and maximum was 10 (the maximum possible quality score). A score of 7 and above was described as indicative of good quality, and 10 (58.8%) of the articles scored at this level (see Supplementary Table 4).

Publication bias was checked using Egger's test and the results showed no significant publication bias, as evidenced by $p = 0.865$, 0.055, and 0.735 for stunting, wasting, and overweight, respectively. The symmetrical distribution of the funnel plots indicated that publication bias was not a significant problem in this meta-analysis (Figs. 5, 6, and 7).

Discussion

This review shows that evidence of undernutrition among adolescents living with HIV in LMICs is scarce. This is an important omission because most such adolescents are at risk of undernutrition secondary to an elevated nutritional need imposed by their age-related growth spurt and HIV infection. Further, undernutrition may predict disease progression in HIV-infected individuals and result in a higher risk of morbidity and mortality in both HIV-infected adolescents and adults. Consequently, efforts to treat HIV infection are less likely to achieve good outcomes for the individual (and their community) if underlying malnutrition is not also addressed [36]. Whilst no study examined this, the cost-effectiveness of the treatment of HIV may be severely impacted in the

Table 8 Subgroup meta-analysis for the percentage of prevalence effect size of wasting among adolescents living with HIV in LMICs

Sub-group by category type	Studies (n)	Pooled prevalence % ES (95%CI) with Test of Differences within each subgroup					
		%ES (95% CI)	*P*-Value	Q	I^2	Tau^2	H^2
Sub-group by country							
Brazil	3	8.7 (-3.5, 21.0)	0.162	19.04	95.22	0.011	20.91
Cambodia[a]	1	13.1 (9.2, 17.0)	< 0.001				
Central and West-African[a]	1	10.0 (7.8, 12.2)	< 0.001				
Ethiopia[a]	2	40.1 (0.7, 79.5)	0.045	129.28	99.23	0.08	129.28
Uganda	2	12.7 (2.5, 22.9)	0.015	8.6	88.37	0.005	8.6
Sub-Group by study design							
Cross-sectional study	8	19.3(7.0, 31.6)	0.002	412.0	98.66	0.031	74.41
Observational study[a]	1	2.0 (-1.9, 5.9)	0.317			0.000	
Study population							
Only adolescent age population	3	15.6(9.3, 22.0)	0.000	18.3	86.34	0.003	7.32
Mixed Age Population	6	18.1(1.0, 35.6)	0.000	427.29	98.96	0.047	96.14

CI Confidence Interval, *ES* Effect Size

[a] Countries and study designs having single study

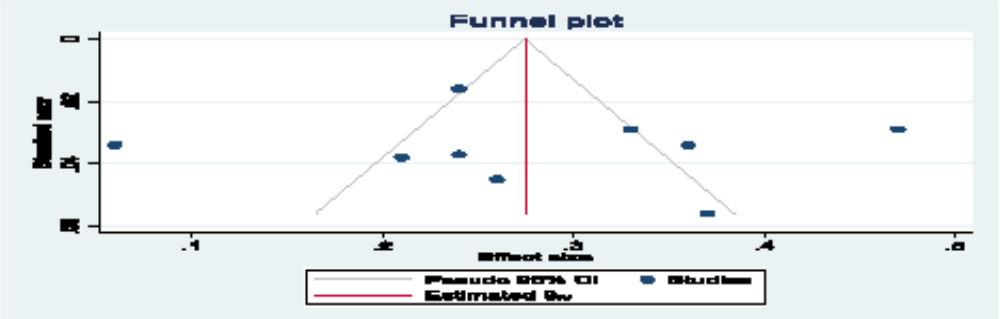

Fig. 5 Funnel plot showing the symmetric distribution of articles analyzed for pooled prevalence of stunting among adolescents living with HIV in LMICs

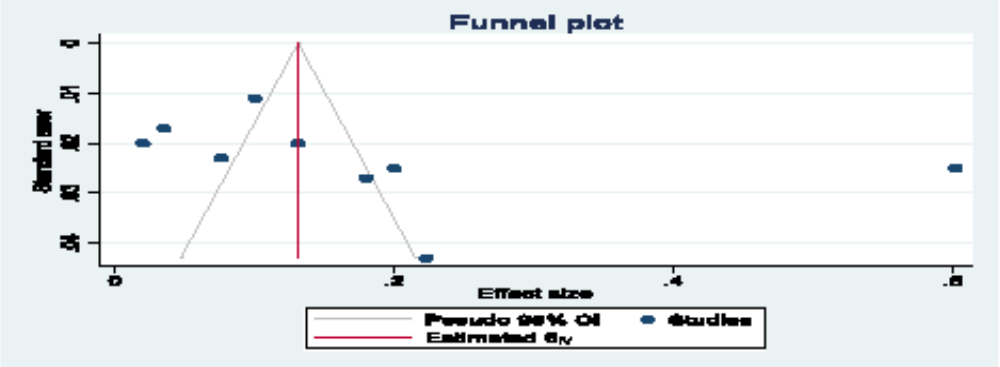

Fig. 6 Funnel plot showing the symmetric distribution of articles analyzed for pooled prevalence of wasting among adolescents living with HIV in LMICs

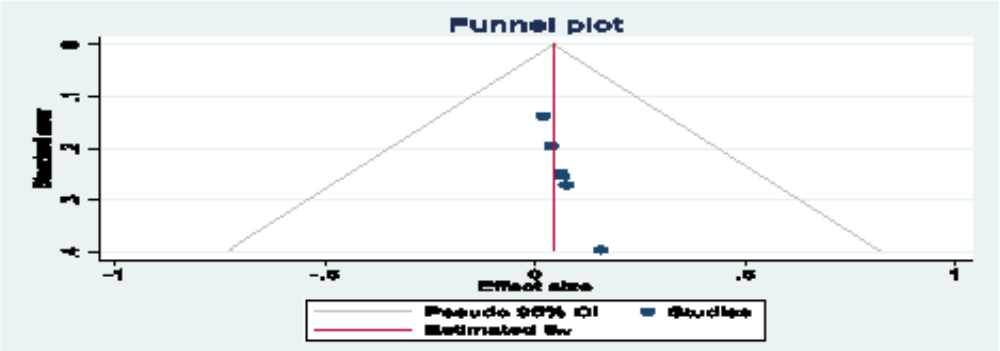

Fig. 7 Funnel plot showing the symmetric distribution of articles analyzed for pooled prevalence of overweight among adolescents living with HIV in LMICs

absence of treatment of underpinning vulnerability factors such as malnutrition.

This review revealed the narrow variety of nutritional assessment techniques in use with adolescents with HIV on ART. Most studies used anthropometric assessments, most commonly BMI-for-Age (76.5%) and Height-for-Age (41.2%). These anthropometric tools are inexpensive, portable, simple to use, and require minimal training, but are less sensitive and specific indicators of nutritional status. A few studies (17.6%) also conducted body fat composition measurements, using various standardized tools, such as skin-fold thickness, circumference measurement (Waist/hip circumference), Bioelectrical Impendence Analysis (BIA), Dual-energy X-ray Absorptiometry and Air Displacement Plethysmography (ADP) [21, 22, 27]. These measurement tools have better ability to determine nutritional status and to differentiate fat from fat-free mass but are used much less often in LMICs, based on the review findings. One possible reason for this might be the scarcity of such resources and personnel trained to use them.

Some studies (35.3%) evaluated dietary intake, using one-time 24-h dietary review ($n=4$), FFQ ($n=1$) and individual assessment of dietary diversity ($n=1$) to identify energy and nutrient intake. There are significant challenges in obtaining accurate diet histories as the tools are arduous to complete and of little value unless there is a high degree of completeness and accuracy. Use of such limited methods in the determination of nutritional status results in limited information and difficulty in differentiating whether apparent undernutrition was a result of disease effects, inadequate food intake or other predisposing factors.

This review revealed a high pooled prevalence of stunting and wasting and a low prevalence of overweight in this population. Among the seventeen studies included in this meta-analysis, nine reported the prevalence of stunting with the range from 6.1% to 46.6%. This significant discrepancy in the studies may be caused by a varied but generally limited emphasis on nutrition treatment and support for undernourished children and adolescents, lack of standardized and integrated service provision for HIV-positive individuals and poor screening in clinical and nutrition-related conditions during ART follow-up at health facilities [37]. Further the different research methods used in these studies may have contributed to variability in findings. The overall pooled prevalence of stunting in this systematic review meta-analysis was 28.0% among adolescents living with HIV in LMIC. This finding was lower than that seen in the large-scale study conducted among HIV infected adolescents (41%) in sub-Saharan Africa, the Asia–Pacific, Caribbean, Central and South America regions of the world [38]. Discrepancies may result from differences in samples and sample sizes, study design and settings, and socio-cultural differences (e.g. socio-economic status, dietary habits and health services) between studies.

Nine of these seventeen studies reported the prevalence of wasting, ranging from 2% to 60.2%. In many LMICs, including Ethiopia with the highest reported prevalence of wasting, integrated HIV care and support services are recent developments for adolescents living with HIV during ART follow-up. Weak policy implementation, resulting in inadequate provision of nutrition screening, counselling and supplementation, may all contribute to the high rates of wasting seen amongst this population in many LMICs. Discrepancies between studies and countries might be related to differences in socio-cultural and/ or socioeconomic characteristics, health care providers' knowledge, attitudes and skills, health facilities and health systems, and study methods and settings. However, the pooled prevalence of wasting, 12.0% in this meta-analysis, is similar to that in another study from less developed regions of the world (14.5%) [38].

Six of these seventeen studies revealed the prevalence of overweight, with the pooled prevalence of 5.0% and the highest and lowest frequencies reversing the findings for wasting. A study in Brazil found the highest frequency of overweight young people (15.6%), with Ethiopia providing the lowest prevalence (1.9%) [24]. This variation may be caused by genetic differences, disparities in socio-economic status, and cultural norms that affect how people perceive their bodies and what they eat. Even though study findings varied, the meta-analysis did not find any statistically significant differences among descriptive studies.

Regarding factors associated with undernutrition, male sex predisposed to both stunting and wasting, occurring at 1.85 and 2.55 times higher than for their female adolescent counterparts, respectively. This might be a consequence of the generally greater growth spurt and energy requirements of male compared to female adolescents [28, 39]. It may also reflect a socio-cultural bias where males are expected to undertake high physical activities to support family subsistence [32]. Similarly, the odds of stunting among adolescents with a history of opportunistic infection was 2.97 times higher than their non-infected counterparts. This finding is consistent with the vicious circle concept of malnutrition and HIV infection, i.e. infection predisposes to malnutrition and malnutrition predisposes to infection [36]. Reasons for this may be that as the disease advances, appetite reduces and disease-related malabsorption problems increase, leading to further vulnerability to opportunistic infection which in turn worsens under-nutrition. Worryingly, only a single trial examined supplementation, showing one year of

intervention improved nutritional indices in adolescent with HIV.

Adolescent nutrition has been largely overlooked in intervention and policy research. Most intervention studies have focused on micronutrient supplementation, and few have considered multiple factors in adolescent nutrition [40]. It may indicate that implementation is not progressing as expected. However, there is evidence that nutrition interventions result in beneficial effects [29, 33]. Effective interventions and strategies therefore need to be better implemented to address multiple challenges in communities and sectors. It is supported by a multi-faceted and multi-level policy.

Sustainable nutrition care and support for adolescents with HIV are used to provide adequate nutrient intake to promote normal growth and development during puberty, maintain adequate nutritional status to promote health and prevent disease after physiological growth is complete, promote optimal nutrition and prevention of malnutrition, manage or reduce symptoms of HIV disease, enhance drug compliance and efficacy through diet counseling, prevent food-borne illness, and manage complications associated with HIV and antiretroviral therapy (ART) [41]. Integration of nutrition care and support with the national HIV care and treatment implementation guideline is crucial for effective prevention, building the ART pipeline, ensuring the continuum of care and quality service, and healthy living with HIV.

Strength and limitation of the review

This assessment has many strengths. An extensive search strategy was implemented and data were analyzed using a rigorous methodology. Explicit inclusion and exclusion criteria related to population and comprehensive outcomes were assessed. Four authors were involved in the quality assessment. As the included studies showed considerable heterogeneity, we performed advanced statistical analysis such as meta-regression to identify possible sources of heterogeneity. Despite the above strengths, this review has some limitations that should be considered before interpreting the results. Since most of the primary studies included in this systematic review and meta-analysis are cross-sectional, no analyses could be undertaken to pool intervention effects as only one single eligible intervention study was found. In addition, the limited number of published studies from low-middle income countries that were retrieved and used for the pooled effect size, may have yielded underrepresentation of data from other low middle-income countries. Other limitations of this study included significant heterogeneity between the primary studies, with review methods limited to those published in the English language. This may have resulted in the exclusion of some essential studies.

Conclusion and recommendation

In conclusion, the review demonstrates the paucity of research on nutrition in adolescents living with HIV, and the effects of supplementation intervention could not be tested. The review results indicate a high prevalence of stunting and wasting in HIV-infected adolescents, but low proportions of overweight. Opportunistic infection was the sole factor shown by this review to be both significant and amenable to intervention. The inadequate and fragmented nutritional screening and support programs used by government and non-governmental organizations for this population in clinical settings were highlighted.

Review findings have implications for improving the healthy living of adolescents infected with HIV in LMIC through acting on the demonstrated prevalence and identified determinants of undernutrition; by integrating rigorous nutritional screening and assessment modalities into routine services, and developing and evaluating nutritional interventions.

Review findings indicate that comprehensive systems of nutritional assessment and intervention should be integrated within HIV services to be delivered during routine follow-up of adolescents in the ART clinic. Despite its limitations, review findings provide evidence that can be used by policy-makers, health planners and managers, researchers, and planners in LMICs to create an evidence-informed strategy supporting Sustainable Development Goal 1–3.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s40795-023-00714-z.

Additional file 1: Supplementary Table 1. Search Strategy "Population, Intervention / Exposure, Comparator / Control, Outcomes (PICO or PEO) Framework". **Supplementary Table 2.** Characteristics of studies included in this systematic review and meta-analysis, 2022. **Supplementary Table 3.** Distribution of included studies outcomes in this systematic review and metanalysis, 2022. **Supplementary Table 4.** Quality appraisal status of studies included according to JBI characteristics, 2022.

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Authors' contributions

Meless Gebrie(MG) has taken a leading role in writing the systematic review proposal under the supervision of Lin Perry(LP), Xiaoyue Xu(XX), Andargachew Kassa(AK) and Marilyn Cruickshank(MC). All authors (LP, XX, AK, and MC) made

a significant contribution to the conception and conceptualisation of the study protocol. All authors revised the paper carefully for important intellectual contents after which they read and approved the final manuscript.

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Declarations

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Competing interests
The authors declare no competing interests.

Author details
[1]College of Medicine and Health Science, Hawassa University, Hawassa, Ethiopia. [2]Faculty of Health, University of Technology Sydney, Ultimo, Australia. [3]Prince of Wales Hospital, Randwick, NSW, Australia. [4]School of Population Health, Faculty of Medicine, University of New South Wales, Kensington, NSW, Australia. [5]Sydney Children's Hospitals Network, Sydney, Australia.

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Publisher's Note

Appendix II: Supplementary Tables

Supplementary Table 1: Distribution of included studies characteristics in this systematic review and meta-analysis, 2022

Citation	Country	Study setting	Aim/Question	Sample population	Design	Data collection methods	Nutritional assessments
Carlos, et al., 2019	Brazil	Joana de Gusmao" Children's Hospital (HJG), Florianopolis, Brazil	To verify the association between anthropometric indicators and fat percentage estimated by using different reference techniques (DXA and ADP) in children and adolescents diagnosed with HIV, and by controlling factors related to treatment, maturation, and physical activity.	n=62, age range 8 - 15, mean 12.8 years. 28 male, 34 females	Quantitative correlational study	Anthropometric measurements: • Skinfolds using skinfold callipers (Cescorf, Porto Alegre, Brazil) • Body parameters were measured using an inelastic tape • Body weight was measured using a portable digital Electrical Bathroom scale • Height measured using a stadiometer • All anthropometric indicators were measured based on recommendations of the International Society for the Advancement of Kin-anthropometry (ISAK) by a single level-1 ISAK anthropometric. • Body fat was measured USING dual X-ray absorptiometry (DXA), air displacement plethysmography (ADP), and computed tomography.	Skinfolds (abdominal, triceps, subscapular, calf), perimeter relaxed arm (PRA), waist circumference (WC), perimeter neck, body mass index (BMI), waist-to-height ratio, conicity index, and body adiposity index (BAI)

Bissigo, et al., 2016	Brazil	HIV/AIDS Pediatric Ambulatory of the Hospital de Clinicas de Porto Alegre	To evaluate macro and micronutrient intake of adolescents living with HIV/AIDS in use of antiretroviral therapy and compare it to the Dietary Reference Intakes.	n=39, mean age - 15 years, 20 male, 19 females	Cross-sectional study	• 24-hour dietary recall standardized structured interview questionnaires were used to assess all food and drink consumed in the previous 24 hours to determine the nutrient intake • medical record reviews about clinical status by using a standardized format	24-hour Recall Dietary Intake DATA COMPARED to Dietary Reference Intakes (DRI) (2005). Total fat, saturated fat, and cholesterol intakes were evaluated COMPARED TO AHA recommendations (Lichtenstein AH, et al., 2006).

Castro, et al., 2017	Brazil	Brazilian regional referral hospital for HIV treatment.	To determine the validity of body composition analysis by BIA compared to dual-energy X-ray absorptiometry (DXA) and air displacement plethysmography (ADP) in HIV-positive children and adolescents	n= 64, mean age - 12.22 years, 29 males, 35 females	Cross-sectional validity study	• Body composition assessments using DXA performed with GE Lunar Prodigy Advance equipment and ENCORE 2004, version 8.10.027 (GE Lunar Corporation, Madison, WI, USA) • Body mass measured with a digital scale integrated with the Bioelectrical Impedance Analysis (BIA) equipment • BIA procedures performed with In Body-720 octapolar multifrequency equipment (Biospace, Los Angeles, CA, USA) • Stature measured using an AlturaExata stadiometer (Belo Horizonte, Brazil) • From these procedures, body mass index (BMI) was calculated • Air displacement plethysmography (ADP) procedures performed with BOD-POD equipment (Life Measurement Inc., Concord, CA, USA)	Body Mass Index, Total Body Composition [FM-BAI (Kg), FM ADP(kg), FM DXA(Kg), %BF ADP, FFM BIA(kg), FFM ADP(kg), Lean Soft Tissue Mass (LSTM) BIA(kg), Bone Mineral Content(BMC) BIA(kg), BMC DXA(kg)]

Darshit, et al., 2020	Uganda	Pediatrics Infectious Diseases Clinic	To assess the nutrition status and associated factors among HIV positive adolescents on Atazanavir-based regimen attending an urban clinic in Uganda	n=132, mean age - 17 years, 86 males, 46 females	Cross-sectional study	• A structured pretested interviewer-administered questionnaire in English and Luganda languages was used to collect sociodemographic data. • Anthropometric Assessment: 1. Weight measured using an electronic Seca scale with daily calibration and recorded to the nearest 0.1 kg. 2. Height measurements were taken at maximum inspiration using a standardized erect stadiometer recorded to the nearest 0.1 cm. REDCap ® platform was used for data management.	BMI-for-Age (BAZ) and Height-for-age (HAZ) indices and analyzed using WHO Anthro Plus software.
David, et al., 2020	Cameroon	Mother and Childcare Centre of the Chantal BIYA Foundation (i.e., Specialized unit for the care of HIV-positive children and mothers)	To describe and compare the growth of children living with HIV with those not infected and identify the associated factors	n=76, aged range - 10-19 years, 35 male, 41 female, 19 HIV-positive cases, and 57 uninfected controls matched by sex and age plus or minus 02 months.	Case-control study	This study used three methods of assessment by using standardized tools: 1) Clinical evaluations/assessment on past history, clinical and biological stages of the disease; 2) Anthropometric parameters assessment based on WHO Anthro software requirements. 3) Individual Dietary Diversity assessment with food group intake	Height-for-Age, Weigh-for-Height, Weight-for-Age measurements indices, and Individual Dietary Diversity Score (IDDS) to determine the dietary diversity and nutrient intake

Dos Reis, et al., 2015	Brazil	HIV/AIDS out-patient clinic of the Institute of Child Health, São Paulo.	To investigate the relationship between anthropometric parameters and body composition of perinatally HIV-positive children and adolescents under HAART, according to use and non-use of protease inhibitors.	n=89, aged range- 6 - 19 years, 43 male, 46 females	Cross-sectional study	• Demographic, socioeconomic, clinical, and anthropometric data were collected by using a structured questionnaire, Physical examination, and medical records review. • The anthropometric data were taken by this article: • Weight measured using a portable electronic scale • Height measured with a Leicester stadiometer • Mid-arm, waist, and neck circumferences were obtained with an inextensible centimeter-graded measuring tape • Triceps skinfold thickness was taken with a calibrated Lange® adipometer (Beta-Technology, Santa Cruz, CA, USA) • The mid-arm fat and muscle areas were calculated using the equations recommended by Frisancho(1981). • Body fat percentage obtained by bioelectrical impedance analysis (BIA) using the Biodynamics® analyser (model 310, Seattle, WA, USA).	BMI for Age (z score), Height-for-age (z score), Waist circumference-for-age (percentile), Neck circumference-for-age (percentile), Triceps skinfold thickness (percentile), body fat percentage, upper-arm fat area and upper-arm muscle area

Hillesheim., et al., 2014	Brazil	Hospital Infantil Joana de Gusma˜o	To investigate the nutritional status and dietary intake of HIV-positive children and adolescents and the relationship between nutritional status and dietary intake and CD4+ T-cell count and viral load.	n=49, mean age - 12.6 years, 25 male, 249 females	Observational study	• Face-to-face interviews using a standardized questionnaire for socio-demographic data • Medical record review to obtain Immunological data • Anthropometric Measurement- Weight using a calibrated digital scale • Dietary intake was collected using the Food Frequency Questionnaire for Adolescents (FFQA) validated (Slater, et al, 2003).	• Anthropometry indices: height-for-age (H/A) z-score and body mass index-for-age (BMI/A) • Total energy intake (TEI), and nutrient intake from FFQ Dietary intake assessment using the software Programme a de Apoio a` Nutric¸a˜o – NutWin 1.6.0.7 (Federal University of Sa˜o Paulo, Brazil).
Jesson, et al., 2015	Central and West-African	HIV-care programmes supported by the Sidaction Growing Up Programme	To assess the prevalence and associated factors of acute and chronic malnutrition among HIV-positive children	n= 684, age range - 10 - 19 years, 349 male, 335 females	Cross-sectional study	• Medical records review was used to collect socio-demographic characteristics, Anthropometric, clinical data, and nutritional support (flour, powdered milk, solid or semi-solid foods, or Ready-to-Use Therapeutic Food [RUTF])	Anthropometry indices: Weight-for-Height Zscore(WHZ) or BMI-for-AgeZ-score (BAZ), Height-for-Age Z-score (HAZ) and analyzed using WHO Anthro Software (version 3.2.2) and WHO AnthroPlus
Lwanga, et al., 2015	Uganda	The AIDS Support Organization (TASO) HIV care services in HIV-care Programme in Urban and Rural Uganda	To assess the nutritional status of HIV-positive adolescents receiving HIV care services at six The AIDS Support Organization (TASO) in Uganda.	n=200, age range- 10-19 years, 77 male, 123 females	Cross-sectional study	• Structured interviewer-administered questionnaire and anthropometric measurements: Weight using Seca scales and Height using height board	Anthropometry indices: BMI-for-Age (BAZ) and Height-for-age (HAZ)

Murray, et al., 2020	Myanmar	Outpatient HIV testing and care in a rural community in south-eastern Myanmar	To examine the patient's high levels of viral repression, malnutrition and second-line ART use in adolescents living with HIV	n= 177, age range - 10 -19 years, 81 males and 96 females for quantitative; and 12 adolescent and 10 caregivers' sub-sample for qualitative study	Mixed Method Study	• The quantitative component includes clinical history, medical examination, and laboratory investigation conducted by a medical doctor and counsellor. • In-depth interviews (IDIs) and two focus group discussions (FGD) for collecting qualitative data. • For clinical data: a physical and neurological exam was conducted for each patient, and a laboratory investigation was conducted on whole blood samples. • A Patient Health Questionnaire A (PHQ-A), a modified version of the PHQ-9, a standardized assessment tool, was used as a depression screening tool by a trained HIV counsellor • Lipodystrophy is based on a physician's diagnosis of abnormal fat distribution (lipoatrophy or lipo-hypertrophy).	Anthropometric indices: Body mass index (BMI) scores, and Lipodystrophy physical diagnosis abnormal fat distribution

Niasse, et al., 2020	Senegal	Study of Nutrition and Activity in Childcare (SNAC) Settings	To assesses the overall acceptability and perception of a Ready-to-use food (RUF)-based therapy and risk factors associated with sub-optimal RUF intake in HIV-positive undernourished adolescents in Senegal	n=173, aged range - 5 - 18 years (median age: 12.5 years) who are under active follow-up and presenting with acute malnutrition, i.e., 104 MAM and 69 SAM	Clinical Trial Study	• Medical Record Review: Clinical and therapeutic characteristics • The Household food insecurity access scale (HFIAS) was used to assess food insecurity. • 24-h recall of Ready-to-use food (RUF) intake at enrolment • At week 2, a structured questionnaire covering 5 topics, organoleptic appreciation of RUF, mode of intake, 24-h recall of RUF intake, self-stigma associated with RUF intake, and RUF sharing, was administered primarily to participants ≥7 years or caregivers below that age. • Questions about RUF sharing were administered separately to participants ≥7 years and caregivers.	Anthropometry indices: Weight, Height, BMI Z-score
Rao & Ragireddy, 2020	India	ART center	To assess the nutritional status and nutritional supplementation in children with HIV at ART center	n=100, Mean age (SD)- 11.02 years, 44 males, 56 females	Observational study	Clinical and anthropometric data (as baseline) and after supplementation were taken	Anthropometry indices: Height-for-age (HFA), Weight-for-age (WFA), BMI for-age and computed using standard references [using WHO Anthro software (version 3.2.2.) and WHO Anthro Plus software]

Ramalho., et al., 2014	Brazil	Paediatric Immunodeficiency Clinic at the State University of Campinas Hospital, Campinas, Sa˜o Paulo, Brazil, a tertiary referral center	To compare body composition outcomes between HIV-positive children and adolescents on ART and healthy controls, and to evaluate their association with clinical, immunological and lifestyle variables, within the HIV-positive group	n= 94, 55 males aged range-7.68–19.76 years (median 12.72), and 39 females aged 8.15–18.35 years (median 12.07) and 364 healthy children and adolescents (178 males and 186females) comprised the control group	Cross-sectional study	• Anthropometric evaluations and blood sample collections after a 12-hour fast • Height and weight were measured according to recommendations from the Anthropometric Standardization Reference Manual (Lohman TG, et al., 1988). • BMI international standards are used to determine overweight, obesity, and thinness (Cole et al. 2007). • Waist and hip circumferences with flexible metric tape (precision of 1 mm). • Skinfold measurements were performed with a Lange caliper (Beta Technology Inc, Cambridge, MA, USA), according to procedures established by Lohman (Lohman et al. 1988), and skinfold thickness equations calculated for fat percentage. • Lipodystrophy is defined by clinical examination Clinical and immunological HIV categories are defined according to CDC standards, adapted by the Brazilian Ministry of Health. • Physical activity was measured with the physical activity questionnaire for children, 20 for patients up to 12 years old, and the international physical activity questionnaire, 21 for patients older than 12 years.	Anthropometry: Weight, height, body mass index (BMI), waist and hip circumferences, Skinfold thickness, Fat percentage, BMD and body composition (percent body fat and lean mass), 24-hour recall, and energy and nutrient intake.

			• Food energy intake is measured by 24-hour recall and its adequacy was evaluated according to Recommended Dietary Allowances

Schtscherbyna, et al., 2012	Brazil	Brazilian cohort of vertically HIV-positive adolescents followed-up at the Infectious Diseases Service of the HUCFF-UFRJ	To assess the prevalence and factors associated with low bone mineral density (BMD) in HIV-positive adolescents	n=74, mean age - 17.3 years, 33 males, 41 females	Cross-sectional study	• DXA scans were performed on the lumbar spine (LS) and total body (TB) to assess Bone Mineral Density (BMD) and body composition (percent body fat and lean mass), using Prodigy software v. 11.40, adequate for child and adolescent assessment. • single 24-h recall dietary intake conducted by a trained registered nutritionist, using measuring cups, spoons, and portion-size images to increase the accuracy of the recall. • The household measurements are converted into grams and millilitres for quantitative analysis of the energy and nutrient intake using the software Avanutri online (version online; 2010, Rio de Janeiro, Brazil). • Only energy, macronutrients (carbohydrate, protein, and lipid), calcium, and vitamin D results are presented here. Calcium and vitamin D consumption was categorized according to the estimated average requirement (EAR)	Anthropometry: Weight, height, body mass index (BMI), Bone Mineral Density and body composition (percent body fat and lean mass), 24-hour recall, and energy and nutrient intake

Sewale, et al., 2018	Ethiopia	HIV-care service center of three public hospitals in East and West Gojjam Zones of North west Amhara	To assess the magnitude of malnutrition and associated factors among HIV-positive children in Amhara Regional State, and Northwest Ethiopia	n=372, mean age -10 years, 186 male, 186 females	Comparative Cross-sectional study	Record review and face-to-face interviews by using the structured adapted tool. Anthropometric measurements: Weight and height measured by using standardized tools and calibration	Anthropometry: weight-for-height Z-score, weight-for-Age Z-score, Height-for-Age Z-score, Body Mass-for-Age Z-score and computed by using WHO anthro and WHO anthroplus software

Shiferaw, et al., 2020	Ethiopia	Two public hospitals and three health centers who provide ART services	To assess the prevalence and predictors of stunting and thinness among adolescents receiving anti-retroviral therapy (ART) in Hawassa city, Southern Ethiopia	n=260, age range 10–19 years, 127 males, 133 females	Cross-sectional study	• Data was collected using an interviewer-administered pretested questionnaire by trained personnel, directly from the primary caregivers and the adolescents while ART follow-ups. • Dietary diversity using a standard tool of the Food and Agriculture Organization of the United Nations (FAO) as the number of food groups consumed over the preceding day, out of the standard list of 12 groups. • Household food insecurity was measured and classified into four ordinal categories (secure, mild, moderate, and severe insecurity) using the standard Household Food Insecurity Access Scale (HFIAS) • Body height and weight are measured via calibrated tools following standardized procedures. • Weight was measured by a digital scale to the nearest 0.1 kg and height was measured using a portable stadiometer to the nearest 0.1 cm. • Clinical characteristics (CD4 count, HIV staging, occurrence of opportunistic infections) extracted from individual medical records	Anthropometry indices: Height, Weight, BMI-for-age index, HFA z-score, BMI-for-age z-score

Yasuoka, et al., 2020	Cambodia	National Pediatric Hospital, which providing pediatric ART in Phnom Penh	To examine nutritional status of school-age children living with HIV in Phnom Penh, Cambodia, and identify factors associated with their nutritional status, especially taking their dietary diversity	n=298, age range 6–15 years, 152 males, 146 female	Cross-sectional study	• Open Data Kit 2.0 was used to directly record study participants' responses to questionnaires (available at https://opendatakit.org/use/2_0_tools/). • Body weight, height, and clinical data were recorded on paper-based forms and entered electronically by data management assistants at the National Pediatric Hospital. • Dietary diversity using the standard tool and a dietary diversity score (DDS) calculated by summing the number of food groups consumed by each child over the previous 24-h recall period. • Overall health-related quality of life was measured using pediatric Quality of Life Inventory 4.0 (PedsQL™ 4.0), which has been validated for children living with HIV	Anthropometry indices: Height, Weight, BMI-for-age index, HFA z-score, BMI-for-age z-score, 24-hour dietary recall

Appendix II, Supplementary Table 2: Distribution of included studies outcomes in this systematic review and metanalysis, 2022

Citation	Nutritional Status (Prevalence Rate)	Factor associated with the existed nutritional status	Nutritional Intervention	Effects of Nutritional Intervention
Carlos, et al., 2019				
Bissigo, et al., 2016				
Castro, et al., 2017				
Darshit, et al., 2020	• Stunting- 31(23.7%), • Wasting - 10(7.6%), • Overweight - 4(3.8%)	• Availability of parent (AOR= 3.70, 95% CI: 1.20-11.37, pv=0.023) • Level of Educational status (AOR: 0.40, 95%CI: 0.17-0.95, Pv=0.037)		
David, et al., 2020	• Stunting- 15(36.6%), • Underweight - 4(18.2%), • Overweight - 3(7.3%)	• Biological Disease grade 3 (OR = 5.67, P = 0.34), • Low nutritional intake (OR = 7.8, P = 0.12), • Gastroenteritis (OR = 3.5, P = 0.29), • Elevated viral load (OR = 5, P = 0.2)		
Dos Reis, et al., 2015	• Stunting- 24(20.9%), • Wasting - 4(3.5%), • Overweight - 18(15.6%)			
Hillesheim., et al., 2014	• Stunting- 3(6.1%), • Wasting - 1(2.0%), • Overweight - 3(6.1%)	• Energy intake - 50.8% above the estimated energy requirement • Inadequate intake of polyunsaturated fat, cholesterol, fiber, calcium, and vitamin C was present in 100%, 57.1%, 40.8%, 61.2%, and 26.5% of the sample, respectively.		

		• MLR analyses revealed that energy intake was correlated with CD4+ T-cell count (r- 0.33; p-0.028) and viral load (r - 0.35; p -0.019).		
Jesson, et al., 2015	• Stunting - 163(23.8%), • Wasting- 69(10.0%)	Factor associated with acute malnutrition (wasting): • Male gender [AOR=2.27, 95%CI (1.52, 3.41)], • Severe immunodeficiency [AOR=2.07, 95%CI (1.25, 3.42)], • Absence of ART [AOR=1.70, 95%CI (1.01, 2.84)]; Factors of chronic malnutrition (Stunting): • Male gender [AOR=1.56, 95%CI (1.20, 2.03)] Factor associated with mixed malnutrition (Underweight): • Male gender [AOR = 2.60, 95%CI (1.64, 4.10)], • Severe immunodeficiency [AOR = 2.43, 95%CI (1.40, 4.23)] • Recent ART initiation (<6 months) [AOR = 2.54, 95%CI (1.17, 5.55)].		
Lwanga, et al., 2015	• Stunting - 72(36.2%), • Wasting- 36(18.0%)	The risk factors for stunting • Male Gender (AOR: 4.0; 95% CI: 1.81- 7.02) and • Living in rural settings (AOR: 6.0; 95% CI 2.70-12.16)		

Murray, et al., 2020	• Severe Underweight (BMI < 16) - 104 (59%), • Moderate underweight - 22(12%), • Mild underweight - 18(10%)			
Niasse, et al., 2020			Medication/ Supplement: RUF, Plumpy Nut® and Plumpy Sup®. Provision: 2 weeks RUF Ration based on age Follow-up: every 2 weeks for clinical assessment and 9 months in decentralized clinics or 12 months in Dakar until recovered or discontinued. Median follow-up duration was 66 days (21–224). Monitoring: of adherence to RUF over the preceding 2 weeks and outcome	

Rao & Ragireddy, 2020			Nutrition supplementation: 2 scoops of Protein powder/day • Total amount: 60gms • Total calorie: 210 kcal • Total protein: 19.2gms Peanut chikki – one serving • Total amount:30gms • Total calorie: 150 kcal • Total protein: 4gms ** Total Calorie: 360Kcal ** Total proteins: 23.2gm	After giving the nutritional supplementation for a period of one year: •statistically significant improvement in height-for-age, weight-for-age, and the Z scores of height-for-age, weight-for-age, and BMI-for-age, but not Mean Value of BMI-for-Age
Ramalho LC., et al., 2014	• Stunting-24(25.5%), • Wasting - 21(22.3%), • Overweight - 6(6.4%)	• When compared with subjects in the control group, HIV-positive patients had: => higher risk of short stature /stunting [OR=5.33, 95%CI (2.83, 10.04)] => thinness /malnutrition [OR=4.7, 95%CI (2.44. 9.06)], => higher waist-to-hip ratios (medians 0.89 versus 0.82 for boys and 0.90 versus 0.77 for girls, P, 0.001), and => lower prevalence of overweight or obesity [OR= 0.33, 95%CI (0.14, 0.78)] • Patients in CDC clinical category C had a higher risk of short stature (OR = 3.68; 95% CI 1.39–9.73). • Children on Protease Inhibitors had a higher risk of lipoatrophy and malnutrition (OR =3.5; 95% CI 1.37–8.95 and OR =3.51; 95% CI		

		1.07–11.44, respectively). • Abdominal lipohypertrophy significantly increased in children in immunological category 3 (OR=2.5; 95% CI 1.06–5.91) • Independently of gender, children in immunological category 3 had higher waist-to-hip ratios (medians 0.91 versus 0.89, P=0.004). • Older age was associated with higher waist circumference (P = 0.58, P, 0.001), higher SS/TR skinfold ratios (P =0.32, P = 0.021), and lower waist-to-hip ratios (P = 20.24, P = 0.003).		
Schtscherbyna, et al., 2012		• Body composition and nutritional status were positively associated with BMD Z-scores, especially in females. • Lumbar spine (LS) and total body (TB) BMD Z-scores were positively correlated with weight, body mass index (BMI), BMI Z-score, total body fat, and nutritional status. • Patients on tenofovir had lower lumbar spine (LS) and total body (TB) BMD Z-scores. • Time on tenofovir was indirectly correlated with LS and TB BMD Z-scores. • No difference was found regarding levels of calcium, parathyroid hormone, or 25-hydroxyvitamin D according to BMD status		

Sewale, et al., 2018	• Wasting - 224(60.2%)	Significant factors of Malnutrition: • Having good individual dietary diversity (AOR = 0.474, 95% CI (0.26, 0.86)). • Sex of child (AOR = 2.37, 95% CI (1.34, 4.20), • Age 10 - 15 years (AOR=0.05, 95% CI (0.01, 0.25), • Comorbidity disease (AOR = 0.34, 95% CI (0.15, 0.800)), • Oral ulcer (AOR = 2.30, 95% CI (1.41, 7.60)), • Diarrhea (AOR = 3.30. 95%CI (1.41, 7.72)) and • History of hospital admission (AOR = 0.34, 95% CI (0.13, 0.84))		
Shiferaw, et al., 2020	• Stunting- 86(33.1%), • Wasting - 52(20.0%), • Overweight - 5(1.9%)	• History of recent opportunistic infection was the only significant predictor of thinness (AOR=3.21; 95% CI: 1.54, 6.73)		
Yasuoka, et al., 2020	• Stunting- 139(46.6%), • Wasting - 39(13.1%)	Factors associated with children's stunting were: • Age (AOR= 2.166, 95% CI: 1.151, 4.077), • Household wealth (AOR= 0.543, 95%CI: 0.299, 0.986), • Duration of receiving ART (AOR 0.510, 95%CI: 0.267, 0.974), and • Having disease symptoms during the past 1 year (AOR 1.871, 95%CI: 1.005, 3.480) Factor associated with wasting was: • Male (AOR 5.304, 95%CI: 2.210, 12.728)		

Appendix II, Supplementary Table 3: Population, Intervention / Exposure, Comparator / Control, Outcomes (PICO or PEO) Framework

Populations / Participants (P)	Intervention (I) or Exposure (E)	Comparators (C) / Controls	Outcomes (O)
- HIV-positive adolescents on HAART / ART - Living in LMICs	- Any intervention (such as nutrition supplementation, food fortification, nutrition education) or factor (e.g., physical, psychological, social) intended or demonstrated to affect the nutritional status or outcome measures.	- HIV positive on HAART/ ART and HIV negative adolescents who are well-nourished as determined using the WHO/FAO cut-off point	- The magnitude of Nutritional Status (Undernutrition / Malnutrition, Micronutrient deficiency) - Dietary practice

Terms were combined as follows:

Line 1: ("nutritional status" OR "Nutrition*" OR "undernutrition" OR "malnutrition" OR "nutritional deficienc*" OR "energy deficienc*" OR "protein deficienc*" OR "fat deficienc*" OR "micronutrient deficienc*")

AND

Line 2: ("adolescent" OR "older children" OR "young adults" OR "teen*" OR "young person" OR "young people")

AND

Line 3: ("HIV" OR "human immunodeficiency virus" OR "Human" OR "Immunodeficiency" OR "AIDS" OR "acquired immunodeficiency syndrome" OR "HAART" OR "highly active antiretroviral therapy" OR "antiretroviral therapy")

AND

- Line 4: ("Angola" OR "Benin" OR "Botswana" OR "Burkina Faso" OR "Burundi" OR "Cameroon" OR "Cape Verde" OR "The central African Republic" OR "Chad" OR "Comoros" OR "Republic of the Congo" OR "Democratic Republic of the Congo" OR "Cote d'Ivoire" OR "Djibouti" OR "Equatorial Guinea" OR "Eritrea" OR Ethiopia" OR "Gabon" OR "The Gambia" OR "Ghana" OR "Guinea" OR "Guinea-Bissau" OR "Kenya" OR "Liberia" OR "Madagascar" OR "Malawi" OR "Mali" OR "Mauritania" OR "Mauritius" OR "Mozambique" OR "Namibia" OR "Niger" OR "Nigeria" OR "Rwanda" OR "Sao Tome and Principe" OR "Senegal" OR "Seychelles" OR "Sierra Leone" OR "Somalia" OR "South Africa" OR "South Sudan" OR "Sudan" OR "Swaziland" OR "Tanzania" OR "Togo" OR "Uganda" OR "Zambia" OR "Zimbabwe")

Appendix II, Supplementary Table 4: Quality appraisal status of studies included according to JBI characteristics, 2022

Author, year	Study design	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Score per tool Item
Carlos A.S., et al, 2019	Analytical, quantitative, correlational study	1	0	0	1	0	1	1	1	-	-	-	-	-	5
Fernanda Bissigo P., et al., 2016	Cross-sectional study	1	1	1	1	0	0	1	1	1	-	-	-	-	7
Castro J. A. C., et al., 2017	Cross-sectional validity study	1	1	0	0	1	0	1	0	1	-	-	-	-	5
Darshit D., et al., 2020	Cross-sectional study	1	1	0	1	1	1	0	0	1	-	-	-	-	6
David Chelo, et al., 2020	Case-control study	1	1	1	0	0	1	1	0	1	1	-	-	-	7
Dos Reis, LC., et al., 2015	Cross-sectional study	1	1	1	1	1	1	0	1	1	-	-	-	-	8
Hillesheim, E., et al, 2014	Observational study	1	1	0	1	1	0	1	1	1	-	-	-	-	7
Jesson et al., 2015	Cross-sectional study	1	1	0	1	1	0	0	1	1	-	-	-	-	6
Lwanga F., 2015	Cross-sectional study	1	1	0	1	1	1	1	1	1	-	-	-	-	8
Murray J., et al., 2018	Mixed Method Study	1	1	1	1	1	0	1	0	1	-	-	-	-	7
Niasse F., et al., 2020	Clinical Trial Study	1	1	1	1	0	1	1	0	1	1	0	1	1	10
Rao Muddana N. and Ragireddy A., 2020	Observational study	1	1	0	0	1	0	1	0	1					5
Ramalho LC., et al., 2014	Cross-sectional study	1	1	0	1	1	1	1	1	1	-	-	-	-	8
Schtscherbyna A., et al., 2012	Cross-sectional study	1	1	1	0	1	1	0	1	1	-	-	-	-	7
Sewale Y., et al., 2018	Cross-sectional study	1	1	0	0	1	0	1	1	1	-	-	-	-	6
Shiferaw H., and Gebremedhin S., 2020	Cross-sectional study	1	1	0	1	1	0	1	1	1	-	-	-	-	7
Yasuoka J., et al., 2020	Cross-sectional study	1	1	1	1	0	0	1	0	1	-	-	-	-	6

NB.- JBI critical appraisals tools for all studies are used as shown in the link below https://jbi.global/critical-appraisal-tools

Appendix II, Supplementary Table 5. Household Food availability, supplementation, and intakes of ALHIV on ART follow-up in selected public hospitals of the two Regions of Ethiopia

Variables	Description	Frequency N (%)
Ever worried about not having enough food in the household	No	252 (65.6)
	Yes	132 (34.4)
Ever unable to eat preferred food due to resource limitation	No	176 (45.8)
	Yes	208 (54.2)
Ever eaten a limited variety of food due to resource limitation	No	180 (46.9)
	Yes	204 (53.1)
Ever eaten some foods did not want to eat due to resource limitations to obtain other types of food	No	230 (59.9)
	Yes	154 (40.1)
Ever eaten smaller meals than needed because not enough food was available	No	230 (59.9)
	Yes	154 (40.1)
Ever eaten fewer meals in a day because there was not enough food	No	212 (55.2)
	Yes	172 (44.8)
Ever had no kind of food to eat due to limited resource	No	285 (74.2)
	Yes	99 (25.8)
Ever gone to bed/sleep at night hungry because there was not enough food at home	No	171(44.5)
	Yes	213 (55.3)
Ever gone day and night without eating because there is not enough food	No	325 (84.6)
	Yes	59 (15.4)
Usual meals frequency in 24 hours (day and night)	≤ 2 meals	60 (15.6)
	3 – 5 meals	324 (84.4)
Lifetime skipping Meal	No	63 (16.4)
	Yes	321 (83.6)
Ever had feeding-related complications after eating food, such as vomiting, diarrhea, loss of appetite	No	274 (71.4)
	Yes	110 (28.6)
Ever had nutrition supplementation intake	No	146 (38.0)
	Yes	238 (62.0)
Kinds of supplementation ever taken (n=238)	Ready to use Therapeutic Feeding (RUTF)	238 (100)
Number of supplementations taken per day (n=238)	1 Sachet RUTF per a day	153 (64.3)
	1.5 – 2 sachet RUTF per day	57 (23.9)
	3 – 4 Sachet RUTF per day	28 (11.8)
Length of supplementation taken (n=238)	≤ 2 months	151 (63.4)
	3 – 4 months	74(31.1)
	5 or more months	13 (5.5)
Place of supplementation taken (n=238)	ART Centre of the hospital	236 (99.2)
	NGO	2 (0.8)

Appendix II Supplementary Table 6: Household water and toilet facility-related characteristics of ALHIV on ART follow-up in selected public hospitals of the two Regions of Ethiopia

Variables	Description	Frequency N (%)
Lived in households with a clean water supply	No	87 (22.7)
	Yes	297 (77.3)
Treat the water to make it safe to drink or for other purpose(n=87)	No	44 (50.6)
	Yes	42 (48.3)
	Unknown	1 (1.1)
Methods used for making the water safe for drinking [*Multiple responses] (n=42)		
Use of wuha agar (chlorine-based water treatment solution)		26 (61.9)
Use a water filter (ceramic/sand/composite)		23 (54.8)
Boiling water		14 (33.3)
Let the water stand and settle (sedimentation)		14 (33.3)
Use of highland mineral water		5 (11.9)
Strain through a cloth		3 (7.1)
Solar disinfection		1 (2.4)
Toilet Facilities of the households	Flush or pour-flush toilet	66 (17.2)
	Pit latrine	315 (82.0)
	Communal Latrine	2 (0.5)
	Open field	1 (0.3)

Appendix II Supplementary -Table 7: HIV-related characteristics of ALHIV on ART follow-up in selected public hospitals of the two Regions of Ethiopia

Variables	Description	Frequency N (%)
Awareness time of HIV status	≤ 3 years ago	77(20.1)
	≥ 4 years ago	307(79.9)
Availability of HIV-positive family member	Yes	309(80.5)
	No	59(15.4)
	Unknown	16(4.2)
Family Member HIV Positive [*Multiple Response] (n=314)	Only Father	26 (8.3)
	Only Mother	166(52.9)
	Both Mother and Father	76(24.2)
	Nuclear Family Member [Mother, Father, Brother and/or Sister]	43(13.7)
	Extended Family Member	3(0.9)
Ever had an episode of opportunistic infection (OI) in the past	No	71(18.5)
	Yes	313(81.5)
Kinds of OI ever had [*Multiple Responses] (n= 313)	Mouth and throat problems (Oral thrush/candidiasis, Mouth ulcer, Tonsilitis)	28 (8.9)
	Chronic Diarrheal Disease	50(16.0)
	Chronic Cough (Cold, Pneumonia, Tuberculosis)	180(57.5)
	Herpes Zoster	12(3.8)
	Other Infection	69(22.0)
Other Infection ever had [*Multiple Response] (n=69)	Accessary organ problems (Liver Disease)	4(5.8)
	Central Nervous System Problem	23(33.3)
	Cardiovascular system Problem	9(13.0)
	Dermatologic system problem	32(46.4)
	Ear, Eye, Nose, and Throat (EENT) problems	9(13.0)
	Hematologic system Problem	13(18.8)
	Gastrointestinal System Problem	39(56.5)
	Respiratory System Problem	1(1.4)
	Urinary System problem	11(15.9)
	Endocrine and Musculoskeletal system problems	4(5.8)
Ever had a long-standing disease like Tuberculosis	No	257(66.9)
	Yes	127(33.1)
Ever had an illness in the last 3 months	No	192(50.0)
	Yes	192(50.0)
Ever had any kind of illness in the last 3 months (*multiple Responses) (n=192)	Accessary organ problem (Liver Disease)	3(1.6)
	Central Nervous System Problem	23(12.0)
	Dermatologic System Problem	10(5.2)
	Ear, Eye, Nose, and Throat (EENT) problems	15(7.8)
	Hematologic Problem	4(2.1)
	Gastrointestinal System Problem	37(19.3)

	Respiratory System Problem	129(67.2)
	Urinary System Problem	6(3.1)
	Other system problems (i.e. Musculo Skeletal and Reproductive)	2(1.0)
Length of ART initiation	< 15 years ago	142(37.0)
	≥15 years ago	242(63.0)
Ever missed an ART clinic appointment for an ART follow-up	Yes	182(47.4)
	No	202(52.6)

Appendix II Supplementary Table 8. Medical record profile of ALHIV on ART follow-up in selected public hospitals of the two Regions of Ethiopia

Variables	Description	Frequency N (%)
Age at diagnosis and ART enrolment	< 4 years	190(49.5)
	≥ 4 years	194 (50.5)
Mean ± SD	4.66 ± 3.7 years	
Weight during ART enrolment	< 14 kg	189(49.2)
	≥ 14 kg	195(50.8)
Height during ART enrolment	<104 cm	190(49.5)
	≥ 104 cm	194 (50.5)
CD_4 status on ART enrolment	< 200 cell/mm3	25(6.5)
	200 – 500 cell/mm3	11(30.2)
	500 – 1500 cells/mm3	209(54.4)
	≥1500 cell/mm3	23(6.0)
	Unknown	11(2.9)
CD_4 status within the last 3 months	200 – 500 cell/mm3	2(0.5)
	500 – 1500 cells/mm3	4(1.0)
	≥1500 cell/mm3	4(1.0)
	Unknown	374(97.4)
Viral load status within the last 3 months	≥ 150 copies per ml of blood	4(1.0)
	< 150 copies per ml of blood	375(97.7)
	Unknown	5(1.3)
Hemoglobin level (n=359)	Low levels (< 11.5 gm/dl)	55(15.3)
	Normal level (11.5 – 15.0 gm/dl)	284 (79.1)
	High level (≥ 15 gm/dl)	20(5.6)
Alanine Transaminase (SGPT)(n=234)	Normal level (0 – 50 U/L)	221(94.4)
	Elevated level (> 50 U/L)	13(5.6)
Aspartate Amino Transferase (SGPOT) (n=236)	Normal Level (0 – 60 U/L)	227(96.2)
	Elevated Level (> 60 U/L)	9(3.8)

WHO Clinical stage before ART initiation	Stage I	247(64.3)
	Stage II	2(0.5)
	Stage III	113(29.4)
	Stage IV	22(5.7)
Current WHO clinical stage	Stage I	371 (96.6)
	Stage II	7(1.8)
	Stage III	6(1.6)
Highly Active Anti-Retroviral Therapy (HAART) used	First Line	305(79.4)
	Second Line	77(20.1)
	Third Line	2(0.5)
Ever had Side effect history to HAART	No	318(82.8)
	Yes	66(17.2)
Kinds of side effect (n=66)	CNC problems (Headache, Depression, Insomnia, Vertigo, and neurological problem)	7(10.6)
	Dermatologic problem (Allergic rash, dermatitis, itching, lesion)	47 (71.2)
	Eye and Ear problems (Eye discolouration, ear pain and tinnitus)	3(4.5)
	Gastrointestinal problems (abdominal discomfort, gastritis, liver disease)	9(13.6)
Measure taken for the side effect (n=66)	Symptomatic management and drug continued	21(31.8)
	Drug changed	45(68.2)

Appendix II Supplementary Table 6.1a. Average 24-hour Nutrient Intakes as percent of RDA met among ALHIV by different age groups

Age Category		Energy (Kcal)	Carbohydrate (gm)	Protein (gm)	Fat (gm)	Fiber (gm)	Retinol Equivalent (µgm)	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Calcium (mg)	Iron (mg)	Phosphorus (mg)	Zinc (mg)
10 - 13 years (Early Adolescent) (n=11)	Mean RDA Met (%)	77.2	84.8	71.3	81.0	50.3	5.9	129.0	64.2	56.1	23.0	43.5	384.5	76.4	14.5
	SD	17.2	18.3	21.7	42.0	26.0	6.7	31.2	22.6	41.4	19.7	15.7	156.6	23.2	12.6
14 - 17 years (Middle Adolescent) (n=30)	Mean RDA Met (%)	80.8	92.9	80.4	71.1	58.8	11.5	174.0	86.1	50.7	29.2	57.3	569.5	108.1	29.8
	Sd	16.6	18.1	34.9	48.8	25.3	18.6	78.5	25.9	50.4	18.9	17.7	124.5	27.7	34.8
18 - 19 years (Late Adolescent) (n=17)	Mean RDA Met (%)	73.3	84.1	62.2	67.9	52.6	7.8	146.0	109.6	34.7	32.3	69.0	473.7	91.6	36.8
	SD	21.3	24.0	19.8	57.7	31.9	10.9	57.9	110.8	15.3	35.3	82.4	205.1	30.4	58.8
Total (n=58)	Mean RDA Met (%)	77.9	88.8	73.4	72.0	55.4	9.3	157.3	88.8	47.1	28.9	58.1	506.3	97.3	28.9
	SD	17.9	20.2	29.6	49.7	27.3	14.9	67.7	64.2	41.6	24.7	46.8	171.1	30.0	40.9

Appendix II Supplementary Table 6.1b: ANOVA Analysis of Average 24-hour Nutrient Intake as percent of RDA met Among ALHIV of Different Age Groups

ANOVA Table						
Variables		Sum of Squares	df	Mean Square	F	P-value
Energy (Kcal) * Age	Between Groups	609.6	2.0	304.8	0.953	0.392
	Within Groups	17594.5	55.0	319.9		
	Total	18204.0	57.0			
Carbohydrate (gm) * Age	Between Groups	1065.4	2.0	532.7	1.325	0.274
	Within Groups	22117.4	55.0	402.1		
	Total	23182.7	57.0			
Protein (gm) * Age	Between Groups	3660.5	2.0	1830.2	2.172	0.124
	Within Groups	46354.0	55.0	842.8		
	Total	50014.5	57.0			
Fat (gm) * Age	Between Groups	1213.5	2.0	606.7	0.239	0.788
	Within Groups	139540.6	55.0	2537.1		
	Total	140754.1	57.0			
Fiber (gm) * Age	Between Groups	763.0	2.0	381.5	0.504	0.607
	Within Groups	41658.7	55.0	757.4		
	Total	42421.7	57.0			
Retinol Equivalent (µgm) * Age	Between Groups	584.7	2.0	292.4	0.470	0.628
	Within Groups	34216.8	55.0	622.1		
	Total	34801.5	57.0			
Thiamine (mg) * Age	Between Groups	19381.5	2.0	9690.8	2.203	0.120
	Within Groups	241979.4	55.0	4399.6		
	Total	261360.9	57.0			
Riboflavin (mg * Age	Between Groups	14203.3	2.0	7101.6	1.766	0.181
	Within Groups	221199.2	55.0	4021.8		
	Total	235402.5	57.0			
Niacin (mg) * Age	Between Groups	3895.3	2.0	1947.7	1.130	0.330
	Within Groups	94772.4	55.0	1723.1		
	Total	98667.7	57.0			
Vitamin C (mg) * Age	Between Groups	584.7	2.0	292.4	0.470	0.628
	Within Groups	34216.8	55.0	622.1		
	Total	34801.5	57.0			
Calcium (mg) * Age	Between Groups	4390.1	2.0	2195.0	1.003	0.373
	Within Groups	120326.3	55.0	2187.8		
	Total	124716.4	57.0			
Iron (mg) * Age	Between Groups	300972.1	2.0	150486.0	6.050	0.004
	Within Groups	1367950.3	55.0	24871.8		
	Total	1668922.4	57.0			

Phosphorus (mg) * Age	Between Groups	8878.4	2.0	4439.2	5.754	0.005
	Within Groups	42431.6	55.0	771.5		
	Total	51310.0	57.0			
Zinc (mg) * Age	Between Groups	3369.8	2.0	1684.9	1.006	0.372
	Within Groups	92107.2	55.0	1674.7		
	Total	95477.0	57.0			

Significant at *P value ≤ 0.05, **P value ≤ 0.01 and p*** value ≤ 0.001

Appendix III: Survey questionnaire (English version) for healthcare professionals

IDENTIFICATION: Participant Code……Region code.....
Hospital code …....…..

Part I. Sub-study I Questionnaire for Healthcare Professionals
Abbreviations: ALHIV = adolescents living with HIV; ART = anti-retroviral therapy

Section 1.1. Background of respondents					
No	Questions	Coding categories		Code	Skip to
001	How old are you?	_.....years			
002	What sex/gender do you identify?	Male Female		0 1	
003	What is the highest educational level you have completed?	Diploma graduate Bachelor graduate Masters graduate Others		0 1 2 3	
004	What is your profession?	Nurse Health Officer General Practitioner Specialist Medical Officer Other, please specify ……..		0 1 2 3 4	
005	How long have you been working in your current profession/role?	…… years			
006	How long have you worked in ART clinics altogether?	…… year			
007	What is your average monthly income?	……. EBR			
Section 1.2. Respondent's nutritional assessments practices					
008	What methods of nutritional assessment are used in your clinic for adolescents with HIV?	a) Bodily assessments such as measuring weight or height	No / Yes	0 / 1	
		b) Biochemical assessments such as blood or urine laboratory tests	No/ Yes	0 / 1	
		c) Clinical assessments	No / Yes	0 / 1	
		d) Dietary intake assessments	No / Yes	0 / 1	
		e) Food security assessment	No / Yes	0 / 1	

009	What tools and materials do you have in your ART unit/clinic for conducting bodily assessments or anthropometric measurements?	a) Height board	No / Yes	0 / 1	
		b) Weight scale	No / Yes	0 / 1	
		c) Arm circumference tape	No/ Yes	0 / 1	
		d) Calipers	No / Yes	0 / 1	
		e) Measuring Tape for waist circumference	No / Yes	0 / 1	
		f) Bioelectrical impedance analysis (BIA)	No / Yes	0 / 1	
		g) Underwater weighing dual-energy x-ray absorptiometry (DXA)	No / Yes	0 / 1	
		h) Grip strength dynamometer	No / Yes	0 / 1	
010	What anthropometric measurements are used to determine the nutritional status of adolescents living with HIV in your ART clinic?	a) Height	No / Yes	0 / 1	
		b) Weight	No / Yes	0 / 1	
		c) Body mass index (BMI)	No / Yes	0 / 1	
		d) Mid Upper Arm Circumference	No / Yes	0 / 1	
		e) Skin-fold thickness	No / Yes	0 / 1	
		f) Waist circumference	No / Yes	0 / 1	
		g) Waist-to-hip ratio	No / Yes	0 / 1	
		h) Lean body mass	No / Yes	0 / 1	
		i) Body fat	No / Yes	0 / 1	
		j) Grip strength	No / Yes	0 / 1	
011	If you answered yes for Q10 (e), which body site(s) of skinfold measurement are taken? Please mark all sites that are used.	Biceps skinfold	No / Yes	0 / 1	
		Triceps skinfold	No / Yes	0 / 1	
		Subscapular skinfold	No / Yes	0 / 1	
		Supra-iliac Skinfold	No / Yes	0 / 1	
		Other, please state …… ……	No / Yes	0 / 1	
012	What biochemical assessments are taken routinely for ALHIV during ART follow-up?	a) Glucose	No / Yes	0 / 1	
		b) BUN	No / Yes	0 / 1	
		c) Creatinine	No / Yes	0 / 1	

		d) BUN/Creatinine Ratio	No / Yes	0 / 1	
		e) Calcium	No / Yes	0 / 1	
		f) Total Protein	No / Yes	0 / 1	
		g) Albumin	No / Yes	0 / 1	
		h) Alkaline Phosphatase	No / Yes	0 / 1	
		i) Alanine Amino-transferase	No / Yes	0 / 1	
		j) White Blood Cell count	No / Yes	0 / 1	
		k) Red Blood Cell count	No / Yes	0 / 1	
		l) Hemoglobin	No / Yes	0 / 1	
		m) Hematocrit	No / Yes	0 / 1	
		n) Mean corpuscular Volume	No / Yes	0 / 1	
		o) Mean Corpuscular Hemoglobin	No / Yes	0 / 1	
		p) Platelet count	No / Yes	0 / 1	
		q) Helminth Infection (Hookworm and Ascaris)	No / Yes	0 / 1	
013	What clinical indicators of nutritional status are routinely assessed for ALHIV during ART follow-up?	a) Bilateral pitting edema	No / Yes	0 / 1	
		b) Visible wasting	No / Yes	0 / 1	
		c) Recent weight loss	No / Yes	0 / 1	
		d) Dermatosis	No / Yes	0 / 1	
		e) Eye sign (Bitot spot, corneal cloudiness, conjunctivitis, corneal ulceration)	No / Yes	0 / 1	
		f) Palm, mucus membrane, and nail bed	No / Yes	0 / 1	
Section 1.3. Questions on nutritional care, support practices, and related factors					
014	Does your hospital or clinic have standard admission criteria for the nutrition care and support program used for adolescents living with HIV?	No Yes		0 1	
015	If you answered Yes to the previous question, what admission criteria do your unit use for the nutrition care and support program for ALHIV?	---------- ---------- ---------- ---------- ----------			
016	What types of nutritional care and support are given to adolescents living with HIV?	Nutrition screening	No / Yes	0 / 1	
		Nutrition case management	No / Yes	0 / 1	
		Nutrition supplementation	No / Yes	0 / 1	

		Nutrition counseling/education	No / Yes	0 / 1	
		Other, please describe …… …… …… …… ……	No / Yes	0 / 1	
017	Are nutrition education/ counseling services available in your hospital?	No Yes		0 1	If No, skip to Q021
018	Do you practice nutrition counseling regularly with these patients?	No Yes		0 1	
019	If you answered yes to Q018, do you use the GALIDRAA (Greet, Ask, Listen, Identify, Discuss, Recommend, Agree, and Appoint) approach to nutrition counseling for adolescents living with HIV?	No Yes		0 1	
020	If you answered yes to Q018, do you use the ORPA (observe, reflect, personalize, act) approach during discussion time for nutrition counseling for adolescents living with HIV?	No Yes		0 1	
021	If you answered no to Q018, what other approach to nutrition counseling (apart from GALIDRAA or/and ORPA) do you use with these clients?	---------- ---------- ---------- ---------- ----------			
022	Is supplementation given in your hospital for adolescents living with HIV?	No Yes		0 1	
023	If you answered yes to Q022, what nutritional supplements are used in your hospital for adolescents living with HIV?	Ready to Use Therapeutic Food (RUTF)	No / Yes	0 / 1	
		Ready to Use Supplementary Food (RUSF)	No / Yes	0 / 1	
		Super cereal plus	No / Yes	0 / 1	
		Other, please specify …… ……			

024	If supplementation is provided, how often supplies are picked up by the adolescents?	Daily Weekly Every two weeks Every month Other, please describe ……		0 1 2 3 4	
025	Do you have a strategy to detect sharing with others?	No Yes		0 1	
026	If you answered yes to Q025, what are the strategies you use?	---------- ---------- ---------- ---------- ----------			
027	Does your hospital or clinic have standard discharge criteria from the nutrition care and support program used for adolescents living with HIV?	No Yes		0 1	
028	If you answered Yes to Q027, what discharge criteria does your hospital or clinic use to determine readiness for discharge nutrition care and support for ALHIV?	---------- ---------- ---------- ---------- ---------- ----------			
Section 1.4. Facility-related nutritional care and support					
029	Is staff nutrition training available in your hospital?	No Yes		0 1	
030	Does your hospital have a nutrition monitoring strategy?	No Yes		0 1	
031	Are standard operating procedures/ standards of practice available for nutritional care in your hospital?	No Yes		0 1	
032	What supplies or resources are available in your hospital for nutrition care and support for adolescents living with HIV?	Nutritional support guidelines	No / Yes	0 / 1	
		Job aids (instruction cards used for doing the job effectively)	No / Yes	0 / 1	
		Patient information and education material	No / Yes	0 / 1	
		The ability to treat undernourished patients	No / Yes	0 / 1	
		Referral and linkage to systems to support ALHIV	No / Yes	0 / 1	
		Monitoring checklist/multi-chart/card	No / Yes	0 / 1	

		Reporting format and system to regional health bureau and others	No / Yes	0 / 1	
033	Thinking about how nutrition screening, care, and support is managed in your hospital, can you name any activity which is performed particularly well, in your view? If so, please describe this and what is particularly good about it.	---------- ---------- ---------- ---------- ---------- ----------			
034	Thinking about how nutrition screening, care, and support is managed in your hospital, can you name any activity which does not work well, in your view? If so, please describe this and what the problem is.	---------- ---------- ---------- ---------- ---------- ----------			

Appendix IV: Sub-study 2 Questionnaire for adolescents living with HIV

IDENTIFICATION: Participant Code……Region code.....
Hospital code ….....…..

Part I: Survey Questionnaire 1 for adolescents living with HIV

Section 1. Questions about you				
No	Questions	Coding categories	Code	Skip to
001	How old are you?	.....years		
002	What sex are you?	Male Female	0 1	
003	What is your living situation?	Live alone Live with other peers Live with parents/responsible adults Live with partners/spouse	0 1 2 3	
004	What is the highest educational level you completed?	Unable to read & write Grade 1-8 Grade 9-10 10+2 completed & above	0 1 2 3	
005	What is your religion?	Orthodox Catholic Protestant Muslim Others, please specify	0 1 2 3 4	

		…… …….…		
006	What ethnic group do you belong to?	Afar Amhara Guragie Hadiya Oromo Sidama Somali Tigray Welaita Others (specify).....	0 1 2 3 4 5 6 7 8 9	
007	What is your current occupation?	Student/ school child Daily-laborer Housewife House-maid/servant Merchant Others(specify) ----------	0 1 2 3 4 5	
008	What is your approximate average monthly income?	…….. EBR		
009	How many people live with you in your household?	…….		
Section 2.2. Questions about how well-nourished you are				
010	There are lots of different measurements that can be taken to assess how well-nourished you are. Please fill in any recent bodily assessments or measurements that have been taken for you.	Height ……cm Weight…….kg Body mass index…… kg/m2 Mid-upper arm circumference……cm Skin-fold thickness Biceps Skinfold Thickness…….mm Triceps Skinfold Thickness…...…mm Subscapular Skinfold Thickness……mm Supra-iliac Skinfold Thickness…mm Waist circumference……cm Hip circumference…….cm Waist-to-hip ratio…….. Grip strength R hand…… Grip strength L hand……. Dominant hand (tick as appropriate) R [ ] …… L [ ] Other		
Section 2.3. Questions about your nutrition				
011	Sometimes families don't have	Worry that your household would not have enough food.	No / Yes	0 / 1

	enough food for everyone. In the past four weeks, in your family, did you or any household member:	Be unable to eat the foods you preferred because of a lack of resources.	No / Yes	0 / 1	
		Eat a limited variety of foods due to a lack of resources.	No / Yes	0 / 1	
		Eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food.	No / Yes	0 / 1	
		Eat a smaller meal than you felt you need because there was not enough food.	No / Yes	0 / 1	
		Eat fewer meals in a day because there was not enough food.	No / Yes	0 / 1	
		Ever had no food to eat of any kind in your household because of a lack of resources to get food.	No / Yes	0 / 1	
		Go to sleep at night hungry because there was not enough food.	No / Yes	0 / 1	
		Go a whole day and night without eating anything because there was not enough food.	No /Yes	0 / 1	
012	When you first started going to the ART clinic, were any nutritional assessments, such as measurements of your body or a clinical evaluation, done?	No Yes		0 1	
013	How many meals do you eat in a 24-hour period (day and night)?	……			
014	Do you have a history or a habit of skipping a meal?	No Yes		0 1	
015	Do you ever have feeding-related complications after eating food, such as vomiting, diarrhea, loss of appetite, etc?	No Yes		0 1	
016	Have you ever taken nutritional supplements?	No Yes		0 1	

017	If you answered yes to Q016, what form of food supplementation have you taken?	Ready to Use Therapeutic Food (RUTF) Ready to Use Supplementary Food (RUSF) Super cereal plus Other, please state …… …….	0 1 2 3	
018	How many supplements are you taking each day?			
019	How long have you been taking the supplements?	----------days / weeks / months		
020	Where do you collect the supplements?	ART center of the Hospital Non-Governmental organization Other places, please explain …… ……	0 1 2	
Section 2.4. Health-related questions				
021	How long ago were you told you were HIV positive?	Less than a year ago 1-3 years ago 4 – 6 years ago More than 6 years ago	0 1 2 3	
022	Is anyone else in your family HIV positive?	Yes No Unknown	0 1 2	
023	If you answered yes to Q022, what family members are HIV positive?			
024	Have you experienced any episodes of infection in the past?	No Yes Unknown	0 1 2	
025	If you answered yes to Q024, what kind of infections did you have? Mark all that apply	Mouth and throat problems Chronic diarrhoea Chronic cough Herpes zoster Other, please specify …… …… ……..	0 1 2 3 4 5	
026	Have you ever had a long-standing infection such as Tuberculosis?	No Yes Unknown	0 1 2	
027	Have you experienced any illness during the last 3 months?	No Yes Unsure	0 1 2	

028	If you answered yes to Q027, what kind of illness did you have?	…… …… ……		
029	How long ago did you start on the drugs for HIV?	……months / years		
030	Has there ever been a time when you have missed a clinic appointment for ART follow-up?	No Yes	0 1	

Section 2.5. Some questions about how you feel

031	Over the last two weeks, how often have you been bothered by the following problems?	Not at all	Several days	More than half the days	Nearly every day	
	a) Feeling nervous, anxious, or on edge	0	1	2	3	
	b) Not being able to stop or control worrying	0	1	2	3	
	c) Worrying too much about different things	0	1	2	3	
	d) Trouble relaxing	0	1	2	3	
	e) Being so restless that it is hard to sit still	0	1	2	3	
	f) Becoming easily annoyed or irritable	0	1	2	3	
	g) Feeling afraid, as if something awful might happen	0	1	2	3	
032	Over the last 2 weeks, how often have you been bothered by any of the following problems?	Not at all	Several Days	More than half the days	Nearly every day	
	1) Little interest or pleasure in doing things	☐	☐	☐	☐	
	2) Feeling down, depressed, or hopeless	☐	☐	☐	☐	
	3) Trouble falling/staying asleep or sleeping too much	☐	☐	☐	☐	
	4) Feeling tired or having little energy	☐	☐	☐	☐	
	5) Poor appetite or overeating	☐	☐	☐	☐	
	6) Feeling bad about yourself or that you are a failure or have let yourself or your family down	☐	☐	☐	☐	

	7) Trouble concentrating on things, such as reading newspapers or watching television	☐	☐	☐	☐	
	8) Moving or speaking so slowly that other people could have noticed. Or the opposite; being so fidgety or restless that you have been moving around a lot more than usual	☐	☐	☐	☐	
	9) Thought that you would be better off dead or hurting yourself in some way	☐	☐	☐	☐	
Section 2.6. Lifestyle questions						
A. Alcohol use						
033	Have you ever used alcohol in your lifetime?	Yes No			0 1	
034	Do you drink alcohol currently?	Yes No			0 1	If No, Skip Q36
035	Please provide responses to the following questions regarding your alcohol use over the past year. Mark the box in each question that best describes your response. Please give an accurate response.					
		0	1	2	3	4
	1) How often do you have a drink containing alcohol?	Never	Monthly or less	2 – 4 times a month	2 – 3 times a week	4+ times a week
	2) How many drinks containing alcohol do you have on a typical day when you are drinking?	1 to 2	3 to 4	5 to 6	7 to 9	10 or more
	3) How often do you have six or more standard drinks (1 standard drink is 10 grams of alcohol) containing on one occasion?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily
	4) How often during the last year have you found that you were not able to stop drinking once you had started?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily

	5) How often during the last year have you failed to do what was normally expected of you because of drinking?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily	
	6) How often during the last year have you needed a drink first thing in the morning to get yourself going after a heavy drinking session?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily	
	7) How often during the last year have you had a feeling of guilt or remorse after drinking?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily	
	8) How often during the last year have you been unable to remember what happened the night before because of your drinking?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily	
	9) Have you or someone else been injured because of your drinking?	No		Yes, but not in the last year		Yes, during the last year	
	10) Has a relative, friend, doctor or other healthcare worker been concerned about your drinking or suggested you cut down?	No		Yes, but not in the last year		Yes, during the last year	

Section 2.7. Environmental questions

036	Do you live in a household with a clean water source?	No Yes		0 1	
037	If you answered no to Q036, do you treat the water to make it safe to drink and for other household purposes?	No Yes Don't know		0 1 2	
038		Boil the water	No / Yes	0 / 1	

	If you answered yes to Q036, what usually do you do to make the water safer to drink?	Strain through a cloth	No / Yes	0 / 1	
		Use a water filter (Ceramic/ Sand/Composite)	No / Yes	0 / 1	
		Solar disinfection	No / Yes	0 / 1	
		Let the water stand and settle	No / Yes	0 / 1	
		Other, Specify…….	No / Yes	0 / 1	
		Don't know	No / Yes	0 / 1	
039	What kind of toilet facilities do members of your household usually use? Please mark all you use.	Flush or pour-flush toilet Pit latrine Composting toilet Bucket toilet Hanging toilet/hanging latrine No facility/use bush or field Other…….		0 1 2 3 4 5 6	
040	What techniques do you use to prevent food from spoiling? Please mark every method your family uses	Drying	No /Yes	0 / 1	
		Refrigeration	No /Yes	0 / 1	
		Freezing	No /Yes	0 / 1	
		Salting	No /Yes	0 / 1	
		Canning	No /Yes	0 / 1	

Part II: Data Extraction Sheet (Survey 2) for Adolescents living with HIV

Health-related medical history data extracted from medical records

No	Questions	Coding categories *Not available = 9	Code	Skip to
050	Previous weight (kg)			
051	Previous height (cm)			
052	CD_4 status on ART enrolment/awareness of HIV			
053	CD_4 status within the last 3 months			
053	Viral load status within the last 3 months			
055	Clinical stage before ART initiation	Stage I Stage II Stage III Stage IV	0 1 2 3	
056	Current WHO Clinical Staging	Stage I Stage II Stage III Stage IV	0 1 2 3	
057	Clinical biochemical test findings	Haemoglobin……..mg/dl, Alanine Transaminase (ALT) Test……U/l Aspartate Aminotransferase (AST) Test …… U/l Creatinine……mg/dl Urea……..…….. mg/dl Total protein…….g/dl RBP……..….g/dl, C-Reactive Protein……..,g/dl Albumin……...g/dl Prealbumin …….…….g/dl Glucose……mg/dl		
058	Immune marker test results	WBC……mm3 Differential WBC count Neutrophil……..% Lymphocyte……...% Monocyte……..% Eosinophil…….% Basophil……....% Interleukin 6 (IL6) ……		
059	HAART drugs used as prescribed	---------- ---------- ---------- ---		

060	HAART drugs dosage used as prescribed	…….. …….		
061	Frequency of HAART used as prescribed	…….. …….		
062	Is there any record of the ALHIV experiencing any side effect HAART?	Yes No		
063	If the answer to Q062 is yes, please detail side effect as recorded, date of occurrence and how treated / managed.	---------- ---------- ---------- ---------- ----------		

Part III: Survey Questionnaire 3 for sub-sample adolescents living with HIV on Dietary intake History

The 24-hour dietary intake assessment questionnaire

Dietary Diversity Questionnaire

Please describe all the foods (meals and snacks) that you ate and drank YESTERDAY during the day and night, whether at home or outside the home. Start with the first food or drink of the morning. Write down all foods and drinks mentioned. When composite dishes are mentioned, ask for the list of ingredients. When the respondent has finished, probe for meals and snacks not mentioned

064

INTERVIEWER: _____

INTERVIEW DATE: _____

DAY FOOD EATEN: _____

HOSPITAL: _____

SUBJECT ID CODE: _____

	Time	Place eaten	Food or drink, description, and cooking method Amount	Amount eaten	Weight Equivalent (g)
Breakfast					
Snack					
Lunch					
Snack					

	Dinner Snack						
	Probe for alcohol? Yes / No Was it a feast day? Yes / No			Probe for sickness? Yes / No If yes, did sickness affect appetite? Yes /No If yes, how? Increase or decrease			
	Was food intake unusual? Yes / No If yes, how was it unusual?			Probe for tablets? Yes / No Iron Malaria Vitamins Other			

065

Please provide responses to the following questions regarding your food group intake use experiences over the 24 hours. Mark either yes or no in each question that best describes your response. Give an accurate response.

	Food Group	Example		
a)	Cereals	Corn/maize, rice, wheat, sorghum, millet or any other grains or foods made from these (e.g. bread, noodles, porridge or other grain products) + insert local foods e.g. ugali, nshima, porridge or paste	No /Yes	0 / 1
b)	White roots and tubers	White potatoes, white yam, white cassava, or other foods made from root	No /Yes	0 / 1
c)	Vitamin a rich vegetables and tubers	Pumpkin, carrot, squash, or sweet potato that are orange inside + other locally available vitamin A-rich vegetables (e.g. red sweet pepper)	No /Yes	0 / 1
d)	Dark green leafy vegetables	Dark green leafy vegetables, including wild forms + locally available vitamin A-rich leaves such as amaranth, cassava leaves, kale, spinach	No /Yes	0 / 1

	e)	Other vegetables	Other vegetables (e.g. tomato, onion, eggplant) + other locally available vegetables	No /Yes	0 / 1		
	f)	Vitamin a rich fruit	Ripe mango, cantaloupe, apricot (fresh or dried), ripe papaya, dried peach, and 100% fruit juice made from these + other locally available vitamin A rich fruits	No /Yes	0 / 1		
	g)	Other fruits	Other fruits, including wild fruits and 100% fruit juice made from these	No /Yes	0 / 1		
	h)	Organ meat	Liver, kidney, heart or other organ meats or blood-based foods	No /Yes	0 / 1		
	i)	Flesh meats	Beef, pork, lamb, goat, rabbit, game, chicken, duck, other birds, insects	No /Yes	0 / 1		
	j)	Eggs	Eggs from chicken, duck, guinea fowl or any other egg	No /Yes	0 / 1		
	k)	Fish and seafood	Fresh or dried fish or shellfish	No /Yes	0 / 1		
	l)	Legumes, nuts and seeds	Dried beans, dried peas, lentils, nuts, seeds or foods made from these (eg. hummus, peanut butter)	No /Yes	0 / 1		
	m)	Milk and milk products	Milk, cheese, yogurt or other milk products	No /Yes	0 / 1		
	n)	Oils and fats	Oil, fats or butter added to food or used for cooking	No /Yes	0 / 1		
	o)	Sweets	Sugar, honey, sweetened soda or sweetened juice drinks, sugary foods such as chocolates, candies, cookies and cakes	No /Yes	0 / 1		
	p)	Spices, condiments, beverages	Spices (black pepper, salt), condiments (soy sauce, hot sauce), coffee, tea, alcoholic beverages	No /Yes	0 / 1		
	Household level only	Did you or anyone in your household eat anything (meal or snack) OUTSIDE the home yesterday?		No /Yes	0 / 1		
	Individual level	Did you eat anything (meal or snack) OUTSIDE the home yesterday?		No /Yes	0 / 1		

Thank you very much for your participation in the survey of this study!!!

If you invited for an in-depth personal interview (IDI) or focus group discussion (FGD), would you be willing to participate?

A. Yes ☐ B. No ☐

In-depth Interview Guide for Sub-study 2 (Objective 3)

Semi-Structured Interview Questions for adolescents living with HIV on ART follow-up in Addis Ababa Regions and Oromia Regions

Interview date: ___/___/___ (Date/Month/Year) Participant ID number: _____

Start time: _____ End time_____

Research Assistant / Researcher ID number: _____

Introduction: Hi, I am _____ a research assistant/researcher of the study entitled: 'Nutrition status among adolescents living with Human Immuno-Deficiency Virus (HIV) on Anti-Retroviral Therapy (ART) Follow-up living in selected regions of Ethiopia'. I am doing a research project to find out how well-nourished adolescents living with HIV are and identify what factors affect this, including what nutritional care they receive from hospitals when they attend their regular medication follow-up, and their food intake and eating habits.

There is an Information Sheet about this project; do you have a copy?

(If no, offer a copy).

(If yes) Have you read the information?

(If no) Would you like to read it now, or would you like me to read it to you?

(If yes) Do you have any questions?

(If no) If you agree, I would like to interview you in a private room so that everything you say will remain confidential. Taking part in the research is voluntary, so if you are not interested, you do not need to participate. If you agree, the interview will be audio recorded, and this is just to make sure we don't miss anything that you say. The recording will be typed up afterwards and the voice recording deleted. You can have someone accompany you during the interview if you prefer. The interview will take between 40 and 60 minutes.

To confirm, would you like to take part in an interview?

(If consents) Are you able to take part in your interview now?

(If no, arrange a convenient time)

(If yes, take the interviewee to a convenient location, obtain/ record consent, and commence the interview).

Interview guide for adolescents with HIV and family /caregivers of ALHIV
1. Can you tell me a bit about yourself and your HIV condition? Probing questions: ▪ What is your age? ▪ What is your gender? ▪ How long has it been since your diagnosis with HIV? ▪ Are there any other members of your family who live with you? (If yes) Do any of these family members who live with you also have HIV? ▪ Please tell me about your experience taking medications for HIV. Probes: o How long have you been taking HIV medicines? o How does it feel to have to take these medications on a regular basis? o Do you take any other medicines besides those for your HIV? (If yes) How do you make sure you take the right pills at the right time? o Has it ever happened that you have missed a dose or taken the wrong dose of your medication? (If yes) What was happening around the times you missed or took the wrong dose? o Have you ever experienced any unexpected symptoms from your medications? (If yes) What happened – What symptoms did you have? How did you feel? When did this happen? Which drug did you think caused this? What did you do? Did you continue with the medication? Did you tell any of the doctors or nurses looking after you?
2. Next, I have some questions about what you normally eat and whether this has been affected by your HIV. • Tell me about what food you eat, and your daily meals: • What are your favorite foods? • Do you get enough to eat? (If not, is it every day that you don't get enough to eat or only sometimes? If only sometimes, when does this happen? Do you know why food is sometimes short for you?) • Do you think that you are well-nourished? (If not, why do you think that? If yes, what helps this?) • Did getting HIV affect what you can eat?

- Did the treatment for your HIV affect how or what you can eat?
- Has having HIV or the treatment for it affected how well-nourished you think you are? (Can you tell me more about that?)
- What factors, in your opinion, can affect how well-nourished people are?
- What factors, in your opinion, can influence how well-nourished people living with HIV are?
- Are there any particular problems /issues with people getting enough food or being well-nourished? If yes, can you tell me more about that? What can be done about this? What can local people do about this?

3. Now, I have some questions about the hospital where you are being treated for your HIV. Can you tell me a bit about what it is like when you come to the hospital for treatment?
   a) Is the clinic good at keeping to time for your routine healthcare appointments? Does the clinic run on time? Are they ready for you when you arrive?
   b) How good are the doctors and nurses at talking to you and explaining things to you? Do they tell you what you need to know? Do they talk to you in words you can understand? Are they generally friendly? Helpful?
   c) How do the doctors and nurses treat you? Do you feel you are treated differently from those younger than you? Or those older than you?
   d) If you were to describe what works well for you about the HIV services at the clinic, what things would that be?
   e) If you were to describe what doesn't work well for you about the HIV services at the clinic, what things would that be?
   f) People living with HIV experience a number of difficulties. For example, sometimes they forget to take their medication or even forget to use condoms during sex. How easily can you talk to your doctors and nurses about some of the difficulties you face? Can you talk freely to your doctors and nurses about anything? What about when you have not taken your medication as you were supposed to? How about discussions on sexual activity?
   g) Do you have any specific needs that you feel are not being met at the hospital clinic or by your doctors and nurses?
      Probe: (If yes) What would you like to happen to put this right?

4. Is there anything else about the clinic, about living with HIV and its treatment, what you can eat, and how well-nourished you are that you would like to tell me?

Closing: Thank you for taking part in the research and the information you have given. The information will only be used for research purposes and the information you have given stored in a private place to maintain confidentiality.

Do you have any questions about anything that was discussed?

Do you have anything else you would like to tell me that you think is important about caring for adolescents with HIV?

If you have concerns about the research you think my supervisor or I can help you with, please feel free to contact me at the following phone number and email address for any future inquiries: +61-420755856 / +251911708987 and MelessGebrie.Bore@student.uts.edu.au. You can also speak to a local independent contact, Dr. Andargachew Kassa, at andkassa@hu.edu.et.

Focus Group Discussion Guide for Sub-Study 2 (Objective 4)

Focus Group Discussion Date: ___/___/___ (Date/Month/Year)

Number of participants present: _____

Start time: _____ End time_____

Research Assistant/Researcher ID number: _____

Introduction: Hi, I am _____ a research assistant/researcher of the study entitled: 'Nutrition status among adolescents living with Human Immuno-Deficiency Virus (HIV) on Anti-Retroviral Therapy (ART) Follow-up living in selected regions of Ethiopia'. We are doing some research to find out about the food and eating habits of adolescents and young adults with HIV who regularly take medicines and are followed up at hospital for this. If you agree, we want to hold discussion groups to talk about what you think about what you eat. These discussion groups will take place in a private room so that the conversations will stay confidential. Taking part in this research is voluntary, so if you are not interested, you do not need to participate. If you agree, the discussion will be audio recorded, and this is just to make sure we don't miss anything that you say. The recording will be typed up afterwards and the voice recording deleted. Your name will not be included in the record of what you said.

We will set out some guidelines prior to beginning the discussion. These include that only one person speaks at a time; phones should be switched off or on silent mode; everyone respects that there are no right or wrong answers to our questions, and we respect everyone's ideas.

The discussion will take between 40 and 60 minutes. If you have any questions, you are welcome to ask before the start of the discussion.

Have you any questions?

(If yes, address these and ask if any other questions)

(If no, ask if the proposed discussion time is convenient. If no, see if any other FGD time is convenient).

(If yes, collect consent and start the discussion).

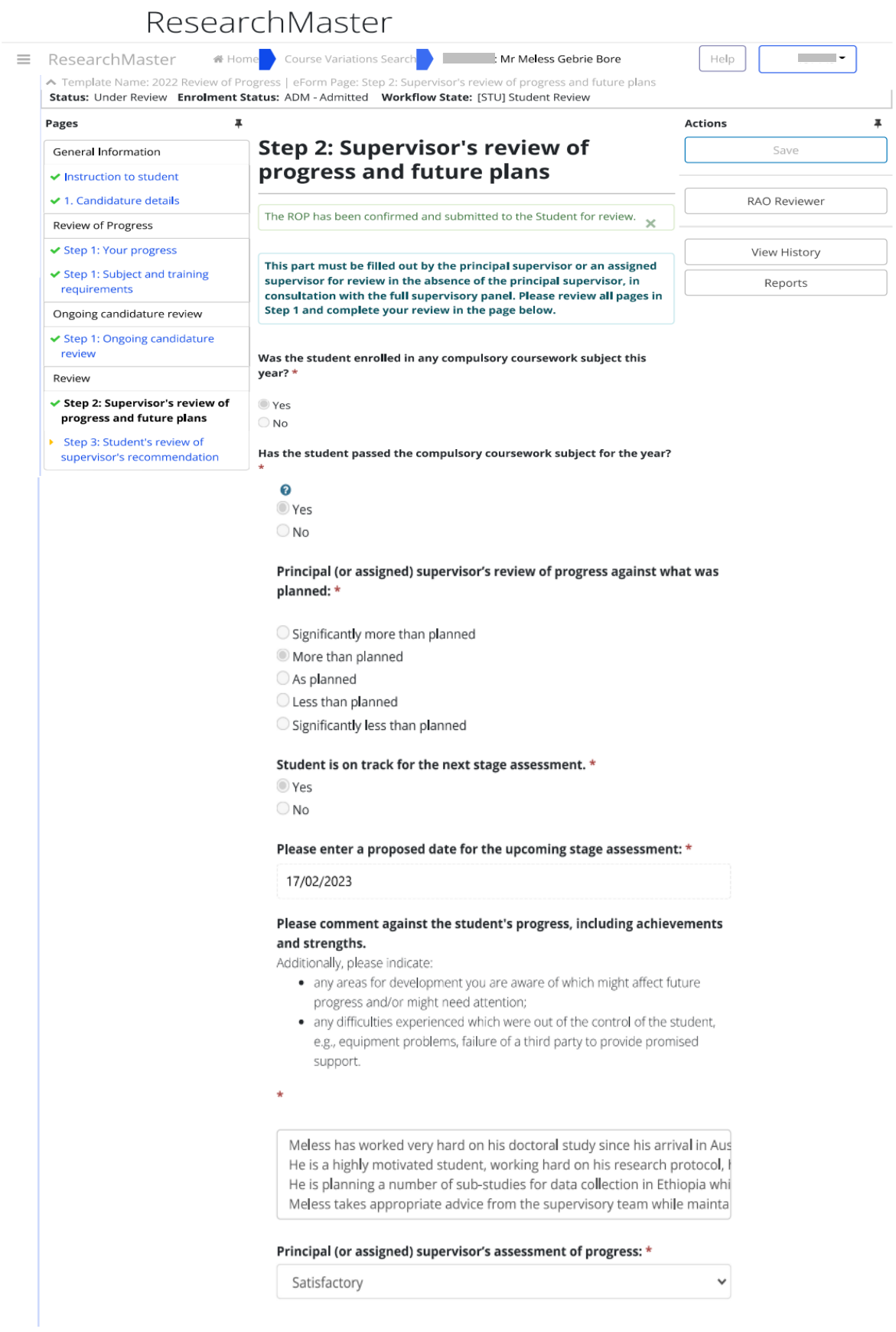
FGD Interview Guide for Adolescents Living with HIV
. First, I am going to go round the room and ask everyone a few questions about themselves. (Start with someone who seems comfortable to talk in this situation) • First, can you tell me how old you are? • How do you describe yourself – as a boy or young man or as a girl / young woman? • Who lives with you at home? (Probe: Do you live with your parents? Have you got any brothers or sisters? (If yes) do they live with you? Are you married? (If yes) do you live with your husband/ wife? (If yes) Do you live with their family? • How long has it been since a doctor or nurse told you that you have HIV? • Do any of the family members who live with you also have HIV?
. Next, I have some questions for everyone to talk about, about what you normally eat and whether this has been affected by your HIV. • First question: Do you think having HIV affects what you can eat? • Next question: Do you think the treatment for HIV affects how or what you can eat? • Has having HIV or the treatment for it affected how well-nourished you think you are? (Can you tell me more about that?) • What factors, in your opinion, can affect how well-nourished people are? • What factors, in your opinion, can influence how well-nourished people are, living with HIV? • Are there any particular problems /issues with people getting enough food or being well-nourished? If yes, can you tell me more about that? • What can be done about this? What can local people do about this?
. Now I have some questions for everyone to talk about, about the hospital where you are being treated for your HIV. • Can you tell me a bit about what it is like when you come to the hospital for treatment? • Can you tell me about what services or treatment or help you get for your HIV from the clinic? (Probe: Do you get medicines? Do you get weighed or your height or any other part of your body measured?) • Has anyone at the clinic talked to you about how well-nourished you are? If yes, what did they say?

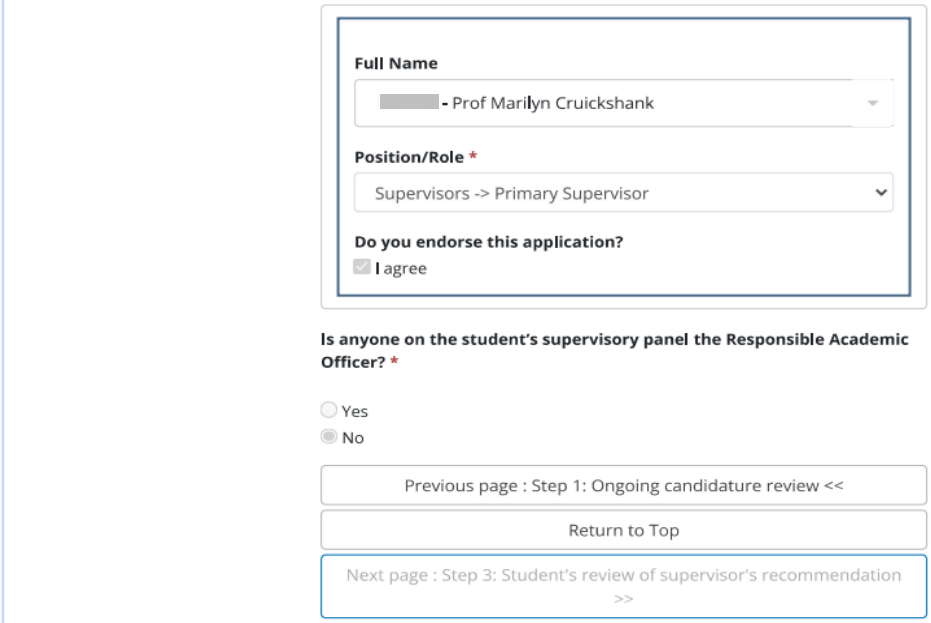
- Are the doctors and nurses and the treatments you get from this clinic helpful for you in relation to your weight and any nutrition problems? Can you tell me more about this? What is helpful? Is anything unhelpful? Why is this?
- Has anyone talked to you about food and eating to maintain a healthy weight? If yes, what did they say?
- Do you think the counsellor at the clinic considers you as an individual person with your own special life conditions when providing counselling?
- Have you been offered the opportunity to have supplementary/therapeutic food? If yes, did the doctors or nurses or anyone else at the clinic explain to you how and when to use this? How is this working out? Do you think it is helpful? Can you tell me why?

Closing: Thank you for taking part in the research and the information you have given. The information will only be used for research purposes and the information you have given stored in a private place to maintain confidentiality.
Do you have any questions about anything that was discussed?
Do you have anything that wasn't raised which is important to know in understanding HIV care among adolescents living with HIV?

If you have concerns about the research you think my supervisor or I can help you with, please feel free to contact me at the following phone number and email address for any future inquiries: +61-420755856 / +251911708987 and MelessGebrie.Bore@student.uts.edu.au. You can also speak to a local independent contact, Dr. Andargachew Kassa, at andkassa@hu.edu.et.

Appendix V: ROP and STASH Data Management Plan





ResearchMaster

HDR eForm

Student Name : Mr Meless Gebrie Bore

Important information

CANDIDATURE STAGE ASSESSMENT

For Higher Degree by Research students

Candidature Stages

The Graduate Research Education Framework comprises of three formal candidature stages for both Master's (Research) degree graduate research students and Doctoral degree graduate research students.

The objective of each stage is to ensure that the student has the necessary knowledge and skills to complete the research program successfully and in a timely manner.

Please refer to the Graduate Research Candidature Management, Thesis Preparation and Submission Procedures for further information regarding each stages' requirements.

Candidature details

Student ID:

Firstname:

Meless Gebrie

Surname:

Bore

Study load:

Full-time

Course code/name:

Doctor of Philosophy

Enrolled thesis subject:

1	Subject Type	Thesis
	Subject Code	93001_V2
	Subject Name	PhD Thesis: Health

Current thesis title:

Adolescent Nutrition and associated factors among HIV-positive adolescents who are attending ART Follow-up in Public Health Institution of South Nation National People, Ethiopia

Current EWS date:

12/02/2025

Signatory supervisory panel:

1	Sign-off delegate?	Yes
	Active?	Yes
	Position	Principal Supervisor
	Preferred First Name	Marilyn
	Preferred Last Name	Cruickshank
	Preferred Full Name	Prof Marilyn Cruickshank
	Email Address	Marilyn.Cruickshank@uts.edu.au
2	Sign-off delegate?	No
	Active?	Yes
	Position	Co-Supervisor
	Preferred First Name	Luna
	Preferred Last Name	Xu
	Preferred Full Name	Dr Luna Xu
	Email Address	Xiaoyue.Xu@uts.edu.au

Non-signatory supervisory panel:

1	Active?	Yes
	Position	External Supervisor
	Preferred First Name	Andargachew
	Preferred Last Name	Biratu
	Preferred Full Name	A/Prof Andargachew Kassa Biratu
	Email Address	andargachewka@hu.edu.et

Candidature Stage Assessment

Candidature Stage Assessment details

Please ensure the faculty/school keep the record of stage assessment reports for auditing purpose.

Assessment stage:

Stage 3

Type of assessment:

First assessment

Assessment date:

30/08/2024

Panel members (optional):

1	Name	Amanda Wilson
	Position	Chairperson
2	Name	Daniel Demant
	Position	Assessor

Please upload documents submitted by the panel (optional):

1	Document name	Panel Report
	Document type	Soft copy
	Document	Meless Bore_Stage 3 Assessment Outcome_Report.pdf

RO comments (outline final recommendation and any further steps required):

This question is not answered.

Key dates and Review timelines

Candidature stage assessment and Review of Progress Sigevents:

This question is not answered.

Please go to the Student profile for information of past Review of Progress & Candidature Stage Assessment results.

Assessment outcome

Assessment outcome

On this page, you will find the outcome and recommendation of your stage assessment provided by the Faculty Responsible Academic Officer (RAO). Please review them carefully, and contact the Graduate Research School if you require further clarification.

Responsible Academic Officer's assessment of the outcome of the stage assessment:

Satisfactory

Progression to the next stage is confirmed

RAO review notes:

This question is not answered.

Nutrition status among adolescents living with Human Immuno-Deficiency Virus (HIV) on Anti-Retroviral Therapy (ART) follow-up living in the selected Region of Ethiopia: Mixed Method Study Design

Description

Adolescents (defined as aged 10 to 19 years (WHO, 2014)) account for 16% of the global population, totaling 1.3 billion adolescents. According to the United Nations, adolescents experience significant growth and development between childhood and adulthood between the ages of 10 and 19 (UNICEF, 2021). Although more than half of all adolescents live in Asia, sub-Saharan Africa is the region where adolescents make up the greatest proportion of the population, at 23% (UN, 2019; UNICEF, 2021). The proportion of adolescents is even higher in Ethiopia where one-third (33.7%) of the population, is aged between 10 and 24 years.

Adolescence is also a critical time period in relation to the later development of adult non-communicable diseases, since many of the risk factors for diseases develop during this age. Targeting adolescents with health interventions can have a positive ripple effect. However, despite decreasing trends in Communicable, Maternal, Neonatal, and Nutritional (CMNN) disorders, malnutrition (i.e., undernutrition, micronutrient deficiencies, and overweight/obesity) remains a major public health concern (Reiner RC Jr, Olsen HE, Ikeda CT, et al., 2019). Moreover, the progress is inequitable since countries with a low and low–middle social development index (SDI) bear a higher burden of morbidity amongst children and adolescents compared to middle-, high–middle-, and high-SDI countries (Reiner RC Jr, Olsen HE, Ikeda CT, et al., 2019).

Adolescents are disproportionately affected by HIV. It is a different epidemic from adult HIV because of the compounding effects of the disease. An adolescent who contracts HIV remains infected and afflicted for the rest of their lives (Naswa & Marfatia, 2010). Not only do adolescents have trouble accepting their HIV status, they also have a need for lifelong treatment, and need to adjust to the effects of other positive family members. They also have painful memories of their lost parents. They are faced with unanswered questions about their future health, education, careers, and marriage. In common with other young adults in this age group, the likelihood of risky sexual behavior is high, while at the same time, they have less frequent contact with the healthcare system. While monitoring of HIV spread in this demographic group is critical for long-term epidemic control, it remains particularly challenging (Ethiopian Public Health Institute (EPHI),

2020) and adolescents are rarely specifically prioritized in national HIV-plans and programming efforts.

This study is significant for several reasons. Firstly, findings from the study will help the adolescents living with HIV to know their level of nutritional status and provide information about the role of nutrition for healthy living with the disease lifelong and helps to sustain the life cycle of adolescent health and pregnancy. Secondly, the findings of the study will help government and non-governmental organizations achieve future integrative nutrition policy and program goals in addition to routine clinical care to reduce adolescent undernutrition, and how to engage facilitators and overcome barriers and the determinant factors. Finally, recommendations from the study findings will offer direction for future policy, implementation strategies, and research on adolescent nutrition in Ethiopia with emphasis on adolescents living with HIV.

To address this research objective, we will use Mixed Method design, collect prospective and retrospective data by using pre-tested structured questionnaire for quantitative component, and "in-depth interview and FGD" for qualitative components.

Expand/Collapse all

– Project

Project overview

Project name

Nutrition status among adolescents living with Human Immuno-Deficiency Virus (HIV) on Anti-Retroviral Therapy (ART) follow-up living in the selected Region of Ethiopia: Mixed Method Study Design

Research Master Project Code / Student ID

☑ HDR student project

Project description

Adolescents (defined as aged 10 to 19 years (WHO, 2014)) account for 16% of the global population, totaling 1.3 billion adolescents. According to the United Nations, adolescents experience significant growth and development between childhood and adulthood between the ages of 10 and 19 (UNICEF, 2021). Although more than half of all adolescents live in Asia, sub-Saharan Africa is the region where adolescents make up the greatest proportion of the population, at 23% (UN, 2019; UNICEF, 2021). The proportion of adolescents is even higher in Ethiopia where one-third (33.7%) of the population, is aged between 10 and 24 years.

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This study is significant for several reasons. Firstly, findings from the study will help the adolescents living with HIV to know their level of nutritional status and provide information about the role of nutrition for healthy living with the disease lifelong and helps to sustain the life cycle of adolescent health and pregnancy. Secondly, the findings of the study will help government and non-governmental organizations achieve future integrative nutrition policy and program goals in addition to routine clinical care to reduce adolescent undernutrition, and how to engage facilitators and overcome barriers and the determinant factors. Finally, recommendations from the study findings will offer direction for future

policy, implementation strategies, and research on adolescent nutrition in Ethiopia with emphasis on adolescents living with HIV.

To address this research objective, we will use Mixed Method design, collect prospective and retrospective data by using pre-tested structured questionnaire for quantitative component, and "in-depth interview and FGD" for qualitative components.

Keywords

Adolescent, ART, HIV, Nutrition / Dietary Intake, Nutritional status, Undernutrition, Overweight,

Start date
01/01/2021

End date
31/12/2024

Funders

None

Grant ID

None

– People

People

First-named chief investigator / UTS supervisor

Name	Email	Project Role	ORCID
Marilyn Cruicksha nk	Marilyn.Cruicksha nk@uts.edu.au	Chief Investigator	0000-0001-9890 -3141

Data manager

Name	Email	ORCID
Meless Gebrie Bor e	melessgebrie.bore@student.uts.edu.au	

Contributors

Name	Email	ORCID

Additional supervisors

Name	Email	ORCID
Lin Perry	lin.perry@uts.edu.au	0000-0002-8507-1283
Luna Xu	luna.xu@unsw.edu.au	https://orcid.org/0000-0003-4787-6547
Andargachew Kas sa Biratua	[redacted]@gmail.com	https://orcid.org/0000-0003-4696-2582

- Ethics and security

Ethics and Security

Initially your research data is classifed as UTS Internal. To improve the accuracy of this classification, please answer the following

Information Security Classification
UTS: Confidential

Does the research involve:
Human participant data

Will the data you collect from individuals include personal information?
Yes

Will the data you collect from individuals include sensitive personal information other than health information?
Yes

Will the data you collect from individuals include health information?
Yes

Will any data or information be individually identifiable or potentially re-identifiable (i.e. include codes) at any stage of the research?
Yes

Outline any potential risk to participants from accidental disclosure of the data and any strategies for minimising those risks
Hiding the HIV status, Client name, Client card Number, Client code of regestration, and assigning code for the rsearcher to be used

If you are collecting data from residents of countries other than Australia, which countries?
Ethiopia

Is Ethics approval required for your project?
Yes

- Data collection and storage

Data collection and storage

Please provide a brief description of your data collection methodology
We will use mixed method design which have both quantitative and qualitative components. For quantitative components, we will use prospective and retrospective date by using adopted interviewer administered structured questionnaire; whereas for qualitative data, we will use in-depth interview and FGD.

Predominant file type(s), e.g. textual, tabular, image or recording. Give file format if known
Multiple file format

Data storage location
eResearch storage platforms (e.g Omeka, Geoserver etc)
UTS provided survey platform (e.g Qualtrics, REDCap, etc)
UTS provided collaboration space (e.g. CloudStor, OneDrive etc)

If other, provide further details: (Including access arrangements for the minimum retention period)

Describe the form(s) of the identifiable or re-identifiable data
audio-visual recordings, patient records or survey responses, untranscribed and transcribed data

What platforms or tools will you use to collect or import identifiable or re-identifiable data?
eResearch Store
OneDrive
RedCap

Where will the identifiable or re-identifiable data be stored?
eResearch Store
OneDrive
RedCap

Will you be seeking prior informed consent to publish identifiable participant data?
Yes

Will identifiable or re-identifiable data be transferred in or out of secure UTS storage (e.g. in from linkage agency, out for transcription)?
No

Will you de-identify the data?
Yes

Outline how and when (e.g. after transcription, before analysis) you will de-identify the data:
removing direct identifiers, masking, or blurring or cropping of images

Where will any link files (files that match pseudonyms/codes to identifiable information) be stored?
Link files should be stored separately from the de-identified data

– Data retention and disposal

Data retention and disposal

Minimum retention period
5 years (general research)

The data steward is:
Marilyn Cruickshank

Have you made commitments to destroy part of the data prior to end of retention period (e.g original recordings, linking/code files)?
No

When should it be destroyed?
01/01/2028

– Access and rights

Access and rights

Copyright and intellectual property owners of data created in project
Higher Degree Research Student

Please list any other owners:
None

Access after the project will be
Mediated, by permission from the data manager

Are you using any secondary or third-party data?
No
Licences or Agreements:

– Research Workspace

Research Workspace

Associated workspaces

Name	Description	Location
Marilyn Crukshank, Lin Perry, Luna Xu, Andargachew Kassa	SCREQ0099677 : Isilon Storage SMB Share (Windows/Mac/Linux) storage_size	https://uts.service-now.com/serviceconnect/?id=sc_request&is_new_order=true&table=sc_reque

Appendix VI: Conference Participation Evidence

DAY 1 - PROFESSIONAL DEVELOPMENT WORKSHOPS | WEDNESDAY 8TH NOVEMBER

12.00pm	**Arrival tea/coffee and registration open** *Riverbank foyer 5-8*		
	Workshop stream 1 *'Youth only' (Delegates aged 25 years or under)* Please join us for tips on how to make the most of the conference, connect with other young people and to share your 'Solution Generation' perspectives on how we work together to advocate for better youth health & wellbeing	**Workshop stream 2** *'Health care setting'* These sessions cover a range of contemporary adolescent health issues, with a particular focus on the response by clinicians and community health services.	**Workshop stream 3** *'Research and evaluation'* These sessions will provide inspiration and support to anyone interested in how to conduct research with young people, or to evaluate current programmed based on evidence-based principles.
Room	*Riverbank room 5*	*Riverbank room 6*	*Riverbank room 7*
12:30pm – 2.00pm	**"How to Conference" – Hacks for First Timers and Young People** *Presented by Jasmine Elliot*	**Medical Controversies in Adolescent and Young Adult Medicine: SSRIs for Depression and the increasing prevalence of Functional Diagnoses** *Presented by Simon Denny*	**Using qualitative research methods to engage young people: a workshop about innovative methods and ethics** *Presented by Cristyn Davies*
2.00pm - 3.30pm	Youth Forum	**Fundamental components of complex adolescent rehabilitation** *Presented by Payton Soussa*	**Queering Health Interventions from Ethics to Application** *Presented by Jacob Thomas*
3:30pm-4.00pm	**Afternoon tea and 'get to know AAAH'** *Riverbank foyer 5-8*		
	Workshop stream 1 *'Youth Forum'*	**Workshop stream 2** *'Health professional'*	**Workshop stream 3** *'Researcher'*
Room	*Riverbank room 5*	*Riverbank room 6*	*Riverbank room 7*
4.00pm – 5.00pm	Youth Forum	**Feedback on the proposed Youth Appropriate Care position statement for Adolescent and Young Adult services in secondary and tertiary health services** *Presented by Simon Denny*	**Transformation of research: how can we revolutionise conventional approaches of research to enable engagement of adolescents as co-researchers?** *Presented by Stephanie Patridge*

DAY 2: CONFERENCE | THURSDAY 9TH NOVEMBER

7.00am – 5.00pm	**Arrival tea/coffee and registration open** *Riverbank foyer 5-8*				
8.30am - 8.40am	**Welcome address** *Riverbank room 6 & 7*				
8.40am - 8.55am	**Welcome to Country** *Riverbank room 6 & 7*				
8.55am - 9.10am	**Minister welcome address** *Riverbank room 6 & 7*				
9.10am - 10.10am	**Imogen Kane, UN Youth Ambassador** *Riverbank room 6 & 7*				
10.10am – 10.45am	**Sector based networking** *Riverbank room 6 & 7*		**Youth networking – For delegates aged 12-25 years only** *Riverbank room 8*		
10.45am – 11.15am	**Morning tea break** *Riverbank foyer 5-8*				
	Proffered paper session 1 *'Amplifying youth voices'*	**Proffered paper session 2** *'Substance use'*	**Proffered paper session 3** *'Digital health solutions'*	**Proffered paper session 4** *'International programs & research'*	**Proffered paper session 5** *'Mental health'*
Session Chairs					
Room	*Riverbank room 2*	*Riverbank room 3*	*Riverbank room 4*	*Riverbank room 5*	*Riverbank room 6 & 7*
11.15am – 11.30am:	**Listening to learn – embedding the voice of young people in evaluation,** Dr Claire Treadgold	**A fresh perspective,** Alexandra Bell	**Role-Playing Resilience: A Positive Action Framework for Youth-led Empowerment,** Lori Fahey	**Nutritional status and its determinants among adolescents with HIV on anti-retroviral treatment in low- and middle-income countries: a systematic review and meta-analysis,** Meless Gebrie Bore	**Old People's Homes for Teens: The Role of Social Connection in promoting wellbeing of young people,** Ziyad Serhan
11.30am – 11.45am:	**Empowering the next generation of health advocates through capacity building and mentorship,** Tiana Kittos	**Platforming the voices of young people for public health advocacy,** Ciara Madigan	**Digital psychosocial assessment of adolescents at the Sydney Children's Hospital Network: A qualitative evaluation of implementation,** Dr Jane Ho	**Preferences of young men who have sex with men in Vietnam for an eHealth intervention to promote PrEP uptake,** Minh Nguyen	**Mental health conversations among South Sudanese young people in the south-east of Melbourne,** Ana Orozco
11.45am – 12.00pm:	**Chronic Conundrums: elevating the voices of young consumers with lived experiences,** Deanna Darwell	**How parents influence their teenager's vaping and smoking behaviours,** Emily Jenkinson	**The Creating Space Project: Using Participatory Video and Drama with Young People to Inform Healthcare,** Michael Neufeld	**Unraveling the Pandemic's Impact on University Students' Health, Learning Experiences, Well-being, and Resilience: Evidence from Five Studies Conducted in Five Countries with Implications for Future Actions,** Hoang Nam Tran	**Resilience or Risk? The dual impact of rurality on youth mental health,** Sarah Youngson

Appendix VII: Ethics Approval

ResearchMaster

Ethics Application

Application ID :	ETH23-7873
Application Title :	Nutrition status among adolescents living with Human Immunodeficiency Virus (HIV) on Antiretroviral Therapy (ART) follow-up living in selected region of Ethiopia: Mixed Method Study
Date of Submission :	13/02/2023
Primary Investigator :	Prof Marilyn Cruickshank (Chief Investigator)
Other Personnel :	Mr Meless Gebrie Bore (5Research Student) Prof Lin Perry (Co-Supervisor) Dr Luna Xu (Co-Supervisor) A/Prof Andargachew Kassa Biratu (Co-Supervisor)

Section 1: Ethics Portal

Select your application type

What type of application are you looking for?
Please **do not** change your application type without first consulting with the Ethics Secretariat (9514 9772).*

- (●) New application (including scope-checking for nil/negligible risk research)
- ( ) Ratification of existing approval
- ( ) Transfer of existing approval
- ( ) Evaluation of teaching and learning activities
- ( ) Amendment to existing approval
- ( ) Program approval

You have selected "new application (including scope checking for nil/negligible risk research)". This option allows you to create a new form. The system will check if your application can be approved by the Faculty or whether it requires full ethics approval by the HREC. Please click "save" before continuing.

What should I know before I start?

Would you like more information on:

- ( ) This system
- (●) The ethics process
- ( ) Purpose of the ethics review process

The ethics process

This form has a risk assessment which will help decide whether your research is nil/negligible risk or whether you will need to complete a full ethics application form. If you are unsure how to answer these questions or disagree with the outcome you can contact us by phone (02) 9514 9772 or by email the Ethics Secretariat.

Staff applications: If your research is nil/negligible risk, you will receive an email after submitting this form which will confirm this. If your research is low or high risk, it will be submitted automatically to your local research office after you click on Submit.

Student applications: Your application will first be reviewed by your supervisor. If your research is nil/negligible risk, you will receive an email after your supervisor has endorsed the application. If your research is low or high risk, it will be submitted automatically to your local research office after your supervisor has endorsed your application online.

For more information, go to our website.

What you should read when completing this form
This form should be read in conjunction with the relevant University policies and guidelines, the National Statement on Ethical Conduct in Research Involving Humans (PDF, 652Kb) and the Australian Code for the Responsible Conduct of Research (2007) (PDF, 829Kb).

Section 1A: Risk evaluation

Risk A

Determining the level of risk and review

- Please answer each question carefully **and consecutively**.
- For assistance with answering these questions please refer to the National Statement on Ethical Conduct in Human Research as per the chapters listed below.
- If you need to contact the Research Ethics Officer you can call (02) 9514 9772
- Click on the help buttons (?) for more information
- You can save your application at any time by clicking on the save button on the left hand side in the toolbar. For further information and help in completing your application go to our website.

Does your research involve:

Projects involving covert observation, active concealment, or planned deception of participants

e.g. covert observation of the hand-washing behaviour of hospital employees, undisclosed role-playing by a researcher, etc. Does NOT include observation in a public place WITHOUT the use of photographs, images, video or audio footage (Chapter 2.3, p.19)

*

○ Yes
◉ No

Targeted recruitment or analysis of data(?) from any of the groups listed below (or where any of these groups are likely to be significantly over-represented in the group being studied)

- Women who are pregnant and the human fetus (Chapter 4.1, p. 61)
- Children and young people (under 18 years) (Chapter 4.2, p. 65)
- People in dependent or unequal relationships (e.g. lecturer/student [except T&L], doctor/patient, employer/employee) (Chapter 4.3, p.68)
- People highly dependent on medical care who may be unable to give consent Chapter 4.4, p.68)
- People with a cognitive impairment, an intellectual disability, or a mental illness (may include the disadvantaged/homeless) (Chapter 4.5, p. 70)
- People who may be involved in illegal activities (including those affected e.g. victims of domestic violence) (Chapter 4.6, p.73)
- Aboriginal and Torres Strait Islander Peoples (Chapter 4.7, p.77)

*

◉ Yes
○ No

Targeted recruitment of people in / from countries that score <50 on the Corruption Perception Index (CPI) (check here)
This includes any cohorts from these countries, i.e. it is not restricted to marginalised groups within these countries*

◉ Yes
○ No

Collection, use or disclosure of personal information without consent of the participant(?)

- **a record which may include your name, address and other details about the participant (e.g. date of birth, financial information etc.)**
- **photographs, images, video or audio footage**
- **fingerprints, blood or DNA samples**

*

○ Yes
◉ No

Collection, use or disclosure of health information(?)

Collection, use or disclosure of health information(?)

- personal information that is information or an opinion about
  - the physical or mental health or a disability (at any time) of an individual; or
  - an individual's expressed wishes about the future provision of health services to him or her, or
  - a health service provided, or to be provided, to an individual or
- other personal information collected to provide, or in providing, a health service, or
- other personal information about an individual collected in connection with the donation, or intended donation, of a individual's body parts, organs, body substances, or
- other personal information that is genetic information about an individual arising from a health service provided to the individual in a form that is or could be predictive of the health (at any time) of the individual or of a genetic relative of the individual, or
- healthcare identifiers

N.B Includes information collected through physiological testing or assessment. Examples include but are not limited to EEG, EMG, BMI, blood pressure, DEXA, etc.*

◉ Yes
○ No

Collection, use or disclosure of sensitive information
Racial, ethnic information, political, religious and philosophical beliefs, sexual activity or identity, and trade union membership
*

◉ Yes
○ No

Activity that potentially infringes the privacy or professional reputation of participants, providers or organisations
e.g. observation in the workplace, collection of commercially confidential information, etc.
Commercially confidential information = Any information which is not in the public domain or publicly available, and where disclosure may undermine the economic interest or competitive position of the owner of the information (TGA adopted definition from European Medicines Agency (EMA)).

N.B. if canvassing opinion via consensus methods i.e. Delphi (?), answer "No" here
*

○ Yes
◉ No

Establishment of a register or databank of identifiable data for possible use in future research projects (Chapter 3.2, p.27) (?)

*

○ Yes
◉ No

Collection, transfer(?) and/or banking of human biospecimens.
e.g. tissue, blood, urine, sputum etc.(?)

*

○ Yes
◉ No

Any significant alteration to routine care or service provided to participants
e.g. deviation from standard care or usual practice
*

○ Yes
◉ No

Prospective assignment of human participants or groups of humans to one or more health-related interventions to evaluate the effects on health outcomes(?) (Chapter 3.14-3.17) *

○ Yes
◉ No

Potential for participants to experience harm (i.e. anything more than discomfort)(?)
e.g. physical, psychological, devaluation of personal worth, social, economic and/or legal (Chapter 2.1, p.12)
*

◉ Yes
○ No

High Risk

Section 2: Project information

Project title

We recommend you save your application regularly while editing. You can save your application at any time by clicking on the save button.
For further information and help in completing your application go to our website

Application ID (automatically generated):
ETH23-7873

Application Title:*
Nutrition status among adolescents living with Human Immunodeficiency Virus (HIV) on Antiretroviral Therapy (ART) follow-up living in selected region of Ethiopia: Mixed Method Study

Please note that the HREC is now granting a standard approval period for the research proposals.
The approval period for your project will be specified in your approval letter.
Please also note that research should not commence until ethics approval has been granted. The Committee cannot grant retrospective approval for data that has already been collected.

Ethics category code (automatically selected):*
Human

Is this a resubmission of a previous application?*
○ Yes
◉ No

Is this a pilot study? *
○ Yes
◉ No

Has a pilot study been conducted as part of this project? *
○ Yes
◉ No

Please save and continue to the next page

Please save and continue to the next page

Consultation

We recommend you save your application regularly while editing. You can save your application at any time by clicking on the save button.
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Have you undertaken any consultation in preparing this application?*

◉ Yes
○ No

Please describe*

Extensive consultation amongst the supervisory team members

Please save and continue to the next page

Section 3: Personnel

Investigators

We recommend you save your application regularly while editing. You can save your application at any time by clicking on the save button.
For further information and help in completing your application go to our website

Are there external investigators or personnel listed on this protocol?*

◉ Yes
○ No

Is this application for a student project?*

◉ Yes
○ No

Student applicants:

1. Please note that once your application is submitted it will go directly to your supervisor and not to the Committee.
2. We **strongly** recommend notifying your supervisor that you have submitted your application in case of any technical issues, to avoid potential delays in the review process.
3. Once your supervisor endorses your application it will go to your Local Research Office for endorsement before coming to the Ethics Secretariat for review.
4. Your electronic application must be endorsed by your supervisor by the Local Research Office (LRO) submission deadline.
5. Please also ensure that the Primary AOU at the end of this page is updated to your supervisor's AOU. This will show in the table under 'Internal personnel listed below', once you add them. If you need any assistance with this please contact Research.Ethics@uts.edu.au or call 9514 9772. Please note that this is particularly important if you have a dual role as a staff/student as your application could go to the wrong faculty for review through the automated process.

Positions in the personnel table

Position type:	In the personnel table use the following positions from the drop-down list:
Chief Investigator/Supervisor	1Chief Investigator (students must **not** be listed as Chief Investigator)
Co Investigator	3Assoc. Investigator
Co Supervisor	Co-Supervisor
Research Student	5Research Student
Project Administrator	7Project Administrator

Note: Further options are available in the drop down list.

Instructions on how to add a person to the personnel table:

1. Click on "Add"
2. Start typing the details (first name, last name or Staff ID) in the search bar.
3. Click on "Add selected"
4. The extra information panel will open, select their position from the drop-down list. If they are the primary contact (e.g. Chief Investigator/Supervisor), tick "Yes" under 'Primary contact' and then select "OK"

- **Student research:** Students must add their supervisors to their application and must mark their primary supervisor as a Chief Investigator and as a primary contact. Students must be listed as "5Research student" under the column 'Position' to ensure the application is properly submitted to their supervisor.
- **Ratifications/Transfers:** If this list differs from that of the original application, you must provide evidence that any additional investigators have been added via amendment to the lead/external HREC [attach relevant amendments and evidence of approval].

Internal personnel listed on this ethics protocol:*

1	Primary	No
	ID	
	Surname	Bore
	Given Name	Meless Gebrie
	Full Name	Mr Meless Gebrie Bore
	Position	5Research Student
	Type	International
	AOU	FoH.School of Nursing and Midwifery
	Managing Unit	Faculty of Health
	Email Address	MelessGebrie.Bore@student.uts.edu.au
	Work Number	
2	Primary	No
	ID	
	Surname	Perry
	Given Name	Lin
	Full Name	Prof Lin Perry
	Position	Co-Supervisor
	Type	Internal
	AOU	FoH.School of Nursing and Midwifery
	Managing Unit	Faculty of Health
	Email Address	Lin.Perry@uts.edu.au
	Work Number	5840
3	Primary	No
	ID	
	Surname	Xu
	Given Name	Luna
	Full Name	Dr Luna Xu
	Position	Co-Supervisor
	Type	Honorary
	AOU	FoH.School of Nursing and Midwifery
	Managing Unit	Faculty of Health
	Email Address	Xiaoyue.Xu@uts.edu.au
	Work Number	+61 2 95145972
4	Primary	Yes
	ID	
	Surname	Cruickshank
	Given Name	Marilyn
	Full Name	Prof Marilyn Cruickshank
	Position	Chief Investigator
	Type	Internal
	AOU	FoH.School of Nursing and Midwifery
	Managing Unit	Faculty of Health
	Email Address	Marilyn.Cruickshank@uts.edu.au
	Work Number	9382 1658

If any details are incorrect or missing please contact the Ethics Secretariat on (02) 9514 9772 or by email.

If any details are incorrect or missing please contact the Ethics Secretariat on (02) 9514 9772 or by email.

The ResearchMaster database has a very large number of external personnel so please conduct a search for them before adding them in the text box below. Please contact the Ethics Secretariat on 9514 9772 if you cannot find an external investigator through the system.

External personnel listed on this ethics protocol:
*

1	Primary	No
	ID	PER0103398
	Surname	Biratu
	Given Name	Andargachew
	Full Name	A/Prof Andargachew Kassa Biratu
	Position	Co-Supervisor
	Type	External
	AOU	
	Managing Unit	
	Email Address	
	Work Number	

Please provide additional (or preferred) contact details of any of the people listed on the project if necessary (4000 character limit)

(1) Meless Gebrie Bore,
Address: College of Medicine and Health Science, Hawassa University, Hawassa, Ethiopia; and Faculty of Health, University of Technology Sydney;
Email: MelessGebrie.Bore@student.uts.edu.au or [redacted]@gmail.com
Tel: +61[redacted]
(2) Professor Marilyn Cruikshank,
Address: Faculty of Health, University of Technology Sydney, Ultimo, Australia; and Sydney Children's Hospitals Network
Email: Marilyn.Cruickshank@uts.edu.au
Tel: +61[redacted]
(2) Professor Lin Perry,
Address: Faculty of Health, University of Technology Sydney, Ultimo, Australia; and Prince of Wales Hospital, Randwick, NSW, Australia;
Email: lin.perry@uts.edu.au; Tel: +61[redacted]
(3) Xiaoyue Xu,
Address: School of Population Health, Faculty of Medicine, University of New South Wales, NSW, Australia
Email: luna.xu@unsw.edu.au
Tel: +61295 145 972
(4) Andargachew Kassa, Hawassa University, College of Medicine and Health Science, Hawassa, Ethiopia;
Email: andkassa@hu.edu.et; Tel:+251-911-338895

Please provide details of any formal qualifications (REF NS 1.1(e)) of each person listed on the project (4000 character limit)*

Formal Qualification:
1. Meless Gebrie Bore - Nutritionist, RN, Community development and leadership, PhD student in Health
2. Professor Marilyn Cruickshank - RN, PhD FACN, FACIPC
- Professor of Nursing – Research
3. Professor Lin Perry - RN, MSc, PhD
- Professor of Nursing Research and Practice Development,
4. Dr Luna Xu - RN, MSc, MPH, PhD,
- Lecturer at UNSW Sydney, Australia
5. A. Professor Andargachew Kasa - RN, MSc, PhD
- Associate professor in Health Studies at Hawassa University

Please outline the experience of each person listed on this project relevant to this application (4000 character limit)*

Experience:
1) Meless Gebrie Bore
- More than 12 years experience in clinical, academic and research
2) Professor Marilyn Cruikshank
- Ample experience in research in clinical area and also pediatric nurse with more than 10 years of clinical experience; and 15 years in safety and quality, including more than 10 years' experience in infectious diseases
3) Professor Lin Perry
- An implementation scientist with more than two decades experience of clinical research in nutrition and management of chronic disease.

4) Dr Luna Xu

5) Associate Professor Andargachew Kassa
- More than 15 years work experience in Nursing, Midwifery, Reproductive health, academic, and research

Primary AOU*

FoH.School of Nursing and Midwifery

Managing Unit

Faculty of Health

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Student details

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For further information and help in completing your application go to our website

Degree being undertaken (500 character limit)*

PhD in Health

Have you been successful in your doctoral/masters assessment? *

- (•) Yes
- ( ) No

Please make sure you attach a copy of your Stage 1 confirmation (or the stage 1 panel's report) in the attachments section.

Students, please read carefully: Once you have completed this application and followed the submission instructions, your application will go to your supervisor for review. Once your supervisor has reviewed and endorsed your application it will come to the Ethics Secretariat for a pre-review. This pre-review process helps ensure that your application is complete, has all necessary attachments, and that the quality of responses to the questions meets the Committee's expectations. Your application should therefore be submitted as early as possible. If you do not submit your application in time, it may be delayed and held off until the next closing date.

Section 4: Funding and Disclosure of interests

Funding details

We recommend you save your application regularly while editing. You can save your application at any time by clicking on the save button.
For further information and help in completing your application go to our website

Have you received funding in relation to this research?*

- ( ) Yes
- (•) No

Do you intend to apply for funding in the future?*

- ( ) Yes
- (•) No

Please save and continue to the next page

Disclosure of Interests

We recommend you save your application regularly while editing. You can save your application at any time by clicking on the save button.
For further information and help in completing your application go to our website

Do any members of the research team (including persons not listed in this application), have any financial or non-financial interests related to this research?*

- ( ) Yes
- (•) No

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Section 5: Methodology

Description

We recommend you save your application regularly while editing. You can save your application at any time by clicking on the save button.
For further information and help in completing your application go to our website

The purpose of this section is to place your research in context for the HREC and demonstrate your ability to conduct the research. The HREC may only approve research which is methodologically sound. Remember to use simple language that can be understood by people from a variety of backgrounds. Avoid jargon and acronyms.

What are the hypotheses/goals/aims/objectives of your research? Please include a brief description using plain English explaining your research aims (approximately 100 words) (4000 character limit)*

The rationale for this study is as follows:
1. Given the high prevalence of HIV in the Addis Ababa and Oromia regions of Ethiopia, conducting an in-depth analysis of the nutrition assessment and support given to adolescents living with HIV will be crucial to improve nutritional care and support in HIV care settings in these study regions and to inform national policies in Ethiopia.
2. The research literature review has identified a gap in relation to information to guide adolescent nutritional screening, care, and support programs in HIV care settings, and factors that affect the effectiveness of nutritional programs for the improvement of nutritional and health outcomes in resource-poor settings.
3. Limited research has examined adolescent nutrition and nutritional programs in HIV care in Ethiopia.
4. Real-world programmatic evidence evaluating the multifaceted challenges of nutritional care and support programs in HIV care settings in addition to clinical care is lacking and needed to guide future policies and programs to ensure optimal nutrition and health outcomes for adolescents living with HIV.
5. No previous study has been identified that sought the perspectives of program stakeholders about the barriers and facilitators of the utilization of adolescent nutritional care and support programs in HIV care settings in Ethiopia.
6. Evidence related to the programmatic health system and sociocultural factors challenging nutritional care and support programs in HIV care is lacking.

To address these research gap, the following research objectives will be answered by this research:
1. To determine the methods by which nutritional status is assessed, and counseling and any other nutritional support practices are planned and delivered for adolescents living with HIV on ART follow-up by health workers in ART units in selected regions of Ethiopia. This objective seeks to describe the nutrition-related assessment and support practices of health workers for adolescents living with HIV on ART follow-up.
2. To assess the level of nutritional status of adolescents living with HIV on ART follow-up in selected regions of Ethiopia. This objective seeks to demonstrate the level of undernutrition and over-nutrition in these young people
3. To identify determinant factors for the nutritional status of adolescents living with HIV on ART follow-up living in selected regions of Ethiopia. This objective seeks to identify those factors or variables shown to be significant influences on the nutritional status of adolescents living with HIV on ART in selected regions of Ethiopia.
4. To determine the level of food consumption, dietary patterns, and eating habits of Adolescents living with HIV on ART follow-up in order to compare their energy, protein, and nutrient intake with WHO/FAO standard minimum requirements. This objective seeks to identify the adequacy and the level of any inadequacy of energy, protein, and nutrient consumption in these young people.

Note: Clinical Trials, Recruitment of Participants and Data Collection are dealt with later in the application so you do not need to describe them in detail below

Please provide a brief description of the research design including research questions and proposed methods for conducting the research (approximately 250 words) (4000 character limit)*

The research questions of this study are:

Sub-study 1: For Health professional working in ART clinic
- What are the nutritional assessments, counselling, and management practices for adolescents living with HIV among health workers? What are the effects of this on the nutritional status of adolescents living with HIV/AIDS on ART follow-up?

Sub-study 2: For adolescents living with HIV on ART Follow-up
- What is the level of nutritional status of adolescents living with HIV on ART follow-up living in the selected regions of Ethiopia?
- What are the determinant factors associated with the nutritional status of adolescents living with HIV on ART follow-up living in the selected regions of Ethiopia?
- What is the level of food consumption, dietary pattern, and eating habits of adolescents living with HIV in relation to the recommended levels of energy and nutrient intake from the WHO/FAO?

This research uses mixed method study design comprising two prospective sub-studies which entail a dominant quantitative descriptive study and a small qualitative inquiry.

To address these research questions, two sub-studies will be conducted.

Sub-study 1 (For Health Professionals): This sub-study will determine the methods by which nutritional status is assessed, and counselling and any other nutritional support practices are planned and delivered for adolescents living with HIV on ART follow-up by health workers in ART units in selected regions of Ethiopia (addressing a research question and objective 1). This sub-study will use a survey design with predominantly quantitative and a small-scale qualitative component.

Sub-study 2 (For Adolescent living with HIV): This sub-study will assess the level of nutritional status, food and eating practices, and determinant factors for the nutritional status of adolescents living with HIV on ART follow-up in selected regions of Ethiopia (addressing research questions and objectives 2, 3, and 4). This sub-study will use a survey design with a predominantly quantitative component supplemented by clinical assessments and extraction of clinical data from health records, and a small-scale qualitative component.

What do you hope the outcome(s) of this research will be? (4000 character limit)*

The outcome of this research will be:

Sub-Study 1: For Health Professionals working in ART Clinics
Determination of the methods that are used by health professionals to assess the nutritional status, conduct counselling, and manage nutritional-related problems of adolescents who are HIV positive on ART follow-up living in the selected region of Ethiopia; and description of the effects of these practices on the nutritional status of adolescents living with HIV while on ART follow-up.

Sub-study 2: For Adolescents Living With HIV on ART Follow-up
Demonstration of the level of nutritional status of adolescents living with HIV on ART follow-up living in the selected regions of Ethiopia
Identification of the determinant factors associated with the nutritional status of adolescents living with HIV on ART follow-up living in the selected regions of Ethiopia
Identification of the level of food consumption, dietary pattern, and eating habits of adolescents living with HIV in relation to the recommended levels of energy and nutrient intake from the WHO/FAO

Who do you think will benefit from this research? (4000 character limit)*

The health and nutritional needs of young adolescents are high among those living with HIV, adding to the common health vulnerabilities of all adolescents. The nutritional status of adolescents, both with and without HIV, is increasingly recognized as a key driver of health and well-being for the next generation. While adequate nutrition can help delay HIV disease progression, improving the diet and hence nutritional status in a group who are rarely a priority for nutrition interventions, is a challenge for policymakers, service providers, and caregivers.

Therefore, the benefits of this research are as follows:
• The research will benefit health professionals by providing information to indicate the level of nutritional assessment, counseling, care, and management practices that are provided for adolescents living with HIV while on ART. It will provide evidence on the areas of good performance and poor performance. As a result, health professionals will have a better understanding of their current practice affording them the chance to come up with quality improvements for services provided to adolescents living with HIV during ART follow-up.
• Health professionals will be provided with information about the magnitude of undernutrition among adolescents living with HIV; the dietary practices of adolescents living with HIV on ART follow-up and their energy, protein, and fat intake as compared to WHO recommendation standards. This will enable them to better understand the nutritional situation of this patient group and enable them to develop locally tailored and age-appropriate nutritional support services for adolescents living with HIV during ART follow-up.
• Similarly, Local Health Bureaus will benefit from the same information in relation to details of nutrition support services and outcomes for adolescents living with HIV during ART follow-up. This will inform Health Bureaus and enable them to develop evidence and data-based strategies to strengthen adolescent youth-friendly services and reduce the magnitude of undernutrition among adolescents with HIV.
• Dietary outcome data will be useful for future HIV-positive adolescent patients if we can improve nutritional status based on the data identified in this research. This might allow them to take on more active roles in their communities, which would benefit families and communities more broadly.

Please provide a brief description of the significance of your research (approximately 100 words)
(4000 character limit)*

This study helps to address substantial evidence gaps, and the knowledge generated by this study is anticipated to be clinically relevant and directly applicable.
- The findings from the study will inform service delivery for all adolescents with HIV on ART follow-up and the clinicians who provide care for them about their level of nutritional status, and this information will support the development of treatment plans and healthy choices for healthy living with the disease lifelong and sustain the life cycle of adolescent health.
- The findings of the study will encourage government and non-governmental organizations to prioritize future integrative nutrition policy and program goals in addition to routine clinical care to reduce adolescent undernutrition.
- The study finding will help to offer direction / recommendation for policymakers, managers, implementers, researchers for improvements of future policy, implementation strategies, and conducting research in support of adolescent nutrition in Ethiopia, with an emphasis on adolescent living with HIV.

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Literature review & references

We recommend you save your application regularly while editing. You can save your application at any time by clicking on the save button.
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Please give a brief literature review. The aim is to explain how your research fits
into the context of other research in the area (REF NS 1.1(c)) (4000 character limit with spaces)
Please note that you cannot paste links into the online form
*

Adolescents (defined as those aged 10 to 19 years (WHO, 2014)) account for 16% of the global population, totalling 1.3 billion adolescents. More than half of all young people live in Asia, but sub-Saharan Africa is the region where this age group comprises the largest percentage of the population, accounting for 23%(UN, 2019; UNICEF, 2021). Ethiopia has an even higher percentage of young people, with one-third of the population (33.7%) aged between 10 and 24 years. This phenomenon is often referred to as the youth bulge(EPHI, 2020). More than 1.5 million adolescents and young adults aged 10 -24 years die each year, nearly 5000 every day, from largely preventable causes; three-fourths occur in LMICs (WHO, 2022). One of the leading causes of preventable deaths is HIV which is also responsible for disability, morbidity, and mortality among adolescents and young people, who increasingly also report depression, stigma, violence, and suicidal behaviour(UN, 2019; UNICEF, 2021; WHO, 2022).

Adolescents are disproportionately affected by HIV(UNICEF, 2021; WHO, 2014) due to a combination of children infected perinatally now reaching adolescence, and adolescents newly infected due to factors such as risky sexual behaviors. Adolescents living with HIV are vulnerable to undernutrition secondary to elevated nutritional needs imposed by a growth spurt and HIV infection. Malnutrition is a major threat to the health of HIV-infected individuals and is associated with increased risks of morbidity and mortality(Naswa & Marfatia, 2010). The increase in HIV-related deaths among young people is primarily due to several factors including the low priority of young people in HIV programmes, inadequate provision of accessible and acceptable HIV testing and counselling and treatment services, and lack of support for adolescents to remain in care and adhere to antiretroviral therapy (ART)(WHO, 2013). The health and nutritional needs of younger adolescents are higher in HIV infected individuals, which poses additional challenges on top of the broader health vulnerabilities of all adolescents(Ahinkorah et al., 2021). The focus of this study is to assess the nutritional status, food and eating practice, and determinant factors among adolescents living with HIV (ALHIV) on ART follow-up in Ethiopia.

Please list the references only used in the literature review and cited in your application
NOTE: Do not include references you have not used in this application (4000 character limit)
*

Ahinkorah, B. O., Kang, M., Perry, L., Brooks, F., & Hayen, A. (2021). Prevalence of first adolescent pregnancy and its associated factors in sub-Saharan Africa: A multi-country analysis. PLoS One, 16(2), e0246308. https://doi.org/10.1371/journal.pone.0246308

Ethiopian Public Health Institute [EPHI]. (2020). Ethiopia Population-based HIV Impact Assessment (EPHIA) 2017-2018: Final Report. W. H. Organization.

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Krueger, R. A., & Casey, M. A. (2000). Focus groups: A practical guide for applied research (3rd ed.). Thousand Oaks, CA: Sage.

Ministry of Health [MOH]. (2021). Health and health-related indicators. http//www/.moh.gov.et

Naswa, S., & Marfatia, Y. (2010). Adolescent HIV/AIDS: Issues and challenges [Review Article]. Indian Journal of Sexually Transmitted Diseases and AIDS, 31(1), 1-10. https://doi.org/10.4103/0253-7184.68993

United Nation [UN]. (2019). World population prospects 2019. Department of Economic and Social Affairs. World Population Prospects, 1-23. United Nations International Children's Emergency Fund [UNICEF]. (2021). HIV and AIDS in adolescents. https://data.unicef.org/topic/adolescents/hiv-aids/#resource

UNICEF. (2013). Improved child nutrition: The achievable Imperative for Global Progress.

World Health Organization [WHO]. (2013). HIV and adolescents: Guidance for HIV testing and counseling and care for adolescents living with HIV: recommendations for a public health approach and considerations for policy-makers and managers.

WHO. (2014). Health for the world's adolescents: a second chance in the second decade: summary. https://apps.who.int/iris/handle/10665/112750

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Methods and methodologies

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In order to consider your research, the HREC will need to know what it will involve for your participants (REF NS 3.1)

What kinds of methods and methodologies will you use in your research? (More than one box may be checked)*

- ☑ Quantitative
- ☑ Qualitative

Does your research involve collection and/or use of secondary data? (e.g. existing / routinely collected data etc.)*

- ◉ Yes
- ○ No

Please provide a description of the secondary data source(s) below*

Sub-study 1: For Health professionals
- The researcher will not use secondary data for this sub study

Sub-study 2: For Adolescents living with HIV on ART follow-up
- The researcher will use secondary data from Health Management Information System (HMIS), ART Follow-up Registration book and patient card /records of the research sites.

The data to be collected from health records are:
(1) health-related (Medical History) factors: time / duration since diagnosis as HIV positive, partner status, initial and current CD4 status, recent viral load, clinical stage pre-ART, current clinical stage, history of any opportunistic or chronic infection, history of any illness during the last 3 months, types of ART prescribed, time/ duration enrolled on ART.; and
(2) Clinical related variables include co-morbid disease, infective complications, haematological / biochemical test values including, where available, Haemoglobin, Creatinine, Urea, Protein (Total protein, C-Reactive Protein, Albumin), glucose, and Immune marker (WBC, Total lymphocyte, and Differential WBC count).

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Quantitative

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Section 1: Quantitative Methodologies*

- ☐ Experimental
- ☐ Quasi-experimental
- ☐ Correlational research
- ☑ Survey Design
- ☐ Meta analysis
- ☐ Other *(Please describe below)

Section 2: Quantitative methods*

- ☑ Written survey
- ☐ Online survey/research
- ☐ Pre-post/testing
- ☐ Telephone survey
- ☑ Questionnaires
- ☑ Access to records
- ☐ Clinical trial
- ☑ Statistical analysis
- ☐ Content analysis
- ☑ Physiological testing/assessment
- ☐ Other* (please describe below)

What **quantitative** methodology and methods will you be using in this research? More than one box may be checked.

Please save and continue to the next page

Qualitative

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What **qualitative** methodology and methods will be using in this research?

Section 1: Qualitative methodology*

- ☐ Auto-ethnography
- ☐ Historical research
- ☐ Action research
- ☑ Narrative enquiry
- ☐ Biographical research
- ☐ Case study
- ☐ Phenomenology
- ☐ Indigenous research paradigm
- ☐ Discourse analysis
- ☐ Grounded theory
- ☐ Other *(Please describe below)

Section 2: Qualitative methods*

- ☐ Participants observation
- ☐ Covert observation
- ☐ On-line research
- ☐ Psychological testing/assessment
- ☐ Verbal protocol
- ☐ Journaling
- ☐ Artifact analysis
- ☐ Document/Policy analysis
- ☐ Access to records
- ☑ Audio/video recording
- ☐ Life story or oral history

- ☑ Focus groups
- ☑ Structured interviews
- ☑ Semi-structured interviews
- ☐ Unstructured interviews
- ☐ Other * (Please describe below)

Please describe how focus groups will be conducted, including how many focus groups, how many participants will be involved (from each participant group if there is more than one group/cohort), the amount of time required of participants for this, whether it will be recorded, and any other information applicable (4000 character limit)*

Sub-study 2: Adolescent and young adults (16 years and older) living with HIV on ART Follow-up

In this sub-study, adolescents aged 16 and older will be invited to take part in the survey and additionally invited based on their willingness and opt to take part in a FGD.

In this study, a total of 1 - 2 Focus Group Discussion per selected study site will be conducted. Each will entail:
- 2 moderators (one for facilitating the FGD and the other to observe and record all non-verbal communication),
- 6 - 10 study participants per focus group,
- 40 - 60 minute duration, extended to a maximum of 90 minutes with the participant's agreement
- Audio recording of the focus group
- A sequenced list of questions used as an interviewer guide

Please describe how interviews will be conducted, including how many participants will be involved (from each participant group if there is more than one group/cohort), the amount of time required of participants for this, whether it will be recorded, and any other information applicable (4000 character limit)*

Sub-study 2: For Adolescent and young adults (16 years and older) living with HIV on ART Follow-up

In this sub-study, adolescents aged 16 and older will be invited to take part in the survey and additionally invited based on their willingness and opt to take part in an in-depth interview.

In this study, up to 30 one-to-one in-depth interviews will be conducted, with the number of interviews determined by the point at which information saturation is achieved.

While conducting the interview, the following ground rule will be maintained:
- a series of sequenced questions will be used as an interviewer guide
- Time taken per interview will be 40 - 60 minutes, extended to a maximum of 90 minutes with participants' agreement.
- Interviews will be taken place in a safe, confidential, and distraction-free place/environment
- Audio recording will be done with the participant's consent
- The interview will be taken by one facilitator (who facilitates the interview, observe non-verbal communication, and monitor the audio record), but the facilitator will be changed based on the adolescent gender, if the participants are female, women facilitator will be used.

Please describe how audio/video recording will be used in the research, including how many participants will be involved (from each participant group if there is more than one group/cohort), the amount of time required of participants for this, whether it will be recorded, and any other information applicable (4000 character limit)*

In addition to a survey (offered to all adolescents), adolescents aged 16 -19 years may be invited to take part in either a focus group discussion or an individual interview. In total, 6 - 10 study participants per site will be invited to take part in a focus group and up to 30 study participants will be interviewed. Both focus groups and interviews will run for 30 – 60 minute duration, extending to a maximum of 90 minutes with the participants' agreement. The voice recording in this study, of focus group discussions and one-on-one in-depth interviews, will use a Sony digital audio/voice recorder. Before recording the focus group discussions and the interviews, the researcher/ interviewer will give a thorough explanation of the research goals, procedures (including ground rules for focus group discussions), confidentiality, storage, and who will have access to the recorded information.

Section 6: Research participants/subjects part 1

Participant involvement

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What time commitment will the research involve for your participants?
NOTE: This information must be included in any information to participants
(4000 character limit)*

In this study, the study participant involvement and data collection timing are based on each sub-study's specific objectives, the target population, and their accessibility.

In sub-study one:
- All health professionals and staffs who are working in the ART unit/clinic in the selected hospitals are the target participants of this survey sub-study.
The survey data will be collected during the clinic hours (8:30 AM - 5:00 PM) when they come for their routine work. The data collection process for each participant will take 30 – 60 minutes, extended to a maximum of 90 minutes with participants' agreement.

Sub-study two:
- Participants are all adolescents living with HIV who are attending ART follow-ups in selected hospitals. This sub-study has three specific objectives and the data collection time depends on the type of data to be collected based on the specific objective. The type of data collected will vary based on age category. All adolescents aged 10-19 years living with HIV in ART follow-up will be invited to participate in the survey study. Adolescents aged 16 years and older with HIV may also be invited to take part in either a FGD or an in-depth interview, according to their preference.

The data will be collected during the clinic hours (8:30 AM - 5:00 PM) when participants come for their ART follow-up. The data collection process for each participant will take 30 – 60 minutes for each component, i.e. 30 - 60 minutes for the quantitative survey component, and another 30 - 60 minutes for the small-scale qualitative component (FGD or in-depth interview), if they opt to take part; each can be extended to a maximum of 90 minutes, with participants' agreement.

In what location will the research/data collection take place?
NOTE: This information must be included in any information to participants
(4000 character limit)*

Addis Ababa and Oromia have 13 and 29 hospitals, respectively, that provide ART services. With permission of the Regional Health Departments, these hospitals will be invited to participate in this study. Of those that agree, 10 hospitals will be randomly selected. The data collection will be conducted in the ART units of these 10 randomly selected Hospitals of Addis Ababa and Oromia Region in a quiet room in the clinic after participants ART follow-up clinic sessions has been completed.

What travel, if any, does the research involve for your participants?
NOTE: This information must be included in any information to participants
(4000 character limit)*

In sub-study 1: All healthcare professionals and staffs will be surveyed during their work days at their workplace and therefore no travel will be required.

In sub-study 2: All selected Children and adolescents aged 10-19 years will be surveyed and all adolescents and young adults aged 16 years and above will additionally be interviewed or involved in FGD during their regular ART followup. Therefore, no additional travel will be required.

Please include any additional information relating to participants that you think relevant
NOTE: This information must be included in any information to participants
(4000 character limit)*

None

Describe and justify any benefit, payment or compensation the participants will receive. For research being conducted with Aboriginal and Torres Strait Islander People, the described benefits from research should have been discussed with and agreed to by the Aboriginal or Torres Strait Islander research stakeholders. (REF NS 2.1) and 4.7.8 & 4.7.9)
(4000 character limit)*

The researcher will not give any payment or compensation for participation in the study.

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Recruitment of participants

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In line with the National Statement, the definition of participants includes not only those humans who are the primary focus of the research but also those who will be affected by the research. The HREC regards the principle of respect for persons as of paramount importance. (REF NS 1.1 (d), 1.6-1.9, 1.10, 2.1).

How will you initially select and contact your participants? More than one box may be checked, if appropriate*

- ☐ Advertisement/flyer
- ☐ E-mail
- ☐ Telephone
- ☐ Internet
- ☑ Organisation
- ☐ Personal contact
- ☐ Letter
- ☐ Other contact method to be used

Outline how you will obtain participants' contact details*

The researcher will first obtain a permission support letter from the local health office and selected hospital administrators of the 10 purposively selected regional health departments (Addis Ababa and Oromia) before requesting the contact information from hospital administration.

Based on the sub-study's target populations, participant contact details will be obtained with the help of a research assistant.

Sub-study 1: For Health professionals working in ART clinic
- Health professionals who work in ART clinics at chosen hospitals are the target populations. The research assistant will obtain their contact information from the human resource department and/or ART department by presenting a letter of permission and support.

Sub-study 2: Adolescents living with HIV on ART follow-up
- Adolescents living with HIV on ART follow-up at selected regional hospitals are the target population.

The researcher will obtain all study participant's details from the selected hospitals of the ART unit by reviewing the ART registration book with the help of the research assistant after securing permission support letters and randomly selecting 10 hospital of both regions.

Please describe your recruitment plan/strategy*

This study has two sub-studies and two target groups, i.e. Health professionals working in ART Unit for at least 3 months and all adolescents, 10 - 19 years living with HIV on ART Follow-up.
The researcher will use the following recruitment strategies for each sub-study and population.
- For both sub-studies:
1. Secure Ethical approval from UTS-HREC, Addis Ababa & Oromia Regional Health HREC and/or Hawassa University IRB
2. Secure a support letter from Hawassa University written to selected hospitals and asking for cooperation of the hospital administrators
At each randomly selected hospital research site:
- For sub-study one: Recruiting health professional working in ART clinic
• The researcher will request contact information of health professionals working in ART clinic from the hospital administration. The researcher will seek a representative sample of health professionals who are currently working for at least 3 months in the ART units of the selected hospitals of the Addis Ababa and Oromia regions. The research assistant will first ask the ART department head how many health professionals are currently working in the hospital before conducting the actual sampling. Since there aren't many health professionals who work in ART units, all eligible health professionals will be invited to take part in the study using a purposive sampling strategy. To recruit each sample of health professionals, the research assistant meets the staff at the beginning of each shift and asks if anyone is interested to take part. It is anticipated that between 40 and 60 healthcare professionals will be invited to take part in the study.
- For sub-study two: Adolescents living with HIV on ART follow-up
(1) For the quantitative survey study
A total of 10 hospitals (5 in each region) will be randomly selected based on the minimum number of adolescent patients with HIV currently receiving ART follow-up and comprehensive service provision (i.e., medical, nursing, and nutrition service) with the permission of the hospital administrators and their ART unit head. After securing permissions, the number of adolescents with HIV will be determined by the research assistant and a sampling frame will be prepared in each selected hospital. Based on the sampling frame and consideration of probability proportional allocation per sample size required (PPS), the study participants will be recruited by using a Simple random technique. Therefore, the researcher will recruit a total of 384 study participants for the survey. The Researcher / RA meet selected adolescents after their ART follow-up and ask them if they are interested to take part. From this sample, 10% of the calculated sample size of 384 will be chosen by simple random sampling and invited to take part in 24 hours recall dietary assessment. There is no mention here of contacting and getting consent from parents/ guardians of adolescents aged 10–15 years, as well as the assent of the adolescents of that age group.
(2) For the qualitative study
Up to 30 one-to-one in-depth interviews and 1 - 2 FGD per selected site will be held. Participants will be recruited using a purposive sampling technique targeting adolescents with HIV on ART follow-up care.
Adolescents aged 16 and older will be invited and recruited to take part in the survey, and additionally invited and recruited for an interview or a FGD. The information saturation determines the appropriate number of participants for an in-depth interview. The minimum anticipated sample size for an in-depth interview is 10–12 study participants; however, if data saturation is not achieved at this point, the sample size may increase up to 30 study participants.

The researcher will select and recruit study participants who have the ability and sufficient local language skills to understand and provide detailed information, and those participants who have had at least 6 months of ART follow-up and who consent/assent to participate.

How many participants do you intend to recruit? (If you are intending to recruit different groups of participants, please answer all relevant questions for each group, e.g. control group, test group, etc)
(4000 character limit)*

This study has two sub-studies and four objectives, the number of study participants planned to be recruited depends on sub-study and specific objectives.

For sub-study one: Health professionals working in ART clinic
- Since a relatively small number of health professionals work in these ART units, i.e. an estimated number of 4 - 6 health professional per each hospital, all health professionals working in these units will be invited in the study. Therefore, it is estimated that a total of 40 to 60 health professionals working in the 10 hospital ART units of these regions (i.e., five in each health facility) will be eligible and invited to participate.

For Sub-study Two: Adolescents living with HIV on ART follow-up
- For the quantitative survey component, the researcher will recruit 384 participants to address objective three, with 10% of these participants also invited to address objective four.
- For the qualitative components of objectives 3 and 4, the researcher will recruit up to 30 participants for one-on-one in-depth interviews. The minimum anticipated sample size for an in-depth
interview is usually around 10 - 12 study participants, but recruitment will continue to data saturation up to a maximum of 30 study participants. Similarly, for 1 – 2 FGD per site, the researcher will recruit 6 - 12 participants per focus group, i.e., 60 – 120 study participants per all FGD.

Explain how and why you have chosen this number. If the research is quantitative, explain the power calculations; if the research is qualitative, explain why the proposed number is likely to result in adequate data based on evidence/literature. For guidance, check our Fact Sheets.*

In this study, the number of participants varies according to the sub-study and specific objectives.
A. For Quantitative study components:
For sub-study one: Health professional working in ART clinic
Since a relatively small number of health professionals work in these ART units, all health professionals working in these units will be included in the study using a purposive sampling technique. It is estimated that a total of 40 to 60 health professionals invited to participate.

For sub-study Two: Adolescents living with HIV on ART follow-up
The number of study participants was determined by using a single population formula (for specific objective 2 and 4) and double population formula (for specific objective 3).
(1) For specific objective 2, sample size was calculated using a single population proportion formula with the assumption of 5% marginal error (d) and confidence interval of 95% (Z α/2= 1.96) based on the estimated proportion of 33.1% with undernutrition seen in the study by Shiferaw and Gebremedhin in 2020 in southern Ethiopia(Shiferaw & Gebremedhin, 2020). Based on these assumptions, the calculated sample size was: 340.
(2) For specific objective 3, sample size was based on variables shown to be significant using unmatched cohort and cross-sectional studies which have determined predictors of undernutrition. It was calculated using the two-population proportion formula, based on the following assumptions: type one error of 5%, power of 80%, and 1:1 ratio of exposed to non-exposed and taking the adjusted odds ratio and percent of an unexposed group from previous studies(Sewale et al., 2018; Shiferaw & Gebremedhin, 2020; Yasuoka et al., 2020). Applying these assumptions and the sample size will be calculated using Epi Info version 7 software based on each significant variables of each article indicated as follows: sex (n=196), Opportunistic Infections(n=106) and dietary diversity (n=292)(Sewale et al., 2018); social support(n=148) and meal skipping (n=352)(Shiferaw & Gebremedhin, 2020); disclosure of HIV(n=346) and sex (n=66) (Yasuoka et al., 2020). The selected sample size for this objective is the largest sample size of meal skipping: 352.
(3) For objective 4 sample size was calculated using a single population proportion formula with assumptions of 5% marginal error (d) and confidence interval of 95% (Z α/2= 1.96) based on the estimated proportion 50% since there have been no prior similar studies. Based on these assumptions, the required sample size was 384.

Lastly, we selected the largest sample size for the study: 384. The researcher will use a sub-sample for specific objective 4, i.e., 10% of the selected sample size rather of using total calculated sample size, because of the resource constraint to collect 24 hour dietary recall data, and difficulty of analysis of 24 hour recall data to generate the level of energy, protein and fat intake and compared with WHO recommendation.

B. For qualitative study component
In this study, only two objectives require qualitative study components. Since the study is quantitative dominant mixed study, the researcher will incorporate qualitative components for the explanatory and exploratory purpose of the study. Likewise, because of logistic constraint, the researchers will recruit up to 30 study participants for one-on-one in-depth interview based on purposive sampling for specific objective three. The minimum anticipated sample size for an in-depth interview is 10 -12 study participants, but if data saturation is not achieved, it will extend up to 30 study participants. Likewise, 6 -12 study participants per focus group will be used for specific objective four according to the recommendation of Krueger, R. A., & Casey, M. A. (2000). Only 1- 2 focus groups per selected site will be conducted for these studies, to do this 60 - 120 study participants will be invited to participate in the focus group.

Describe your inclusion and exclusion criteria for participants*

The inclusion and exclusion criteria vary according to the sub-study components.

For sub-study one: Health professional working in ART clinic
- The study includes all Health Professional currently working in ART units of selected hospitals of the selected regions for the last three-month duration and who will consent to participate in the study.

For sub-study Two: Adolescents living with HIV on ART follow-up
- Sub-study 2 will randomly sample adolescents living with HIV (aged 10 -19 years) on ART and attending the selected hospitals' ART units in Addis Ababa and Oromia regions of Ethiopia.

Inclusion criteria: Adolescents aged 10 to 19 years with HIV on ART and attending ART units of hospitals in the Addis Ababa and Oromia regions for a minimum of 6 months.

Exclusion criteria: Adolescents only recently aware of their HIV status and enrolled in ART follow-up service for less than 6 months; adolescents with any cognitive or communication deficits;
adolescents under the age of 16 years when parental or guardian consent cannot be obtained;
adolescents without a medical registration number (MRN) or unique ART number or able to supply name and date of birth will be excluded due to the difficulty of reconciling data sources.

Please save and continue to the next page

Consent

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For further information and help in completing your application go to our website

Will you be obtaining written consent?*

- (●) Yes
- ( ) No

Please provide sample documents in attachments list at the end of the application form
Please use the following HREC templates when creating an information sheet and consent form: HREC templates

Do you believe there will be any special issues relating to consent in your research? (REF NS 1.13, 2.2, 2.3, Chapter 4)*

- ( ) Yes
- (●) No

Are the participants able to consent fully? (REF NS Chapter 2, 4.4, 4.5)*

- (●) Yes
- ( ) No

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Limited disclosure

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Does this research involve limited disclosure to participants? (REF NS 2.3)*

- ○ Yes
- ◉ No

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Ethical considerations specific to participants

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Indicate if your research will involve the following populations (as per the National Statement) other than as incidental participants (i.e. they are not included in the design of the project but may be participants) (REF NS Chapter 4)
*

- ☐ Women who are pregnant and the human foetus
- ☑ Children and young people
- ☐ People in dependent or unequal relationships
- ☐ People highly dependent upon medical care who may be unable to give consent
- ☐ People with a cognitive impairment, an intellectual disability or a mental illness
- ☐ People who may be involved in illegal activities
- ☐ People who are incarcerated
- ☐ Aboriginal and Torres Strait Islander Peoples
- ☑ People in other countries
- ☐ None of the above

Describe how you will respect the ethical considerations specific to your participants, in accordance with Chapter 4 of the National Statement (4000 character limit)*

To ensure that research adheres to all ethical principles, ethical approval for the research will be required by the Regional Health Service Ethics Review Committee in Ethiopia and University of Hawassa Ethics Review Committee and the Human Research Ethics Committee at the University of Technology Sydney in Australia. Authorization to conduct the study will be sought from the Regional Health Department and from the management of all included health facilities.

Sub-study 1: Health Professionals working ART clinic
- Informed consent will be obtained with respect to the autonomy of the participants. Participants will be informed of the purpose of the study, its procedures, and potential risks. Consent will be recorded on the consent form.

Sub study 2: Adolescents living with HIV on ART follow-up
- For Adolescents and young adult living with HIV age 16 years and above, informed consent will be obtained to respect the autonomy of the participants. Participants will be informed of the purpose of the study, its procedures, and potential risks. Consent will be recorded on the consent form.

- For Adolescents living with HIV aged <16 years, we will seek the assent of their adult partner (if married) or parents / guardians for the adolescent to participate in the study, as well as seeking the informed assent of the young person.

- Participants who are illiterate can either supply witnessed verbal consent or, with a witness, can -- make their mark on the consent form. Participants who are <16 years can supply witnessed verbal assent. All participants will be informed that they have the right to refuse participation without consequences and without giving any reason.

Participants will be assured of confidentiality and privacy, which will apply throughout the study.
Data will be collected using study codes to respect the confidentiality of the participants. No participant's name will be identified in the study material. Respondents will be assured that the information will not be provided to third parties. When reporting the results, pseudonyms or code numbers will be used to protect the identities of participants. Data will be stored separately to identifiable information, such as consent forms and participant code lists.

Regarding the FGD, the researcher will adopt strategies to minimize any sense of imbalance of power, obligation or coercion to respond. First, the researcher will conduct the FGD at a location of the participants' choice, where they will feel more comfortable answering questions. Second, the researcher will train a research assistant who will be present during the focus group discussions.
Finally, the researcher will build trust with the participants by assuring them that they have the freedom to express themselves in any way and that they should not be shy or intimidated by the status and gender of the researcher. Participants will be offered soft drinks and locally available light foods as refreshments. There will be no reimbursement of travel expenses.

If your research is being conducted in Australia, does it involve Culturally and Linguistically Diverse (CALD) People (other than incidentally)?*

- ○ Yes
- ◉ No

Does your research involve Defence or the Department of Veteran Affairs in any way?*

○ Yes
◉ No

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Section 7: Research participants/subjects part 2

Risk/harm

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Risk or harm could be described as damage or hurt to the wellbeing, interests or welfare of an individual, institution or group. Harm could range from physical hurt or damage such as illness or injury, to psychological or emotional hurt or damage, such as embarrassment or distress. Please note that as a researcher, you are not necessarily immune from risk yourself and should give careful consideration to this question (REF NS 2.1).

NOTE:
It is **really** important that you carefully consider all ***potential*** risks that could occur, even if they seem negligible.
Please **do not** provide one-word answers to any of the questions below.
Describe, as best as you can, any possible risks to research participants, subjects and related groups
NOTE: This information must be included in any information to participants (4000 character limit)*

In this research, there is a possibility that study participants and parents/ guardian may experience of discomfort or distress during interview or FGD since the topic includes sensitive and confidential considerations.

How would you categorise the magnitude of potential risk? (e.g. inconvenience, discomfort, harmful, painful)
Explain why you believe this is so (4000 character limit)*

The magnitude of the problem depends on stress coping ability and tolerance level of the participants. The magnitude of potential risk ranges from minor inconvenience of the time commitment through to a degree of discomfort or distress.

How would you categorise the likelihood of risk? (i.e. slight, possible, likely, probable, unavoidable)
Explain why you believe this is so (4000 characters)*

The likelihood of risk might be slight or possible because many of the study participants are not of mature age and the information is sensitive.

What strategies will you use to minimise and/or manage the risks? (4000 character limit)*

To reduce the possibility of this risk, the researcher will:
- ask consent and/or assent prior to collection of data,
- provide explanation about the research objectives
- use one moderator for facilitation of the interview, and to monitor and record non-verbal communication. The facilitator/moderator will be chosen to match participant sex/gender because young girls may be uncomfortable with a male facilitator/interviewer in a designated private room. In addition, the researcher will offer the option of having a family member or health care professional to present to reduce the risk of discomfort during the interview.
- deliver information about confidentiality and privacy of information provided in the study
- provide information about safety, storage, and reporting system
- If any potential discomfort or distress (physical, psychological / emotional distress) are observed during or after the conduct of an interview/FGD, the researcher will interrupt the interview /focus group, and apply the distress management protocol as indicated in the attachment document. For example, the researcher will stop the interview/FGD, offer immediate support, and may remove the participant from the discussion/interview, direct the participant to a quieter location, contact a general practitioner or mental health professional if appropriate, and follow-up with the participant up with a courtesy call (if the participant consents).

For adolescents <16 years, obtain consent of parents/ guardians and assent of the adolescents.

Discuss likely or possible risk to researchers (including yourself), and your strategies for minimising such risks (4000 character limit)*

There is a minimal foreseeable risk for the researcher. The researcher may experience a risk of discomfort or distress while facilitating an interview or focus groups as a result of the volume of workload, physical stress during measuring anthropometric indices, 24-hour data analysis, and emotional labour of work. The following protocol will be put in place should a researcher becomes distressed or be at risk and require assistance. A range of services could be offered depending on the circumstance.
- If the researcher feels distressed during co/facilitating a focus group, they will mediate with other co/facilitators, so the other can assume leadership of the session as required
- The research team will debrief after the session and following data analysis
- The researcher will continue to have regular meetings and debriefing with supervisors
- The researcher will self-monitor to detect any early sign of discomfort and discuss it with supervisors
- The researcher will be referred/linked to appropriate support such as a local counseling professional, mental health, or general practitioner to discuss their concern or a referral made to their workplace employee assistance programs as required.
- The researcher will complete a research diary and will stay in continued close contact with the research team.

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Pre-existing relationships

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Are there likely to be any pre-existing relationships with research participants? (e.g. employer/employee, colleague, friend, relation, student/teacher, etc) (REF NS 4.3)*

- ○ Yes
- ◉ No

Will you be recruiting UTS staff and/or students as research participants?*

- ○ Yes
- ◉ No

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Children & young people

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You have indicated on the 'Ethical considerations specific to participants' page that your research involves this particular population. If your research does not involve this population, you will need to change your answer on the 'Ethical considerations specific to participants' page.

Research involving children and young persons under the age of 18 years raises special issues and considerations. If your research does involve children, you are advised to discuss your application with the Research Ethics Officer beforehand. Adults in any employment that involves direct contact with children are subject to the Child Protection Legislation and the Working With Children Check. The University has specific guidelines which are be accessible on via our website. In addition, researchers should familiarise themselves with Chapter 4.2 of the National Statement on Ethical Conduct in Human Research (REF NS 4.2), and the guidelines published by the Commission for Children and Young People and the Child Protection Legislation

How will you obtain consent from both children and their parents, and any other stakeholder?*

The researcher will take consent from adolescents (aged 16 years and older), providing verbal and written explanation of the purpose and processes of the research. The researcher will obtain consent from parents or guardians of children and adolescents aged between 10 and 15 years, as well as the assent of the adolescent participants to take part in the survey. The researcher will use the address in the hospital clinic registration follow-up book to contact potential study participant families to invite their adolescents to participate in the study. The researcher will seek family's consent to include their young adolescent in the study after explaining the study objectives. The researcher will obtain signed written consent from the study participants and their parent or guardian prior to participation in the study. The researcher will obtain verbal witnessed consent if the participant cannot read or write.

The HREC recommends that when conducting research with children, a third person is present, or that the researcher and child are in a room that is visible from outside. If for any reason this is not your intention, please explain:*

The researcher will invite a family member or staff member to be present with adolescents <16 years when they complete the survey with a member of the research team. The researcher will arrange for a quiet room which is distraction free and confidential. The researcher has undertaken training given in Australia in New South Wales(NSW) on working with children and has been cleared to work with children. The Working With Children Check(WWC) Number of the researcher is: WWC2500270E.

Will you be alone with the children/young people at any time?*

- ○ Yes
- ◉ No

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Aboriginal & Torres Strait Islanders/people overseas/culturally & linguistically diverse people

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For further information and help in completing your application go to our website

You have indicated on the 'Ethical considerations specific to participants' page that your research involves this particular population. If your research does not involve this population, you will need to change your answer on the 'Ethical considerations specific to participants' page.

Research involving people from identifiable language and cultural groups, including your own, may require special sensitivity. If the research is being carried out in another country, you must comply with UTS as well as local standards, laws and guidelines.
The NHMRC's guidelines and the National Statement provide guidance to researchers in the conception, design and conduct of research. There are six values at the heart of these guidelines: reciprocity, respect, equality, responsibility, survival and protection, spirit and integrity. The questions regarding reciprocity have been addressed under 'Participant
Involvement' and 'External organisations'.
Respectful research relationships acknowledge and affirm the right of people to have different values, norms and aspirations. Those involved in research processes should not be blind to difference. Also essential to a respectful research relationship is the recognition of the contribution of others and the consequences of research.

For guidance on how to put these the above values and principles into practice, please see Keeping research on track II.

Will you be travelling overseas as part of your research?*

- (●) Yes
- ( ) No

Is the research being conducted in English?*

- ( ) Yes
- (●) No

What language is the research being conducted in? (500 character limit)*

The research will be conducted in Amharic local language

What is your level of competence in this language?
1=None, 2=Some, 3=Conversational, 4=Fluent (spoken), 5=Fluent (written), 6=Fluent (spoken & written)
*

6

Please tick which of the following will be used (More than one box may be checked if required):*

- [x] I will be translating
- [ ] Interpreter
- [x] Translator
- [ ] I will be interpreting

Please describe who you will be using as translator, their qualifications and experience (4000 character limit)*

Legal Linguistic professionals will be used to translate the questionnaire and other necessary document to conduct the study.

How have you ensured that the translator will maintain confidentiality? *

- [x] Confidentiality agreement
- [ ] Other

Please save and continue to the next page

Aboriginal & Torres Strait Islanders/people overseas/culturally & linguistically diverse continued

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Has the participant information been translated from English into the relevant language(s)?*

- (●) Yes
- ( ) No

Please provide copies of all material, clearly labelled, in English and other relevant languages

The Committee requests that you arrange for a local independent contact person, to make it easier for your participants should they wish to confirm your identity or express any concerns. Please provide details (name and contact details) (NS Chapter 4.7 and Chapter 4.8):
(4000 character limit)*

Name: Daba Ejara,
Address: Mada walabu University, Shashemene, Oromia, Ethiopia
email: [redacted]@gmail.com; Tel: +251 911 583586

How have you incorporated consideration for local prudential rules and customs in your research design? (4000 character limit)*

yes

Please save and continue to the next page

People overseas/culturally and linguistically diverse people

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For further information and help in completing your application go to our website

You have indicated on the 'Ethical considerations specific to participants' page that your research involves this particular population. If your research does not involve this population, you will need to change your answer on the 'Ethical considerations specific to participants' page.

Do you require any special approval arrangements (e.g. visa)? *

◉ Yes
○ No

Has this been arranged?*

◉ Yes
○ No

Have you read the Vice-Chancellor's Travel Directive for staff and students?*

◉ Yes
○ No

Please save and continue to the next page

External organisations

We recommend you save your application regularly while editing. You can save your application at any time by clicking on the save button.
For further information and help in completing your application go to our website

Indicate if your research will involve any of the following:*

☑ Institution
☑ Organisation
☑ Community Group
☐ None of the above

Please describe what type(s) of institution / organisation / community group will be involved and how many will be involved (4000 character limit)*

Research institutions/organization:10 selected hospitals having ART service

Was the research generated from within the institution / organisation / community group?*

○ Yes
◉ No

Please save and continue to the next page

External organisation consent

We recommend you save your application regularly while editing. You can save your application at any time by clicking on the save button.
For further information and help in completing your application go to our website

Have you sought appropriate approval or support from the institution / organisation / community group involved?*

◉ Yes
○ No

Please attach a copy of any letter of approval/agreement at the end of this form

Do you intend to feed the research results back to the institution / organisation /community group?*

◉ Yes
○ No

Please describe how (4000 character limit)*

The result will be presented in-person and virtual presentation, sharing the document and designing the project based on the outcome. The results are presented to the Hawassa University Faculty of Health, College of Medicine and Health Sciences, School of Nursing, all hospital administrators and ART department medical professionals involved in the study, adolescents and their parents, and all affected stakeholders. The reason why the study finding will be presented as follows:
• the Hawassa University Institutional Review Board reviewed the document and provide local ethics approval,
• the nursing school prepared a letter of support for each hospital and gave me academic leave to attend my doctoral dissertation
• all adolescents/young people living with HIV and their parents are the primary target audiences
• other concerned stakeholders (i.e. Adolescent HIV care and support organization, MOH officials, local and International NGO) are the indirect beneficiary in the local area for policy change and developing implementation strategy

Does this research involve any contracts, including confidentiality agreements? (REF NS 3.2.12, 3.5.6) (Section 2.5 and 4, The Code)*

○ Yes
◉ No

Please save and continue to the next page

Section 8: Data

Data collection & use

We recommend you save your application regularly while editing. You can save your application at any time by clicking on the save button.
For further information and help in completing your application go to our website

Does your research involve access to student records at this University?*

- ○ Yes
- ◉ No

Provide an analysis plan outlining how the aims/objectives will be met, the statistical methods to be used, and who will be carrying out the analysis. *

For the quantitative components, data will be stored using the Research Electronic Data Capture (REDCap) or KOBO toolbox. Data will be checked for completeness of the questionnaires before data are processed, cleaned, coded, and stored in the REDCap storage platform/ KOBO toolbox storage platform. Data will be exported to SPSS software version 26 / STATA version 17 for analysis. Descriptive statistics and univariate/bivariate analysis will be undertaken for the quantitative components of the study. Based on the data finding, the model of analysis will be decided to determine the significant predictors. Structural equation model analysis will be used for testing the link between multiple variables at any point in time for sub-study 2.

For exploratory qualitative data the following steps will be used: verbatim transcription, translation, back translation, uploading the translated script into NVivo version 12 for analysis. NVivo version 12 will be used for thematic analysis of exploratory qualitative data. The data will be analyzed following the six phases of thematic analysis proposed by Braun and Clarke (2006): (i) Familiarization, (ii) Generating initial codes, (iii) Generating /searching themes, (iv) Reviewing themes, (v) defining and naming themes, (vi) producing reports (Braun, 2013; Clarke, 2006).

Finally, triangulation of quantitative and qualitative finding will increase the credibility and validity of the results.

Describe any foreseeable future use of this data; such as sharing with other researchers, secondary use for related research, publishing for unrelated research and non-research purposes and any other possible uses. Please note this information must be included in the participant information sheet.*

All this research information will be treated confidentially. In all instances, the information/data will be kept securely and safely. Audio record data and other personal identities will be confidentially managed. Original data, including verbatim transcribed data, will be anonymized and stored for seven years after the project is completed/ends or forever if possible. Audio recording files, on the other hand, will also be stored in a secure, private place until the verbatim transcription is complete, to ensure the accuracy and adequacy of the transcription before the analysis using the transcript. After confirming the sufficiency of the verbatim, the audio recording is destroyed, as there is no way to anonymize the speaker's original audio recording.

With additional and specific Human Research Ethics Committee approvals, the results of this research may also be shared through open access (public) scientific databases, including internet databases, presented to a conference, and shared with concerned stakeholders /hospitals. This will enable other researchers to use the data to investigate other important research questions. Data shared in this way will be disidentified, removing all personal information (e.g., name, address, date of birth, etc.).

Do you have a research data management plan?*

- ◉ Yes
- ○ No

Please save and continue to the next page

Section 9: Additional information

Other ethical issues

We recommend you save your application regularly while editing. You can save your application at any time by clicking on the save button.
For further information and help in completing your application go to our website

If there are any additional ethical issues which you do not believe have been covered by this form, please explain them for the HREC: (4000 character limit)*

No

Please save and continue to the next page

Section 10: Attachments

Attachments

We recommend you save your application regularly while editing. You can save your application at any time by clicking on the save button.
For further information and help in completing your application go to our website

I have attached the following supporting documents

Doctoral or Masters assessment (i.e. panel's report)*

- ◉ Yes
- ○ N/A

Sample research advertisement/announcement

- (●) Yes
- ( ) N/A

Participant Information Sheet(s)*

- (●) Yes
- ( ) No

Informed consent form(s)*

- (●) Yes
- ( ) N/A

Translation of forms/information letter(s)/instruments*

- (●) Yes
- ( ) N/A

Evidence of approval from external institution, organisation or community group*

- (●) Yes
- ( ) N/A

Explanations of any technical terms used *

- ( ) Yes
- (●) N/A

Research data management plan (RDMP)*

- (●) Yes
- ( ) No

Standard Operating Procedures

N.B. May include a distress or disclosure protocol [see UTS HREC Disclosure Guidelines under University policies and guidelines], Faculty of Health - Low Risk protocol; procedures for participant screening, physiological, or biological sampling and/or laboratory or safety procedures where relevant.

*

- (●) Yes
- ( ) No

Documents attached to this application:

How to attach documents

1. Click on 'Add'
   Ensure the fields are as follows:
   - Document type- soft copy
   - Name: Include the document name and version number
   - Description: This field is optional
2. You can then either select the file you want to upload OR drag and drop it where it says 'Drop file here'
3. Click on 'OK'

Note: Please use the following HREC templates when creating an information sheet, consent form, verbal script, etc.: HREC templates. All submitted documents should be titled, and have have version control included in the footer.*

1	Document type	Soft copy
	Name	Participant Information sheet for Adolescents Young Adult (18 years and older), Version 1
	Reference (Document Title)	Participant Information sheet for Adolescents Young Adult (18 years and older), Version -1.docx
	Description	
2	Document type	Soft copy
	Name	Consent form for AYA (18 years and older), Version 1
	Reference (Document Title)	Consent form for AYA (18 years and older), Version-1.docx
	Description	
3	Document type	Soft copy
	Name	Participant Information Sheet for Parents or Guardians of ALHIV on ART Follow-up(10 - 17 Years), Version 1
	Reference (Document Title)	Participant Information Sheet for Parents or Guardians of ALHIV on ART Follow-Up (10 - 17 Years), Version 1.docx
	Description	
4	Document type	Soft copy
	Name	Consent form for parent or guardian of ALHIV on ART Follow-Up(10 -17 years), version 1
	Reference (Document Title)	Consent form for parents Guardians of ALHIV (10-17 years), Version 1 .docx
	Description	

5	Document type	Soft copy
	Name	Participant information sheet with consent form for Health Professional Staff, Version 1
	Reference (Document Title)	Participant information sheet with consent form for Health Professional Staff, Version 1.docx
	Description	
6	Document type	Soft copy
	Name	Distress Protocol, Vesion 1
	Reference (Document Title)	Distress Protocol, Vesion 1.docx
	Description	
7	Document type	Soft copy
	Name	RDMP
	Reference (Document Title)	STASH rdmp.pdf
	Description	
8	Document type	Soft copy
	Name	Meless BORE PhD PH Stage 1 assessment CRs Feedback
	Reference (Document Title)	Meless BORE PhD PH Stage 1 assessment CRs Feedback.pdf
	Description	
9	Document type	Soft copy
	Name	ETH23-7873 - CRUICKSHANK (for BORE) - MREC Outcomes and Comments
	Reference (Document Title)	ETH23-7873 - CRUICKSHANK (for BORE) - MREC outcome and comments.docx
	Description	
10	Document type	Soft copy
	Name	Amharic version questinnarie
	Reference (Document Title)	Amharic Version Survey Questinnarie.docx
	Description	
11	Document type	Soft copy
	Name	English Version Indepth Interview and FGD Guide
	Reference (Document Title)	English Version Indepth Interveiw and FGD Interview guide LP final Edited March 14-2023 lp.docx
	Description	
12	Document type	Soft copy
	Name	Local Ethics approval Letter
	Reference (Document Title)	HU IRB Letter CamScanner 04-25-2023 17.35.pdf
	Description	
13	Document type	Soft copy
	Name	New version of English survey questinnarie
	Reference (Document Title)	English new Version Survey Questinnarie Final.docx
	Description	
14	Document type	Soft copy
	Name	New version Amharic survey questionnarie
	Reference (Document Title)	Amharic new Version Survey Questinnarie.docx
	Description	
15	Document type	Soft copy
	Name	Response to Question raised by ethics office
	Reference (Document Title)	ETH23-7873 - CRUICKSHANK (for BORE) - MREC outcome and comments response _MC.docx
	Description	
16	Document type	Soft copy
	Name	Revised Version of PIS for Adolescent young adult 18 years and above
	Reference (Document Title)	1. New Version Participant Information sheet for Adolescents Young Adult (18 years and older) May-3-2023.docx
	Description	
17	Document type	Soft copy

	Name	Revised version of PIS for ALHIV aged 10-17 years
	Reference (Document Title)	2. New Version Participant Information Sheet for ALHIV (10-17 years) May 3-2023.docx
	Description	
18	Document type	Soft copy
	Name	Revised version of PIS for Health Professionals
	Reference (Document Title)	3. New Version Participant Information Sheet for Health Professionals May 3-2023.docx
	Description	
19	Document type	Soft copy
	Name	Revised Version Indepth Interview and FGD Interview guide, Version 2, 26-6-23
	Reference (Document Title)	Revised Version Indepth Interview and FGD Interview guide, Version 2, 26-6-23.docx
	Description	
20	Document type	Soft copy
	Name	Revised Version Amharic Version of In-depth Interview and FGD guide., Version 2, 26-6-23
	Reference (Document Title)	Revised Version Amharic Version of In-depth Interview and FGD guide., Version 2, 26-6-23.docx
	Description	
21	Document type	Soft copy
	Name	Revised Version Participant Information and Consent sheet for Adolescent(16 years and older), Version 2, 26-06-23
	Reference (Document Title)	Revised Version Participant Information and Consent sheet for Adolescent(16 years and older), Version 2, 26-06-23.docx
	Description	
22	Document type	Soft copy
	Name	Revised Version Participant Information and Consent sheet for Children and adolescents aged 10 -15 years, Version 1, 26-06-23
	Reference (Document Title)	Revised Version Participant Information and Consent sheet for Children and adolescents aged 10 -15 years, Version 1, 26-06-23.docx
	Description	
23	Document type	Soft copy
	Name	Revised Version Participant Information and Consent Sheet for Health Professionals and staffs, Version 2, 26-6-23
	Reference (Document Title)	Revised Version Participant Information and Consent Sheet for Health Professionals and staffs, Version 2, 26-6-23.docx
	Description	
24	Document type	Soft copy
	Name	Revised Version Participant Information and Consent Sheet for Parents or Guardians, Version 2, 26-06-23
	Reference (Document Title)	Revised Version Participant Information and Consent Sheet for Parents or Guardians, Version 2, 26-06-23.docx
	Description	
25	Document type	Soft copy
	Name	Revised Version Survey Questionnaires including secondary data record review questions, Version 2, 26-06-23
	Reference (Document Title)	Revised Version Survey Questionnaires including secondary data record review questions, Version 2, 26-06-23.docx
	Description	

Reminder to student applicants:

1. Please note that once your application is submitted it will go directly to your supervisor and not to the Committee.
2. We **strongly** recommend notifying your supervisor that you have submitted your application in case of any technical issues, to avoid potential delays in the review process.
3. Once your supervisor endorses your application it will go to your Local Research Office for endorsement before coming to the Ethics Secretariat for review.
4. Your electronic application must be endorsed by your supervisor by the Local Research Office (LRO) submission deadline.
5. Please also ensure that the Primary AOU listed at the end of the Investigators page is updated to your supervisor's AOU. This will show in the table under 'Internal personnel listed below', once you add them. If you need any assistance with this please contact Research.Ethics@uts.edu.au or call 9514 9772. Please note that this is particularly important if you have a dual role as a staff/student as your application could go to the wrong faculty for review through the automated process.

Declaration

Declaration

I have answered all questions in the risk assessment truly and completely to the best of my knowledge
I will notify the UTS Human Research Ethics Committee of any variation to this research that may alter the level of risk associated with it
This research will be undertaken in compliance with the UTS Research Policy or any replacement or amendment thereof
This research will be undertaken in compliance with the Australian Code for the Responsible Conduct of Research and National Statement on Ethical Conduct in Human Research

Please click on the "Submit" button in the Actions menu.

Confirmation

Confirmation by Local Research Office High Risk

Application type*

Research (student project)

Internal personnel listed on this ethics protocol*

1	Primary	No
	ID	
	Surname	Bore
	Given Name	Meless Gebrie
	Full Name	Mr Meless Gebrie Bore
	Position	5Research Student
	Type	International
	AOU	FoH.School of Nursing and Midwifery
	Managing Unit	Faculty of Health
	Email Address	MelessGebrie.Bore@student.uts.edu.au
	Work Number	
2	Primary	No
	ID	
	Surname	Perry
	Given Name	Lin
	Full Name	Prof Lin Perry
	Position	Co-Supervisor
	Type	Internal
	AOU	FoH.School of Nursing and Midwifery
	Managing Unit	Faculty of Health
	Email Address	Lin.Perry@uts.edu.au
	Work Number	5840
3	Primary	No
	ID	
	Surname	Xu
	Given Name	Luna
	Full Name	Dr Luna Xu
	Position	Co-Supervisor
	Type	Honorary
	AOU	FoH.School of Nursing and Midwifery
	Managing Unit	Faculty of Health
	Email Address	Xiaoyue.Xu@uts.edu.au
	Work Number	+61 2 95145972

4	Primary	Yes
	ID	
	Surname	Cruickshank
	Given Name	Marilyn
	Full Name	Prof Marilyn Cruickshank
	Position	Chief Investigator
	Type	Internal
	AOU	FoH.School of Nursing and Midwifery
	Managing Unit	Faculty of Health
	Email Address	Marilyn.Cruickshank@uts.edu.au
	Work Number	9382 1658

External personnel listed on this ethics protocol*

1	Primary	No
	ID	PER0103398
	Surname	Biratu
	Given Name	Andargachew
	Full Name	A/Prof Andargachew Kassa Biratu
	Position	Co-Supervisor
	Type	External
	AOU	
	Managing Unit	
	Email Address	
	Work Number	

Checked by:*
RTatian

Date of review:*
08/02/2023

The Local Research Office has confirmed that: All information in this application and supporting documentation is correct and as complete as possible *
(•) Yes
( ) No

Confirmation by ADR

Application type
Human

Internal personnel listed on this ethics protocol

1	Primary	No
	ID	
	Surname	Bore
	Given Name	Meless Gebrie
	Full Name	Mr Meless Gebrie Bore
	Position	5Research Student
	Type	International
	AOU	FoH.School of Nursing and Midwifery
	Managing Unit	Faculty of Health
	Email Address	MelessGebrie.Bore@student.uts.edu.au
	Work Number	
2	Primary	No
	ID	
	Surname	Perry
	Given Name	Lin
	Full Name	Prof Lin Perry
	Position	Co-Supervisor
	Type	Internal
	AOU	FoH.School of Nursing and Midwifery
	Managing Unit	Faculty of Health
	Email Address	Lin.Perry@uts.edu.au
	Work Number	5840
3	Primary	No
	ID	
	Surname	Xu
	Given Name	Luna
	Full Name	Dr Luna Xu
	Position	Co-Supervisor
	Type	Honorary
	AOU	FoH.School of Nursing and Midwifery
	Managing Unit	Faculty of Health
	Email Address	Xiaoyue.Xu@uts.edu.au
	Work Number	+61 2 95145972

4	Primary	Yes
	ID	
	Surname	Cruickshank
	Given Name	Marilyn
	Full Name	Prof Marilyn Cruickshank
	Position	Chief Investigator
	Type	Internal
	AOU	FoH.School of Nursing and Midwifery
	Managing Unit	Faculty of Health
	Email Address	Marilyn.Cruickshank@uts.edu.au
	Work Number	9382 1658

External personnel listed on this ethics protocol

1	Primary	No
	ID	PER0103398
	Surname	Biratu
	Given Name	Andargachew
	Full Name	A/Prof Andargachew Kassa Biratu
	Position	Co-Supervisor
	Type	External
	AOU	
	Managing Unit	
	Email Address	
	Work Number	

Date of LRO review

08/02/2023

Declaration:

- I am aware that this research is being conducted within this Faculty/School/Centre.
- I am satisfied that the researchers have met all Faculty/School/Centre requirements in relation to this research
- This research will be undertaken in compliance with the UTS Research Ethics and Integrity Policy or any replacement or amendment thereof
- This research will be undertaken in compliance with the Australian Code for the Responsible Conduct of Research and National Statement on Ethical Conduct in Human Research

*

(•) Yes
( ) No

Comments

This question is not answered.

Research Office use only

Research Office use only

Application Status

Approved

Approval Purpose

Research (student project)

Current Committee

0Health and Medical Research Ethics Committee (Human)

TRIM number

RES23/197

Date received

13/02/2023

Date Reviewed

16/03/2023

Date Approved

01/08/2023

Start date

01/08/2023

End date

01/08/2028

Date Withdrawn

This question is not answered.

Special conditions

n/a

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የምርምር ስነ-ምግባር ኮሚቴ ቦርድ

HAWASSA UNIVERSITY
COLLEGE OF MEDICINE AND HEALTH SCIENCES
Institutional Review Board

Ref. No: IRB/321/15
Date: 25/04/2023

Name of Researcher(s): **Meless Gebrie, Marilyn Cruickshank (PhD, Prof.), Lin Perry (PhD, prof.), Xiaoyue Xu (PhD), Andargachew kassa (Asst. prof.)**

Topic of Proposal: ***Nutrition status among adolescents living with human immunodeficiency virus (HIV) on anti-retroviral therapy (ART) follow-up living in selected region of Ethiopia: Mixed method study design***

Dear researcher(s),
The Institutional Review Board (IRB) at the College of Medicine and Health Sciences of Hawassa University has reviewed the aforementioned research protocol with special emphasis on the following points:

1. Are all principles considered?
   - 1.1. Respect for persons: Yes ☑ No ☐
   - 1.2. Beneficence: Yes ☑ No ☐
   - 1.3. Justice: Yes ☑ No ☐
2. Are the objectives of the study ethically achievable? Yes ☑ No ☐
3. Are the proposed research methods ethically sound? Yes ☑ No ☐

Based on the aforementioned ethical assessment, the IRB has:

A. Approved the proposal for implementation ☑ Approval period -**25 April 2023** to **24 April 2024**
B. Conditionally Approved ☐ Element Approved: **Protocol Version No.** 1
C. Not Approved ☐ Follow up report expected in 6 **months**

Obligation of the PI:

1. Should comply with the standard international and national scientific and ethical guidelines
2. All amendment and changes made in protocol and consent form needs IRB approval
3. The PI should report SAE within 1 days of the event
4. End of study, including major [illegible] should be reported to the IRB

Yours faithfully,

Hawassa University College of Medicine & Health Science

Dr. Embialle Mengiste (Ph.D. Associate Prof.)
Chairperson, Institutional Review Board

☎: +046 8209290 Website: Fax: +046 2208755 ✉ 1560 CMHS, Hawassa Ethiop

Ref. No: PMC-3/181

Date: 21/8/2023

Institutional Review Board (IRB) of St. Paul's Hospital Millennium Medical College (SPHMMC)

Ethical Clearance

Research Title:-Nutrition Status among adolescecents living with Human immunodeficiency virus (HIV) on anti retroviral therapy (ART) Follow-up living in selected region of Ethiopia: Mixed Method Study Design

Principal Investigator: Meless Gebrie

The IRB of SPHMMC has reviewed the above mentioned research proposal and made the following decision:

- Approved: _____x_____
- Approved with recommendation: _____
- Approved on condition :-_____
- Disapproved:-_____

The decision is valid for 12 months and the research should be conducted in compliance with the protocol/proposal approved by the IRB of SPHMMC. Any subsequent revison/amendment of the protocol/proposal needs approval before conduct of the research. The researcher should also submit written summaries of the research status to the IRB every 03 months. Upon the conclusion of the study, manuscripts and thesis work to the final/completed research project needs to be submitted to the IRB.

IRB Chair:

Signature: _____

Date:Auguset /18, 2023

Cc:

- Vice Provost for Academic and Research
- IRB
- Meless Gebrie
  SPHMMC

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City Government of Addis Ababa Health Bureau

REF.N.O. A/A/3152/727

DATE 7/1/2016

TO:

- **ZEWUDITU MEMORIAL HOSPITAL**
- **YEKATIT 12 HOSPITAL MEDICAL COLLEGE HOSPITAL**
- **RAS DEASTA DAMTEW MEMORIAL HOSPITAL**

Subject: Request to access Facilities to conduct approved research

This letter is to support **Meless Gebrie Bore** to conduct research which is entitled as **"Nutrition status among adolescents living with Human Immuno-Deficiency Virus (HIV) on Anti-Retroviral Therapy (ART) follow-up living in selected regions of Ethiopia: Mixed Method Study."** The study proposal was duly reviewed and approved by Addis Ababa Health Bureau IRB, and the principal investigator is informed with a copy of this letter to report any changes in the study procedures and submit an activity progress report to the Ethical Committee as required. Therefore we request the Health offices and staffs to provide support to the Principal investigator.

With Regards

Ethical Clearance Committee

Cc

- **MELESS GEBRIE BORE**
- **ETHICAL CLEARANCE COMMITTEE**

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City Government of Addis Ababa Health Bureau

REF.N.O. ሀ/ሀ/3/5ሀ/227

DATE 7/1/2016

TO:

- ZEWUDITU MEMORIAL HOSPITAL
- YEKATIT 12 HOSPITAL MEDICAL COLLEGE HOSPITAL
- RAS DEASTA DAMTEW MEMORIAL HOSPITAL

Subject: Request to access Facilities to conduct approved research

This letter is to support **Meless Gebrie Bore** to conduct research which is entitled as **"Nutrition status among adolescents living with Human Immuno-Deficiency Virus (HIV) on Anti-Retroviral Therapy (ART) follow-up living in selected regions of Ethiopia: Mixed Method Study."** The study proposal was duly reviewed and approved by Addis Ababa Health Bureau IRB, and the principal investigator is informed with a copy of this letter to report any changes in the study procedures and submit an activity progress report to the Ethical Committee as required. Therefore we request the Health offices and staffs to provide support to the Principal investigator.

With Regards

Ethical Clearance Committee

Cc

- MELESS GEBRIE BORE
- ETHICAL CLEARANCE COMMITTEE

To: - ART dept

Zewditu memorial hospital

Subject: - Request to access departments to conduct approved research

The letter is to support (Mr)/Ms/Dr Melese Getaw

On the research topic of

Assit of Nutritional Status among Adolescents Living with HIV on ART follow up at TZMH

the study proposal was duly reviewed and approved by Addis Ababa Health Bureau IRB and the approval letter was left to our department (Training and research directorate).

Therefore we request the department and staffs to provide support to the principal investigator.

With regard

Appendix VIII: Training /workshop Certificate

JBI

CERTIFICATE

OF ATTENDANCE

This is to certify that

Meless Gebrie Bore

Attended

Comprehensive Systematic Review Training Program

Sydney, Australia
19 November 2021 – 3 December 2021

Production Note:
Signature removed
prior to publication.

Prof Zoe Jordan, PhD
Executive Director
JBI, University of Adelaide
Adelaide, South Australia

LinkedIn LEARNING

Certificate of Completion

Congratulations, Meless Bore

COURSE COMPLETION

Communication Tips

Course completed on Oct 27, 2022 at 09:00PM UTC • 3 hours 42 min

By continuing to learn, you have expanded your perspective, sharpened your skills, and made yourself even more in demand.

Head of Content Strategy, Learning

LinkedIn Learning
1000 W Maude Ave
Sunnyvale, CA 94085

Certificate ID: ARLCnXfq6lI9YN27hjRpUG2Dv1Ze

LinkedIn LEARNING

Certificate of Completion

Congratulations, Meless Bore

COURSE COMPLETION

Project Management Foundations: Requirements

Course completed on Oct 27, 2022 at 08:14AM UTC • 27 min

By continuing to learn, you have expanded your perspective, sharpened your skills, and made yourself even more in demand.

Head of Content Strategy, Learning

LinkedIn Learning
1000 W Maude Ave
Sunnyvale, CA 94085

Certificate ID: ATkNUqG6mdu3TBYZpwdYCj2IPTKJ


Respect. Now. Always.
Consent always matters
Certificate of Completion
This is to certify that
Bore Meless Gebrie
ID:
has successfully passed Consent Matters.
17/08/2024
UTS UNIVERSITY OF TECHNOLOGY SYDNEY
epigeum


Respect. Now. Always.
This is to certify that
Student Meless Gebrie Bore
ID
has successfully completed the UTS Consent Matters subject
UTS
OXFORD UNIVERSITY PRESS
epigeum
Date 31/08/2022

JOHNS HOPKINS
BLOOMBERG SCHOOL
of PUBLIC HEALTH

IPHCE
International Institute for Primary Health Care - Ethiopia

CERTIFICATE
OF ATTENDANCE

PROUDLY PRESENTED TO

Meless Bore

For attending the webinar with the topic

"IMPLEMENTATION RESEARCH FOR PRIMARY HEALTH CARE"

Organized by the International Institute for Primary Health Care-Ethiopia, in collaboration with the Johns Hopkins Bloomberg School of Public Health.

DATE:
September 29th, 2022

This certificate guarantees 1 CEU Points.

UTS HELPS

UTS AVOIDING PLAGIARISM QUIZ RESULTS

HEALTH1

Student ID: [redacted]
Meless Gebrie Bore
Date : 28/10/2022 - 23:26

You got 8 points of 10 possible.

You have passed the quiz! Well done!

If you want to improve your understanding, you can always come back again to have another try!
You can also go to the 'What is Plagiarism' page and the 'Tutorial' page in the module for more information.
Don't hesitate to contact helps@uts.edu.au if you have any questions.

Regards,
UTS: HELPS

http://avoidingplagiarism.uts.edu.au

CERTIFICATE OF COMPLETION

Meless Gebrie Bore

Has successfully completed the online training module
Research Integrity – Introduction for Staff

September 2, 2022

RES Hub

Office of the Deputy Vice-Chancellor (Research)

University of Technology Sydney

CPD MEMBER
The CPD Certification Service

Sophie Mepham GCP™

This is to certify that

Meless Gebrie Bore

Has successfully completed

Introduction to Good Clinical Practice V2.0

"This ICH E6 GCP Investigator Site Training meets the Minimum Criteria for ICH GCP Investigator Site Personnel Training identified by TransCelerate BioPharma as necessary to enable mutual recognition of GCP training among trial sponsors"

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