UTS UNIVERSITY OF TECHNOLOGY SYDNEY

Equity in Access to Quality Maternal and Child Health Services in sub-Saharan Africa

By Firew Tekle Bobo

Thesis submitted in fulfilment of the requirements for the degree of

Doctor of Philosophy

Under the supervision of Professor Andrew Hayen, Professor Angela Dawson, Dr. Augustine Asante, and Professor Mirkuzie Woldie

University of Technology Sydney

Faculty of Health

September 2022

Certificate of Original Authorship

I, Firew Tekle Bobo declare that this thesis, is submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the School of Public Health, Faculty of Health at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise referenced or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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

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

Production Note:
Signature removed prior to publication.

Date: 04 Sep 2022

Abstract

Background: Maternal health services, such as antenatal care (ANC), skilled birth attendance (SBA), postnatal care (PNC), and child vaccination, have been instrumental in reducing morbidity and mortality rates among women and children globally. However, despite their proven efficacy, access to and utilisation of these services in low- and lower-middle-income countries (LLMICs) remain limited. While much attention has been given to monitoring and addressing coverage disparities, there has been a notable lack of evidence on disparities in access to quality care. This study aimed to assess the status of equity in access to quality maternal and child health (MCH) services in sub-Saharan Africa (SSA).

Methods: This study analysed the SSA countries that had the latest Demographic and Health Surveys (DHS) conducted between 2013 and 2020. Socioeconomic inequalities were examined using three equity analysis methods: rate/ratio, concentration curve, and concentration index. Multilevel analysis that adjusts for clusters, countries, and sampling weights were used to explain inequalities. In addition, decomposition analysis was used to explain inequalities.

Results: The first study assessed inequalities in quality ANC. The results revealed a significant gap between the quantity of ANC contacts received by women and the quality of ANC services provided during those contacts, with just over half (54.4%) receiving four or more ANC contacts, while only 21% received quality ANC services. The second study analysed spatial patterns and inequalities in SBA and caesarean section. The proportion of SBA varied greatly across countries, with Chad having the lowest rate at 24.3% and South Africa having the highest at 96.7%. In ten out of 25 countries, the rate of caesarean delivery was less than 1% for the poorest quintile, while in nine countries, it was more than 15% for the richest quintile. The third study evaluated the continuum of care for maternal health services. About 89% of women reported

having at least one ANC contact, but only 30% of women received the recommended care package that includes four or mere ANC contacts, SBA, and PNC. Nearly 9% of women reported not having contact with the health system during pregnancy or childbirth; this ranged from 0.1% in Burundi to 34% in Chad. The fourth study investigated inequalities in child vaccination across 25 SSA countries. The research findings showed that 56.5% of children received all recommended vaccinations, 35.1% had incomplete vaccinations, and 8.4% had received no vaccinations, with a disproportionate concentration of zero-dose vaccination among the poor, while full vaccination coverage was more common among wealthier households in many countries. The fifth study revealed an increase in the proportion of children who received full vaccination in Ethiopia, rising from 24.6% in 2011 to 38.6% in 2016, with higher coverage among children from wealthier households. Overall, this research highlighted the existing disparities in maternal health and child vaccination, influenced by various factors such as wealth, education, access to media, place of residence, as well as maternal factors such as age and parity.

Conclusions: Progress toward comprehensive MCH coverage has been insufficient at both the national and across equity dimensions, impeding progress toward universal health coverage (UHC). Ensuring equitable coverage of MCH services is critical to achieving UHC. Therefore, when planning interventions and assessing progress, prioritising equity considerations is essential. Regular evaluations of health inequality can serve as a diagnostic tool to identify and address the needs of vulnerable populations. To further improve MCH services in SSA, it is essential to address areas with limited coverage and tailor services to meet the specific needs of marginalized groups. Additionally, special attention must be given to child immunisation to maintain previous progress and extend coverage to all demographics.

Acknowledgements

I am incredibly grateful to my excellent supervisors, Professor Andrew Hayen, Professor Angela Dawson, Professor Mirkuzie Woldie, and Dr Augustine Asante, for their superb guidance and huge investment of time into this project. Professor Andrew Hayen gave me the opportunity and freedom to pursue my research interests and taught me a great deal about epidemiological methods. Professor Angela Dawson and Dr Augustine Asante shared their thoughtful advice and excellent expertise in health systems and services. Professor Mirkuzie Woldie provided insightful and fantastic expertise in maternal and child health programs and has also been a great role model and mentor to my academic and research career.

I gratefully acknowledge the University of Technology Sydney for funding assistance through the UTS President's Scholarship and UTS International Research Scholarship to support my study. I would also like to thank Measure DHS ICF International for the permission to use the datasets for this thesis.

My heartfelt gratitude goes to my family: Mom, Dad, Bilisuma, Hawi, and Keneni, for their endless support and care at all times. Thank you to Mom, for all the sacrifices and for setting me on this path through all the challenges and struggles. To my brother Bilisuma, thank you for always having my back. To my wonderful sisters Hawi and Keneni, thank you for all your love and care.

And last but certainly not least, I would like to thank all my friends. I am grateful to Tesfaye, Gemechu, Beky, Taye, Fekede, Asem, and Lelise for their encouragement and support during my study.

Thank you all!

Publications included in this thesis

Peer-Reviewed Papers

1. **Bobo F.T.**, Asante A, Woldie M, Hayen A. Poor coverage and quality for poor women: Inequalities in quality antenatal care in nine East African countries. Health Policy and Planning. 2021;36(5):662-72.

2. **Bobo F.T.**, Asante A, Woldie M, Dawson A, Hayen A. Spatial patterns and inequalities in skilled birth attendance and caesarean delivery in sub-Saharan Africa. BMJ Global Health. 2021;6(10).

3. **Bobo, F. T.**, Asante, A., Woldie, M., Dawson, A., & Hayen, A. (2022). Child vaccination in sub-Saharan Africa: Increasing coverage addresses inequalities. Vaccine, 40(1), 141-150. doi:10.1016/j.vaccine.2021.11.005

4. **Bobo, F.T**. & Hayen, A. 2020, 'Decomposition of socioeconomic inequalities in child vaccination in Ethiopia: results from the 2011 and 2016 demographic and health surveys', BMJ Open, vol. 10, no. 10, p. e039617.

Submitted manuscripts included in this thesis

Bobo F.T., Asante A, Woldie M, Dawson A, Hayen A. Evaluating equity across the continuum of care for maternal health services: analysis of household surveys from 25 sub-Saharan African countries. International Journal for Equity in Health. (Under review)

Conference abstracts

1. **Bobo F**, Asante A, Woldie M, Dawson A, Andrew H, (2022) Evaluating equity across the continuum of care for maternal health services: analysis of household surveys from 25 sub-Saharan African countries "15th Annual Conference on the Science of Dissemination and Implementation in Health" December 11-14, 2022

2. **Bobo F**, Asante A, Woldie M, Dawson A, Andrew H, (2022) Inequalities in access to quality Antenatal Care in nine east African countries "15th Annual Conference on the Science of Dissemination and Implementation in Health" December 11-14, 2022,

3. **Bobo FT.** Asante A, Woldie M, Dawson A, Hayen A. Inequalities in quality antenatal care in nine East African countries. Sixth Global Symposium on Health Systems Research, 08-12 November 2020

4. **Bobo FT.** Asante A, Woldie M, Dawson A, Hayen A. Child vaccination in sub-Saharan Africa: Increasing coverage addresses inequalities. In33rd EPHA Annual Conference Feb 16, 2022.
5. **Bobo FT.** Asante A, Woldie M, Dawson A, Hayen A. Decomposition of socioeconomic inequalities in child vaccination in Ethiopia: results from the 2011 and 2016 demographic and health surveys. In 33rd EPHA Annual Conference 2022 Feb 16.

Media articles related to this thesis

1. **Bobo F**, Hayen A. Dawson A. December 9, 2021, Addressing Inequalities in Access to Quality Maternal and Child Health Services in Sub-Saharan Africa. Intouch Public Health. https://intouchpublichealth.net.au/addressing-inequalities-in-access-to-quality-maternal-and-child-health-services-in-sub-saharan-africa/

2. **Bobo F**, Asante A, Woldie M, Hayen A. April 13, 2021, A long way to ensuring access to quality antenatal care in east Africa: challenges and future directions. Health Policy and Planning Debated. https://blogs.lshtm.ac.uk/hppdebated/2021/04/13/a-long-way-to-ensuring-access-to-quality-antenatal-care-in-east-africa-challenges-and-future-directions/

3. **Bobo F**, Hayen A. Dawson A. Asante A, Woldie M, November 16, 2021. Accessing maternal healthcare in sub-Saharan Africa. UTS News in Health https://www.uts.edu.au/about/faculty-health/news/accessing-maternal-healthcare-sub-saharan-africa

4. **Bobo F**, Asante A, Woldie M, Hayen A. April 23, 2021. Quality antenatal care in East Africa. UTS News in Health https://www.uts.edu.au/about/faculty-health/news/quality-antenatal-care-east-africa

Table of contents

List of Figures

List of Tables

List of acronyms

ANC	Antenatal care
ANC 4+	Four or more antenatal care visits
BCG	Bacille Calmette-Guérin vaccine
CCI	Composite coverage index
CI	Confidence interval
CoC	Continuum of care
DHS	Demographic and Health Survey
DTP3	Third dose of diphtheria-tetanus-pertussis vaccine
LLMIC	Low- and -lower middle-income country
LMIC	Low-income and middle-income country
MDG	Millennium development goals
OPV3	Third dose of oral polio vaccine
OR	Odds ratio
PNC	Postnatal care
RR	Risk ratio
SBA	Skilled birth attendance
SDG	Sustainable Development Goal
SSA	Sub-Saharan Africa
UHC	Universal health coverage
UN	United nations
WHO	World Health Organization

Chapter One: Introduction

1.1 Concepts of equity and quality in health

The aim of this study was to evaluate the status of equity in access to quality maternal and child health (MCH) services in sub-Saharan Africa. Many women die from preventable causes related to pregnancy and childbirth worldwide. Countries can end such deaths by improving access to and quality of services such as contraceptives, antenatal care (ANC), birth at the facility, and postnatal care (PNC). However, access to and utilisation of these services is very limited in many low- and lower-middle-income countries (LLMICs), especially across sub-Saharan African countries. Access is even more limited for the poorer and marginalised population groups.

Exploring variations in the quality of care across socioeconomic levels and identifying the gap in the content of care provided at facilities is critical to determining and implementing effective interventions. In the absence of comprehensive and reliable health information systems to monitor equity and quality in health services, survey data (e.g., Demographic and Health Surveys) though limited in scope and depth to provide comparative assessments, become the primary source of information. This study reports on spatial patterns, inequalities, and drivers of inequality in access to quality MCH services using a set of tracer indicators that provide a good picture of overall MCH services coverage in sub-Saharan Africa.

This chapter provides descriptions of basic concepts mentioned in this thesis that include health inequalities, universal health coverage, social determinants of health, and quality of care measures. Later on in the chapter, I discuss the need and gaps we aim to address in this thesis.

1.1.1 Health inequities

Health inequities are systematic differences in health status and health outcomes between different population groups (1, 2). These avoidable differences are often caused by inequalities in the distribution of health and health-related resources among different population groups and are worsened by social conditions in which people are born, grow, live, work and age (3, 4).

With the promise to leave no one behind, health equity has become a priority agenda for the Sustainable Development Goals (SDGs) (5). Because of this, all UN Member States are now committed to achieving the SDGs by ending discrimination and exclusion, eradicating poverty, and reducing the inequalities that undermine the potential of individuals and of humanity as a whole and leave people behind (5). This promise should not be limited to reaching the poorest of the poor but also requires addressing discrimination and rising inequalities within and between countries (6, 7). The existence of persistent inequalities in resource allocation and distribution that leaves individuals, families, and whole communities marginalised and excluded provides an important explanation for people being left behind (8).

In LLMICs, there is a persistent inequality in access to and utilisation of important healthcare services. Ensuring equity in healthcare is the key to reducing morbidity and mortality among women and children across all socioeconomic levels (9). Across the continuum of care, women should have access to contraceptives, antenatal care, intrapartum care, and postnatal care (9-11). However, many do not have access to these life-saving healthcare services in sub-Saharan Africa (12). In part, this is due to health systems' inability to identify and implement effective strategies to reach those in need (9, 13, 14).

The root causes of inequities in MCH services can be categorised into three main groups: individual factors, systemic factors, and societal factors (15). Individual-level factors include poverty, lack of education, and lack of knowledge about MCH. Women living in poverty may have limited access to health services and are less likely to use MCH services, which can result in poor health outcomes. Furthermore, a lack of education can limit women's access to services, as well as the quality of care they receive.

System-level factors are factors related to inadequate health infrastructure and a shortage of healthcare providers. In many low-income countries, there is a dire shortage of health facilities, which can greatly limit access to health services. This is particularly true for women living in rural areas, who may have to travel great distances to access health facilities. Societal-level factors include discrimination, cultural and social norms, and gender inequality. Discrimination based on race, ethnicity, or socioeconomic status can also limit access to health services. Health inequalities can also rise as a result of discriminatory laws, policies, and social practices that leave particular groups of people further and further behind (16, 17).

The factors causing health inequities interact with each other in complex ways, creating a web of challenges that can have serious consequences for individuals and communities (18). These factors interact and reinforce one another, resulting in a vicious cycle of health inequities. For example, a poor woman may have limited access to health care, resulting in poor health outcomes. This, in turn, can limit her access to education and employment opportunities, exacerbating her poverty and limiting her access to health care. Similarly, systemic and societal-level factors can interact and reinforce one another, resulting in a self-perpetuating cycle of health disparities.

These interactions can have serious consequences for both individuals and communities. Poor health outcomes can lead to lower productivity, higher healthcare costs, and a lower quality of life (19). Furthermore, health inequities can perpetuate poverty and social injustice, exacerbating the difficulties that individuals and communities face. Addressing the root causes of health inequities, including the interactions and reinforcement of individual, systemic, and societal factors, is critical for improving health outcomes and reducing health disparities across communities.

Globally and within countries, redressing inequalities requires a comprehensive and careful examination of individuals and communities that are being left behind and why, formulating effective strategies to address root causes, monitoring and measuring progress, and ensuring accountability to those who are left behind (20, 21). This would also require analysing the existing situation and generation of evidence disaggregated beyond gender, geography, and age to include all forms of inequality and their root causes identified and addressed using appropriate and acceptable strategies.

A key component is that policies and programs addressing individuals and communities left behind require stakeholders' active and meaningful engagement, particularly those who have been left behind (10, 22). Furthermore, there is a need to focus on policies, programs, and practices other than the health system that impact health and health equity. For example, the availability and accessibility of transportation infrastructure affect access to health care; employment and affordable healthy foods are also important drivers of health and wellness (16, 17, 23).

1.1.2 Universal health coverage

Universal health coverage (UHC) refers to a situation where all people, regardless of their socioeconomic status, geography, race, or any other defining character, have equal access to the health services they need, when and where they need them, without facing financial hardships (3, 4).

Health is an integral part of the Sustainable Development Goals (SDGs). Ensuring UHC is the ultimate goal that health systems strive to achieve (24). For example, the SDG 3.8 aims to "achieve universal health coverage, including financial risk protection, access to quality essential healthcare services, and access to safe, effective, quality, and affordable essential medicines and vaccines for all" (16). However, the path to UHC has been challenging for all countries, even for some developed nations, more so for the developing countries (21). The challenges health systems face in addressing health inequalities exacerbated by catastrophic health expenditure and poor quality of care highlight the need for more efforts and effective political engagement in achieving UHC (25).

Although countries across the globe have committed to ensuring universal health coverage for all, about half of the people in the world do not receive the health services they need. Approximately 100 million people are exposed to catastrophic health expenditures and are pushed into extreme poverty each year (26). Ensuring health for all requires providing high-quality health services for individuals and communities so that they look after their own health and the health of their families (27).

1.1.3 Social determinants of health

How long people live in this world varies dramatically depending on socioeconomic status, education level, place of birth, and country of residence. Higher levels of illness and premature mortality are more common among the poorest of the poor. Health and illness follow a social status: the lower the socioeconomic position, the worse the health (28). According to WHO, health is a human right, which affirms and envisions "the highest attainable standard of health as a fundamental right of every human being." Therefore, any systematic differences in health status are judged unfair, unreasonable, and thus should be avoided (4).

Health inequalities can be explained from different perspectives (29). The first perspective is the social selection perspective which implies that health determines socioeconomic status instead of socioeconomic status determining health (1, 2). The assumption here is that health exerts a substantial effect on attaining a social position, resulting in a pattern of social mobility through which healthy individuals move up the social class and unhealthy drift down. The second perspective, the social causation perspective, suggests that the social position determines health through intermediary factors. The social causation perspective suggests a higher risk of developing health problems in the lower socioeconomic groups as the primary explanation for socioeconomic inequalities in health (2).

The third perspective, the life course perspective, indicates the importance of time and timing as a cause of health inequalities by explaining the causal links between exposures and outcomes within an individual life course, across generations, and in population-level disease trends (29, 30). This perspective explains how social determinants of health operate at all

levels of development—early childhood, childhood, adolescence, and adulthood—to immediately influence health and provide the basis for health or illness later in life (31).

The social determinants of health are forces, systems, and sectors that influence health outcomes. They are the broader set of forces and systems that shape daily life conditions where people are born, grow, work, live, and age (1, 2). These forces and systems can be divided into two broader sections that include structural determinants and intermediary determinants of health (32).

The main groups of intermediary determinants of health, such as material, psychosocial, behavioural and biological factors, play an important role in explaining health inequalities (31, 33, 34). Material factors can include housing, the physical working environment, and the living conditions of people. People who have more capacity in terms of knowledge, money, power, and social connections are better able to avoid health-related risks and adopt the protective strategies that are available at a given time and place (31, 35). Psychosocial factors are relevant factors that include stressors (e.g., negative life events), lack of social support, and stressful living circumstances that can significantly affect individuals' health status. Behavioural factors, such as excessive alcohol consumption and smoking, can have a detrimental effect on the health status of an individual (36, 37). On the contrary, physical exercise and access to healthy food are important for a healthier lifestyle (35).

Health inequalities occur when the quality of these intermediary factors are unevenly distributed across the different socioeconomic levels: socioeconomic status, in turn, determine a person’s living standards and behaviour, and these determinants cause a higher or lower prevalence of health problems (16, 27).Structural determinants of health inequalities refer to the interplay between the socio-economic and political contexts, as well as structural

mechanisms generating social stratification and the resulting socioeconomic position of individuals (32). The socioeconomic positions of individuals, in turn, determine their health status.

Socioeconomic position of individuals can be measured using three major variables; wealth status, education, and occupation (38). Income is an important indicator of socioeconomic position that measures the material resources available to an individual or a household. There is a strong association between income and an individual's health status (39). In many instances, though, household income may be a useful indicator than measuring individual-level income since assets and resources are shared among household members. Household income/wealth can influence a wide range of material circumstances with direct health implications. The higher the wealth status, the better the health status because as wealth increases, access to healthcare improves (40).

Educational status is another important social determinant of health. Education begins at an early age and is impacted by access to and performance in primary and secondary school, and reaches the final stages in young adulthood for most people (41). It shows the long-term influences of both early life circumstances on adult health and the influence of adulthood status (e.g., through employment status) on health. The knowledge and skills acquired through education may affect a person’s cognitive ability, make them more responsive to health education messages, and enhance their ability to communicate with and access appropriate health services (41). Occupation is strongly related to income and an individual’s living standards. The monetary and other tangible rewards for work, on the other hand, determine access to and use of health services. It may also reflect specific work-related hazards that may have harmful health effects (42).

According to the WHO Commission on Social Determinants of Health, improved health outcomes may be attributed to improved non-medical sectors than the health care system itself. Several studies indicate that social determinants of health contribute to 30-55% of health outcomes observed (4, 43). In addition, estimates show that sectors outside health contribute to population health outcomes more than the health sector itself (28).

Figure 1.1 shows the conceptual framework for action on social determinants of health used to explain health inequalities in this study. Frameworks help to understand and explain complex issues such as social determinants of health by clarifying the impact of health and non-health factors on the well-being of individuals, communities and populations (1, 2, 44). Having a clear framework enables health managers and policymakers to understand the complex relations between various determinants of health and generate innovative plans and policies to reduce health inequities experienced by certain population groups effectively.

A conceptual framework developed by the WHO Commission for action on Social Determinants of Health is commonly used to explain and address health inequalities. This framework lays out key dimensions and directions for policy, focusing on intersectoral action and social participation and empowerment at the global, public policy, individual and community levels (1, 2). It is an explanatory, interactive, and action-oriented framework that helps identify the root causes and pathways of health inequalities among social groups (44, 45). This framework was used for this study as it takes account of a holistic and intersectoral action, recognises social exclusion, the role of individuals and communities, the importance of income and social status, or early childhood development, and clear identification of interactions between determinants (3, 4, 44).

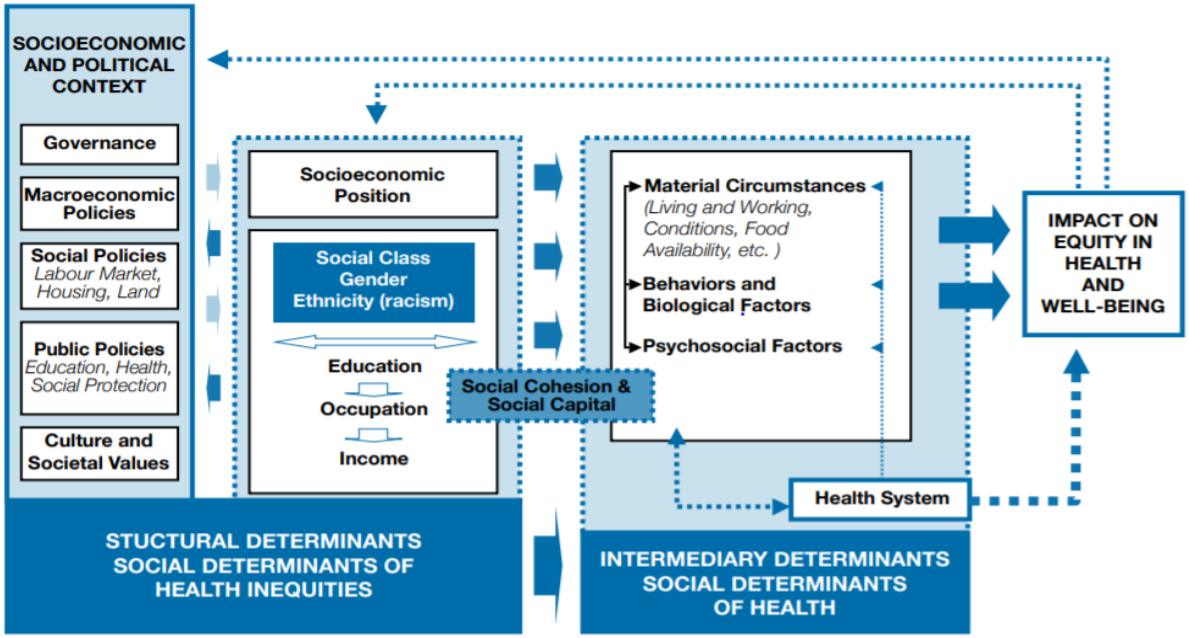

Figure 1-1 Commission on Social Determinants of Health conceptual framework. Source WHO (2)

1.1.4 Defining quality of healthcare

Despite having significant importance, quality in healthcare is difficult to define and measure. Quality of care can have varying definitions based on the context. The relevant dimensions of care and values used to measure quality largely depend on the underlying goals and setting of the health service delivery (46, 47).

Donabedian's framework for quality improvement in healthcare is the most commonly used conceptual framework in the health sector (48). Figure 1.2 shows the relationship between structure, processes, and health outcomes. The structure of healthcare includes the physical and organisational aspects of the health systems. Structural elements include all the factors affecting the environment in which care is provided, including the availability of drugs and equipment, physical infrastructure, staff availability, and organisational characteristics such as staff training and payment methods (48, 49). Structural measures alone do not provide

comprehensive insight into the state of quality of healthcare as the relationship between structure, process and outcomes is complex (48).

The process measure of quality is concerned with carrying out patient care activities. The assumption regarding processes is that if healthcare is provided in compliance with scientific recommendations, potentially attainable outcomes will be achieved. Process elements include all the activities that make up health care, from diagnosis to treatment, and preventative actions such as community-based outreach activities, patient education, and counselling (50). Processes can further be classed as interpersonal processes (representing the manner in which care is provided) and technical processes (representing how care is delivered) (51, 52).

The outcome aspect is concerned with the change observed in beneficiaries health status (individuals or population) that is attributable to healthcare (48, 53). Outcome measures of quality include an assessment of healthcare impacts on the population, whether it be changes in health-related knowledge and behaviours, patient satisfaction or quality of life, or changes in mortality and morbidity rates (54). Outcome indicators are difficult to measure because of limitations regarding causality, mainly due to many external factors other than medical care that may influence outcomes. A comprehensive measurement of the quality of care thus requires all three dimensions to be included in the analysis (50, 54).

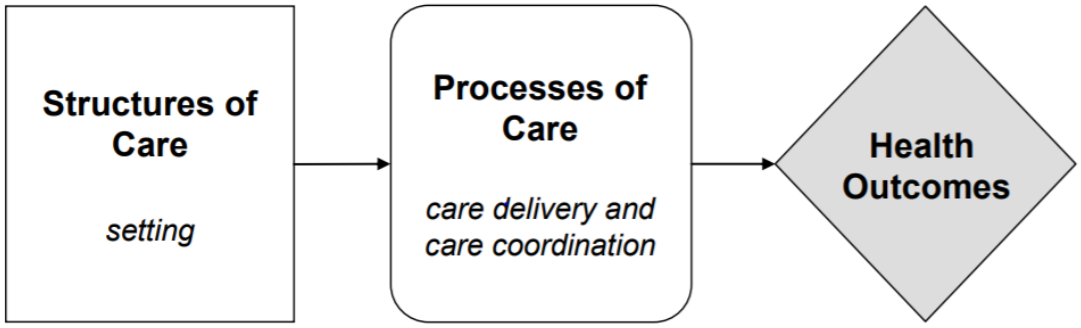

Figure 1-2 Donabedian's framework for quality improvement in healthcare. Source (48)

Another important framework to understand or measure quality in healthcare is the one developed by the WHO (49). The framework identifies six quality dimensions that health systems should seek to improve and frames these as goals that health systems should strive to achieve. The WHO framework defines standards of quality health care as care that is safe (delivering care that minimises risk to patients), patient-centred (providing culturally appropriate care taking into account individual preferences), effective (delivering evidence-based care that results in improved health outcomes), equitable (delivering care that does not vary in quality because of patient characteristics), timely (providing appropriate, geographically reasonable care with minimal delay), and efficient (delivering care in a manner that best uses available resources) (49, 55). These achievement benchmarks drive the actions to be taken, which may occur as actions targeting regulations and standards, leadership, patient and population engagement, information, organisation capacity, and models of care.

The WHO Quality of Care Framework for Maternal and Newborn Health, developed by Tuncalp et al. in 2016, is another comprehensive guide for evaluating the quality of care provided to mothers and newborns during pregnancy, childbirth, and postpartum. The framework is designed to ensure that care is centred on the needs, preferences, and values of women and their families. Quality of care is defined as being safe, effective, patient-

centred, timely, efficient, and equitable. The framework defines six domains of care: readiness and access to care, continuity and coordination of care, informed choice, respectful and dignified care, labour and childbirth support, and postpartum care. The framework also emphasises the importance of providing care in a timely and efficient manner, as well as ensuring that health care providers have the necessary knowledge, skills, and resources to provide high-quality care. The WHO Quality of Care Framework is an effective tool for assessing and improving the quality of maternal and newborn healthcare, and it can help to ensure that care is centred on the needs of women and their families.

WHO is also a strong advocate for women-centred care and has developed guidelines and tools to support its implementation. Women-centred care is a healthcare approach that prioritises women's needs, preferences, and perspectives. This approach places women at the centre of the healthcare experience, from the design and delivery of health services to the interpretation and use of health information. The purpose of women-centred care is to ensure that maternal health services are of high quality and meet the specific needs of each woman.

Women-centred care approaches typically include a variety of strategies, such as involving women in decision-making, providing comprehensive health information and education, and providing personalised and culturally appropriate care. Furthermore, multidisciplinary teams of health care providers frequently collaborate to provide a continuum of care, from preconception to postpartum and beyond.

Women-centred care has been shown to improve maternal health outcomes by prioritising women's needs and perspectives, including lowering maternal mortality and morbidity and increasing women's overall satisfaction with their healthcare experiences. A women-centred

care approach can also help to address some of the root causes of health inequities, such as poverty, a lack of education, and discrimination.

1.1.4.1 Measuring quality of healthcare

Evaluating the quality of care primarily depends on the definition of quality, but one would also need to consider the type of data available or the way in which data regarding quality dimensions is collected (49). Measuring specific quality dimensions would often require different data collection techniques, each of which has advantages and limitations.

The most common method for collecting data on quality of care is through facility-based records screening (56). Data for structural elements of quality can be gathered from a range of sources including annual reports and organisational and accounting documents – from which indicators such as staff, drug, and equipment availability may be drawn. Sources for process indicators can include individual patient records from which indicators such as diagnosis and treatment of patients may be drawn. Outcome indicators such as case fatality rates is also available from facility records.

There are many ways and sources for collecting health care quality data, such as direct observations, facility surveys, exit interviews with patients, standardised patients, clinical vignettes, and patient follow-up interviews where good quality records are unavailable. For example, the direct observation approach involves – interviewers following a particular health provider, noting physical surroundings, sitting in on patient-provider consultations, and recording the provider's actions (57). Household surveys present another opportunity for

collecting data on quality of care. Surveys are very effective for collecting data on client perspectives, their care experience, and reasons for health-related decision-making.

1.1.5 The link between equity and quality

The assumption that equity is all about the ease with which one can access healthcare is a common misconception (58). However, there's a wider and growing acknowledgement in the literature that access alone is not enough. Inequities are indeed caused by a lack of access to care among poor and marginalised subgroups that cannot afford healthcare (45). However, studies have shown that even when there is equitable access to care, the poor, racial and ethnic minority groups tend to receive lower-quality care (25). This shows how health improvements can remain elusive even with increased and equitable access to services unless those services are of sufficient quality to be effective. This also implies that quality improvement initiatives that only focus on the population at large, but fail to address racial and ethnic differences, can result in unequal quality (59, 60).

There is a strong connection between equity and quality in healthcare. Achieving health equity involves ensuring that all people who need health services receive high-quality care without financial hardship (4). Providing quality care also implies equitable care that does not vary in quality because of someone's race, gender, income or location. Without equity in quality of care, equity in health outcomes is impossible; hence, quality improvement initiatives that lack attention to equity will fail to address those most in need (59). Therefore, health systems must strengthen both equity and quality of health services (i.e., promotive, preventive, curative, rehabilitative and palliative) to improve population health outcomes, and this is in line with what the UHC campaign promotes – not just access to any health care but access to quality health care.

1.2 Significance of the research

Before 2000, global health literature on equity in MCH in LLMICs was sparse (61). This has led to the assumption that all women and children in LLMICs are equally poor, which resulted in a lack of attention to health intervention strategies that address inequalities (61). This situation has changed in the past couple of decades, and stronger attention has been given to ensuring health equity since the introduction of SDGs with the notion that progress should be measured not only by overall rates of change but also by how well the poorest and most vulnerable subgroups of the population are reached (62, 63).

Multi-country or country-level assessments of inequalities in MCH coverage have been published before, but those studies have mostly been limited to wealth-related inequalities (64-66). In many of these studies, wealth index has been largely used as the only indicator of social exclusion and vulnerability. The wealth index estimates socioeconomic status and is already available in several household surveys in LLMICs. It can be used to divide the population into quintiles (i.e., five groups) based on a household's ownership of selected assets, such as televisions and bicycles, housing materials, and drinking water and sanitation facilities, and is measured using principal component analysis (67).

Recently, more evidence has been available on inequalities in the coverage of health services across LLMICs. This evidence suggests that the progress across LLMICs has been uneven along with the factors such as geography, gender, religion, ethnicity, wealth, and other socioeconomic factors (35, 37, 40). Many studies have reported socioeconomic inequalities in access and coverage of MCH services (20, 22, 61, 68). These studies showed that improved access and coverage of health services are concentrated among the wealthier, educated, and

those living in urban areas. The poorer population groups in LLMICs, especially in sub-Saharan Africa, were found to be less likely to use health services. Even within urban areas, coverage may be lower among those living in urban slums and in other vulnerable groups (69).

Equity and reducing inequalities are key agendas for the SDGs. SDG 3 specifically calls for universal health coverage and access for all to quality essential medicines and vaccines. Achieving SDG3 will not only require examining inequalities in coverage of health services but also giving due attention to effectively analysing, monitoring, and addressing inequalities in access to quality health services (16). However, as studies focused on examining inequalities in coverage of health services, not much is known about inequalities in access to quality MCH services. In part, this could be due to the difficulty of measuring the quality of care as it is complex and requires examining its multidimensional constructs (7). It could also be because many countries could not provide sufficient health services, and when quantity is lacking, quality is often not a priority. Many countries have dealt with the quantity problem over the years, not 100% still, but the availability of health services has improved significantly. Good quality of care includes but is not limited to access to effective health interventions and strengthened health infrastructure and attitude of health workers, resulting in satisfaction of patients and providers and improved health outcomes (7). As part of strategies to improve MCH care, great emphasis has been placed on improving coverage of life-saving MCH services (22, 62). Although coverage can be objectively monitored and assessed, other quality dimensions are hard to measure.

Generally, there is a lack of evidence on the status of equity in access to quality MCH services worldwide, especially across sub-Saharan African countries. Existing evidence generally depends upon the facility-based records and focuses on higher-level care that may not

represent community and primary level health services critical for addressing the quality gap (70, 71). Generating evidence on quality of care at multiple levels of the health system and the need to measure quality of care among disadvantaged groups is the key to initiating and strengthening quality improvement efforts in LLMICs (4, 8, 9). Much of the existing literature explores structural and outcomes-based measures of quality, omitting process-based measures necessary to examine how health system elements interact and essential to how patients perceive the quality of care (72, 73).

Equitable access and use of health services is a priority concern for health systems in all countries. Exploring variations in the quality of services provided to women at all socioeconomic levels and examining the gap in the quality of services offered at the health facilities would help focus intervention strategies. Inequalities in access to quality MCH services should also be analysed across other dimensions of vulnerability. As measured by wealth indices, economic poverty does not reflect the full complexities of social disadvantage. A wider set of social determinants that potentially affect health include geographic location, age, education and access to a health facility, and employment status. Therefore, additional work is needed to update the description of inequalities using recent data and determine the magnitude of inequalities in access to quality MCH services across dimensions of vulnerability other than the wealth index, using comparable measures that enable cross-country comparisons. To that end, we aimed to systematically address this gap and examine inequalities in access to quality MCH services in sub-Saharan Africa. Specifically, we showed distributions and spatial patterns of key MCH services in sub-Saharan African countries. We further explored within and between country wealth-related inequalities in access to quality

MCH services. We then identified predictors of inequality in the use of MCH services and discussed the implications of our findings for health policy and practice.

1.3 Research aims and objectives.

The aim of this research was to examine spatial patterns, estimate socioeconomic inequities in access to quality maternal and child health services, and investigate drivers of inequality in access to quality maternal and child health services in sub-Saharan Africa (Figure 1.3).

1. To assess inequality and drivers of inequality in access to quality antenatal care in nine east-Africa countries (Chapter four)
2. To assess inequality and drivers of inequality in the access to skilled birth attendance and caesarean delivery in sub-Saharan Africa (Chapter five)
3. To assess inequality and drivers of inequality in access to continuum of care for maternal health services in sub-Saharan Africa (Chapter six)
4. To assess inequality and drivers of inequality in full vaccination coverage among 12-23 months children in Sub-Saharan Africa (Chapter seven)
5. To assess inequality and drivers of inequality in full vaccination coverage among 12-23 months: the case of Ethiopia (Chapter eight)

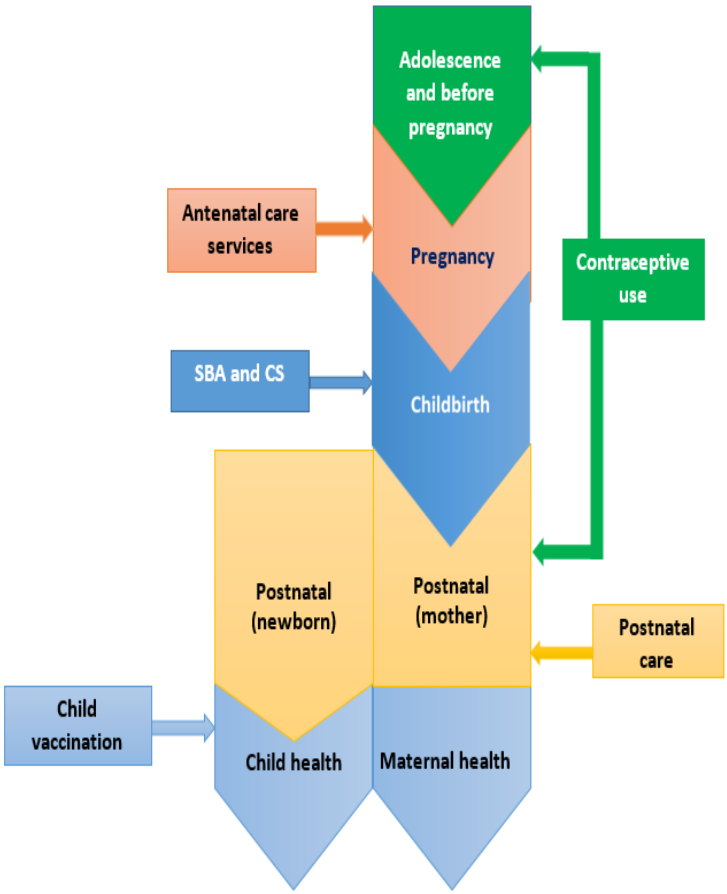

Figure 1-3 continuum of care for maternal, newborn and child flowchart

1.4 Thesis structure

This thesis presents spatial patterns, socioeconomic inequalities, and drivers of inequality in access to quality MCH services using a set of tracer indicators that provide a good picture of overall MCH services coverage in sub-Saharan Africa. The thesis consists of five research papers that investigate equity in access to MCH services, along with an introductory chapter, methods chapter, and a concluding discussion chapter. Findings and detailed descriptions of the methodology used in the study are found in the respective manuscript chapters. Each chapter is described below:

Chapter one: provides descriptions of basic concepts mentioned in this thesis, including universal health coverage, health inequalities, social determinants of health, and quality of care measures. This chapter also covered the rationale for the thesis, its goals, and the intended outcomes.

Chapter two: presents a literature review on equity in access to quality MCH services. Here we discuss an overview and gaps in understanding inequalities and determinants of access to quality MCH service use.

Chapter three**:** covers the methodologies and materials employed in scrutinising the datasets utilised in Chapters 4-7. The study drew data from the Demographic and Health Survey, which was conducted between 2013 and 2021. This section also elaborates on the primary statistical and analytical approaches utilised in each research paper integrated into the thesis.

Chapter four: contains a manuscript that provides a comprehensive assessment of inequalities in the use of quality antenatal care by examining the adequacy of both contact and content of antenatal care in nine east-African countries.

Chapter five**:** presents a manuscript on spatial patterns, wealth-related inequalities, and drivers of inequality in skilled birth attendance and caesarean delivery in sub-Saharan Africa.

Chapter six: contains a manuscript on inequities in access to the continuum of care for maternal health services in sub-Saharan Africa. This chapter reports on the extent of dropouts along the continuum of care in these countries. Further explored within-country wealth-related inequalities across the continuum of care. Predictors of inequality in the continuum of care were also identified, and implications of our findings for health systems were discussed.

Chapter seven: contains manuscripts that reported on inequality and drivers of inequality in vaccination coverage in sub-Saharan Africa. We measured wealth-elated inequality in full vaccination, incomplete vaccination, and zero-dose children within and between countries. In addition, this manuscript also reported on drivers of inequality in full vaccination coverage.

Chapter eight: we present drivers of inequality for receipt of full vaccination. This chapter also contains a manuscript that examines inequities in full vaccination coverage among 12-23 months children in Ethiopia using two waves of DHS (2011 and 2016). We measured wealth-related inequality in full vaccination, incomplete vaccination, and zero-dose children within and between countries. We used decomposition analysis to explain inequality in receipts of full vaccination.

Chapter nine: provides an organised and contextualised interpretation of the main findings of this thesis and discusses policy and practice implications for future research directions. We have also discussed the strength and limitations of using demographic health survey data.

Chapter Two: Maternal and child health services in sub-Saharan Africa: A literature review

This chapter provides a review of the literature focused on inequalities in access to quality MCH services in sub-Saharan Africa. It is not intended to be systematic or exhaustive. However, it presents an overview of the current situation and gaps in understanding inequalities and determinants of access to quality MCH services. The purpose of this literature review is thus to establish the conceptual background for this thesis by providing an overview and summary of existing knowledge examining inequalities in access to quality MCH services, including antenatal care, intrapartum care, continuum of care, and child vaccination in sub-Saharan Africa.

Although this literature review focuses on sub-Saharan Africa, articles from other regions, including high-income countries, were included where deemed necessary. Electronic database searches were made in MEDLINE/PubMed, with additional articles searched in Google Scholar. Bibliographies of some articles were checked for key studies. The primary focus of the search was (i) antenatal care, antenatal care quality; (ii) skilled birth attendance, intrapartum care, caesarean delivery; (iii) continuum of care; and (iv) child vaccination. We first present the importance of key MCH services. We then reviewed the evidence on inequalities in access to those key MCH services.

2.1 Overview

Ending preventable maternal mortality continues to be a critical challenge worldwide, particularly in LLMICs (74). Many countries have failed to achieve the Millennium Development

Goals (MDG) set to reduce maternal mortality by three quarters (75). Efforts during the MDGs era reduced maternal mortality by 45% worldwide, but still, 800 women die each day from mostly preventable causes related to pregnancy and childbirth (14). Women living in LLMICs face a higher risk, as 99% of maternal mortality occurs in those countries (14). Within countries, the risk of death is concentrated among economically disadvantaged, less educated, minority groups, and those living in rural areas (76).

The five leading causes of maternal mortality—which collectively account for 75% of such deaths—are severe bleeding (most commonly postpartum), infections (typically after delivery), high blood pressure during pregnancy (pre-eclampsia and eclampsia), complications during delivery, and unsafe abortion practices. These causes can largely be prevented with access to quality maternal health care services such as prenatal care, skilled birth attendance, emergency obstetric care, and family planning options. (74). On the other hand, indirect causes of maternal mortality are underlying health conditions or diseases that are unrelated to pregnancy or childbirth but can increase the risk of maternal mortality. Anaemia, malaria, tuberculosis, cardiovascular disease, and HIV/AIDS are among the leading indirect causes of maternal mortality. These underlying conditions can have a negative impact on a woman's overall health, weaken her immune system, and increase the risk of complications during pregnancy and childbirth.

The direct and indirect causes of maternal mortality frequently interact with one another, increasing the risk of maternal mortality. A woman, for example, who has a pre-existing health condition like anaemia or malaria may be more vulnerable to infections during pregnancy and childbirth. Similarly, a woman living with HIV/AIDS is more likely to develop high blood pressure during pregnancy and have complications during delivery. Addressing both the indirect and

direct causes of maternal mortality is critical in these cases for lowering the risk of maternal mortality.

In 2015, the highest maternal mortality rates were in sub-Saharan Africa, with a lifetime risk of 1 in 36; the lowest rates were in developed nations (1: 4900), with a global ratio of 180 maternal deaths per 100,000 live births (14). Global MDG target set to reduce under-5 mortality by two-thirds failed to hit the target. During this period, under-5 mortality reduced by 53% and therefore missed the MDG 4 target that planned reduction by two-thirds. Sub-Saharan Africa and South Asia were the regions that had the highest under-5 mortality (77). Maternal and under-5 mortality could largely be prevented using key interventions that include family planning, antenatal care, access to skilled labour and emergency care, and full vaccination of under-5 children (23).

Despite the encouraging progress in increasing coverage across MCH programs, most countries are still far from universal coverage (22). Coverage is inadequate for all interventions along the continuum of care. In LLMICs, in particular, sub-Saharan Africa, quality of care is increasingly identified as a primary aspect of the unfinished maternal and newborn health agenda, mainly with respect to care around antenatal care, childbirth, and the immediate postnatal period (25).

2.2 Status of equity in access to quality maternal and child health services

Improving the quality of care and ensuring equity in health outcomes is a common objective of health systems in all countries (4). This has gained greater popularity with the adoption of the SDGs, which set universal health coverage (UHC) as a critical target for all nations on the globe (25). Over the past two decades, global monitoring and reporting indicators used for tracking MCH coverage have increased considerably, but declines in maternal and neonatal death have

remained slow (14). In 2015, more than 800 women died each day from complications related to pregnancy and childbirth. Almost all (99%) of these deaths occurred in developing countries, more specifically sub-Saharan Africa (14).

In LLMICs, encouraging progress has been made in increasing access to health services (25, 78). However, the quality of care across different countries and health status remains low and impedes progress to improving health outcomes (79). Improvements in coverage of maternal and newborn health have not reproduced anticipated progress in impact indicators related to maternal and newborn survival (7). The global measures of coverage of maternal and newborn health are recognised to capture only contacts with the health system with insignificant information about the quality of care received. However, maximising coverage of measures focused on contacts alone is not sufficient to reduce maternal, newborn and child mortality (80-82). Accompanying increased coverage of services with recommended service contents would significantly contribute to the move towards the elimination of preventable causes of maternal and child mortality (81-83).

Globally recognised key healthcare interventions can prevent the death of women from pregnancy-related causes (81-83). Attendance of antenatal care, birth at facility and having a skilled health worker at birth improve maternal health (23, 81-85). Nevertheless, the use of these services is limited in developing countries, including sub-Saharan Africa. The use of maternal and child healthcare is also reported to vary within developing countries, with most findings showing differences between wealthy and poor women, and between women living in rural and urban areas (86-90).

During the MDG era, the main focus of LLMICs was improving access to health care services (91). While the focus on increasing access to health care services has resulted in substantial

improvements in health service coverage in many countries, the quality of health care has lagged behind (92).

Coverage improvements also showed variation across countries. In some countries, coverage has improved markedly, but the quality of care remains low, while in others, both coverage and quality of care remain problematic (25). For example, coverage of four or more antenatal care visits in Ghana increased from 63.7% in 1998 to 87.3% in 2014, while full vaccination among children increased from 62% in 1998 to 77.3% in 2014 (93). In Ethiopia (94), coverage of four or more antenatal care increased from 10.4% in 2000 to 31.8% in 2016, and full vaccination among children increased from 14.3% in 2000 to 38.5% in 2016. In Nigeria (95), relatively lower coverage changes were observed: four or more ANC visits was 50.9% in 1990 to 56.8% in 2018, while full vaccination among children increased from 29% in 2000 to 31.3% in 2018. With increasing coverage, inequalities in access to MCH services decreased (61). This indicates that with lower national coverage of MCH services, the poor are less likely to access health services.

Currently, the more significant barrier to reducing mortality is not poor coverage but the poor quality of care (25). Poor quality care has resulted in 60% of deaths from conditions amenable to the health care system, while the impact of barriers to access and failure to utilise health care resulted in the remaining 40% mortality (79, 96). Improving the quality of facility delivery by providing effective care for all women and newborn babies could prevent an estimated 113,000 maternal deaths, 1.325 million neonatal deaths, and 531,000 stillbirths annually by 2020 (23). Similarly, increasing coverage and quality of preconception, antenatal, intrapartum, and postnatal care services by 2025 could avert 71% of neonatal deaths, 33% of stillbirths, and 54% of maternal deaths per year (23). Improving health care quality is thus primarily identified as an important target in ending preventable morbidity and mortality among mothers and

newborns (7). Concurrently, interventions proposed to improve the quality of care should consider socioeconomic differences and needs of communities, particularly economically disadvantaged and less educated populations, and those living in rural areas.

2.3 Antenatal care

Antenatal care is a proven intervention that helps reduce complications during pregnancy, childbirth, and postpartum periods (23, 82). Before 2016, the WHO recommendation for women with uncomplicated pregnancies antenatal care follow up were at least four contacts. However, WHO (2016) recommendations on ANC for a positive pregnancy experience suggest that women with uncomplicated pregnancies should have a minimum of eight ANC contacts (97). It also recommends that the first ANC contact occurs in the first trimester, before 12 weeks of gestation (98, 99). The guideline also provides recommendations on services women should receive during antenatal care. Services provided during ANC contacts may include but are not limited to weight and height measurement, blood pressure monitoring, urine and blood samples tests, HIV testing and counselling, tetanus vaccination, iron supplements, malaria prophylaxis, drugs for intestinal worms, nutritional counselling, counselling on signs of complications, and counselling on where to go in case of complications (79, 84, 100-102).

Good-quality prenatal care is vital to reducing maternal, neonatal, and infant mortality (82, 103). Improved quality of ANC also helps to retain further care and increase the likelihood of giving birth in a health facility, which could further improve maternal and newborn outcomes (104).

The number of ANC contacts is considered the leading monitoring and evaluation indicator to measure maternal health program performance in many LLMICs (102, 105, 106). This has drawn the attention of health care managers to the number of contacts rather than the content and

process of care. The gap between contact and content indicates ineffective and inefficient care, which also means missed opportunities to achieve better outcomes (83).

2.3.1 Inequalities and determinants of antenatal care use

Several studies have been conducted examining inequalities and determinants of ANC utilisation. A study across 54 countries that analysed 12 maternal, newborn, and child health interventions found that skilled attendant at birth was the most inequitable indicator, followed by four or more ANC visits with an overall coverage of 49.5% and a difference of 34.6% percentage points between women in the poorest quintile and those in the wealthiest (107). Several studies exploring the determinants of ANC consistently found that women from the wealthiest households, living in urban areas, having higher levels of education, and having higher empowerment levels are more likely to have an early initiation, seek recommended number of antenatal care visits or have good quality ANC (108-110). Another study conducted across 64 countries found that women with secondary or more education, belonging to wealthier households, those living in urban areas, and higher empowerment received higher quality ANC in nearly all countries (111).

Recently, more emphasis has been given to assessing the quality of antenatal care services by focusing on the number of visits and the services received during these visits. Previous studies have looked at various aspects of ANC, such as blood pressure measurement, blood and urine tests, tetanus injections, iron supplementation, and other services. According to those studies women who received all these services were considered to have received adequate/high-quality ANC, whereas those who missed one or two were considered inadequate/low-quality. A new study proposes using a single indicator to monitor the quality of ANC, taking both contact and the content of care into account (112, 113). The study assigns weights on various

interventions based on their importance and includes key elements of high-quality ANC such as the first visit in the first trimester, at least one visit with a skilled provider, and as many ANC-related interventions as possible.

A study conducted across 91 nations found that, on average, 89.7% of women attended at least one ANC visit with a skilled provider. However, only 72.9% of these women reported having their blood pressure checked and urine and blood samples taken for tests during their ANC visit (79). The study found that quality lagged behind coverage in low-income countries, where 86.6% of women had at least one ANC visit, but only 53.8% reported having their blood pressure checked, urine, and blood samples tested. At the same time, coverage was 87.8%, and quality was 74.8% in lower-middle-income countries (79). But, in upper-middle-income countries, levels of coverage (96.1%) were closer to the quality (93.3%) of care received (111).As discussed above, many studies have examined the prevalence and associated factors of ANC utilisation while few studies have attempted to evaluate the quality of ANC using four or more ANC contacts (114) and satisfaction (115) of women towards antenatal care services provided at the health facilities as a proxy indicator for ANC quality. Some studies have indicated a positive but weak association between utilisation of antenatal care and maternal health outcomes, which could partly be due to the failure to take into account the content and quality of prenatal care provided (105, 106, 116). This indicates that it is not only the contact that results in better outcomes, but the actual content of the service delivered. The lack of consistent research on the adequacy of antenatal care services across many east African countries highlights the need for research to be conducted in this area. Therefore, assessing the gap between contact and content of antenatal care and identifying factors associated with the delivery of all ANC components is of paramount importance to improve the quality of prenatal care. In this thesis,

I present research that can contribute valuable insights and support the development of policies and programs aimed at enhancing maternal and newborn health outcomes in East Africa.

2.4 Skilled birth attendance and caesarean section

Every year, around 140 million births occur globally (11). Most of these births have no known risk factors for complications at the onset of labour, either for pregnant women or newborn babies (11, 117). However, the risk of morbidity and mortality increases for the woman and baby if complications arise during labour (118). During labour, childbirth, or the immediate postpartum period, complications cause over a third of pregnancy-related life-threatening conditions and maternal deaths (119). Similarly, complications during labour and childbirth cause approximately 50% of stillbirths and 25% of neonatal deaths (11).

Women are encouraged to deliver at facilities to ensure access to skilled health care professionals and timely referrals in case of emergency complications. However, access to care is limited in LLMICs, and when there is access, it is not guaranteed that women will receive good quality care (120). Disrespectful and abusive care is common in many facility settings globally, particularly for disadvantaged populations, which not only violates women's human rights but is also a significant barrier to accessing intrapartum care services (121).

2.4.1 Inequalities and determinants of skilled birth attendance and caesarean section

Globally, the percentage of births attended by skilled care providers increased from 59% in 1990 to 81% in 2019 (122). However, in sub-Saharan Africa, only 59% of births were assisted by skilled health personnel in 2017, compared to 90–95% in South America and 99% in high-income countries (123). This rate is below the global target of having SBA coverage of 90% for

all births (123). Urban-rural disparities are also significant in LLMICs; in urban areas, 87% of births were attended by skilled birth attendants, but it was 56% in rural areas (11).

Home deliveries were common among the poor in sub-Saharan Africa, South Asia, and South-East Asia. However, a trend analysis conducted across developing nations reported an increase in health facility births (124). Women from wealthier communities were more likely to have health facility births than those from poorer communities across all the regions.

Optimal pregnancy outcomes for both the mother and the newborn require quality maternity services during pregnancy, delivery, and the postnatal period (125). This includes skilled birth attendance and access to emergency obstetric care for women with a complicated pregnancy, childbirth, or postpartum period. Emergency obstetric care (EmOC) is a package of evidence-based care critical to saving the lives of women with obstetric complications during pregnancy and childbirth and the lives of newborns during the intrapartum period (126). There are two types of EmOC services: basic emergency obstetric and neonatal care (BEmONC) and comprehensive emergency obstetric care (CEmOC). EmOC plays an important role in reducing maternal mortality (126). However, countries with high maternal mortality reported an insufficient number of EmOC facilities. A systematic review reported that the global met need for EmOC is 45%; the coverage gap was very high between high-income (99%) countries and low-income (21%) (127).

Caesarean delivery is one component of CEmOC services. For more than three decades, the recommended ideal rates for caesarean sections used by the international healthcare community ranged between 10% to 15% (128). The WHO conducted a systematic review and ecological analysis to deal with the intense criticism and controversies about caesarean section rates (129). In this study, it was found that an increase in the caesarean section rate up to 10%

at the population level was associated with a reduction in the number of maternal and newborn deaths. However, an increase in the caesarean section rate beyond 10% did not show a reduction in maternal mortality (130).

The rising rate of caesarean section (CS) deliveries has been a source of concern around the world, with some countries reporting CS rates of 50% or higher (131). With advances in medical technology, healthcare providers are now able to identify and manage potential complications during pregnancy and delivery, resulting in a higher rate of CS when medically indicated (132). This has greatly improved maternal and newborn outcomes, lowering the risk of maternal and newborn deaths and allowing for the management of obstetric emergencies. However, there are also non-medical factors driving the increasing CS rates (133). Some women and their healthcare providers may choose this method due to its perceived convenience and predictability, while others may choose it due to a fear of vaginal delivery or previous traumatic birth experiences. These non-medical drivers are concerning because they can lead to overuse of the procedure and unnecessary complications for both mothers and babies.

The use of caesarean delivery raises a number of complex issues. On the one hand, both developed and developing countries are seeing an increase in unnecessary caesarean sections. On the other hand, many women in remote areas die as a result of a lack of access to health facilities capable of providing quality caesarean delivery services (132-135). Unnecessary CS is a procedure performed without a medical reason. This can have a negative impact on both mothers and babies, including an increased risk of complications for the mother, longer recovery times, a higher risk of future complications in subsequent pregnancies, and an increased risk of breathing problems and admission to neonatal intensive care units for the baby (136-138).

There are continuing inequalities in the rate of caesarean delivery between developing and developed nations (66). Overall, 18.6% of all births occur by caesarean section ranging from 6% in the least developed regions to 27.2% in most developed regions (137). In 2008, according to the WHO estimate, 6.2 million unnecessary caesarean deliveries were done, but 3.2 million women in developing countries who needed caesarean deliveries lacked access (136). There are continuing inequalities in the rate of caesarean delivery between developing and developed nations. Between 1990 and 2014, there was an increasing trend in the global rate of caesarean delivery in which the rate increased by 12.4% (from 6.7% to 19.1%), with an average annual rate of increase of 4.4% (137). Though the rates of unnecessary caesarean delivery are increasing, inequalities remain high between different regions of the world. Latin America and the Caribbean region had the highest caesarean rates (40.5%), whereas Africa accounted for only 7.3% (137).

Birth at a health facility has become a common practice these days, but the poor quality of care, in particular among the underserved, continues to hinder the attainment of the desired health outcomes (68, 139). While women in poor settings lack access to care or receive delayed care, in other settings, women receive interventions (e.g., unnecessary caesarean section) that they do not need too soon (140, 141).

Many studies have examined disparities in skilled birth attendance and caesarean delivery focusing on wealth status. However, there is a need for more research examining these disparities across multiple countries in sub-Saharan Africa. This thesis aims to fill this gap by examining spatial patterns and disparities in skilled birth attendance and Caesarean deliveries in this region. Furthermore, only some studies have examined the spatial patterns of these services, most of which were conducted at national level.

2.5 Continuum of care for maternal health services

Addressing preventable maternal and neonatal mortality is and has mostly been a significant challenge to health systems in developing countries (142). In 2015, the neonatal mortality rate was seven times higher, and the maternal mortality ratio was 20 times higher in low-income and middle-income countries than in high-income countries (79). During the MDG era, improvements in coverage of antenatal care, skilled birth attendance, and postnatal care have only resulted in a 45% reduction in maternal mortality, this is 30% less than the expected target (143). This implies that improvements in maternal and child health outcomes would require not only improving coverage of health services but also ensuring continuity of quality care from pregnancy to post-delivery periods.

The continuum of care has gained more attention to address gaps in maternal, neonatal and child health (MNCH) (144, 145). The continuum of care framework ensure that every child and woman receives care whenever needed. The framework recognises and promotes the strong connection between maternal, neonatal and childcare provided at home and community level and health facilities and throughout life from adolescence, pregnancy, childbirth, the postnatal period, and childhood (104, 146). The continuum of care framework has two dimensions; the first one is time, which refers to the period from pre-pregnancy through prenatal, delivery and postnatal periods for women, and care for children. The second is place, which refers to the provision of integrated service delivery by communities, first level and referral health facilities.

2.5.1 Inequalities and determinants of in continuum of care

Studies addressing the continuum of care in sub-Saharan Africa are limited in number, and the existing literature indicates that there is a high dropout from pre-pregnancy to child continuum

of care (142, 147-150). Results from a study conducted among south Asia and sub-Saharan African countries reported that more than 50% of dropout from the continuum of care occurs early on between the first antenatal care visit and four or more antenatal care visits, whereas (<5%) of women received skilled delivery and postnatal care without attending antenatal care (151). In a study from Ghana, among 86.1% of women who attended four and above antenatal (ANC 4+), only 8% completed the continuum of care, which indicates that these women have received ANC 4+, delivery care, postnatal care within 48 hours, at two weeks, and six weeks (149). In Lao PDR, the Southeast Asian country, only 6.8% of mothers received all the required maternal health, which includes ANC 4+, skilled delivery and postnatal care (152). Studies have found several socioeconomic factors that affect the continuum of care. Factors associated with the completion of the continuum of care among mothers include higher education, being rich, living in an urban area, and having greater autonomy (147, 148, 153, 154).

By committing to SDG3, countries around the world have promised to ensure healthy life and promote wellness for all, with the target to reduce maternal mortality to fewer than 70 per 100 000 live births by 2030. Improving the quality and continuity of antenatal care, skilled birth attendance, and postnatal care play a crucial role (8). Women in sub-Saharan Africa are most at risk of mortality related to pregnancy and childbirth than in any other region in the world. Providing a continuum of care (at least four antenatal visits, skilled delivery, postnatal care) for mothers and newborns is vital in helping countries in Sub-Saharan Africa achieve these goals and beyond. Previous studies have assessed factors affecting antenatal care, skilled birth attendance and postnatal care individually (155-159). However, empirical evidence is lacking on factors that affect equity in the continuum of care for maternal and neonatal health in Sub-Saharan Africa.

Health services provided during pregnancy and childbirth are thought to improve maternal and neonatal health outcomes (25). During antenatal care, WHO recommended interventions such as checking blood pressure, blood and urine tests, iron supplementation, and counselling on nutrition and danger signs during pregnancy are provided to detect and treat complications early (160, 161). Health care providers also offer tetanus immunisations, help establish a birth plan that includes skilled delivery, and educate the mother about postnatal care, healthy behaviours, and sexually transmitted infections. For example, behavioural education helps to caution women about unhealthy behaviours such as drinking alcohol and smoking during pregnancy. Nutritional counselling during pregnancy contributes to improving their dietary habits and, consequently, the health of their unborn child. Full implementation of these services dramatically improves maternal and child health outcomes (162, 163). Previous studies have also demonstrated that women using antenatal care during pregnancy have a better chance of giving birth to healthier babies and are less likely to experience child deaths (161, 164, 165).

Initiatives such as Safe Motherhood and Millennium Development Goals have pushed and successfully contributed to improving access to maternal and child health services (166). As a result, maternal and child mortality has decreased over the past decades. However, progresses made in expanding access to maternal and child health services did not successfully reflect on the reduction in maternal and child mortality to the expected level, mainly due to poor quality of care (91, 92, 163).

Infant care after birth is mostly neglected in developing nations (167). Skilled care provided during this period is lower than the services provided during pregnancy and childbirth. After giving birth to their child, many women are discharged within hours without any indication of

where they can obtain further care or support. Consequently, infants in developing countries, especially those in sub-Saharan Africa, are highly exposed to morbidity and mortality (167).

Studies indicate that having prenatal care is significantly associated with lower infant and under-five mortality (168). A survey conducted in 17 sub-Saharan countries (169) showed that receiving antenatal care from a skilled provider decreased the chance of neonatal mortality by 30%. Another study from Zimbabwe (161) found that a one-unit increase in the quality of prenatal care reduced the risk of mortality by nearly 42.33% in neonates, 30.86% in infants, and 28.65% in under-five mortality. A study conducted in Nepal also found that utilisation of adequate prenatal care was strongly associated with improved infant care practices such as lower neonatal mortality, initiation of breastfeeding within one h after birth and a higher likelihood of having immunisation (165).

2.6 Childhood vaccination

Vaccines are a very important public-health intervention that help prevent 2–3 million deaths each year (170). With improved coverage, vaccines have the potential to save many more children, which is why it is also important to ensure that all children receive the full benefits of vaccination regardless of their family's socioeconomic levels (170).

Though vaccines are the most effective public health intervention, many infants and children in some regions continue to receive lower coverage. The WHO report in 2018 shows that 19.4 million children under the age of one year did not receive basic vaccines; around 60% of these children live in 10 nations, including Nigeria, the Democratic Republic of the Congo and Ethiopia (171).

Lifesaving health interventions such as childhood immunisation continue to be systematically missed by some groups of population in low- and middle-income countries (172). Inequalities in access to health services need to be effectively assessed, monitored, and intervened to address systematically missed groups of the population. Measuring inequalities in full immunisation coverage within and across countries can reveal gaps in a routinely delivered vaccine and helps to inform appropriate approaches to reach disadvantaged subgroups of populations. Examining the extent to which gains in country-level coverage are driven by gains among disadvantaged population subgroups is critical for understanding whether within-country inequalities are decreasing or growing.

2.6.1 Inequalities in and determinants of child vaccination

In 2016, it was reported that 56–69% of eligible children had received full vaccination in the low- and middle-income countries across the WHO's regions (173). However, coverage varied greatly within each region. In the African Region, for example, it ranged from 11.4% in Chad to 90.3% in Rwanda. The study found pro-rich inequality in full vaccination coverage in 45 of the 83 countries and pro-urban inequality in 35 of the 86 study countries (173).

Coverage of DTP3 is usually considered an important childhood vaccination coverage indicator (174). The study examined DTP3 vaccination rates across 51 countries. Coverage ranged from 32% in the Central African Republic to 98% in Jordan (174). Within countries, the DTP3 vaccination coverage suggested pro-rich inequality, with a difference of 20 percentage points or more between the poorest and richest quintiles in 20 of 51 countries. In Cameroon, Central African Republic, Laos, Nigeria, and Pakistan, the difference between the poorest and richest quintiles exceeded 40 percentage points (174). In 15 of 21 study countries, an increase over time in national coverage of DTP3 vaccination was realised alongside faster improvements in the poorest quintile than the richest. For example, in Burkina Faso, Cambodia, Gabon, Mali, and Nepal, the absolute increase in coverage was at least 2 percentage points per year, with faster improvement among the poorest quintiles. Substantial economic-related inequality in DTP3 vaccination coverage was reported in five high-priority study countries (DR Congo, Ethiopia, Indonesia, Nigeria, and Pakistan) (174).

Across the 92 countries, 59.9% received full vaccination that includes all doses of the four vaccines, 70.9% received the four types, 14.6%, 3.4%, and 3.3% received three, two, or one vaccine, respectively; but 7.7% were in the zero-dose group (175). There were high wealth-

related inequalities in zero-dose prevalence, with a difference of 9 percentage points ranging from 12.5% in the poorest to 3.4% in the wealthiest quintile across all countries (175).

Several studies have been done on the reasons for the non-vaccination of children in LMICs (176, 177). The factors most frequently reported included: poor distance and access to vaccination services, costs (direct costs of vaccines or vaccination cards, and indirect costs of time away from work and transportation), poor knowledge and attitude of health workers, parental attitudes and knowledge (mistrust in the health system, limited autonomy of women, limited knowledge on the benefits of vaccination), and family characteristics, such as education, low socioeconomic status, and family size, birth order, and ethnicity or minority religious group (177).

2.7 Chapter summary

This chapter reviewed the literature on inequalities in access to quality maternal and child health services in sub-Saharan Africa. The review assessed and reported on inequalities in and determinants of maternal and child health indicators (i.e., antenatal care, skilled birth attendance and caesarean delivery and vaccine inequities). The gaps in evidence regarding equity in access to quality maternal and child health services were also explored.

The next chapter presents the methods and materials used to analyse data in this research.

Chapter Three: Methods

3.1 Data source

This study examined DHS data collected between 2013 and 2020. While the analysis was primarily based on the most recent available DHS data, it varied by country and generally dated back to 2013. Given the possibility of changes in rates for some countries since 2013, only DHS surveys conducted after 2013 were considered in the analysis. The DHS program was designed to assist developing countries to collect data on fertility, family planning, maternal, and child health (67). The DHS program uses standardised methods in its surveys to ensure uniformity of indicators from different countries. Participating countries adopt standardised uniform questionnaires, manuals, and field procedures that are developed by the DHS to gather information that is comparable across time and countries (178). The DHS is a nationally representative survey conducted every five years. The program is an ongoing collaboration between the United States Agency for International Development (USAID) and country-specific agencies. Since 1984, the DHS has been conducted in over 90 LMICs (178). The surveys are conducted approximately every five years and sample between 5,000 and 50,000 households.

The DHS uses a stratified, two-stage (cluster) random sampling design in all countries. Estimates are therefore representative at the national and several sub-national levels. A structured questionnaire is used to interview women aged 15-49 years, men aged 15-59 years, and collect the anthropometry of children under the age of five from selected households by collecting data on a wide range of socioeconomic, demographic, environmental, and health characteristics. Data is collected on reproductive health, household composition, socioeconomic variables, and maternal and child health, including vaccination, anthropometric measures, infectious diseases and other evolving health and social issues (67). Sampling is

independently repeated in each survey wave. Response rates are high in most surveys, generally around 90% (178-180). The datasets are publicly available from the DHS website (https://dhsprogram.com/data/Using-Datasets-for-Analysis.cfm).

DHS questionnaires are highly standardised, allowing comparisons across countries over time. Interviewers are extensively trained and rigorous data quality control measures are implemented (181). DHS data on maternal and child health are considered to be of high quality. For most surveys and indicators, missing data is below 4% (178).

This thesis used DHS data across nine east African countries to examine inequalities in access to quality antenatal care. The countries were Burundi (2016/17), Ethiopia (2016), Kenya (2014), Malawi (2016), Rwanda (2014/15), Tanzania (2015), Uganda (2016), Zambia (2018), and Zimbabwe (2015). The geographical scope of this study was restricted to East Africa, as previous research had already explored the quality of antenatal care across thirteen nations located in West Africa (182). The other three studies in this thesis were carried out across the same 25 Sub-Saharan African countries. The latest DHS and the specific countries included in the three analyses include Burundi (2016-17), Ethiopia (2016), Kenya (2014), Malawi (2015/16), Rwanda (2014/15), Tanzania (2015), Uganda (2016), Zambia (2018), Zimbabwe (2015), Angola (2015), Cameroon (2018), Chad (2014/15), DR Congo (2013/14), Benin (2018), Gambia (2019), Ghana (2014), Guinea (2018), Mali (2018), Nigeria (2018), Senegal (2017), Sierra Leone (2013/2018), Togo (2013/14), Lesotho (2014), Namibia (2013), and South Africa (2016). The fifth study in this thesis looked at inequalities in child vaccination coverage in Ethiopia.

The DHS has different types of survey datasets. These includes births, couples, fieldwork, households, individuals, children, men, household members and geographic dataset. Among those children's (KR) and geographic DHS datasets were used in the current analysis. Children

born to women interviewed within five years prior to the survey. It comprises information regarding various aspects of the child's healthcare, including pregnancy, delivery, postnatal care, immunisation, and overall health. Additionally, the data for each child's mother is also included in the file. This dataset is utilised to examine key health indicators for young children, such as immunisation coverage, vitamin A supplementation, and occurrences of various illnesses like diarrhea, fever, and cough, as well as the treatment provided for these childhood diseases.

The first study analysed the differences in the level of antenatal care quality for women who had given birth to their most recent baby within the past five years. The second study focused on evaluating the disparities in skilled birth attendance and caesarean section rates based on data collected from women who had births assisted by a skilled provider within the five years leading up to the survey. The third study centred on investigating inequalities in the continuity of maternal health services. Participants were women who had given birth to their most recent baby within the past five years. Lastly, the two studies addressing vaccination inequalities included children who were between 12 and 23 months old and still alive.

3.2 Maternal and child health indicators examined in this study

This research investigated the disparities, and underlying factors that contribute to inequitable access to quality MCH services in sub-Saharan Africa countries. A set of tracer indicators were used to assess the extent of MCH service provision across the region. The tracer indicators used in this study provide a comprehensive and detailed overview of the region's MCH service availability and distribution. Table 3-1 shows maternal and child health indicators analysed in this research. The details of the indicators were described in corresponding chapters.

Table 3.1 maternal and child health indicators examined in this thesis

Categories	Indicators	Numerators	Denominators
Maternal health interventions	Antenatal care	Number of women receiving antenatal care from a skilled provider for the most recent birth. The classification of skilled provider is also country specific, but typically includes providers such as Doctor, Nurse/midwife, and Auxiliary nurse/midwife.	Number of women with a birth in the last 5 years
	Number of antenatal care coverage – at least four visits	Numbers of women who four or more antenatal care contacts (visits) for their last birth	Number of women with the most recent birth in the last 5 years
	Antenatal care services: blood sample test, blood pressure measures, urine sample test, iron supplements, tetanus protection at birth, and drug for intestinal parasites	Number of women with a birth in the past 5 years who received the specific antenatal care service during the pregnancy for the most recent live birth	Number of women with a birth in the past 5 years who received antenatal care for their most recent birth
	Births attended by skilled health personnel	Number of live births delivered by a skilled provider. Skilled provider includes the cadres that are considered skilled attendants for delivery in the country.	Number of live births in the 5 years preceding the survey
	Delivery by caesarean section	Number of live births delivered by caesarean section	Number of live births in the last 5 years
	Continuum of care for maternal health services (four or more ANC contacts, skilled birth attendance and postnatal care)	Number of women with a birth in the past 5 years who received four or more ANC contacts, skilled birth attendance and postnatal care for the most recent live birth	Number of the most recent live births in the 5 years preceding the survey

Newborn and child health interventions	BCG immunisation coverage among 12 to 23 months	Number of living children between age 12 and 23 months at the time of the survey who received the BCG vaccine.	Number of living children aged 12–23 months
	Measles immunisation coverage among 12 to 23 months	Number of living children between age 12 and 23 months at the time of the survey who received the Measles vaccine.	Number of living children aged 12–23 months
	Three doses of polio immunisation coverage among 12 to 23 months	Number of living children between age 12 and 23 months at the time of the survey who received the Polio vaccine.	Number of living children aged 12–23 months
	DTP3 immunisation coverage among 12 to 23 months	Number of living children between age 12 and 23 months at the time of the survey who received the DPT3 vaccine.	Number of living children aged 12–23 months
	Zero-dose vaccination among 12 to 23 months	Number of living children between age 12 and 23 months at the time of the survey who have not received any vaccine.	Number of living children aged 12–23 months
	Incomplete vaccination among 12 to 23 months	Number of living children between age 12 and 23 months at the time of the survey who missed one or more of the following vaccines BCG, 3 doses of DPT-containing vaccine, 3 doses of polio vaccine (excluding polio vaccine given at birth), and 1 dose of MCV	Number of living children aged 12–23 months
	Full immunisation coverage among 12 to 23 months	Number of living children between age 12 and 23 months at the time of the survey who received BCG, 3 doses of DPT-containing vaccine, 3 doses of polio vaccine (excluding polio vaccine given at birth), and 1 dose of MCV	Number of living children aged 12–23 months

3.3 Factors explaining inequalities

We used WHO Commission on Social Determinants of Health conceptual framework (183) to assess potential determinants of inequalities in the use of maternal and child health services (see Figure 1.1).

According to this framework, there are two broad types of health determinants that affect a person's health and contribute to health inequities: structural determinants and intermediary determinants. Structural determinants refer to the socio-economic and political context in which a person lives. These include governance, economic, social and public policies, and social and cultural values that communities place on health. These factors can determine and lead to the unequal distribution of material and monetary resources, which shapes a person's socio-economic position. In accordance with this, important DHS variables critical to determining a person's socioeconomic position were identified and included in the analysis. These variables include the wealth index, education, and occupation.

The wealth index is a metric that provides a comprehensive evaluation of the overall living standard of a household. The household questionnaire is used to gather data on the wealth index, which includes questions on assets and items owned by the household, ownership of a number of consumer items such as a television and car; dwelling characteristics such as flooring material; type of drinking water source; toilet facilities; and other characteristics that are related to wealth status. Principal components analysis is used to calculate and assign a weight or factor score to each household asset, and these scores are standardised to create wealth quintile break points: lowest, second, middle, fourth, and highest. Household scores are totalled, and individuals are ranked based on the score of the household in which they live.

Wealth quintiles are expressed in terms of population quintiles rather than quintiles of individuals at risk for any one health or population indicator.

The single asset index used in tabulations is developed from data from the entire country sample and is not separated into rural and urban indices. This method of defining wealth quintiles provides information relevant to the health status or access to services for the poor in the population as a whole, making comparisons across indicators easier.

The other critical factor that shapes individual's socioeconomic position is educational status. The DHS program also collects information on the highest level of education women acquired in four categories that include no education, primary education, secondary education, and higher-level education.

Occupation has also been included in this analysis as a key indicator of a person's socioeconomic position. There were many occupation categories in the DHS, but for the purposes of analysis, related occupations were grouped together, and four categories of women's occupation were created (not currently working, skilled and professional, agricultural, and sales and services). Other important variables defining a person's socioeconomic status, such as social class, gender, and race, were not included because they were not available in the DHS.

The socio-economic position, in turn, affects the intermediary determinants of health. Intermediary variables include material circumstances, such as neighbourhood, working and housing conditions: psychosocial circumstances include stressors (e.g., negative life events), lack of social support, and stressful living circumstances. The other intermediary determinant includes behavioural and biological factors such as smoking, diet, alcohol consumption and physical exercise, which are important determinants of health. The DHS program did not

include some important variables that can be used as indicators for intermediary social determinants of health. This could be due to the difficulty in measuring intermediary determinants such as psychosocial factors, material circumstances, and behavioural or biological factors. Efforts were made in this analysis to identify and include variables that can be used as proxies for intermediary social determinants of health. For example, availability and use of radio and television was used as indicator for material circumstances, age as a key indicator for biological factor. The use of radio and television was measured based on frequency of use. In this research, the frequency of listening to radio or watching television (TV) were both categorised as not at all, less than once a week, and once a week or more. The other important component of the social determinants of health is health system itself. Health systems determine how easy it is for people to access health services and receive the health care they need. Access to health care services is influenced by various factors such as geographical location, transportation, cost, and the availability of health insurance. People living in remote or underserved areas may face challenges in accessing quality health care services, while those who are uninsured or underinsured may face financial barriers to obtaining care. The perceived difficulty of accessing health facilities was used to determine access to health services in this thesis. Women were asked if they had serious difficulties getting health care for themselves when they were sick. For example, they were asked if they had serious problems getting permission to go to treatment, getting money for treatment, or travelling to the health facility. In this this research, their responses were categorised – as a big problem or not a big problem.

Depending on the framework, efforts were made to identify and include variables consistently available in all datasets that can potentially determine the use of maternal and child health services.

3.4 Statistical analysis

The statistical analysis was conducted in stages: first, estimating the coverage of health indicators under study; we used spatial analysis to show the distribution of indicators in chapters 6 and 7. Second, we quantified socioeconomic inequalities in the use of maternal and child health services using a concentration curve and concentration index. Third, we examined a determinant of inequalities in the use of maternal and child health services.

3.4.1 Measuring socioeconomic inequalities

Equity for each maternal and child health service was estimated using four standard equity measures – equity gaps, equity ratios, concentration curves and concentration indices (24,25). The percentage point difference in service coverage between the richest and poorest groups was used to show equity gaps. The equity ratio is calculated by dividing service coverage in the top wealth quintile by that in the bottom.

Wealth-related inequalities in the use of quality antenatal care, intrapartum care, continuum of care for maternal and child health services and full immunisation coverage among 12-23 months children were examined within each country and across all countries using the concentration curve and concentration index. The concentration curve is a graphical illustration that plots the cumulative percentage of the population, ranked by wealth, starting from the poorest, and ending with the richest (x-axis) against the cumulative percentage of the health variable under study (for example, full vaccination) on the y-axis. If all children 12-23 months

had an equal proportion of full immunisation irrespective of their socioeconomic status, then the curve would coincide with the 45° line, which indicates the presence of perfect equality in the use of full immunisation. If the concentration curve falls below the 45° line of equality, it indicates that the use of full immunisation is more concentrated among the rich. The opposite is true if the curve falls above the line of equality.

The concentration index is defined as two times the area between the line of equality and the concentration curve. The index takes a value between −1 and +1; an index of 0 indicates the presence of equality in the use of the health variable (i.e., full immunisation). If wealth-related inequalities exist, they can be seen in one of the following forms: the first is when there is a higher concentration of a favourable health variable (e.g., full immunisation) among the rich, in this case the concertation index takes on a positive value. The second is the negative value concentration index, which implies a high concentration of the health variable among the poor (commonly mortality and morbidity).

The concentration index can be computed using the "convenient regression" approach as follows:

$$\text{Concentration index} = \frac{2}{y}\text{cov}(h, r), \qquad (1)$$

where h is the healthcare outcome of interest (for example, full immunisation), y is the mean of h and r is the fractional rank of an individual in the wealth distribution. 95% Confidence intervals were used to assess the statistical significance of the concentration index.

3.4.2 Multilevel analysis

The concentration curve and concentration index can only quantify the level of inequalities related to wealth in the use of health services. However, wealth is not the only factor that determines the use of health services. Therefore, we examined individual and community level factors that determine maternal and child health inequities. A similar multilevel regression modelling approach was used in chapters 4-7. The approaches are described further below.

The DHS program employs a multistage cluster sampling technique in which survey participants are nested within Primary Sampling Units (PSU) in all countries. We used a multilevel model to account for three-level data - women at level 1, PSU (clusters) at level 2, and country at level 3 - due to the use of complex survey methods to collect data (i.e., hierarchical data). Multilevel model building process started with the unconditional model (a model containing no predictors), and then more complex models were built gradually by checking improvements in model fit after each model was estimated. Generalised Latent Linear Mixed Model (GLLMM) was used in Stata, which enables to adjust for the hierarchical nature of the data and the sampling weights.

The model construction specified a 3-level model: level 1 variables included women and their household factors, level 2 adjusted for clustering, and level 3 adjusted for country. Results are presented with adjusted odds ratios (ORs), and statistical significance was declared when the P-value was <0.05. Analyses were conducted using Stata 16.1 and IBM Statistical Package for Social Sciences (SPSS, Chicago, IL, USA) version 27.0.

3.4.3 Decomposition analysis

In Chapter 8, decomposition analysis was used to explain the factors that contribute to inequalities in child vaccination coverage. After measuring inequalities in the use of health services, one may be interested in examining factors that explain most of the wealth-related inequalities. This can be done using an approach proposed by Wagstaff and colleagues (184). The concentration index of a health variable can be decomposed into the contributions of individual factors to income-related health inequality. If we consider a linear regression model for the outcome variable, for example, child vaccination status, y, is defined according to k explanatory factors, x_k as.

$$y = \alpha + \sum_k \beta_k x_k + \varepsilon \,, \qquad (2)$$

the concentration index for child vaccination can be decomposed as:

$$C = \sum_k \left(\frac{\beta_k \bar{x}_k}{\mu}\right) C_k + \frac{GC_\varepsilon}{\mu}, \qquad (3)$$

where μ is the mean of y, $\bar{x}_k$ is the mean of x_k, C_k is the concentration index for x_k, (defined analogously to C), and GC_ε is the generalised concentration index for the error term (ε). Equation 2 shows that C is equal to a weighted sum of the concentration indices of the k regressors, where the weight for x_k is the elasticity of y with respect to $x_k (\eta_k = \beta_k \frac{\bar{x}_k}{\mu})$. The residual component—captured by the last term— reflects the income-related inequality in health that is not explained by systematic variation in the regressors by income, which should approach zero for a well-specified model. Analyses were conducted using Stata 14.2 and IBM Statistical Package for Social Sciences (SPSS, Chicago, Il.) version 25.0. ArcGIS software V.10.7.1 was used to generate maps.

3.5 Ethical considerations

The DHS is a nationally representative survey conducted every five years in most low-income and middle-income countries. It is designed to assist and collect data on population, HIV, fertility, family planning, maternal and child health. Participating countries adopt standardised uniform questionnaires, manuals, and field procedures that are developed by the DHS to gather information that is comparable across time and countries.

UTS Faculty of Health reviewed the application and approved it on the grounds that the research project meets the National Statement on Ethical Conduct in Human Research requirements (2007). Our ethics application was approved as a low risk, and we were authorised to commence activities as outlined in our application with ethics approval number UTS HREC REF NO. ETH19-4108. We also received approval and permission from the DHS program to access DHS surveys conducted in sub-Saharan Africa.

3.5 Chapter summary

In this chapter, we discussed the general methods and materials used to analyse data for this research. We discussed data sources, specific methods of analysis and ethical considerations for conducting this research. In the next chapters (4, 5, 6, and 7), we reported detailed data analysis to meet specific research objectives and discussed the implications of the findings for health policy and practice.

Chapter Four: Antenatal care quality: inequalities and determinants

Preamble

Monitoring and addressing disparities in access to quality antenatal care requires careful investigation of inequalities. As discussed in chapter 2, there is a lack of sufficient evidence on inequalities in antenatal care quality. Moreover, little is known about the coverage of antenatal care quality or whether poorer women receive poor quality care across east African countries. In most cases, antenatal care coverage has often been examined by measuring the number of contacts with the health system rather than the content of care women receive.

This chapter presents a comprehensive analysis of inequalities in the use of quality antenatal care by examining the adequacy of both contact and content of antenatal care. First, we examined inequalities in antenatal care contacts, and the content of care women received across all countries. Then we identified predictors of inequalities in four or more antenatal care contacts and receipts of six services separately.

Citation: **Bobo F.T.**, Asante A, Woldie M, Hayen A. Poor coverage and quality for poor women: Inequalities in quality antenatal care in nine East African countries. Health Policy and Planning. 2021;36(5):662-72.

Manuscript one: Poor coverage and quality for poor women: inequalities in quality antenatal care in nine East African countries

4.1 Abstract

The use of quality antenatal care (ANC) improves maternal and newborn health outcomes. Ensuring equity in access to quality maternal health services is a priority agenda in low- and middle-income countries. This study aimed to assess inequalities in the use of quality antenatal care in nine East African countries using the most recent Demographic and Health Surveys. We used two outcome variables to examine ANC service adequacy: four or more ANC contacts and quality antenatal care. We defined quality antenatal care as having six of the recommended ANC components during follow-up: blood pressure measurement, urine sample test, blood sample test, provision of iron supplements, drug for intestinal parasite, and tetanus toxoid injections. We used the concentration index (CCI) to examine inequalities within and across countries. We fitted a multilevel regression model to assess predictors of inequalities in contact and content of antenatal care. This study included 87,068 women; among those 54.4% (n=47,387) had four or more antenatal care contacts, but only 21% (n=15,759) reported receiving all six services. The coverage of four or more antenatal care and receipt of all six services was pro-rich within and across all countries. The highest inequality in four or more antenatal care contacts was in Ethiopia with a (CCI: 0.209), while women in Burundi had the highest inequality in coverage of all six services (CCI: 0.318). Higher education levels and media exposure were predictors of service uptake, while women who had unintended pregnancies were less likely to make four or more antenatal care contacts and receive six services. Interventions to improve access to quality antenatal care require rethinking the service delivery mechanisms in all countries. Moreover, ensuring equity in access to quality antenatal care requires tailoring service delivery modalities to address social determinants of service uptake.

4.2 Introduction

Reducing the high rates of maternal and neonatal mortality has been a persistent challenge for health systems in low- and middle-income countries (LMICs) (185). In 2015, an estimated 303,000 women died from causes related to pregnancy and childbirth worldwide, with more than two thirds of these deaths occurring in sub-Saharan Africa (14). The number of deaths from causes related to pregnancy and childbirth in East Africa was 7,050 in 2015, and ranged from 224 per 100,000 live births in Zambia to 789 per 100,000 live births in South Sudan (14). Ensuring access to quality health care is a key strategy to reduce high rates of maternal mortality (185). In many LMICs, encouraging progress has been made in improving access to health services (20). However, the quality of care delivered across different countries remains low and hinders progress in improving health outcomes (79).

Antenatal care (ANC) is a proven intervention for reducing complications during pregnancy, childbirth, and the postpartum period (23, 82). Antenatal care provides a unique opportunity to advise, educate, and reach women with interventions that can be crucial for maternal and newborn health (97). Moreover, receiving quality ANC is associated with higher retention in the continuum of care for maternal, newborn and child health (104).

Three indicators are commonly used to measure quality of antenatal care: number of ANC contacts, timing of the first ANC visit (initiation of ANC before 12 weeks) and provision of all recommended ANC services (97, 186). The WHO recommendations for quality antenatal care include: the provision of caring and respectful evidence-based care that involves examinations (e.g., history taking and physical assessments) and diagnostic tests (e.g., blood sample test or

urine sample test); appropriate preventive and curative treatments (tetanus vaccinations or iron supplementation); and provision of proper counselling and education (e.g., on healthy eating or danger signs of complications) (97). However, antenatal care contact is commonly used as the principal monitoring and evaluation indicator to measure provision of ANC (83, 187). This has drawn the attention of health care managers and providers to focus on the number of contacts rather than the content and process of care. However, failure to ensure effective coverage (contact with complete delivery of all recommended services) leads to ineffective care resulting in a missed opportunity to achieve improved health outcomes (83).

The urgent need to tackle the causes of maternal and child morbidity and mortality is a target of the Sustainable Development Goals (SDGs). Specifically, SDG target 3.8 aims at "achieving universal health coverage, including financial risk protection, access to quality essential healthcare services and access to safe, effective, quality, and affordable essential medicines and vaccines for all" (188). Exploring variations in the quality of services provided across socioeconomic levels and examining the gap between those who do or do not have access to quality services is an important step towards devising and focusing interventions to ensure equitable access to quality ANC.

The majority of studies in this area have addressed coverage indicators, but most do not reflect on the process and content of ANC (88, 189-192). Many of these studies reported the presence of socioeconomic inequalities in access to antenatal care and indicated that poorer women are less likely to use these health services in LMICs. Arsenault and colleagues reported that 89.7% of women in 91 LMICs had at least one ANC visit with a skilled provider. However, 33% of the women who attended ANC did not receive three important services of ANC including blood and urine sample tests, and blood pressure measurement at any point during their ANC follow-ups.

The richest women were four times more likely to get their blood pressure checked, and urine and blood tested than the poorest women during ANC contacts (79).

In the present study, we aimed to comprehensively assess inequalities in the use of quality antenatal care by examining the adequacy of both contact and content of ANC. First, we examined socioeconomic inequalities in ANC contact and content across all countries. Then we identified predictors of inequalities in four or more ANC contacts and receipts of six services separately.

4.3 Methods

4.3.1 Data

We used the Demographic and Health Surveys (DHS) of nine East African countries collected between 2013 and 2020. The DHS are nationally representative household surveys with large sample sizes and high response rates (the lowest was 98%). The DHS uses multistage sampling procedure in all countries. Standardised questionnaires across time and countries are used to ensure data collected from the survey are comparable. Sampling design and methods have been described elsewhere (67). We used the DHS from Burundi 2016, Ethiopia 2016, Kenya 2014, Malawi 2016, Rwanda 2014/15, Tanzania 2015, Uganda 2016, Zambia 2018, and Zimbabwe 2015. The study population includes all women of reproductive age (15 to 49 years) who had at least one live birth during the 5 years preceding the respective surveys.

4.3.2 Measures

We assessed two dimensions of ANC service adequacy: four or more ANC contacts and the services provided during contacts (processes and procedures of care provided). Based on the World Health Organisation's (WHO) recommendations (97) on ANC for a positive pregnancy experience, we examined the provision of recommended components of care which are potential indicators of antenatal care quality.

Women who attended antenatal care were asked whether they received specific services during contacts. We identified 13 antenatal care services: weight and height measurement, blood pressure measurement, urine and blood sample tests, iron supplements, malaria prophylaxis, drugs for intestinal parasites, counselling on signs of complications, tetanus vaccination, and counselling on where to go in case of complications. For this analysis, we included six of 13 ANC services that were reported and consistently available across all the DHS.

These were blood pressure measurement, urine sample test, blood sample test, tetanus protection at birth, iron supplements, and drug for intestinal parasites. We defined quality of antenatal care as a binary outcome where women who received all six services were labelled as having quality ANC.

4.3.3 Independent variables

We used the WHO Commission on Social Determinants of Health framework (183) to assess potential determinants of inequalities in four or more ANC contacts and all six services received separately. We considered indicators that define women's socioeconomic position including household wealth index, educational status, and occupational status. In the DHS datasets, the wealth index is a composite variable created using principal component analysis and measures the woman's household living standards. It is constructed by collecting and analysing information on ownership of selected household assets such as radio, television, refrigerator, and vehicle; materials used for housing construction; and access to sanitation facilities and water. We ranked households into quintiles from the poorest (Q1) to richest (Q5) depending on their level of wealth.

Educational status of the women is also an important indicator for socioeconomic position. We used four categories of women's education level (no education, primary, secondary or higher). We merged secondary and higher education levels because women with post-secondary education were few (only 4.3% of women had post-secondary education). For the purpose of this analysis, we grouped related occupations together and formed four categories of women's occupation (not currently working, skilled and professional, agricultural, and sales and services). Exposure to media was also included as one of the covariates in this study. Frequency

of listening to radio and watching television (TV) were both categorised as not at all, less than once a week, and once a week or more.

At an individual level, we included women's age and use of healthcare services were. For use of health services, we included pattern of contraceptive method use at the time of the survey and timing of first ANC. We defined early initiation of ANC as starting *antenatal care* before 12 weeks of gestation, while we considered women who were unable to attend ANC or initiated later than 12 weeks of gestation to have delayed ANC initiation. We used timing of the first ANC visit as a determinant because it affects the number of components and the content of care that women receive. A woman was also asked whether she wanted to be pregnant with her last child (wanted then or planned, wanted later or mistimed, or unwanted), which we also included as a covariate.

4.3.4 Statistical analysis

We performed separate analyses for: (1) quantifying socioeconomic inequalities in coverage of (i) four or more ANC contacts and (ii) receipt of all six services and (2) a multilevel logistic regression analysis to determine factors driving inequality were assessed separately for four or more ANC and the six services women received during follow-ups. We adjusted for sampling design (stratification and clustering) and sampling weights in analyses.

4.3.4.1 Measuring inequalities

Socioeconomic inequalities in the coverage of (1) four or more ANC contacts and (2) distribution of the six services were estimated using the concentration curve and concentration index (193). The concentration curve is a plot of the cumulative percentage of the population, ranked by a wealth index (from the poorest to the richest on the x-axis against a cumulative percentage of the health variable under study (for example, four or more ANC contacts) on the y-axis (193).

If all women had an equal proportion of four or more ANC contacts irrespective of their socioeconomic status, then the curve would coincide with the 45° line, which indicates the presence of perfect equality in the use of four or more ANC contacts. If the concentration curve falls below the 45° line of equality, it indicates that the use of four or more ANC contacts is more concentrated among the rich. The opposite is true if the curve falls above the line of equality (193).

The concentration index is two times the area between the line of equality and the concentration curve. The index takes a value between −1 and +1; an index of 0 indicates the presence of equality in the use of the health variable (e.g. four or more ANC contacts) (193). If socioeconomic inequalities exist, there are two main forms: the first and the most common is when there is uneven concentration of favourable health variable among the rich, in this case the concertation index takes on a positive value. The second is negative value concentration index, which implies high concentration of health variable among the poor (commonly mortality and morbidity).

4.3.4.2 Multilevel analysis

The concentration curve and concentration index can only quantify the level of inequalities related to wealth in the use of health services. However, wealth is not the only factor that determines the use of health services. In our study, we assessed individual and community level factors that determine coverage of four or more ANC contacts and receipts of the six services during contacts. We specified a 3-level model: level 1 variables included women and household factors, at level 2 we adjusted for clustering, and at level 3 we adjusted for country (Figure 4-1). Results are presented with adjusted odds ratios (OR) and statistical significance was declared

when the p value was < 0.05. Analyses were conducted using Stata 14.2 and IBM Statistical Package for Social Sciences (SPSS, Chicago, II.) version 25.0.

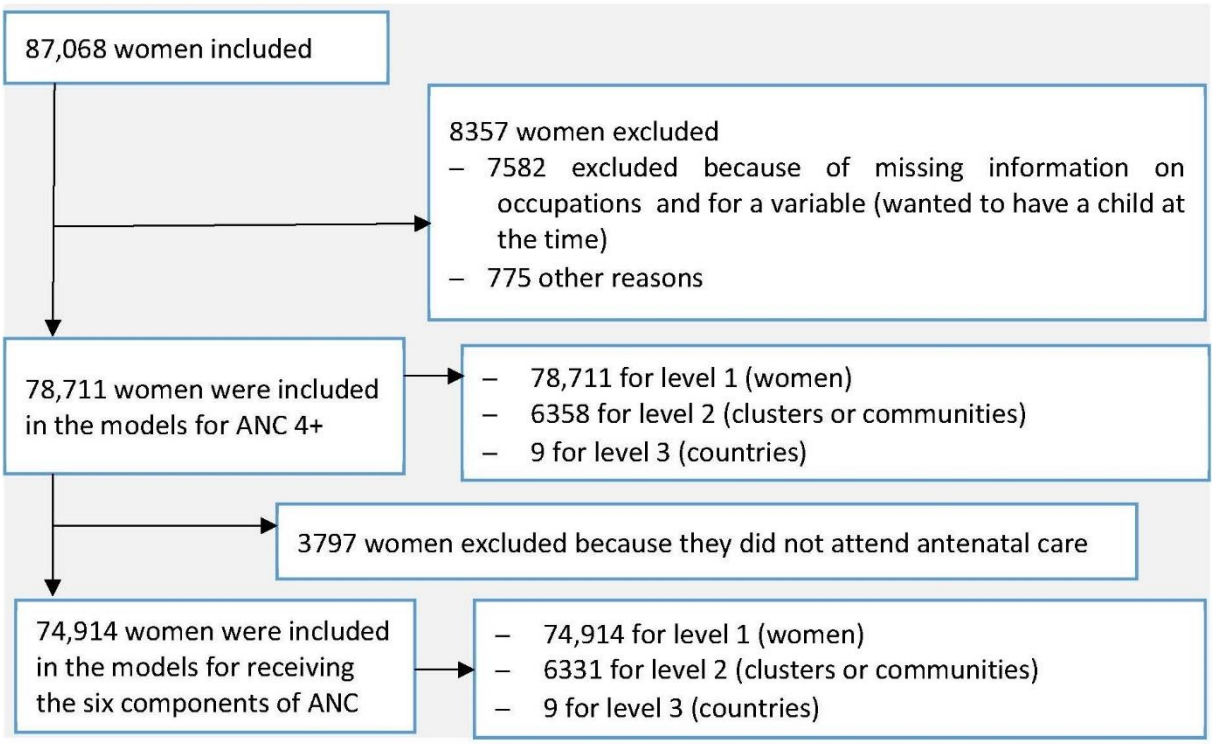

Figure 4-1 Flow chart describing included samples across nine East African countries (DHS: 2013 – 2016).

4.4 Results

We used information on 87,068 women surveyed from nine East African countries. The number of women ranged from 4,988 in Zimbabwe to 14,429 in Kenya. Three in ten women were between 15 to 24 years of age at the time of survey, (53.1%) had primary level of education, (41.9%) were engaged in agriculture, and (74.8%) lived in rural areas (Table 4-1).

4.4.1 Coverage of ANC contact and content

Across all countries, 94.8% (95% CI: 94.2% to 95.3%) of women received one or more antenatal care visits, but only 31.1% (95% CI: 30.5% to 31.7%) of women had a first visit before 12 weeks

of gestation. Coverage of four or more ANC contacts across all countries was 54.4% (95% CI: 53.7% to 55.1%).

Coverage of four or more ANC contacts and the six services varied across countries (Figure 4-2). Women in Zimbabwe had the highest four or more ANC contacts 75.7% (95% CI: 73.8% to 77.6%), while Ethiopian women had the lowest 31.8% (95% CI: 29.2% to 34.5%). The gap between contact and content of care was large across all countries. More than half of women (54.4% 95% CI: 53.7% to 55.1%) had four or more ANC contacts, but only 21% (95% CI: 20.2% to 21.7%) of women who had attended antenatal care received all six services. The largest gap was in Zimbabwe, where 75.7% (95% CI: 73.8% to 77.6%) of women had four or more ANC contacts, but only 1.7% (95% CI: 1.3% to 2.2%) received all six services. Women in Zambia were more likely to receive all six services 41% (95% CI: 39% to 43.1%) compared to other countries in our study.

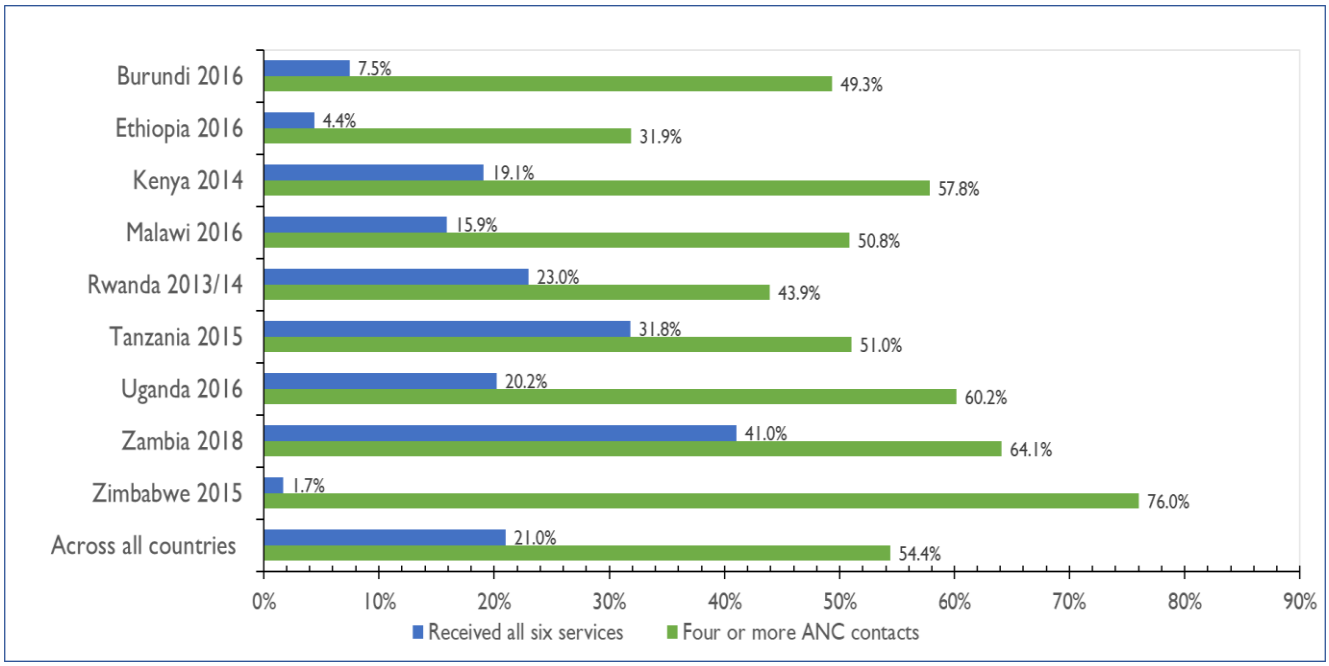

Figure 4-2 Coverage of four or more ANC contacts and the six services across nine East African countries

The majority 91.7% (95% CI: 91.3% to 92.2%) of women reported having a blood sample test, ranging from 72.5% in Ethiopia to 96.7% in Rwanda. The urine sample test had the overall lowest coverage among the six services across all countries 52.8% (95% CI: 51.9% to 53.7%), ranging from 27% in Burundi to 88.8% in Kenya. We found extremely low coverage of drug for intestinal parasite in Zimbabwe 3.6% (3.0% to 4.3%) and Ethiopia 7.6% (95% CI: 6.5% to 9.0%). In Malawi, Rwanda, Zimbabwe, Uganda, Tanzania and Zambia, coverage of iron supplement was greater than 80% (Figure 4-3).

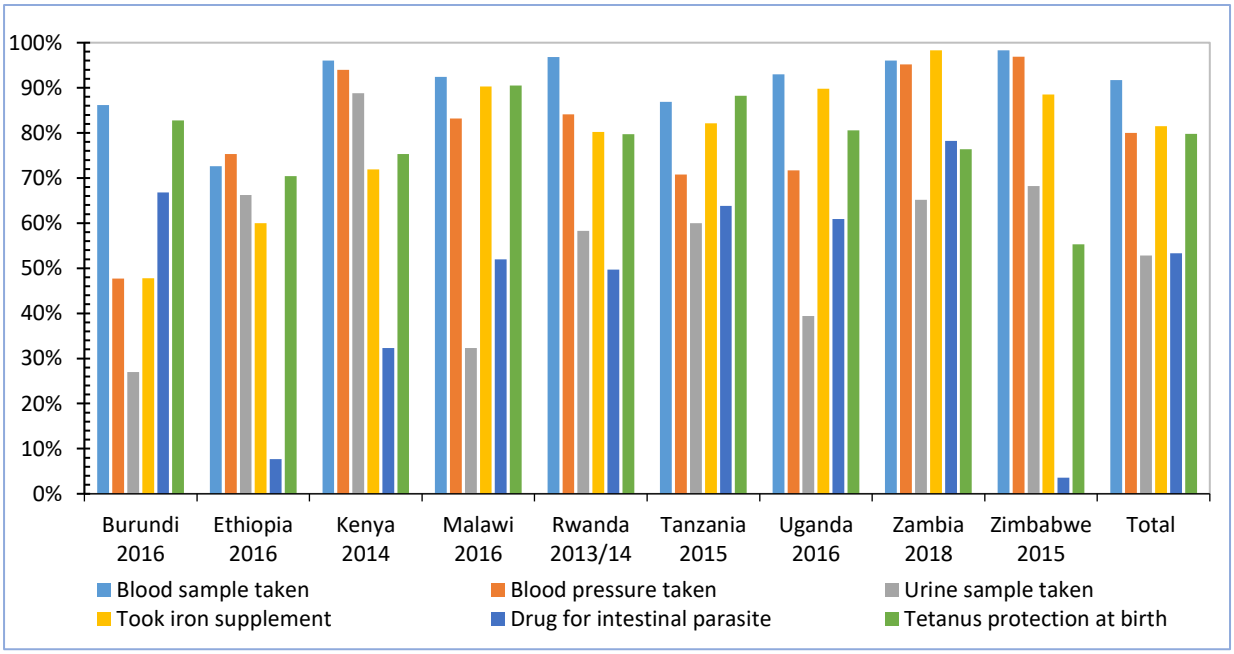

Figure 4-3 Coverage of the six services across nine East African countries (DHS: 2013 - 2018).

As women's education status and wealth increased, coverage of each ANC services also increased (Figure 4-4). Women from urban areas were more likely to have better coverage of each ANC service compared to women from rural areas: coverage of all six services among rural

women was 17.2% (95% CI: 16.5% to 17.9%), but coverage was 32.4% (95% CI: 30.7 to 34.2) among women from urban areas.

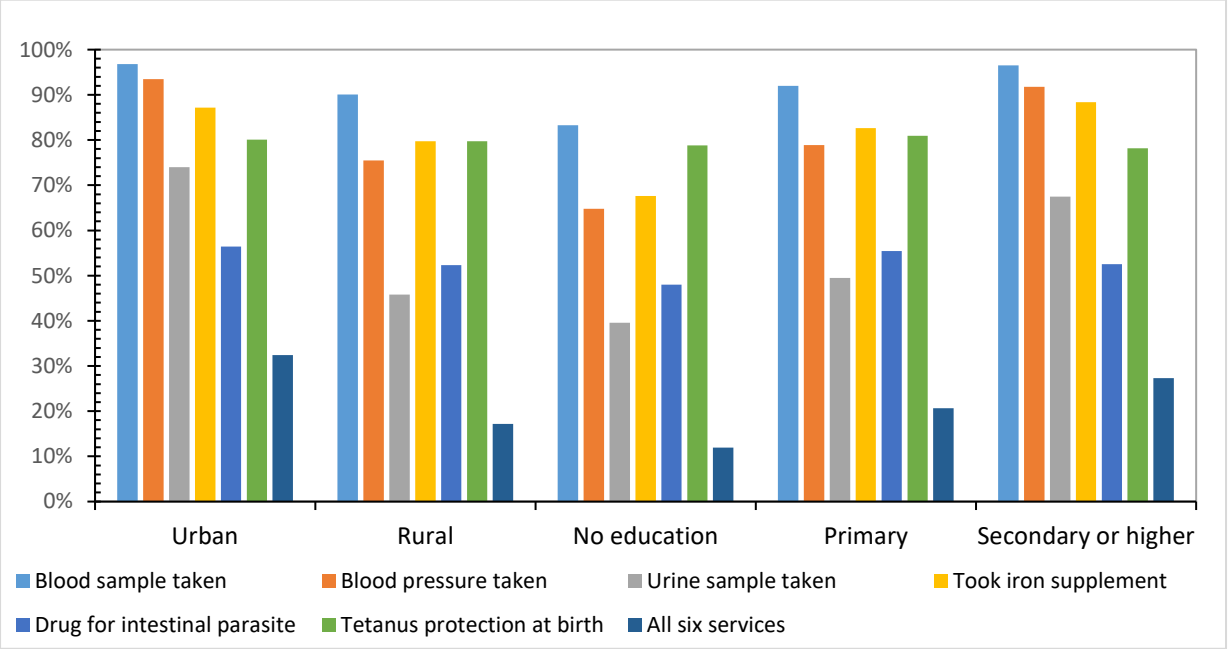

Figure 4-4 Coverage of ANC services by place of residence and educational status across nine East African countries (DHS: 2013 - 2018)

4.4.2 Socioeconomic inequalities

The positive values of concentration indices in Figure 4-5 show that attendance of four or more ANC contacts and receipt of all six services was disproportionately concentrated among wealthier women across all countries (Figure 4-5). The inequality in four or more ANC contacts was statistically significant in majority of the countries but there were no differences in Burundi, Rwanda and Zambia. The highest concentration index in having four or more ANC contacts was registered in Ethiopia (0.209) and lowest in Zambia (Figure 4-6). Countries with higher four or more ANC contacts had lower socioeconomic inequalities in four or more ANC contacts, for example, in Zimbabwe where the coverage was highest (75.7%), the inequality was lower (CCI:

0.029). We observed similar patterns – higher coverage and lower inequalities – in Uganda and Zambia.

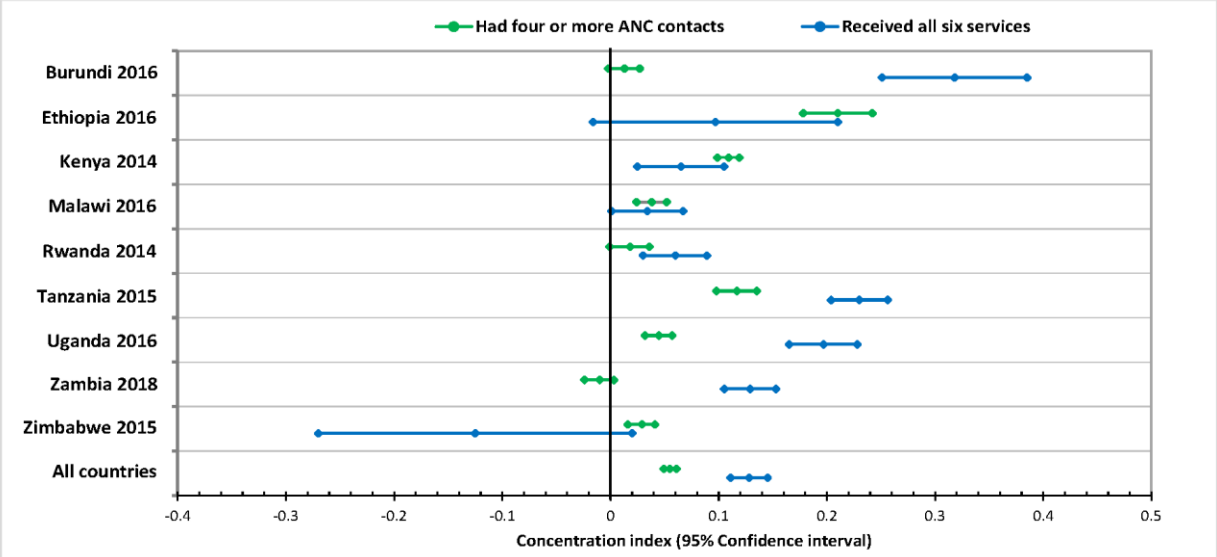

Figure 4-5 socioeconomic inequalities in the coverage of four or more ANC contacts and the six services within and across nine East African countries (DHS: 2013 to 2018)

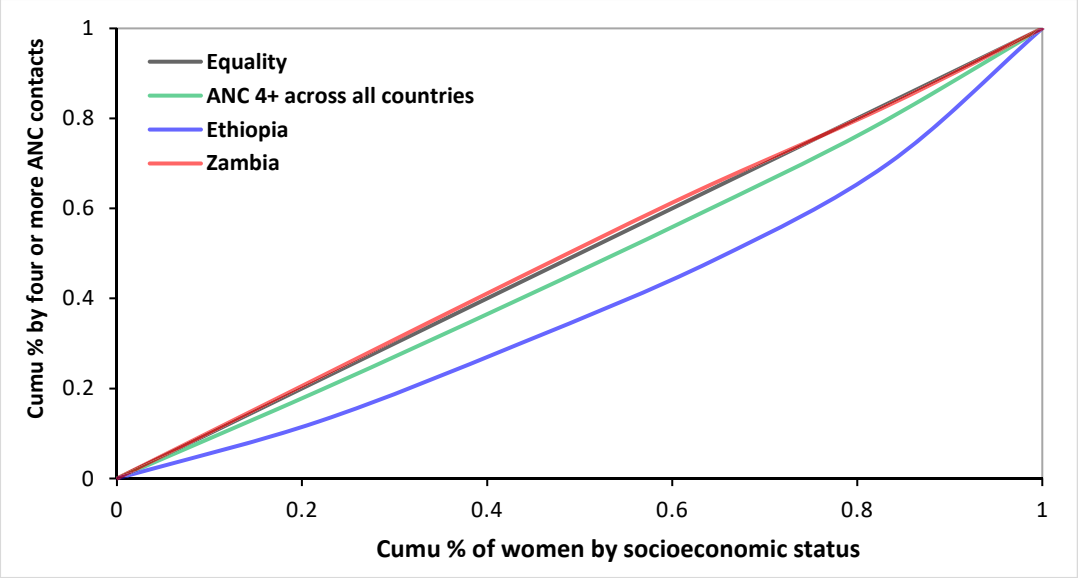

Figure 4-6 Concentration curves for four or more antenatal care contacts across nine East African countries (DHS: 2013 - 2018)

Note: The curve for all nine countries is displayed with those having the highest and the least inequity Ethiopia had the highest inequality in four or more ANC contacts, while Zambia showed no inequality in four or more ANC contacts. The concentration curve for four or more ANC contacts across all countries show that the coverage is pro-rich.

The inequality in the distribution of six services was highest in Burundi favouring wealthier women (CCI: 0.318) (Figure 4-7). There were no socioeconomic differences in receipts of all six services in Malawi and Zimbabwe. Within and across all countries, we found low coverage and high inequality in the coverage of the six services of ANC (Figure 4-5). Among the six services of ANC analysed in our study, urine sample test had the highest inequalities (CCI: 0.121).

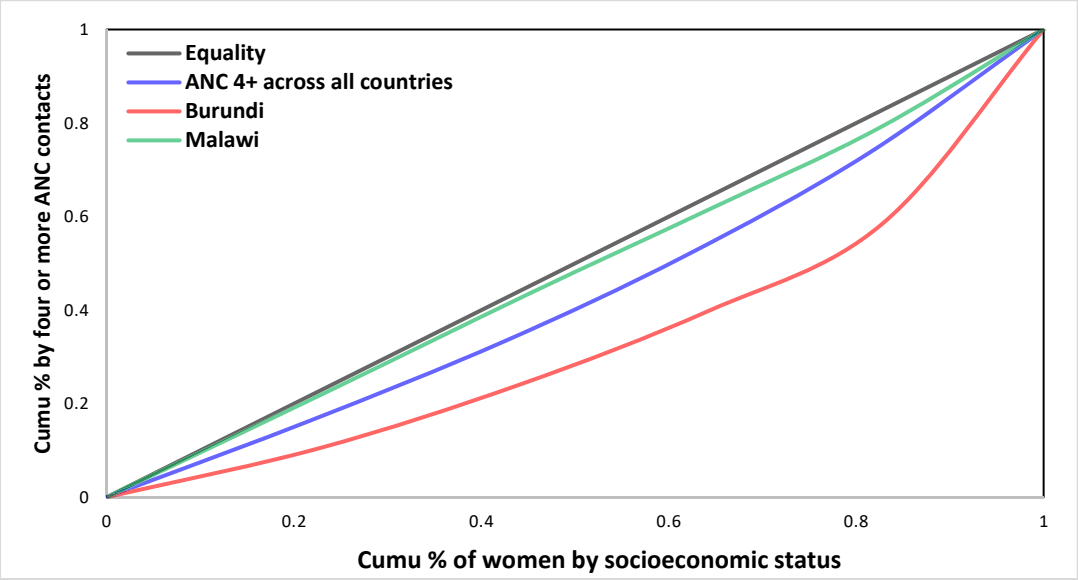

Figure 4-7 Concentration curves for receipts of all six services across nine East African countries (DHS: 2013 - 2018)

Note: The curve for all nine countries is displayed with those having the highest and the least inequity. Burundi had the highest inequality in receipt of all six services, while Malawi showed no inequality. The concentration curve for receipt of all six services across all countries show that the coverage is pro-rich.

The concentration curve for receipt of all six services across all countries show that the coverage is pro-rich. Inequalities in the coverage of all six services among women living in rural areas were statistically significant, and the degree of inequality was (CCI: 0.042), but there was no statistically significant difference among women living in urban areas. We observed similar patterns across the specific services including drug for intestinal parasite, urine sample test, blood sample test and blood pressure measurement services (Figure 4-8).

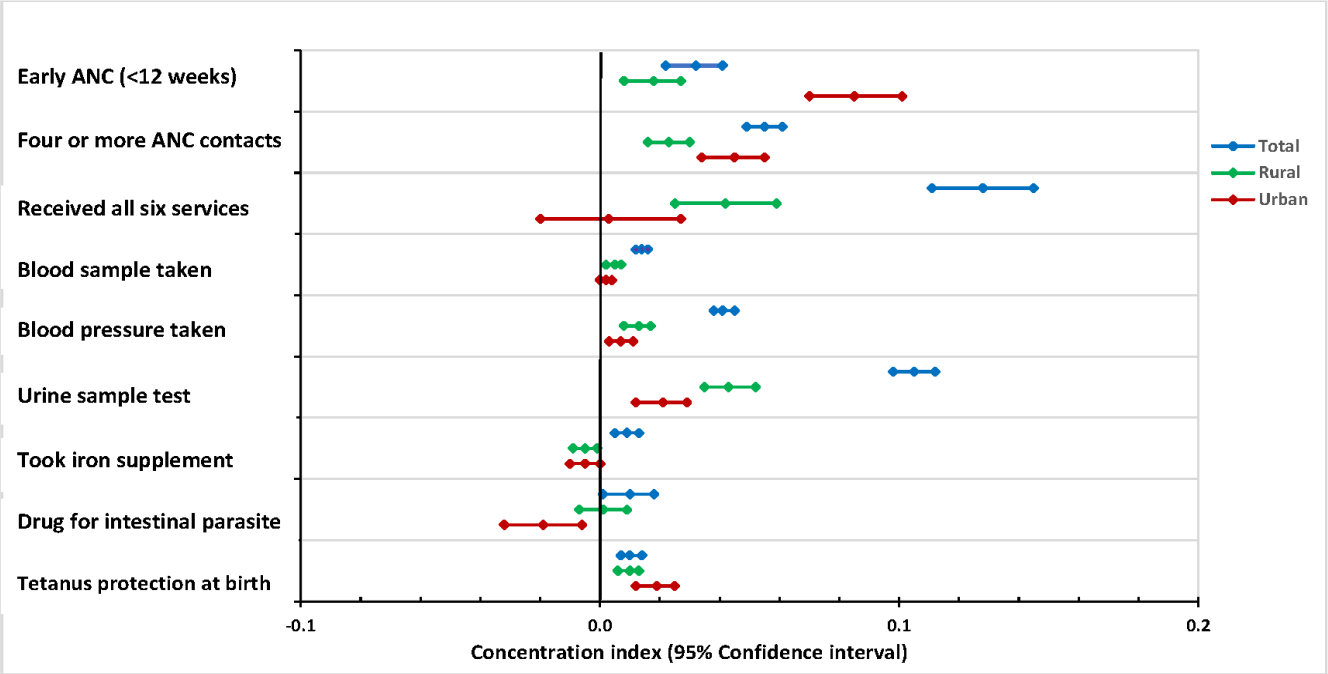

Figure 4-8 Socioeconomic inequalities in the coverage of six ANC components by area of residence across nine East African countries (DHS: 2013 – 2018)

Table 4-1 shows the multivariable models for the associations between the use of four or more ANC contacts and women's socio-demographic factors. Timing of first ANC visit, educational status, experiences of contraceptive use, exposure to media (radio or TV), occupation of women, and wealth of women's household were positively associated with the use of four or more ANC contacts. The odds of four or more ANC contacts attendance increased with increasing level of education: women with secondary or higher education had higher odds (AOR 1.37 95% CI: 1.19, 1.57) compared to women who had no education. With increasing wealth,

status of women's household, the odds of four or more ANC contacts also increased as the richest fifth of women had the highest odds of attendance (AOR 1.30, 95% CI: 1.10, 1.54), followed by those in third quintile (Q3) (1.07 95% CI: 1.01, 1.14) and Q2 (AOR 1.06 95% CI: 1.00, 1.11) than women from the poorest household.

We found two factors that lowered the odds of four or more ANC contacts: unintended pregnancies and distance to health facility. Women with unintended pregnancy had lower odds of four or more ANC contacts: women who had mistimed pregnancy had 21% (AOR 0.79, 95% CI: 0.75, 0.84) lower odds of attendance, while those with unwanted pregnancy had 26% (AOR 0.74, 95% CI: 0.64, 0.84) lower odds of attending four or more ANC contacts compared to women who wanted to be pregnant with the last live birth.

Women who reported distance to health facility as a big problem had 5% lower odds of attending four or more ANC contact (AOR 0.95, 95% CI: 0.91, 0.99) compared to women who did not consider distance to health facility as a big problem.

Table 4-1 Factors associated with four or more antenatal care contacts

Study variables	Total		Women who received four or more ANC contacts Percent (95% CI)	Unadjusted OR (95% CI)	P	Adjusted OR (95% CI)	P
	Number	(%)					
Age-group (years)					**<0.001**		0.141
15 to 24	26886	30.9	54.4 (53.4, 55.3)	1.00(Referent category)		1.00(Referent category)	
25 to 29	22373	25.7	55.6 (54.6, 56.7)	1.09 (1.02, 1.16)		0.98 (0.93, 1.05)	
30 to 34	17836	20.5	55.3 (54.2, 56.4)	1.08 (0.98, 1.19)		1.05 (0.94, 1.17)	
35 to 49	19974	22.9	52.4 (51.2, 53.5)	0.98 (0.85, 1.14)		1.07 (0.92, 1.24)	
Wanted to be pregnant with the last live birth					**<0.001**		**<0.001**
Planned	48936	61.5	56.5 (55.6, 57.4)	1.00(Referent category)		1.00(Referent category)	
Mistimed	22986	28.9	51.7 (50.7, 52.7)	0.73 (0.68, 0.78)		0.79 (0.75, 0.84)	
Unwanted	7597	9.6	46.7 (45.0, 48.3)	0.65 (0.56, 0.76)		0.74 (0.64, 0.84)	
First antenatal care visit <12 weeks of gestational age							
No	59980	68.9	42.7 (41.9, 43.5)	1.00(Referent category)		1.00(Referent category)	
Yes	27089	31.1	80.3 (79.6, 81.0)	7.53 (5.64, 10.05)		6.95 (5.50, 8.79)	
Highest educational level					**<0.001**		**<0.001**
No education	16693	19.2	40.4 (38.9, 41.8)	1.00(Referent category)		1.00(Referent category)	
Primary	46225	53.1	53.4 (52.7, 54.2)	1.31 (1.15, 1.49)		1.19 (1.05, 1.34)	
Secondary or higher	24150	27.7	66.0 (65.1, 67.0)	1.84 (1.38, 2.44)		1.37 (1.19, 1.57)	
Pattern of use of contraceptive method at the time of survey					**<0.001**		**<0.001**
Never used	21433	24.6	59.2 (58.4, 60.0)	1.00(Referent category)		1.00(Referent category)	
Currently using	42318	48.6	56.2 (54.9, 57.6)	1.54 (1.32, 1.79)		1.33 (1.19, 1.48)	
Used since last birth	12728	14.6	52.7 (51.3, 54.0)	1.34 (1.18, 1.54)		1.29 (1.18, 1.41)	
Used before last birth	10590	12.2	44.8 (43.5, 46.1)	1.21 (1.01, 1.45)		1.21 (1.04, 1.41)	
Frequency of listening to radio					**<0.001**		**0.001**
Not at all	36017	41.4	49.8 (48.7, 50.8)	1.00(Referent category)		1.00(Referent category)	
Less than once a week	15241	17.5	53.9 (52.7, 55.1)	1.17 (1.05, 1.30)		1.05 (0.96, 1.14)	

At least once a week	35793	41.1	59.4 (58.6, 60.1)	1.39 (1.27, 1.52)		1.14 (1.06, 1.22)	
Frequency of watching television					**0.002**		**0.003**
Not at all	60509	69.5	51.0 (50.2, 51.8)	1.00(Referent category)		1.00(Referent category)	
Less than once a week	9631	11.1	54.0 (52.5, 55.4)	1.14 (1.03, 1.27)		0.96 (0.90, 1.02)	
At least once a week	16908	19.4	67.0 (65.7, 68.2)	1.61 (1.22, 2.12)		1.09 (1.00, 1.18)	
Woman's occupation					**<0.001**		**<0.001**
Not currently working	22688	28.6	52.8 (51.4, 54.1)	1.00(Referent category)		1.00(Referent category)	
Skilled and professionals	6151	7.8	65.2 (63.4, 66.9)	1.61 (1.32, 1.96)		1.26 (1.12, 1.41)	
Sales and services	17196	21.7	59.2 (57.9, 60.5)	1.20 (1.12, 1.29)		1.13 (1.04, 1.24)	
Agriculture	33262	41.9	50.4 (49.5, 51.3)	1.05 (0.94, 1.17)		1.13 (1.03, 1.25)	
Household wealth index in quintiles					**<0.001**		**<0.001**
Poorest	19265	22.1	48.6 (47.3, 49.9)	1.00(Referent category)		1.00(Referent category)	
Poorer	18035	20.7	51.1 (49.9, 52.3)	1.08 (0.99, 1.17)		1.06 (1.00, 1.11)	
Middle	16689	19.2	52.9 (51.7, 54.1)	1.26 (1.06, 1.51)		1.07 (1.01, 1.14)	
Richer	16697	19.2	55.6 (54.3, 56.9)	1.48 (1.14, 1.93)		1.09 (0.96, 1.24)	
Richest	16383	18.8	65.3 (64.0, 66.6)	2.08 (1.44, 2.99		1.30 (1.10, 1.54)	
Distance to health facility							**0.030**
Not a big problem	47643	59.9	57.0 (56.2, 57.7)	1.00(Referent category)		1.00(Referent category)	
Big problem	31882	40.1	50.0 (48.8, 51.1)	0.88 (0.83, 0.93)		0.95 (0.91, 0.99)	
Place of residence					**<0.001**		0.056
Urban	21983	25.2	63.6 (62.4, 64.8)	1.00(Referent category)		1.00(Referent category)	
Rural	65086	74.8	51.3 (50.5, 52.1)	0.65 (0.48, 0.87)		0.91 (0.83, 1.00)	

In the multivariable models constructed to assess associations between receiving all six services and women's socio-demographic factors, the following factors were positively associated: women's age, timing and number of ANC contact, media exposure (radio or TV), and primary or above levels of education, and occupation of women (Table 4-2).

With increasing levels of women's education, the odds of receiving the six services also increased, as the odds of women who had secondary or more education levels were higher (AOR 1.28 95% CI: 1.12, 1.47) compared to women who had no education. Women who had their first ANC contact before 12 weeks of gestation had higher (AOR 1.29, 95% CI: 1.21, 1.38) odds of receiving all six services compared to women who had no or late ANC contact. Women with four or more ANC contacts had higher odds of receiving all six services (AOR 1.37, 95% CI: 1.20, 1.57) compared to women who had three or lower ANC contacts. The odds of receiving all six care components increased with increasing access to radio: women who listen to radio once a week or more had higher (AOR 1.14, 95% CI: 1.05, 1.23) odds of receiving all six services than women who did not listen to radio at all.

Women from rural areas had 26% lower odds of receiving all six services (AOR 0.74 95% CI: 0.61, 0.90) compared to women from urban areas. Compared to women who wanted to be pregnant with their last live birth, women who had unwanted pregnancy had 13% (AOR 0.87, 95% CI: 0.79, 0.95) lower odds to receive all six services. Women who reported distance to health facility as a big problem had 8% (AOR 0.92, 95% CI: 0.87, 0.97) lower odds of receiving all six services compared to women who did not consider distance to health facility as a big problem.

Table 4-2 Factors associated with receiving all six services of antenatal care

Study variables	Total Number	(%)	Women who received all six services of ANC percent (95 CI)	Unadjusted OR (95 CI)	P	Adjusted OR (95 CI)	P
Age -group (years)					**0.001**		**<0.001**
15 to 24	25812	31.3	19.5 (18.6, 20.4)	1.00 (Reference category)		1.00(Reference category)	
25 to 29	21238	25.7	21.8 (20.7, 22.9)	1.30 (1.16, 1.45)		1.25 (1.12, 1.39)	
30 to 34	16901	20.5	22.1 (21.0, 23.2)	1.35 (1.09, 1.68)		1.31 (1.08, 1.61)	
35 to 49	18551	22.5	21.1 (20.0, 22.2)	1.23 (0.97, 1.55)		1.28 (1.02, 1.59)	
Wanted pregnancy at the time					**<0.001**		**0.009**
Wanted at the time	46256	61.4	21.5 (20.6, 22.4)	1.00 (Reference category)		1.00(Reference category)	
Mistimed	22024	29.3	21.2 (20.3, 22.1)	0.85 (0.74, 0.97)		0.92 (0.83, 1.01)	
Unwanted	7001	9.3	16.9 (15.6, 18.3)	0.83 (0.74, 0.93)		0.87 (0.79, 0.95)	
Timing of antenatal care					**<0.001**		**<0.001**
Initiated late	55413	67.2	19.4 (18.5, 20.2)	1.00 (Reference category)		1.00(Reference category)	
Initiated early	27089	32.8	24.1 (23.1, 25.0)	1.55 (1.36, 1.77)		1.29 (1.21, 1.38)	
Number of ANC contacts					**<0.001**		**<0.001**
Less than four ANC contacts	35115	42.6	17.0 (16.2, 17.8)	1.00 (Reference category)		1.00(Reference category)	
Four or more ANC contacts	47387	57.4	23.9 (23.1, 24.9)	1.56 (1.34, 1.83)		1.37 (1.20, 1.57)	
Frequency of listening to radio					**<0.001**		**0.004**
Not at all	32780	39.7	18.0 (17.0, 19.0)	1.00 (Reference category)		1.00(Reference category)	
Less than once a week	14748	17.9	21.7 (20.5, 22.9)	1.27 (1.09, 1.47)		1.15 (1.00, 1.31)	
Once a week or more	34956	42.4	23.7 (22.9, 24.6)	1.35 (1.21, 1.50)		1.14 (1.05, 1.23)	
Frequency of watching television					**<0.001**		**<0.001**
Not at all	56559	68.6	17.3 (16.6, 18.1)	1.00 (Reference category)		1.00(Reference category)	
Less than once a week	9291	11.3	24.6 (23.2, 26.0)	1.38 (1.24, 1.54)		1.20 (1.07, 1.34)	
Once a week or more	16634	20.2	32.4 (30.8, 34.1)	1.52 (1.12, 2.05)		1.07 (0.89, 1.29)	

Highest educational level					**<0.001**		**0.007**
No education	14027	17	11.9 (11.1, 12.8)	1.00 (Reference category)		1.00(Reference category)	
Primary	44692	54.2	20.7 (19.9 21.4)	1.27 (1.17, 1.39)		1.21 (1.12, 1.31)	
Secondary or higher	23783	28.8	27.3 (26.0, 28.7)	1.57 (1.22, 2.02)		1.28 (1.12, 1.47)	
Women's occupation					**<0.001**		**<0.001**
Not currently working	20512	27.3	22.3 (21.1, 23.6)	1.00 (Reference category)		1.00(Reference category)	
Skilled and professionals	6000	8	27.6 (25.9, 29.3)	1.52 (1.32, 1.74)		1.31 (1.16, 1.48)	
Sales and services	16468	21.9	27.0 (25.7, 28.5)	1.20 (1.03, 1.38)		1.11 (0.97, 1.26)	
Agriculture	32103	42.8	15.8 (15.1, 16.5)	0.85 (0.74, 0.98)		0.92 (0.85, 0.99)	
Household wealth					**<0.001**		**0.048**
Poorest	17704	21.5	15.8 (14.9, 16.8)	1.00 (Reference category)		1.00(Reference category)	
Poorer	16954	20.6	17.1 (16.2, 18.1)	1.08 (0.99, 1.17)		1.03 (0.97, 1.09)	
Middle	15827	19.2	19.8 (18.6, 21.1)	1.26 (1.06, 1.51)		1.13 (0.99, 1.28)	
Richer	15971	19.4	23.4 (22.0, 24.9)	1.48 (1.14, 1.93)		1.16 (1.00, 1.35)	
Richest	16046	19.4	29.6 (28.0, 31.3)	2.08 (1.44, 2.99)		1.26 (1.01, 1.59)	
Distance to health facility					**<0.001**		**0.004**
Not a big problem	46113	61.3	23.4 (22.4, 24.4)	1.00 (Reference category)		1.00(Reference category)	
Big problem	29167	38.7	17.2 (16.4, 18.0)	0.82 (0.76, 0.88)		0.92 (0.87, 0.97)	
Place of residence					**<0.001**		**0.002**
Urban	21585	26.2	32.4 (30.7, 34.2)	1.00 (Reference category)		1.00(Reference category)	
Rural	60917	73.8	17.2 (16.5, 17.9)	0.51 (0.39, 0.67)		0.74 (0.61, 0.90)	

4.5 Discussion

We assessed inequalities in access to quality antenatal care services women received in nine East African countries. We systematically examined inequalities in having the recommended number ANC contacts (four or more) and receipt of quality care, which we defined as having six of the recommended components of ANC. The majority (95%) of women had at least one ANC contact (ranging from 62.9% in Ethiopia to 99.3% in Burundi), but only 31.1% had their first visit within the first 12 weeks of gestation. More than half of women across all countries had four or more ANC contacts; this ranged from 31.8% in Ethiopia to 75.7% in Zimbabwe. Many women did not receive all six components, although they had an adequate number of ANC visits. About 21% of women across all countries received all six components of care, ranging from 1.7% in Zimbabwe to 41% in Zambia. This implies that across all the countries and socioeconomic levels, the majority of women received low-quality care even when they managed to be in contact with health care providers.

Our finding of a large gap between contact and content of ANC that women received is consistent with similar studies from Nigeria (194) and Nepal (84). In such studies, the gap between contact and content of services was partly due to the challenges related to shortages of medical equipment and supplies. Surveys of health facilities in sub-Saharan African countries (195, 196) have found shortages of basic supplies and equipment to collect urine and blood specimens and to measure blood pressure. Lack of adequate healthcare providers with the right set of skills, commitment, care and respect for women provides another explanation for the gap in ANC services in those studies (197, 198).

The service gaps in the present study were mainly due to lower coverage of services that require availability of medications and functional laboratories. The relevant services were urine sample tests, drugs for intestinal parasites, and tetanus injections. We also found that these services were the underlying reasons for inequalities in the content of care received during contacts; in particular, the urine sample test had coverage of 42% among the poorest quintile of women, but was 70.7% among the richest quintile. In 2016, WHO introduced a new antenatal care model that recommends a minimum of eight antenatal care contacts (97). However, increasing the number of contacts alone cannot improve health outcomes without improving the quality of care delivered to women.

The limited availability of health resources, coupled with an inefficient use of existing resources, also compromises the quality of health services in many countries (4, 55). Inadequate financing affects the health system's capacity to provide basic health equipment and supplies to health facilities that are serving communities (199). Due to a lack of adequate laboratory and pharmaceutical supplies, health facilities are often unable to provide good quality care (196). The poor quality of care can also be explained by health systems performance issues that include long queues and waiting times as well as inadequate and sometimes disrespectful treatment women receive from providers (185).

In agreement with previous studies (79, 187, 200), our analysis revealed a pro-rich distribution of both contacts and content of ANC received by women across all countries. Inequalities in ANC contacts and receipt of six components of care in Kenya, Uganda, Tanzania, and Zambia, favoured wealthier women. In Ethiopia, Malawi, and Zimbabwe four or more ANC contacts were higher among richer women. However, in Rwanda, we noticed relatively low, but evenly distributed coverage in terms of the four or more ANC contacts and all six services received.

There is typically a strong association between socioeconomic status and use of health services (79, 201, 202). In our study, the socioeconomic well-being of women was associated with an increased number of ANC contacts. While maternal health services are provided free of charge in many developing countries (79), women may incur both direct (laboratory tests and medications) and indirect costs (e.g. transportation costs), which often limits their uptake of these services. Moreover, women may also have other competing priorities that may affect their use of antenatal care services. Most poor women travel longer distances and may wait for long periods to receive ANC services and consequently incurring the opportunity costs related to work and family responsibilities. A fee exemption for maternal health services is a vital step forward in reducing financial barrier to accessing care but demand-side barriers of indirect costs such as cost of transportation and missing productive work hours remain critical (198).

We observed that older women were more likely to attend four or more ANC contacts than younger women. A recent systematic review that examined determinants of ANC use (108) across sub-Saharan Africa has had a similar finding. On the other hand, we found that after adjusting for age and other confounding variables as the number of pregnancies and births increased, women were less likely to attend ANC, which is consistent findings of other similar studies (84, 203). The decision to seek ANC for second or later pregnancies can be affected by experiences of previous pregnancy and childbirth. If the previous pregnancy and childbirth were safe and uncomplicated, women might think later pregnancies carry lower risk and, therefore, be less likely to attend ANC follow-ups (203).

We found that planning for pregnancy affects a woman's decision to seek ANC. Women who had a mistimed or unwanted pregnancy were less likely to attend four or more ANC contacts

or receive adequate content of care. Failure to recognise the pregnancy early on is one of the reasons for lack or delayed use of ANC, which could be worsened by unavailability of early pregnancy testing services (204, 205).

Urine tests are done to screen for possible pregnancy and examine protein and glucose levels to screen for hypertensive disease of pregnancy and diabetes. In this study, coverage of urine sample test was lowest among the six components of ANC we analysed and this can partly be attributed to unavailability of the test at the facilities. It is also possible that the health care providers could have failed to request for it (79).

Previous studies have highlighted the fact that there are clear connections between antenatal care, institutional delivery and postnatal care (147, 148, 206). More specifically, an earlier study in sub-Saharan Africa has demonstrated that receiving higher quality ANC improves the uptake of skilled birth attendance (207). The associations between use of contraceptives and antenatal care, as revealed in this study, further highlights the need to emphasise continuity of maternal health services.

Education empowers women and reduces gender inequality (183). In the present study, improvements in four or more ANC contacts and the six services received were consistent with improvements in women's education. Education helps to create improved awareness and knowledge about maternal health services, which positively influences women's desire/willingness to use health services (208). Previous studies have also indicated that educated women are more likely to use ANC and other related maternal health services (102, 110, 186).

Access to media can be a powerful tool to reach all women of different socioeconomic status. We found that access to mass media (radio and TV) favourably influences the contact and content of ANC received. Disseminating organised and deliberate messages about the importance of attending maternal health services is crucial to reach not only women, but also their partners and opinion leaders in the community (209). Disseminating messages that target women's partner and community leaders can help to create a supportive environment that can favourably influence women to use health services (209).

Place of residence is recognised as one of the key factors underpinning inequalities in the use of health services (183, 208). Women from urban areas were more likely to receive the six services compared to women residing in rural areas. This finding is consistent with those of earlier studies (110, 187). Various explanations have been suggested for the low quality ANC coverage in rural areas including less developed health infrastructure and fewer skilled providers (195, 196). Similarly, some studies have suggested that women from rural areas who attend urban health facilities are more likely to receive poor quality antenatal care; which might be because they are probably less educated, so providers think they won't complain about quality (110, 203). Others have pointed out that discriminatory treatment from providers can undermine the quality of antenatal care women receive (210, 211). Often, women receive differential treatment as a result of their ethnic background, level of wealth, and educational attainment (211).

The strengths of our study include the use of nationally representative population-based survey collected from nine east African countries. Second, most studies in this area have focussed on wealth related inequalities, while other critical social determinants of health such as education, place of residence, occupation, and other sociodemographic factors have not

been considered. This study provides a more comprehensive evidence by first assessing inequalities in the use of ANC relative to wealth using concentration curve and index and then looking at other important determinants of inequalities in a multilevel analysis.

Our study has some limitations. First, information on women's last live birth was collected retrospectively, and the birth may have been up to five years before the survey. Thus, recall and self-reporting bias are limitations, as women may not accurately remember whether they received a service and/or the number of ANC contacts they have made. Second, measuring quality of care is complex as conceptually quality is a multidimensional construct (48). In the current analysis, we were limited to analysing content of care as a proxy to assess quality of ANC without considering the process of delivering care due to lack of variables to reflect on the later. Furthermore, we were unable to include all recommended 13 components of ANC in our analysis since seven of the services were not provided/available consistently in the survey datasets for the included countries. For example, data for nutritional counselling services were only available in Ethiopia 2016 DHS. Weight measurements were only reported in Kenya, Malawi and Uganda, while height measurements were reported in Kenya and Malawi. Moreover, cost of health services was not included in the datasets while it could have proved to be important determinant of inequitable access to quality ANC as we have shown for distance from health facility.

4.5.1 Conclusions

The findings of this study highlight a large gap between the contact and content of antenatal care. We found that the coverage of quality antenatal care was low across all countries included in our analysis. Women who received all the six services were largely educated, live in urban areas, and had plan to have a child. In effect, this study has shown that there are

multiple factors at play that could be responsible for inequalities in access to adequate antenatal care services. As such, interventions to address current inequalities in access to quality maternal care in sub-Saharan Africa should consider the underlying causes of such inequalities.

Our findings have some policy implications. First, we note that effective coverage is an important way to bridge the quality gap. Effective coverage requires that performance is measured by not only the number of people the health systems is able to reach but also by incorporating indicators to monitor content of care received by the people. The actual delivery of standard components of a health services package to the population should be the ultimate target. Second, while both demand and supply-side issues require attention, health systems need to ensure consistent delivery of all ANC components to enhance quality. Therefore, in addition to promoting more antenatal care contacts, ensuring consistent delivery of ANC components should be a priority in all countries. Third, efforts at strengthening family planning services are required as women who had unplanned pregnancies received lower-quality antenatal care. Fourth, our findings also imply that ministries of health in individual countries should at least study the DHS data with the aim of looking for evidence to improve equitable uptake of quality ANC. This helps identify quality gaps that arise from deficiencies in supplies and equipment versus those that may reflect the need for targeted training of staff. Finally, yet importantly, quality improvement efforts should begin in areas with poor quality ANC services and directly consider the needs and experiences of poor and vulnerable populations.

4.5 Chapter summary

This chapter presented inequalities and drivers of inequality in the use of antenatal care quality. The results highlighted a large gap between women's coverage and services during antenatal care contact. Antenatal care is a vital service point that helps identify risks to the newborn and the mother and promotes related maternal and child health service use. In addition to identifying danger signs and complications during pregnancy, it also cations about the type of services needed to have a safe and positive childbirth experience and receive immediate postnatal care and serves as a warning system if there is a risk to the baby or the mother.

The next chapter presents spatial patterns, inequalities, and drivers of skilled birth attendance and caesarean section. We also present the effects of antenatal care on having skilled birth attendance and caesarean section.

Chapter Five: Intrapartum care: spatial patterns, inequalities and determinants

Preamble

The effort to eliminate preventable maternal and child mortality emphasises the importance of addressing inequalities and ensuring access to critical maternal and child health services. To address inequalities in access to intrapartum care, these inequalities must first be adequately measured and monitored. Investigations into inequality should aid in identifying all vulnerable groups in need of maternal health services and informing policies and programs that will reach these underserved populations.

The previous chapter reported on inequalities and drivers of inequality in using quality antenatal care in east Africa. This chapter contains a manuscript that reported on skilled birth attendance and caesarean section spatial patterns, wealth-related within-country inequalities and critical contributions of other social determinants of health such as maternal education, access to media, place of residence and distance to a health facility. This chapter also reports on the effect of antenatal care use on skilled birth attendance and caesarean section uptake.

Citation: **Bobo F.T.**, Asante A, Woldie M, Dawson A, Hayen A. Spatial patterns and inequalities in skilled birth attendance and caesarean delivery in sub-Saharan Africa. BMJ Global Health. 2021;6(10).

Manuscript two: Spatial patterns and inequalities in skilled birth attendance and caesarean delivery in sub-Saharan Africa

5.1 Abstract

Background: Improved access to and quality obstetric care in health facilities reduces maternal and neonatal morbidity and mortality. We examined spatial patterns, within-country wealth-related inequalities and predictors of inequality in skilled birth attendance and caesarean deliveries in sub-Saharan Africa.

Methods: We analysed the most recent Demographic and Health Survey (DHS) data from 25 sub-Saharan African countries. We used the concentration index (CCI) to measure within-country wealth-related inequality in skilled birth attendance and caesarean section. We fitted a multilevel Poisson regression model to identify predictors of inequality in having skilled attendant at birth and caesarean section.

Results: The rate of skilled birth attendance ranged from 24.3% in Chad to 96.7% in South Africa. The overall coverage of caesarean delivery was 5.4% (95% CI: 5.2% to 5.6%), ranging from 1.4% in Chad to 24.2% in South Africa. The overall wealth-related absolute inequality in having a skilled attendant at birth was extremely high, with a difference of 46.2 percentage points between the poorest quintile (44.4%) and the richest quintile (90.6%). In 10 out of 25 countries, the caesarean section rate was less than 1% among the poorest quintile, but the rate was more than 15% among the richest quintile in nine countries. Four or more antenatal care contacts, improved maternal education, higher household wealth status, and frequently listening to the radio increased the rates of having skilled attendant at birth and caesarean section. Women who reside in rural areas and those who have to travel long distances to access health facilities were less likely to have skilled attendant at birth or caesarean section.

Conclusions: There were significant within-country wealth-related inequalities in having skilled attendant at birth and caesarean delivery. Efforts to improve access to birth at the

facility should begin in areas with low coverage and directly consider the needs and experiences of vulnerable populations.

Summary box

What is already known?

- Improving access to and quality of obstetric care at facilities is a priority.
- Several countries have shown shifts from home deliveries to facility deliveries in the past decade.

What are the new findings?

- There were significant pro-rich inequalities in skilled birth attendance and caesarean section.
- In most countries, the coverage of caesarean section was extremely low, particularly among the poorer populations.
- Women who had a skilled birth attendance or caesarean delivery were more likely to be educated, have access to mass media (TV), have four or more ANC contacts, be residents of an urban area or have better geographical access to a health facility.

What do the new findings imply?

- Efforts to improve access to obstetric care should start in areas with low coverage and directly consider the needs and experiences of vulnerable populations.
- Improving the quality of care to increase the uptake of facility-based delivery.
- Country-specific strategies are critical to addressing these inequalities to improve maternal and newborn health.

5.2 Introduction

Women and children in sub-Saharan Africa are the most vulnerable subgroups and have limited access to quality reproductive, maternal, neonatal and child health services (12, 23). In 2017, 295,000 women died from preventable causes related to pregnancy and childbirth and 2.6 million babies died within the first month of their life worldwide (12). Of those, 195,000 (66%) women and 988,000 (38%) newborns were from sub-Saharan Africa (12). Within countries, the risk of death is disproportionately high among the most vulnerable subgroups (12, 66, 212). The majority of these deaths can be averted by improving access to quality health services (23, 213). While encouraging progress has been made to increase access to health services and reduce maternal and child mortality, preventable deaths are still occurring in sub-Saharan Africa (12, 23, 61).

Successful, consistent and continuous reduction of maternal and child mortality requires improving access to quality maternal and child health services along the continuum of care (61, 139, 214). A critical intervention is ensuring that a health worker with midwifery skills is present at every birth and transportation is available in case of emergency (23, 215). In the past decade, the world has seen remarkable growth in the number of health facilities and improvements in health infrastructures and access to transport services. These have led to considerable improvements in maternal and child health indicators in some countries (e.g. Rwanda), but in many other countries, expectations were not met, and targets were not achieved (21, 68).

Growing evidence from a number of countries has shown significant shifts from home deliveries to facility deliveries in the past decade (78). However, extreme disparities in the use of maternal and child health services continue to exist across regions, within and between

countries (21, 216). Inequalities in access to and quality of health care exist along with the factors such as wealth, geography, gender, religion, ethnicity, and race that put some people at a social disadvantage relative to others and places them at risk for discrimination and unequal treatment (2, 217).

Medically indicated caesarean section (CS) is a life-saving intervention for women and newborns (140). Globally, CS use has increased during the past few decades to a frequency exceeding of the proportion of 10–15% of births that is thought to be optimal (66, 140). A major growth in the rate of non-medically indicated CS in many middle-income and high-income countries has driven the increased use of this procedure (140). However, in low-income countries in general and among the poorer sections of the populations – caesarean sections are not always accessible, even when they are clearly indicated (218).

The global maternal mortality ratio (MMR) decreased from 385 deaths per 100,000 live births in 1990 to 211 per 100,000 live births in 2017, but there were important regional disparities (12). In 2017, the maternal mortality ratio in sub-Saharan Africa was 542 per 100,000 live births, nearly 26 times the rate in high-income countries (12). The Sustainable Development Goal (SDG) 3, which focuses on health, aims to reduce the global MMR to less than 70 deaths per 100,000 live births (13). This rate might be difficult to achieve unless disparities are identified at a basic level to determine how health system operations, planning and programming for maternal health and service distribution result in inequitable health outcomes. Hence, closer examination of drivers of disparities in access to critical interventions such as skilled birth attendance (SBA) and CS will inform the planning and programming effort to address inequitable access to maternal health services. We aim to address this gap in knowledge of these disparities by systematically examining spatial patterns, inequalities, and predictors of SBA and CS in sub-Saharan Africa.

5.3 Methods

5.3.1 Data

We used the most recent Demographic and Health Surveys (DHS) collected from 25 sub-Saharan African countries. The DHS program uses standardised methods to ensure uniformity of data collected across time and countries. We included all DHS that were conducted from 2013 to 2020. Countries are expected to adopt the full standard model questionnaire, but they can add questions of particular interest. However, questions in the model can be deleted if they are irrelevant for a specific country. The DHS uses standard sampling methods and design across all countries. The sampling methods and design have been described elsewhere (67).The study population includes all women of reproductive age (15 to 49 years) who had at least one live birth during the five years preceding the respective surveys. Only the most recent live birth was included in this analysis to reduce recall bias.

5.3.2 Outcomes

We examined two primary outcomes: birth assisted by skilled attendant and delivery by CS. Skilled birth attendance was defined as whether the delivery took place in the presence of qualified personnel: a doctor, nurse, midwife, auxiliary midwife or other cadres that each country individually considers as skilled delivery attendants. Data on assistance at birth in the survey questionnaires were collected through answers to the question "Who assisted with the delivery of (NAME OF THE CHILD)? Information on caesarean sections is based on women's self-reported answer to the question: "Was (NAME OF THE CHILD) delivered by caesarean, that is, did they cut your belly open to take the baby out?"

We also assessed disparities in place of delivery and type of facility (Private vs public). Place of delivery was defined as – birth at home that includes the respondent's home or another

non-institutional setting or birth at a health facility (institutional delivery), which may include public health facilities or the private medical sector. Public-sector deliveries are those occurring in publicly funded, government health facilities. Private sector births are those occurring in facilities outside the public sector and can be further divided into two categories: private-for-profit facilities and private not for profit facilities.

5.3.3 Covariates

We used the WHO Commission on Social Determinants of Health framework to explain predictors of inequality in the use of skilled birth attendance and caesarean section (2). We used household wealth index and education levels to explain socioeconomic position of women. The wealth index was constructed using principal components analysis based on ownership of selected household assets such as television, radio, refrigerator, and vehicle; materials used for housing construction; and access to sanitation facilities and clean water. Households were ranked into quintiles from the poorest (Q1) to richest (Q5) depending on their level of wealth. We categorised mothers' education levels as (no education, primary, secondary or higher). We determined accessibility to health facilities based on the distance to the facility, and ability to afford treatment costs. We considered the distance to a health facility and lack of money for treatment as barriers to accessing health services and categorised – as a big problem or not a big problem. We include exposure to media, which was categorised based on the frequency of reading newspapers, listening to the radio and watching television (TV) as not at all, less than once a week, and once a week or more. We also included the use of antenatal care that was categorised as three or fewer contacts, and four or more contacts. Type place of residence were categorised as urban or rural. Lastly,

maternal factors such as age (15 to 24, 25 to 29, 30 to 34) and parity (one to six) were also included in the analysis.

5.3.4 Statistical analysis

We used concentration index to estimate wealth-related within-country inequalities in SBA and CS. The concentration index ranges between −1 and +1; an index of 0 indicate equality in having skilled birth attendant or CS. A positive values of concentration index indicate a pro-rich coverage of SBA or CS. In contrast, a negative index implies an uneven concentration of skilled birth attendant among the poor (193).

The DHS uses a stratified, two-stage, random sampling design in all countries. Sample weights are included in the DHS to translate unbalanced sampling into national representative data. We used generalised latent linear and mixed model (GLLAMM) that adjusted for country, clusters and sampling weights to fit multilevel Poisson regression. We specified a 3-level model to examine predictors of inequality in SBA and CS. For the first outcome (skilled birth attendant) models – at level 1 we adjusted for women and household factors (181,191 women); at level 2 we adjusted for clustering (14,643 clusters); and at level 3 we adjusted for a country (25 countries). For the caesarean section models – level 1 included 180,837 women; level 2 had 14,643 clusters, and level 3 covered 25 countries. Results are presented with adjusted risk ratio (RR) and statistical significance was declared when the p-value was < 0.05. Analyses were conducted using Stata 14.2 and IBM Statistical Package for Social Sciences (SPSS, Chicago, Il.) version 25.0. We generated maps using ArcGIS software version 10.7.1.

5.3.5 Patient and public involvement

No patients or the public were directly involved in the design, conduct, reporting or dissemination plans of this research.

5.4 Results

We analysed data on 288,730 women who had a live birth. We used the most recent (2013 to 2020) Demographic and Health surveys conducted in 25 sub-Saharan African countries. The majority of women were from rural areas (69%), 56.5% had four or more antenatal care contacts, and 63.7% delivered at health facility.

5.4.1 Inequality in the coverage of skilled birth attendant

Overall, 63.9% (95%CI: 63.1% to 64.7%) of women received assistance during childbirth from a skilled attendant. Of those who received no assistance from a SBA, 17.6% of women (95% CI: 17.1% to 18.2%) received care from a traditional birth attendant (TBA), 12.3% (95% CI: 11.3% to 12.8%) from a friend or relative, and 4.9% (95% CI: 4.7% to 5.2%) received no assistance.

The coverage of SBA ranged from 24.3% in Chad to 96.7% in South Africa (Figure 5-1). The proportion of women who had an SBA was higher than 85% in countries such as Namibia, Malawi, Rwanda and South Africa but, coverage was less than 50% in Angola, Togo, Nigeria, Ethiopia and Chad. Three in seven deliveries were assisted by a midwife or nurse, while only one in ten deliveries were assisted by a physician. More than three quarters (78.2%, 95% CI: 77.6% to 78.8%) of women with four or more ANC contacts received skilled provider assistance during childbirth.

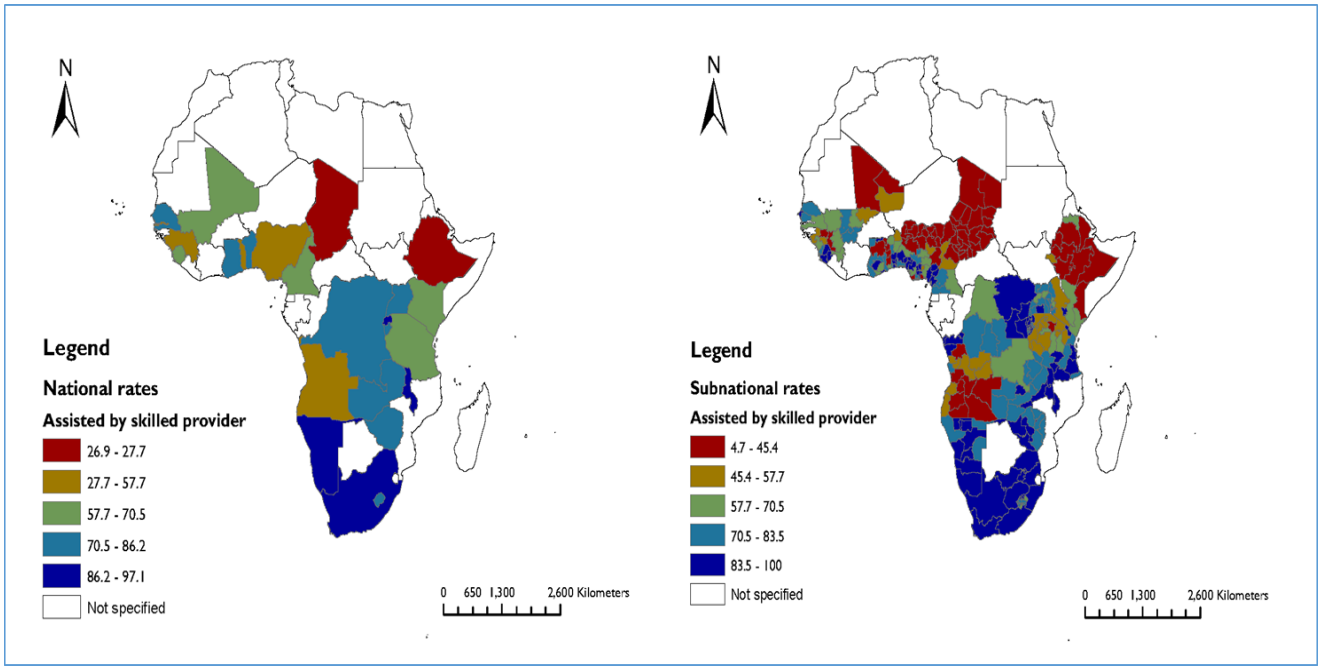

Figure 5-1 National and sub- national rates of skilled birth attendance (SBA) in 25 sub-Saharan African countries.

The wealth-related absolute inequality for all countries in having a SBA was extremely high, with a difference of 46.2 percentage points between the poorest quintile (44.4%) and the richest quintile (90.6%) (Figure 5-2). In four countries, the differences exceeded 65 percentage points: Guinea (68.4 percentage points), Cameroon (69.4 percentage points), Angola (72.4 percentage points), and Togo (76.1 percentage points).

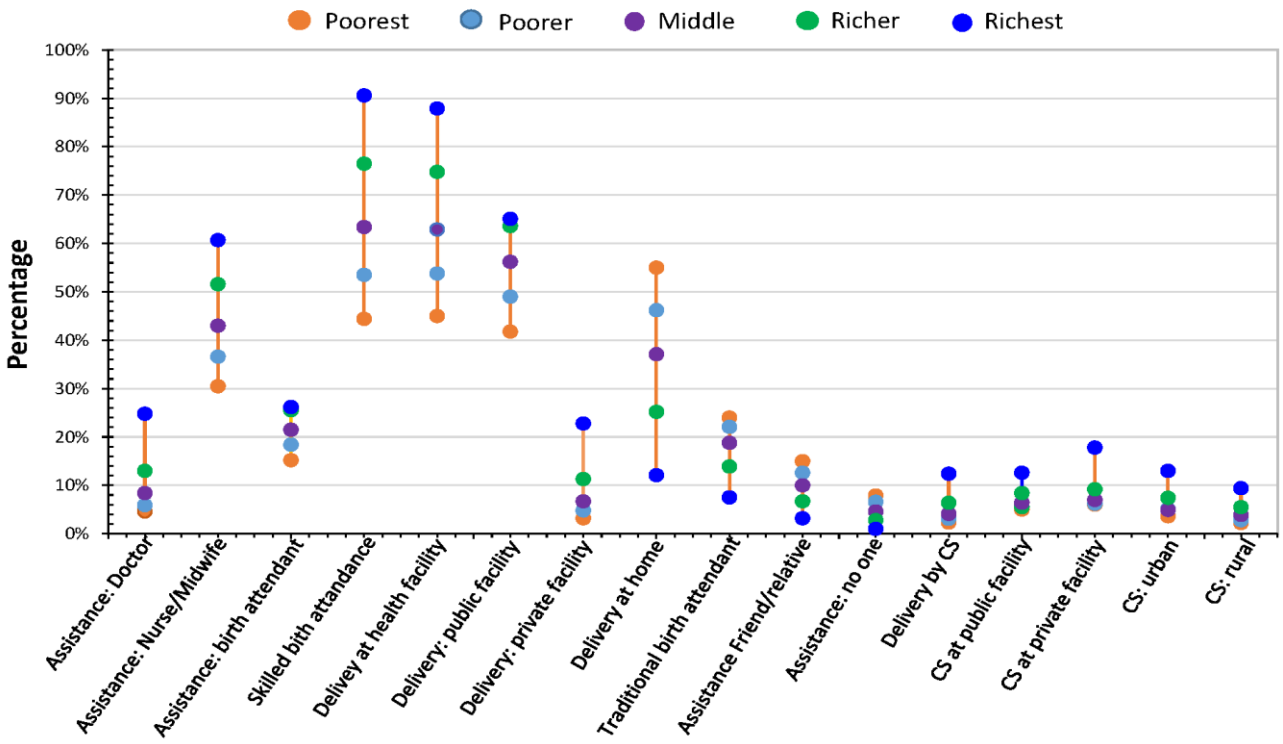

Figure 5-2 Skilled attendant at birth and caesarean delivery rates by socioeconomic status, providers and place of service. Providers or place of service, represented by five circles (one for each wealth subgroup). Vertical lines indicate the difference between the minimum and maximum rate by provider or place of service (DHS 2013–2021).

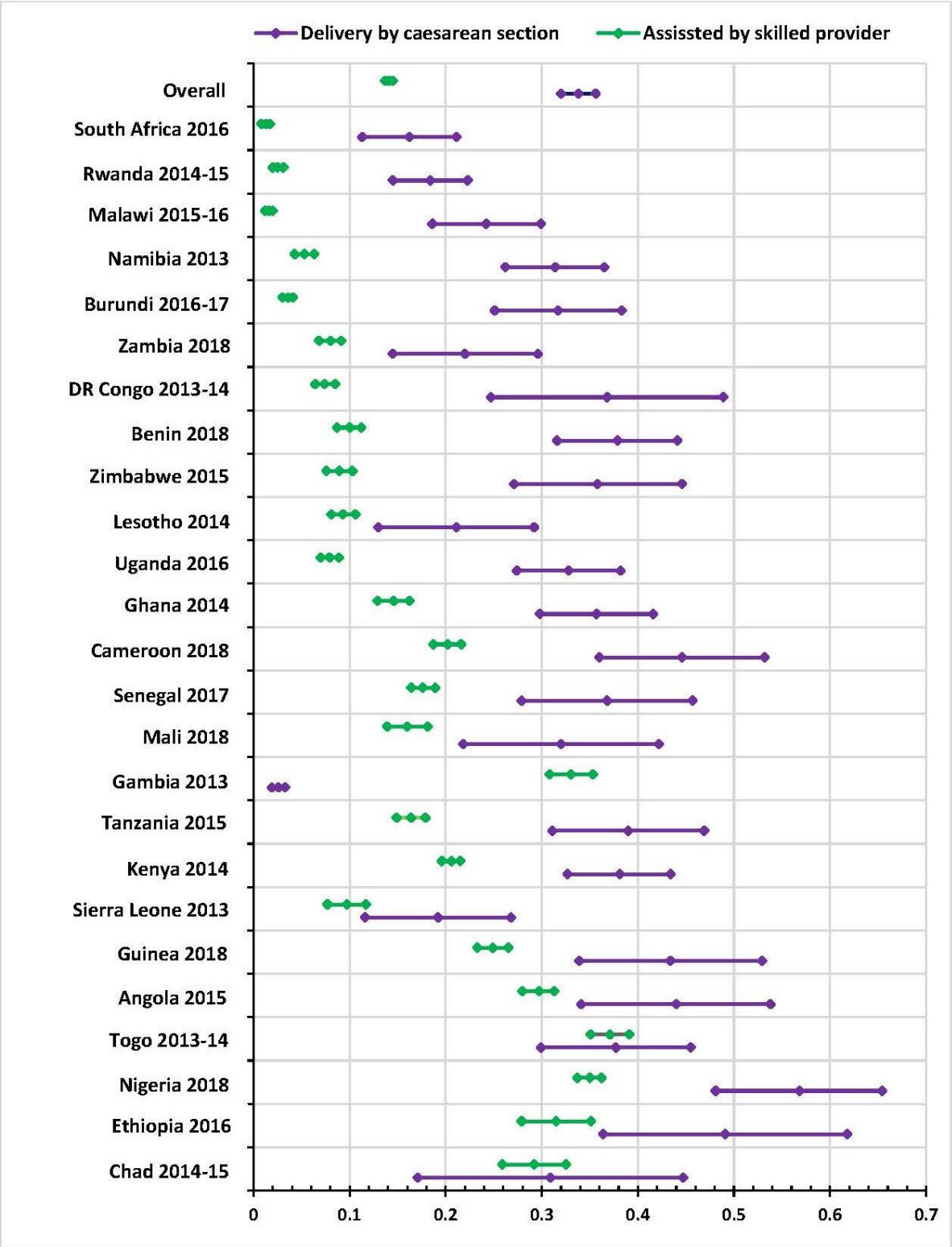

Figure 5-3 Concentration indices for skilled birth attendance and caesarean section across 25 sub- Saharan African countries (DHS 2013–2020).

Figure 5-3 shows statistically significant positive concentration index values across all countries that reveal pro-rich wealth-related within-country inequalities in SBA and CS. We observed strong pro-rich distributions of skilled attendants at birth and caesarean deliveries between and within all 25-study countries. Overall, we found that as coverage increased, inequalities decreased. For example, countries such as South Africa, Rwanda, and Malawi that had more than 90% coverage of a SBA showed the lowest inequalities: South Africa (CCI: 0.013, 95% CI: 0.008 to 0.017), Rwanda (CCI: 0.025 95% CI: 0.02 to 0.031), and Malawi (CCI: 0.016, 95% CI: 0.012 to 0.02). On the other hand, countries such as Togo, Nigeria, Ethiopia and Chad that had lower coverage (50% or less), exhibited higher inequalities: Togo (CCI: 0.371, 95% CI: 0.351 to 0.391), Nigeria (CCI: 0.35, 95% CI: 0.337 to 0.362), Ethiopia (CCI: 0.315, 95% CI: 0.279 to 0.351) and Chad (CCI: 0.292, 95% CI: 0.259 to 0.325).

Table 5-1 shows predictors of a skilled attendant at birth in 25 sub-Saharan African countries. Four or more ANC contacts, higher levels of maternal education, improved access to mass media (radio or TV), and higher household wealth status were associated with increased rates of SBA. While long distances to health facilities and residing in rural areas showed associations with lower rates of SBA. We found higher utilisation rates among women who had four or more ANC contacts (RR: 1.26, 95% CI: 1.16, 1.36) compared to women who had three or lower ANC contacts. With increasing levels of maternal education, the rates of SBA also increased; women who had secondary or higher education had 31% higher rates of (RR: 1.31, 95% CI: 1.16, 1.49) SBA compared to women who had no education. The rates of SBA increased with increasing levels of household wealth status: women in the poorer fifth had higher rates of (RR: 1.12, 95% CI: 1.06, 1.18), middle (RR: 1.22, 95% CI: 1.12, 1.33), richer (RR: 1.29, 95% CI: 1.17, 1.42) and richest fifth (RR: 1.27, 95% CI: 1.13, 1.43) SBA compared to the poorest fifth.

The rates of using an SBA were lower for women who reported long distance to a health facility as a big problem (RR: 0.92, 95% CI: 0.89, 0.95) compared to women who thought distance to health facility was not a big problem. Women living in rural areas had (RR: 0.84, 95% CI: 0.79, 0.90) lower rates of SBA compared to women living in urban areas.

Table 5-1 Factors associated with the use of skilled birth attendance in sub-Saharan Africa

Variables	Number	Percentage	Assisted by skilled attendant	Unadjusted RR (95 CI)	P	Adjusted RR (95 CI)	P
Age groups					<0.001		0.199
15-24	82375	28.1	66.0 (65.1, 66.8)	**1.0 (Reference)**		**1.0 (Reference)**	
25-29	80700	27.6	64.8 (63.9, 65.7)	0.97 (0.96, 0.98)		0.98 (0.96, 1.00)	
30-34	62243	21.2	64 (63.1, 65.0)	0.95 (0.93, 0.97)		0.98 (0.95, 1.01)	
35-49	67600	23.1	60.2 (59.3, 61.1)	0.92 (0.90, 0.94)		0.97 (0.93, 1.01)	
Number of antenatal contacts					<0.001		<0.001
Less than 4 ANC	85674	43.5	52.4 (51.4, 53.4)	**1.0 (Reference)**		**1.0 (Reference)**	
Four or more 4 ANC	111190	56.5	78.2 (77.6, 78.8)	1.34 (1.22, 1.48)		1.26 (1.16, 1.36)	
Highest educational level					<0.001		<0.001
No education	109926	37.5	43 (42.0, 44.3)	**1.0 (Reference)**		**1.0 (Reference)**	
Primary	102614	35	68.2 (67.4, 69.0)	1.25 (1.13, 1.37)		1.21 (1.10, 1.33)	
Secondary	80376	27.4	86.2 (85.7, 86.7)	1.48 (1.30, 1.68)		1.31 (1.16, 1.49)	
Wealth index combined					<0.001		<0.001
Poorest	66498	22.7	44.3 (43.1, 45.4)	**1.0 (Reference)**		**1.0 (Reference)**	
Poorer	63843	21.8	53.5 (52.3, 54.7)	1.16 (1.10, 1.23)		1.12 (1.06, 1.18)	
Middle	58843	20.1	63.7 (62.7, 64.8)	1.32 (1.17, 1.48)		1.22 (1.12, 1.33)	
Richer	54794	18.7	76.4 (75.4, 77.4)	1.53 (1.31, 1.79)		1.29 (1.17, 1.42)	
Richest	48940	16.7	90.5 (89.8, 91.2)	1.79 (1.51, 2.11)		1.27 (1.13, 1.43)	
Frequency of listening to radio					<0.001		0.026
Not at all	129066	44.1	53.3 (52.3, 54.4)	**1.0 (Reference)**		**1.0 (Reference)**	
Less than once a week	56127	19.2	69.5 (68.5, 70.5)	1.11 (1.06, 1.17)		1.04 (1.01, 1.07)	
At least once a week	107553	36.7	74.1 (73.4, 74.8)	1.15 (1.10, 1.21)		1.02 (1.00, 1.04)	

Frequency of watching television					<0.001		<0.001
Not at all	188316	64.4	55.1 (54.1, 56.0)	**1.0 (Reference)**		**1.0 (Reference)**	
Less than once a week	34970	12	72.1 (71.0, 73.1)	1.18 (1.10, 1.26)		1.08 (1.03, 1.13)	
At least once a week	69273	23.7	84.6 (83.9, 85.3)	1.32 (1.21, 1.43)		1.12 (1.07, 1.17)	
Getting money needed for treatment					<0.001		0.328
No problem	122616	45.6	72.7 (71.9, 73.5)	**1.0 (Reference)**		**1.0 (Reference)**	
Big problem	146152	54.4	59.8 (58.8, 60.7)	0.91 (0.88, 0.93)		1.01 (0.99, 1.02)	
Distance to health facility					<0.001		<0.001
No problem	163581	60.9	72.5 (71.7, 73.3)	**1.0 (Reference)**		**1.0 (Reference)**	
Big problem	105181	39.1	55.0 (53.9, 56.0)	0.88 (0.81, 0.96)		0.92 (0.89, 0.95)	
Type of place of residence					<0.001		<0.001
Urban	90751	31	82.7 (81.7, 83.6)	**1.0 (Reference)**		**1.0 (Reference)**	
Rural	202166	69	55.6 (54.7, 56.6)	0.56 (0.49, 0.64)		0.84 (0.79, 0.90)	

RR adjusted for the dependent variable – skilled birth attendance

5.4.2 Inequalities in the coverage of caesarean delivery

The overall average coverage of caesarean deliveries across all countries was 5.4% (95% CI: 5.2% to 5.6), ranging from 1.4% in Chad to 24.2% in South Africa (Figure 5-4). Across all countries except for South Africa, the national caesarean delivery rate was less than 15%. In 10 (40%) countries, the national coverage was less than 5%. Ethiopia and Chad reported the lowest (less than 2%) national rates.

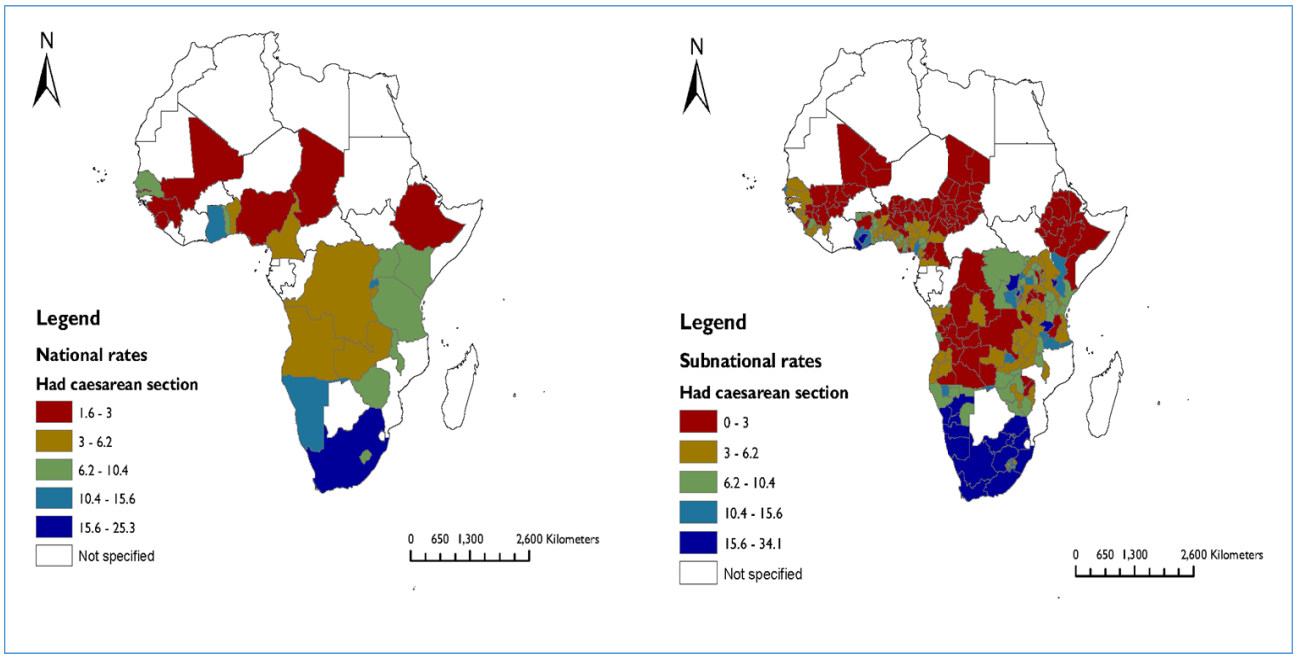

Figure 5-4 National and subnational coverage of caesarean delivery in 25 sub- Saharan African countries.

The overall wealth-related absolute inequality in CS showed 10% percentage points difference between the poorest fifth and richest fifth (Figure 5-2). In three countries, the differences exceeded 20 percentage points: South Africa (21.9 percentage points), Namibia (28.6 percentage points), and Ghana (23.9 percentage points).

We found high wealth-related inequalities in caesarean deliveries within all the 25 sub-Saharan African countries analysed. Coverage of CS was low across all countries and

socioeconomic levels. The highest wealth-related inequalities were reported in Ethiopia (CCI: 0.491, 95% CI: 0.364 to 0.618) and Nigeria (CCI: 0.568, 95% CI: 0.481 to 0.654), while Rwanda and South Africa that had higher coverage showed much lower wealth-related inequalities.

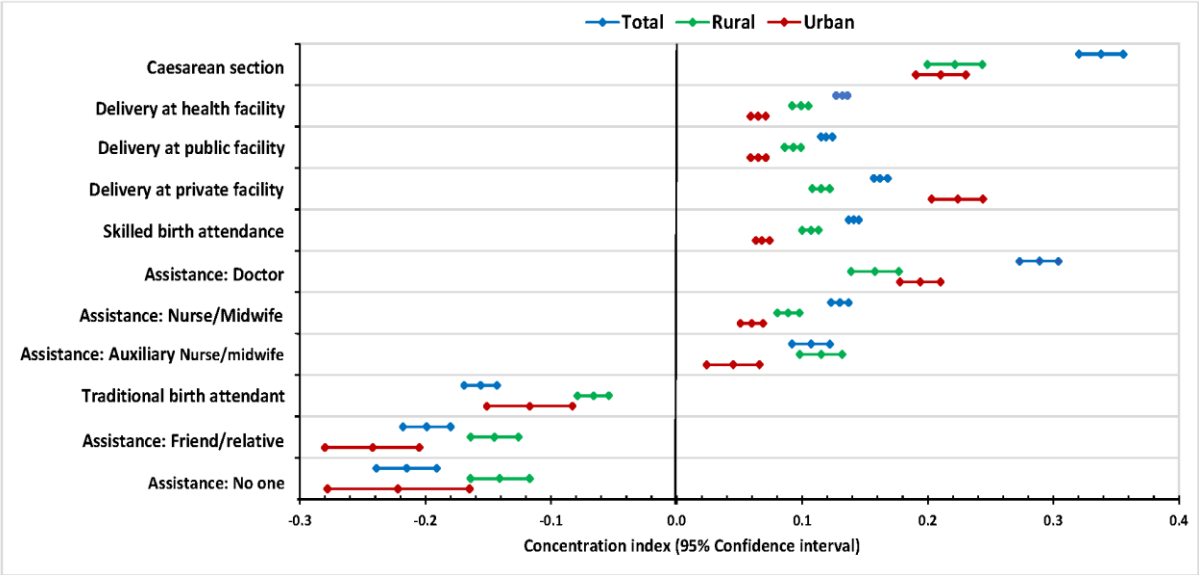

Figure 5-5 Concentration indices for providers of birth assistance and caesarean section in sub- Saharan Africa (DHS 2013–2020).

Figure 5-5 shows wealth-related inequalities in birth assistance providers, place of delivery, and CS in 25 sub-Saharan Africa countries. The positive concentration indices show pro-rich coverage in delivery at a health facility, CS, and SBA. While the distribution of delivery assisted by traditional birth attendants, friends/relatives or women assisted by no one showed disproportionate concentration among disadvantaged women.

Table 5-2 shows predictors of delivery by CS. We found that older age women, higher levels of maternal education, frequently watching TV, and higher household wealth were associated with increased rates of CS. By contrast, higher parity and residing in rural areas showed associations with lower rates of CS.

We found higher rates of CS among women who had four or more ANC contacts (RR: 1.45, 95% CI: 1.31, 1.60) compared to those who had three or lower ANC contacts. The rates of CS increased with increasing levels of maternal education and rising household wealth: women in the wealthiest fifth quintile had the highest rate (RR: 2.14, 95% CI: 1.84, 2.49), followed by richer (RR: 1.65, 95% CI: 1.46, 1.87), middle (RR: 1.32, 95% CI: 1.17, 1.48) and the poorer fifth (RR: 1.17, 95% CI: 1.06, 1.28) compared to the poorest fifth quintile. On the other hand, women living in rural areas had (RR: 0.81, 95% CI: 0.75, 0.88) lower CS rates than women living in urban areas.

Table 5-2 Factors associated with the use of caesarean section in sub-Saharan Africa

Variables	Had caesarean section	Unadjusted RR (95 CI)	P	Adjusted RR (95 CI)	P
Age			<0.001		0.003
15-24	4.8 (4.6, 5.0)	**1.0 (Reference)**		**1.0 (Reference)**	
25-29	5.4 (5.2, 5.7)	1.09 (1.02, 1.17)		1.50 (1.40, 1.61)	
30-34	5.8 (5.5, 6.1)	1.15 (1.03, 1.28)		2.09 (1.85, 2.37)	
35-49	5.7 (5.4, 6.0)	1.19 (1.03, 1.37)		3.04 (2.58, 3.59)	
Birth order number (Parity)			<0.001		0.001
1	8.6 (8.3, 8.9)	**1.0 (Reference)**		**1.0 (Reference)**	
2	6.7 (6.4, 7.0)	0.79 (0.75, 0.83)		0.68 (0.64, 0.72)	
3	5.5 (5.2, 5.8)	0.72 (0.66, 0.78)		0.51 (0.47, 0.56)	
4	4.0 (3.7, 4.3)	0.57 (0.51, 0.62)		0.37 (0.33, 0.41)	
5	3.0 (2.8, 3.3)	0.47 (0.42, 0.54)		0.28 (0.24, 0.34)	
6^{th} or higher	2.6 (2.4, 2.8)	0.45 (0.40, 0.51)		0.26 (0.22, 0.31)	
Number of antenatal contacts during pregnancy			<0.001		<0.001
Fewer than 4 ANC	3.6 (3.4, 3.8)	**1.0 (Reference)**		**1.0 (Reference)**	
Four or more 4 ANC	8.1 (7.9, 8.4)	1.87 (1.60, 2.18)		1.45 (1.31, 1.60)	
Highest educational level			<0.001		<0.001
No education	2.2 (2.1, 2.4)	**1.0 (Reference)**		**1.0 (Reference)**	
Primary	4.9 (4.6, 5.1)	1.51 (1.29, 1.77)		1.17 (1.02, 1.34)	
Secondary	10.3 (9.9, 10.7)	2.90 (2.38, 3.54)		1.35 (1.16, 1.56)	
Wealth index combined			<0.001		<0.001
Poorest	2.3 (2.2, 2.5)	**1.0 (Reference)**		**1.0 (Reference)**	
Poorer	3.1 (2.9, 3.3)	1.29 (1.13, 1.48)		1.17 (1.06, 1.28)	
Middle	4.2 (3.9, 4.5)	1.69 (1.37, 2.07)		1.32 (1.17, 1.48)	
Richer	6.6 (6.2, 6.9)	2.58 (2.07, 3.23)		1.65 (1.46, 1.87)	
Richest	12.6 (12.1, 13.2)	4.75 (3.66, 6.18)		2.14 (1.84, 2.49)	
Frequency of listening to radio			<0.001		0.110
Not at all	3.4 (3.2, 3.6)	**1.0 (Reference)**		**1.0 (Reference)**	
Less than once a week	6.0 (5.7, 6.3)	1.36 (1.23, 1.50)		1.06 (0.97, 1.15)	
At least once a week	7.5 (7.3, 7.8)	1.46 (1.33, 1.60)		1.00 (0.92, 1.08)	
Frequency of watching television			<0.001		<0.001
Not at all	3.4 (3.3, 3.6)	**1.0 (Reference)**		**1.0 (Reference)**	
Less than once a week	6.5 (6.1, 7.0)	1.61 (1.42, 1.83)		1.14 (1.04, 1.24)	
At least once a week	10.3 (9.9, 10.7)	2.36 (2.10, 2.65)		1.21 (1.10, 1.33)	
Lack of money for treatment			<0.001		<0.001
No problem	7.0 (6.8, 7.3)	**1.0 (Reference)**		**1.0 (Reference)**	
Big problem	3.9 (3.7, 4.1)	0.70 (0.66 0.75)		0.93 (0.87, 0.99)	
Distance to health facility			<0.001		0.091
No problem	6.4 (6.2, 6.7)	**1.0 (Reference)**		**1.0 (Reference)**	
Big problem	3.6 (3.4, 3.8)	0.72 (0.66, 0.78)		0.99 (0.92, 1.06)	
Type of place of residence			<0.001		<0.001
Urban	9.5 (9.1, 9.9)	**1.0 (Reference)**		**1.0 (Reference)**	
Rural	3.6 (3.4, 3.7)	0.35 (0.30, 0.40)		0.81 (0.75, 0.88)	

RR adjusted for the dependent variable – delivery by caesarean section

5.5 Discussion

We observed differences in the rates of SBA and CS across countries. While some countries showed remarkable achievements, others are expected to expand and improve access and use of these services. Within countries, there were significant geospatial and wealth-related inequalities. The majority of sub-Saharan African countries have implemented free maternal and child health policies (219). However, many women still face considerable difficulty accessing services as they are exposed to direct costs (e.g., payments for medication and laboratory tests) and indirect costs (e.g., transportation) (219). In countries such as Angola, Togo, Nigeria and Ethiopia that reported low rates of SBA and CS, we found strong pro-rich inequalities. In these countries, the World Bank reports that out of pocket health expenditure exceeds 35% of current expenditure and is as high as 62% in Chad and 77% in Nigeria suggesting a high burden of cost on the poor (220). Geospatial inequalities can partly be explained by the common features shared across areas with low coverage that involves less developed basic infrastructures such as health facilities, schools, electricity, and roads (221). Low coverage is also common among communities that move from place to place (221).

More than three-quarters of women who received birth assistance from skilled providers were attended by either a midwife, nurse, or doctor. The remainder of women received assistance from other health professionals, considered by each country to be skilled delivery attendants, but who might not be as skilled as midwives, nurses, or doctors (222). In addition, they might lack the necessary training or capacity to handle emergency procedures. For example, health extension workers in Ethiopia work in less equipped facilities and, in many cases, might not even have water supply and electricity to provide quality delivery service (223). While those health professionals are critical to providing services to the most

vulnerable and difficult to reach communities, it is vital to increase the capacity of facilities with more highly qualified staff.

In South Africa, Rwanda and Malawi the rates of SBA were greater than 90%. South Africa is one of the richest countries in Africa, which could explain the high rates of SBA. In Rwanda, successes in expanding community-based health insurance, also known as Mutuelles, might have played a significant role in increasing the rates of SBA (224, 225). Rwanda implemented policies that restricted home deliveries; this policy was integrated with facility improvements in infrastructure and workforce, better medicines, lowered costs, and information campaigns (226). Malawi issued Community Guidelines in 2007 that prohibited the use of traditional birth attendants for routine deliveries and promoted SBA (227). The banning of traditional birth attendants may have pushed women to seek a facility-based delivery (228). Malawi has now revoked these policies that restricted traditional birth attendants. However, the introduction of these policies has brought significant changes over a decade. The SBA coverage increased in Malawi and Rwanda from below 30% to higher than 90% of all births delivered in clinics, hospitals and maternity homes. The implementation of these policies has been challenging in other several sub-Saharan African countries (215).

There are many reasons why women in most sub-Saharan African countries experience delays in seeking quality obstetric care (139). A framework presented by Thaddeus and Maine (1994) suggested three phases of delay to accessing obstetric care: (1) delays in seeking care; (2) delays in reaching care; and (3) delays in receiving care (229). Bohren et al. expanded this three-delay model to include the impact of disrespect and abuse on intrapartum care-seeking behaviours and how a woman's decision to seek care is influenced by their perceptions of the quality of care provided by traditional providers and facility-based health workers (139).

Long distances to the health facilities and issues with health referral systems also cause delays in accessing care (214). We found that women who had to travel long distances to a facility were less likely to access both SBA and CS compared to women who did not report distance as a problem. For example, in the Ethiopian three-tier health system, normal delivery services are provided at the primary health care units (PHCU), including health centres (230). However, many women bypass these primary facilities and attend secondary level facilities as they wish to receive better quality services (231). This creates a high volume of clients attending a limited number of facilities resulting in poor quality service delivery and facility overload. The excessive demand means that women cannot use the limited number of delivery suites leading to deliveries in waiting rooms or corridors (232, 233). Evidence from Zambia and Tanzania has also shown how women regularly bypass community clinics to reach first-level hospitals searching for quality services (234, 235). Despite substantial additional time and financial costs to the patient, high bypassing rates could indicate significant gaps in health system efficiency and coverage of health services (235, 236).

Health facility and provider factors that delay receiving care and potentially lower women's trust in the health systems include poor quality of services exacerbated by disrespect and abuse during childbirth (139). Women have reported verbally and physically abusive providers who are disrespectful and lack compassion and care during childbirth (210). Women have expressed additional concerns regarding facility birth, including exposure to unnecessary surgical interventions (episiotomy or CS), unfamiliar birthing positions, and undesirable and intrusive physical examinations (139, 210). These negative interactions with providers and exposure to undesirable procedures were heightened for women of low socioeconomic status (232).

Evidence suggests CS rates of 10% to 15% capture the ideal desirable rates at the population level. We found the highest national rates in Ghana (12.8%), Rwanda (13.0%), Namibia (14.6%), and South Africa (24.2%). The majority of countries (56%) reported CS rates of 5% to 15%. A very low rate of CS (<5%) is indicative of poor access to surgical care, that will lead to maternal and neonatal deaths from preventable causes (140, 237). Of all births, 1% to 2% are associated with conditions such as placenta previa and obstructed labour that require lifesaving CS (65). The very low CS rates reported in some countries might indicate a lack of access, particularly for low-income women. We found rates of less than 3% in Nigeria, Mali, Gambia, Ethiopia and Chad. In ten (40%) countries, the rate of CS was less than 1% among the poorest quintile but the rate was more than 15% among the richest quintile in nine countries. Such inequalities must be urgently addressed.

Our study demonstrated that socioeconomic factors causing delay in seeking care make significant contributions to disparities in SBA and CS. We found that maternal education, household wealth status, and access to mass media were significant predictors of SBA and CS uptake. Having four or more antenatal care contacts positively influenced the use of SBA and caesarean deliveries. There is strong evidence that the use of quality antenatal care improves maternal and newborn health outcomes (2, 215, 217). Having higher levels of education and access to mass media (i.e., watching TV) positively influenced the uptake of SBA and CS. Education and mass media are important tools to create awareness and promote health service use (217). Women from rural areas were less likely to have both SBA and CS compared to women residing in urban areas. This finding is consistent with those of earlier studies (218, 238) and could result from a less developed health infrastructure and fewer skilled providers in rural areas (196). Some studies have also suggested that women from rural areas who attend urban health facilities are more likely to be treated poorly (210).

While there is a need for multifaceted interventions to address persistently high rates of maternal and neonatal mortality in sub-Saharan Africa, a lack of capacity and funding and constant challenges of policy change make it difficult to implement well integrated strategies. However, some of these policies can be implemented in a phased manner. Examples include cash incentives in India (239), policies that restrict home deliveries with traditional birth attendants in Malawi and Rwanda (226, 227), user fee exemptions in many sub-Saharan African countries with a slower follow-up of quality improvements, communication and referral links, outreach health education and transportation funds.

Based on our findings, we make the following policy recommendations. First, strengthening referral systems by expanding delivery services at mid-level facilities and reduce the number of low-quality deliveries at rural facilities. Improvements in the workforce, equipment and supplies in health facilities are core strategies for maternal and child health services in most countries (196, 240). These strategies will strengthen lower-level facilities and reduce women's desire to bypass the nearest primary care facility to seek care in higher-level facilities that places a large financial burden on the most vulnerable families (214). Sometimes women bypass primary facilities to seek care at private facilities because of perceived poor-quality care. However, private facilities may not always provide higher quality services and may expose women to out-of-pocket expenditure. Second, there is a need to improve access for vulnerable rural women through funding for transport infrastructure, and targeted subsidies for services (214, 239). For example, in 2005, India implemented a national conditional cash transfer program, known as Janani Suraksha Yojana (JSY) that increased SBA by 5% to 44%, which was highly variable by state (239). Third, a strong focus on quality improvements at all levels of delivery facilities, with a focus on ensuring and achieving respectful, non-abusive, and high-quality intrapartum care for all women (139, 210). We believe addressing concerns

related to low-quality or disrespectful care at facilities would remove an important barrier to facility birth for many women. Fourth, increasing specialised maternity facilities and dedicated maternity wards within larger institutions are needed.

The strengths of our study include the use of a large sample size involving multiple nationally representative population-based surveys collected from 25 sub-Saharan African countries. Most multi-country studies in this area have only focused on addressing wealth related inequalities. Our analysis examined spatial patterns, wealth-related within-country inequalities and critical contributions of other social determinants of health such as maternal education, access to media, use of ANC, place of residence and distance to a health facility. The limitations of our study include using data from the Demographic and Health Surveys based on a recall period of five years. Second, clinical indications for CS were not available as there was no data to identify whether the procedure was an elective or emergency CS. Third, we used the most recent data available from the Demographic and Health Surveys, which dates back to 2013 for some countries, and there may be differences in the current rates for some countries.

Conclusions

Facility-based childbirth is a priority global health agenda. There are encouraging signs of progress and indications that facility-based delivery could become the new normal in most sub-Saharan Africa countries. However, continued efforts are needed to reach vulnerable population subgroups as we found that three in eight women did not have a SBA. Across all countries, we found significant pro-rich inequalities in SBA and CS. Women from the poorest quintile were more likely to miss out on SBA and CS. Those women who did receive SBA or CS

were more educated, had access to mass media (TV), had four or more ANC contacts, were residents of an urban area and had no distance problems to access a health facility.

Wealth-related inequalities within countries could be due to a combination of scarce access to CS among the poor and high levels of caesarean use without medical indication among rich. Countries should clearly differentiate between population subgroups and invest in targeted policies and strategies to improve access and ensure equity in SBA and CS. Improving the quality of care, ensuring respectful, non-abusive delivery services are critical strategies to increase the uptake of facility-based delivery. In addition, country-specific strategies are critical to addressing these inequalities to improve maternal and newborn health.

5.5 Chapter summary

In this chapter, we discussed socioeconomic inequalities in access to skilled birth attendance and caesarean deliveries. We have shown critical contributions of other social determinants of health such as maternal education, access to media, place of residence and distance to a health facility. We also demonstrated that the use of antenatal care is very critical for the uptake of skilled birth attendance and caesarean delivery.

LLMICs face a persistent challenge in eliminating preventable maternal mortality. Reducing maternal and child mortality requires ensuring equitable access to and quality of maternal and child health services across all countries. In the previous chapters, we highlighted the prevailing inequalities in the use of antenatal care and intrapartum care across sub-Saharan African countries. In the next chapter, we decided to examine gaps in the continuum of care for maternal health services. We aimed to identify service points with the highest dropout occurs along the continuum of care. We then report on within-country wealth-related inequalities across the continuum of care.

Chapter Six: Continuum of care for maternal health services: dropout, inequalities, and determinants

Preamble

Continuum of care is a primary approach to ending preventable maternal and child mortality. The continuum of care in maternal, newborn, and child health programs refers to the integrated delivery of services from adolescence, pregnancy, childbirth, and the postnatal period to childhood. This chapter contains a manuscript that reports on the continuum of care for maternal health services, which refers to ensuring access to quality antenatal care during pregnancy, skilled birth care providers during childbirth and postnatal care for the newborn and the mother. Health systems across all countries target and work towards ensuring equitable access to these maternal health services. However, in chapters four and five, we reported that this is not always the case. We found inequalities in access to quality antenatal care (chapter 4) and skilled birth attendance, and caesarean section (chapter 5).

In this chapter, we aimed to identify where the gaps were along the continuum of care for maternal health services. We estimated dropout rates along the continuum of care at each service point. We explored how within-country wealth-related inequalities change across the continuum of care. We then reported on drivers of inequality in the continuum of care.

Bobo F.T., Asante A, Woldie M, Dawson A, Hayen A. Evaluating equity across the continuum of care for maternal health services: analysis of household surveys from 25 sub-Saharan African countries. International Journal for Equity in Health. (Under review)

Manuscript three: Evaluating equity across the continuum of care for maternal health services: analysis of household surveys from 25 sub-Saharan African countries

Key messages

- The continuum of care is an essential approach to addressing maternal, neonatal and child health inequalities.
- We found a low continuum of care coverage across all countries and socioeconomic levels. There were persistent and increasing inequalities along the continuum of care across many countries.
- Access along the continuum of care can be improved by strengthening the link between place and time health care services.
- Expand and improve service coverage along the continuum of care to ensure access for vulnerable populations and address low coverage.

6.1 Abstract

Background: Ensuring access to the continuum of care for maternal, neonatal, and child health is an effective strategy for reducing maternal and child morbidity and mortality. We investigated the extent of dropout, wealth-related inequalities, and drivers of inequality in the continuum of care for maternal health services in sub-Saharan Africa.

Methods: We used Demographic and Health Surveys from 2013 to early 2021 for 25 sub-Saharan African countries. We performed spatial analysis to show the national and subnational maternal health service coverage. We then used the concentration index to estimate wealth-related inequalities across the care continuum for maternal health services. Using multilevel logistic regression models, we identified predictors of inequalities in the recommended continuum of care package.

Results: About 87% of women reported having at least one antenatal care (ANC) contact, but only 30% of women received the recommended care package that includes four or more ANC contacts, skilled care at birth, and postnatal care (PNC). The proportion of women who had the recommended package of care ranged from 6.5% in Chad to 69.5% in Sierra Leone. Nearly 9% of women reported not having contact with the health system during pregnancy or childbirth; this ranged from 0.1% in Burundi to 34% in Chad. Disadvantaged women were more likely to have no contact with the healthcare system and less likely to have the recommended care continuum than wealthier women. Women with higher education levels, higher exposure to mass media (radio and TV), and higher household wealth status had increased continuum of care uptake.

Conclusions: There were persistent and increasing inequalities along the continuum of care across many countries. Improving access to and integration of services are required to

improve maternal and child health. Initiatives and efforts to improve maternal health services should prioritise and address the needs of communities and groups with low coverage of maternal health services.

Keywords: Equity, Socioeconomic factors, Maternal health, Continuum of care

6.2 Introduction

Ending preventable maternal mortality continues to be a persistent challenge worldwide, especially in low- and lower-middle-income countries (LLMICs) (1, 2). Women in sub-Saharan Africa, in particular, have a significantly higher risk of dying from causes related to pregnancy and childbirth than in any other region, accounting for 66% of all maternal deaths in 2017 globally (1).

In the past two decades, there have been significant increases in health facility construction in LLMICs (3). However, these changes have not always brought anticipated reductions in maternal mortality. At current progress, it is likely we will fall short of achieving the SDG 3.1 target of reducing maternal mortality to fewer than 70 per 100 000 live births (4). The failure to establish continuity of care during pregnancy and childbirth and provide care to the mother and baby after birth is the main reason for the slow progress in LLMICs (5, 6).

Ensuring access to the continuum of care for maternal, newborn, and child health across all countries and socioeconomic levels is critical to improving health outcomes and achieving the SDG target for maternal health (4, 5). However, access to care is limited in many LLMICs (7). Moreover, maternal, neonatal, and child health programs in these countries are often weakly established or integrated, especially during childbirth and the postnatal period (2).

Disparities in access to maternal and child health services continue within and between countries, along with factors such as geography, gender, religion, ethnicity, wealth, and other socioeconomic (8). The poor and vulnerable populations bear the largest share of morbidity and mortality but have minimal access to health care services (9). Addressing such inequalities requires generating evidence on inequality and determinants of inequality in the use of health

services. Most studies have examined inequalities in using individual maternal health services (10-12), but only a few have assessed the prevalence and factors associated with access to the continuum of care for maternal health services (13-15). Comparisons across the continuum of care disaggregated by social determinants of health is crucial to understand inequalities in health coverage and if similar strategies can be used to reduce inequalities.

In this paper, we presented a different approach to examining inequities and attritions along the continuum of care for maternal health services. First, we examined socioeconomic inequalities among women who had no contact with the health system from pregnancy to childbirth. We then estimated inequalities in dropouts along the continuum of care among women who had four or more antenatal care (4+ ANC contacts) contacts and among women who had the recommended care package (4+ ANC contacts, skilled birth attendance and postnatal care). A previous study used a descriptive approach to examine inequalities in continuum of care in 10 geographical regions in Africa, Asia and Latin America and the Caribbean across different categories of age, household wealth quintile, residence (rural or urban) and parity (16). To our knowledge, this is the first study to examine inequalities in dropouts along the continuum of care.

We aimed to address this gap by systematically analysing inequalities along the continuum of care for maternal health services in 25 sub-Saharan African countries. Specifically, we assessed the extent of dropout along the continuum of care in these countries. We further explored within-country wealth-related inequalities across the continuum of care. We then identified predictors of inequality in the continuum of care and discussed the implications of our findings for health systems.

6.3 Methods

6.3.1 Data

We used the latest Demographic and Health Survey (DHS) data from 25 sub-Saharan African countries that were conducted between 2013 to 2021. We included surveys from Angola (2015), Burundi (2016-17), Cameroon (2018), Chad (2014-15), DRC (2013-14), Benin (2018), Ethiopia (2016), Ghana (2014), Guinea (2018), Kenya (2014), Lesotho (2014), Malawi (2015-16), Mali (2018), Namibia (2013), Nigeria (2018), Rwanda (2014-15), Senegal (2017), South Africa (2016), Zimbabwe (2015), Uganda (2016), Tanzania (2015), Zambia (2018), Gambia (2013), Togo (2013-14), and Sierra Leone (2019). The DHS program uses standardised methods and model questionnaires to ensure uniformity and comparability of data collected across time and countries. Across all countries, the DHS uses standard survey design and sampling methods. The sampling strategies and methodology have been described elsewhere (17). The sample used for this analysis includes all women who had at least one live birth during the five years preceding the respective surveys. We used the most recent live birth to reduce recall bias in this analysis.

6.3.2 Measures

Our primary outcome variable of interest is the continuum of care for maternal health services. We defined the continuum of care for maternal health services as women who had received three services, including four or more ANC contacts (4+ ANC contacts), skilled care at birth, and immediate postnatal care (within the first two days).

We estimated coverage of 4+ ANC contacts as the proportion of women who had at least four ANC contacts with a skilled provider during their last pregnancy. We determined the adequacy of the content of ANC using five key interventions for which data were reported

and consistently available in all DHS across all countries. These were iron supplements, blood pressure measurement, urine sample test, blood sample test, and tetanus protection at birth. We defined the early initiation of ANC as ANC contact before 12 weeks of gestation. We considered women who were unable to attend ANC or initiated later than 12 weeks of pregnancy to have delayed ANC initiation.

We defined coverage of skilled birth attendance as a proportion of women who had professional care assistance during childbirth from qualified personnel, including a doctor, nurse, midwife, auxiliary midwife, or other cadres that each country considers skilled delivery attendants. We then estimated coverage of postnatal checks as a rate of women who had received care from a doctor, midwife, nurse, auxiliary midwife, or other cadres that each country considers skilled delivery attendants within the first two days of childbirth.

6.3.3 Covariates

We used a framework developed by the WHO Commission on Social Determinants of Health to explain determinants of inequality in the continuum of care. Household wealth index and educational status were considered to determine the socioeconomic position of women (8). We used the wealth index variable constructed in the DHS using principal components analysis based on ownership of selected household assets such as television (TV), radio, refrigerator, and vehicle; materials used for housing construction; and access to sanitation facilities and clean water. Household wealth index was ranked into quintiles from the poorest to the richest, depending on their level of wealth.

We categorised maternal education as (no education, primary, secondary, or higher). Women were asked if they had serious problems accessing health care for themselves when they were sick because of the long distance to health facilities and lack of money for treatment. We

categorised women's ability to afford treatment costs and the distance to travel to the facility as a big problem or not a big problem. We considered exposure to media, which we categorised based on the frequency of reading newspapers, listening to the radio, and watching TV as not at all, less than once a week, and once a week or more. The type of residence was categorised as urban or rural. Our analysis also included maternal age (15 to 24, 25 to 29, 30 to 49) and parity (1 to 6).

We categorised maternal education as (no education, primary, secondary, or higher). We determined barriers to accessing health services using two factors: women's ability to afford treatment costs and the distance to travel to the facility, which we categorised as a big problem or not a big problem. We considered exposure to media, which we categorised based on the frequency of reading newspapers, listening to the radio, and watching TV as not at all, less than once a week, and once a week or more. The type of residence was categorised as urban or rural. Our analysis also included maternal age (15 to 24, 25 to 29, 30 to 49) and parity (1 to 6).

6.3.4 Statistical analysis

We used ArcGIS software V.10.7.1 to show the spatial distributions of maternal health services, including 4+ ANC contacts, skilled care at birth, and postnatal care at national and subnational levels.

We then analysed dropouts across the continuum of care for maternal health services. We calculated frequencies and proportions at individual points of contact along the care continuum—antenatal, facility delivery and postnatal. We followed the minimum recommended care pathway to assess the uptake of maternal health services at different contact points, including four ANC visits, facility delivery and one postnatal visit. We used a

decision tree to show the pathway choices women make at different points of care. We used the concentration index (CCI) to estimate within-country wealth-related inequalities along the continuum of care for maternal health services (18). We first estimated wealth-related inequalities in no contacts with the health system from pregnancy to delivery. We defined zero-contacts as women who did not have skilled care during pregnancy or childbirth. We also estimated inequalities in having 4+ ANC contacts. We then calculated inequalities in having the recommended continuum care contacts (4+ ANC contacts, skilled care at birth, and postnatal care).

Concentration indices are used to estimate relative inequality by calculating the distribution of one variable (e.g., having 4+ ANC contacts) over the other (wealth status) (18). The index takes a value between - 1 and + 1; an index of 0 indicates equality in the uptake of the recommended maternal care package along the continuum. A positive CCI value indicates a pro-rich coverage of health variables (e.g., 4+ ANC contacts). A negative index implies a disproportionate concentration of the health variable among the poor.

Wealth status is not the only factor determining the use of health services. However, the CCI can only estimate wealth-related inequalities at a time. We used multilevel logistic regression models to identify other social determinants of inequalities in the continuum of care (4+ ANC contacts, skilled care at birth, and postnatal care).

The DHS program uses a multistage cluster sampling technique where participants in the survey are nested within Primary Sampling Units (PSU) across all countries (17). Due to the application of complex survey methods to collect data (i.e., hierarchical data), we used a

multilevel model to account for three-level data – women at level 1, PSU (clusters) at level 2 and country at level 3 (19, 20).

We started the model-building process with the unconditional model (a model containing no predictors), and then more complex models were built gradually by checking improvements in model fit after each model was estimated. We used a Generalised Latent Linear Mixed Model (GLLMM) in Stata, which enabled us to adjust for the hierarchical nature of the data and the sampling weights (19).

We specified a 3-level model: level 1 variables included women (184,567) and their household factors, at level 2 we adjusted for clustering (14,590), and at level 3 we adjusted for country (25). Results are presented with adjusted odds ratios (ORs), and statistical significance was declared when the P-value was <0.05. Analyses were conducted using Stata 16.1 and IBM Statistical Package for Social Sciences (SPSS, Chicago, IL, USA) version 27.0.

6.4 Results

6.4.1 Coverage of maternal health services

We included data on 196 717 women who had a live birth (latest) five years preceding the surveys. The majority (89%) of women had at least one ANC (ANC1) contact, 56% had 4+ ANC contacts, 70% had skilled care at birth, and 48.2% had PNC within the first two days after delivery. Women in Sierra Leone had the highest (89.5%) rates of 4+ ANC contacts, while Chad reported the lowest (31.7%) rates (Figure 6-1). Skilled birth attendance ranged from 21.9% in Chad to 95.9% in South Africa (Figure 6-2). The rate of PNC was highest in Gambia (87.9%) and lowest in Ethiopia (16.5%) (Figure 6-3).

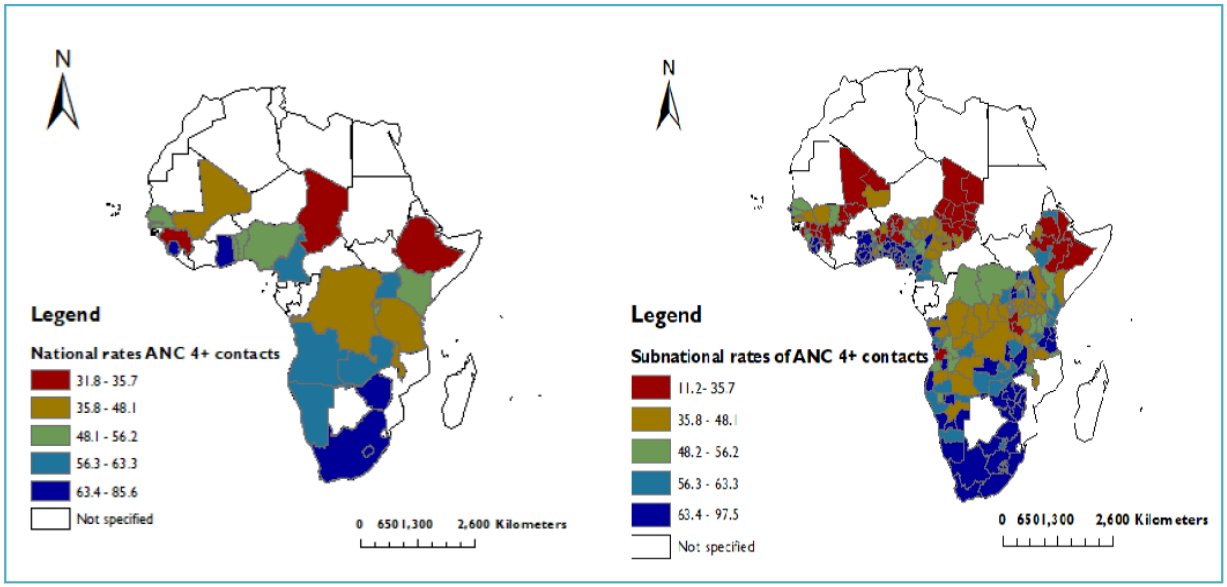

Figure 6-1 National and subnational rates of four or more ANC contacts in 25 sub-Saharan African countries

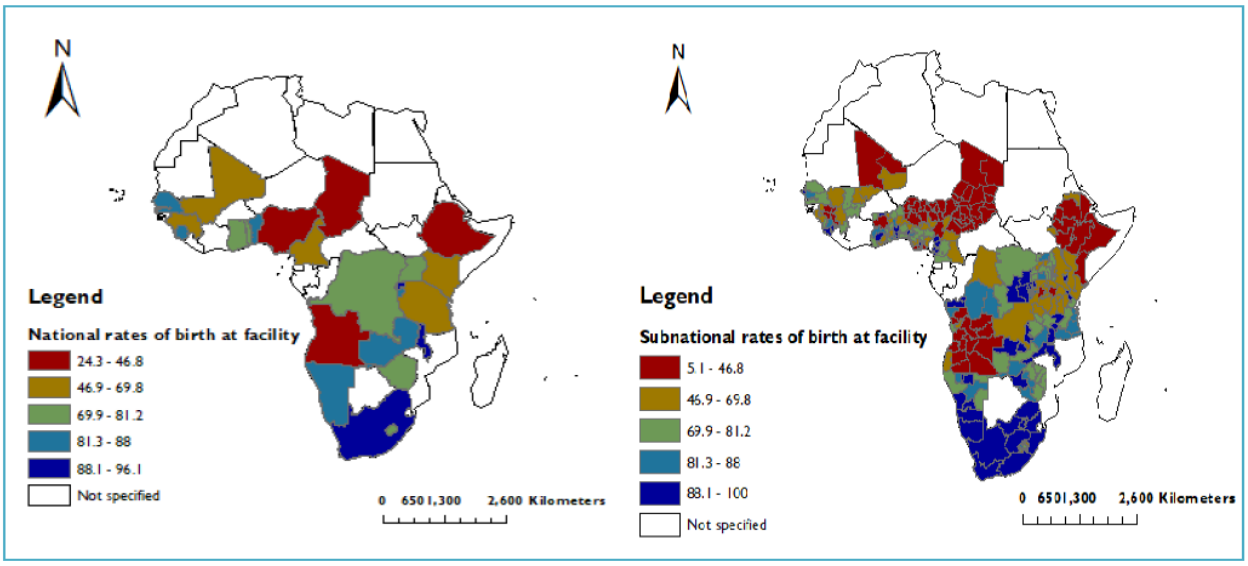

Figure 6-2 National and subnational rates of skilled care at birth in 25 sub-Saharan African countries

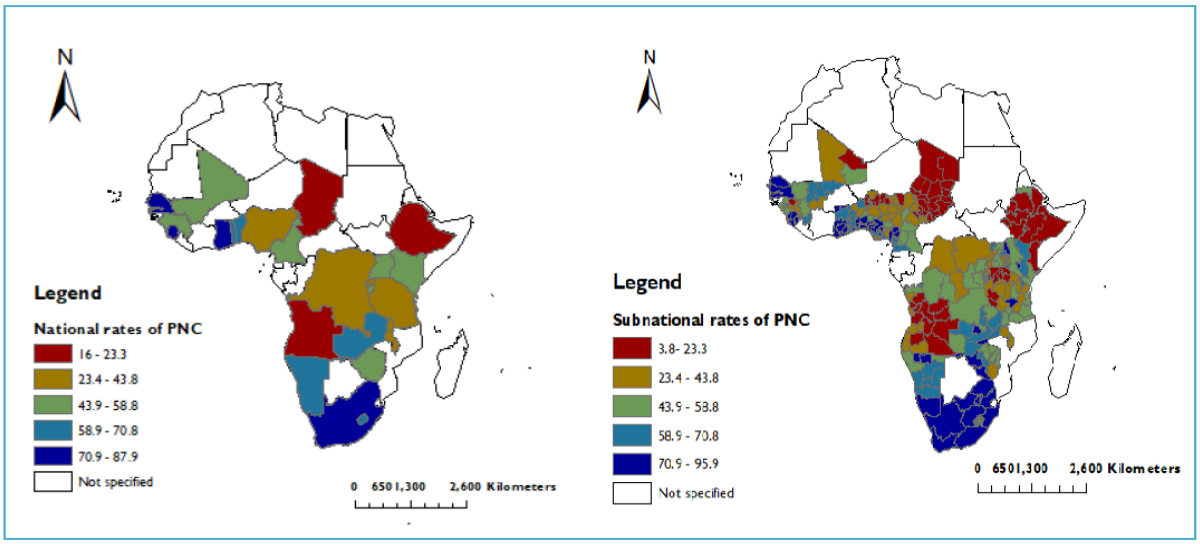

Figure 6-3 National and subnational rates of postnatal care in 25 sub-Saharan African countries

6.4.2 Continuum of care

Overall, 89% of women had at least one ANC contact, 56% (95% CI: 55.5% to 56.6%) had 4+ ANC contacts and 44.6% (95% CI: 44% to 45%) reported having both 4+ ANC contacts and skilled care at birth. Four in nine (44.6%, 95% CI: 44 to 45.2) women had at least one ANC contact, skilled care at birth and PNC within the first two days of delivery. Only 29.8% (29.2% to 30.3%) of women received the recommended care package that included 4+ ANC contacts, skilled care at birth, and PNC (Figure 6-4). The proportion of women who received the continuum of care from pregnancy to the postnatal period varied by country; the highest rates were registered in Sierra Leone (69.5%) and the lowest in Chad, 6.5%. Namibia (53.4%), Gambia (52.1%), Ghana (65.2%) and South Africa (65.4%) also reported relatively high rates of care coverage across the continuum.

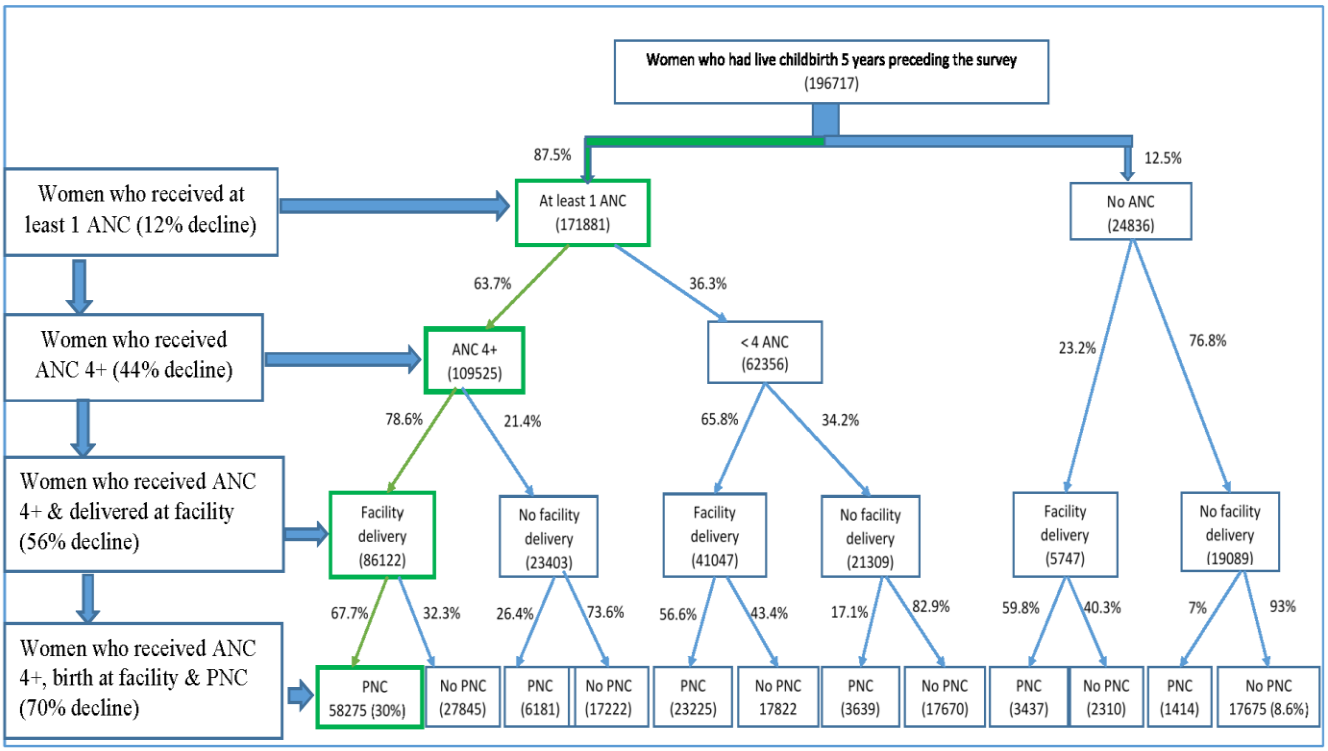

Figure 6-4 Maternal health care pathway. Green boxes and arrows show the recommended pathway. Rates of decline were calculated for all women (196717) included in the study.

Along the continuum of care, the uptake of services declined. Seven in ten women (70%, 95% CI: 69.7% to 70.8%) have not had at least one of the services (4+ ANC contacts, skilled care at birth or PNC) from pregnancy to the postnatal period. Continuum of care dropout rates ranged from 30.5% in Sierra Leone to 93.5% in Chad. About one in eleven women (8.5%, 95% CI: 8.2% to 8.9%) reported not having any contact with the health system at any point during pregnancy or childbirth; this ranged from 0.1% in Burundi to 34% in Chad. The rates of women who reported not having care at any stage were also high in Mali (12%), Angola (15%), Nigeria (21.3%) and Ethiopia (33.5%).

6.4.3 Inequalities in the continuum of care

The wealth-related absolute inequality for all countries across the continuum of care was extremely high, with 29 percentage points between the poorest quintile (18.4%) and the

richest quintile (47.4%). The differences exceeded 50 percentage points in countries such as Ghana (50.4%), Togo (54.8%), Cameroon (57.7%), and Nigeria (60.1%).

Figure 6-5 shows concentration indices for women with zero contacts, 4+ ANC contacts, and women who received all the recommended care packages. A positive CCI indicates a pro-rich coverage, while negative concentration indices suggest a pro-poor coverage. In many countries, we observed persistent and increasing inequalities along the continuum of care. Poor women were more likely to have no contact with skilled providers during pregnancy and childbirth than richer women. Having no contact with the healthcare system was disproportionately concentrated among poor women (Figure 6-5).

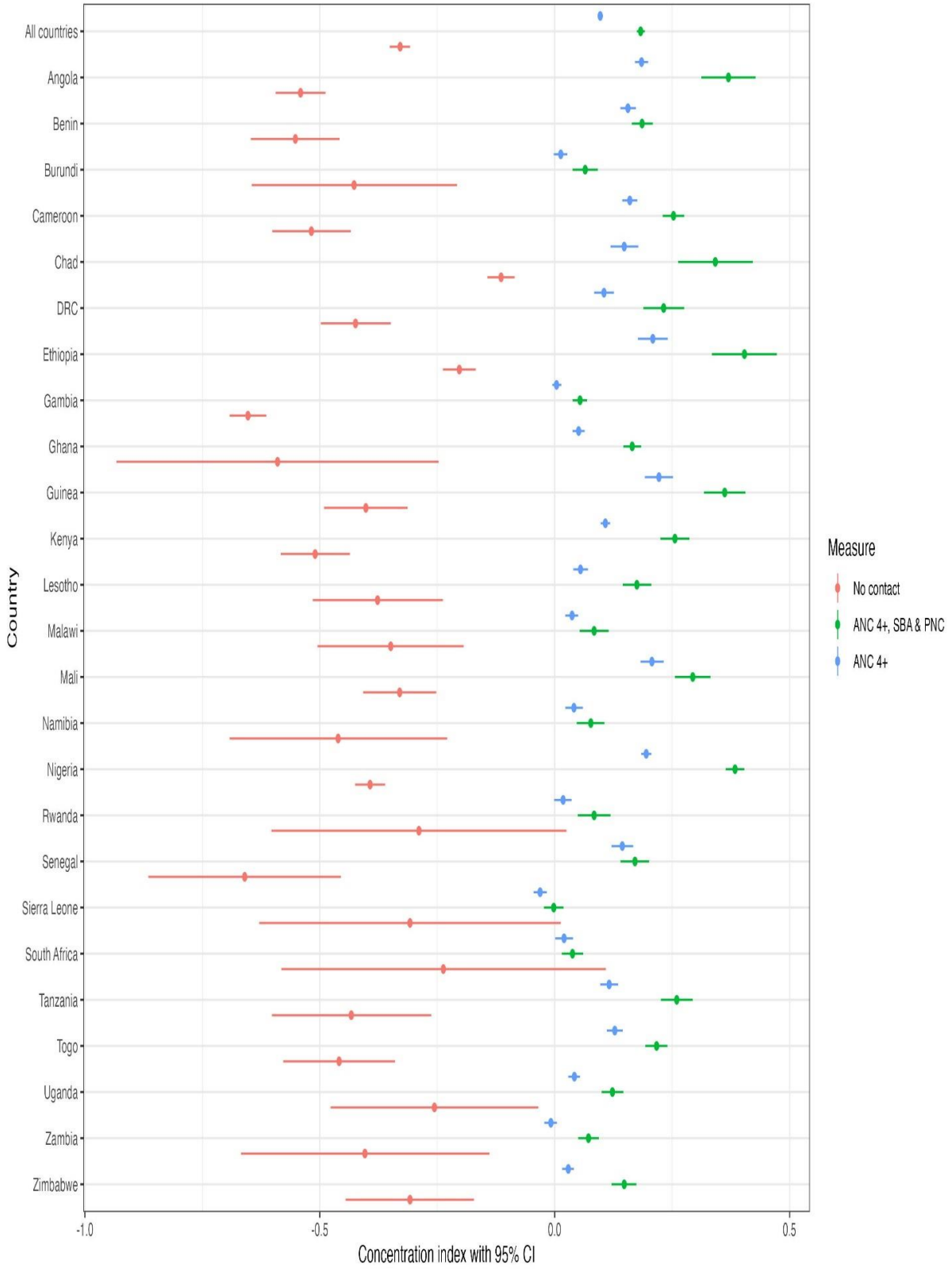

Figure 6-5 Concentration indices for women who had zero contact, 4+ ANC contacts, and 4+ ANC contacts, skilled care at facility and PNC across 25 sub-Saharan African countries (DHS 2013 to 2021)

We found inequalities in the coverage of 4+ ANC contacts in all countries except Burundi, Gambia, and Zambia, where we found no wealth-related differences. In Sierra Leone, we found a pro-poor coverage of 4+ ANC contacts (CCI= -0.031), but Guinea reported the highest pro-rich coverage (CCI: 0.222). We also observed strong pro-rich coverage in Angola, Nigeria and Ethiopia. Inequalities along the continuum of care were highest in countries such as Angola (CCI= 0.37), Chad (CCI= 0.342), Guinea (CCI= 0.362), Nigeria (CCI= 0.384) and Ethiopia (CCI= 0.404).

Table 6-1 shows predictors of inequality in the continuum of care. Older age women, higher levels of education, exposure to media (newspaper, radio, or TV), and higher household wealth status showed positive associations with the continuum of care. Compared with women aged 15 to 24 years, being in any of the older age groups of 25 to 29 (AOR 1.28, 95% CI: 1.21, 1.36), 30 to 34 (AOR 1.58, 95% CI: 1.44, 1.74) and 35 to 49 (AOR 1.81, 95% CI: 1.54, 2.12) had increased the likelihood of receiving the full continuum of care. The odds of receiving the full continuum of care were higher among women with secondary or higher education (AOR 1.77, 95% CI: 1.46, 2.15), followed by women who had primary education (AOR 1.36, 95% CI: 1.16, 1.59) compared to women who had no education. Reading a newspaper at least once a week increased the odds (AOR 1.23, 95% CI: 1.11, 1.38) of receiving the full continuum of care compared to women who did not read a newspaper at all. The odds of receiving care across the continuum coverage increased with increasing levels of household wealth status: as women of the richest quintile had the highest odds of attendance (AOR 1.87, 95% CI: 1.39, 2.52), followed by those in the third quintile (Q4) (1.52, 95% CI: 1.21, 1.91) and Q3 (AOR 1.29, 95% CI: 1.10, 1.51) than women from the poorest household.

We found that factors such as lack of money to pay for treatment, a longer travelling distance to the health facility, and living in rural areas lowered the odds of receiving the full continuum of care. Women who had financial problems accessing facilities had 9% (AOR 0.91, 95% CI: 0.86, 0.97) lower odds of receiving care across the continuum than women who had no financial problems. Women who reported travelling a long-distance to a facility had 10% lower odds of receiving care across the continuum (AOR 0.90, 95% CI: 0.83, 0.98) compared to women who had a long-distance to travel to a health centre. Women from rural areas had 28% lower odds of receiving care across the continuum (AOR 0.72, 95% CI: 0.62, 0.85) than women from urban area.

Table 6-1 factors associated with the uptake of care across the continuum.

Variables	Frequency	Percent	Women who had continuum of care % (95% CI)	Unadjusted OR (95% CI)	P	Adjusted OR (95% CI)	P
Age					<0.001		<0.001
15-24	57563	29.3	27.6 (27, 28.2)	1.0 (Reference)		1.0 (Reference)	
25-29	51040	25.9	30.3 (29.6, 31.0)	1.05 (1.01, 1.09)		1.28 (1.21, 1.36)	
30-34	40220	20.4	31.5 (30.7, 32.3)	1.08 (1.02, 1.14)		1.58 (1.44, 1.74)	
35-49	47894	24.3	29.7 (29, 30.5)	0.98 (0.93, 1.04)		1.81 (1.54, 2.12)	
Parity					<0.001		<0.001
1	41745	21.2	35.7 (34.9, 36.5)	1.0 (Reference)		1.0 (Reference)	
2	37319	19	32.7 (32, 33.5)	0.85 (0.81, 0.90)		0.79 (0.74, 0.85)	
3	31479	16	31.4 (30.6, 32.2)	0.82 (0.77, 0.87)		0.71 (0.65, 0.78)	
4	25161	12.8	29.2 (28.4, 30.1)	0.75 (0.70, 0.80)		0.63 (0.57, 0.70)	
5	19590	10	27.1 (26.2, 28.0)	0.71 (0.66, 0.76)		0.59 (0.52, 0.66)	
6^{th} or higher	41422	21.1	20.8 (20.1, 21.4)	0.59 (0.53, 0.65)		0.48 (0.40, 0.56)	
Highest educational level					<0.001		<0.001
No education	66815	34	20.3 (19.6, 21)	1.0 (Reference)		1.0 (Reference)	
Primary	69861	35.5	24.9 (24.3, 25.4)	1.56 (1.32, 1.85)		1.36 (1.16, 1.59)	
Secondary	60038	30.5	45.5 (44.7, 46.3)	2.80 (2.20, 3.56)		1.77 (1.46, 2.15)	
Wealth index combined					<0.001		<0.001
Poorest	42111	21.4	18.2 (17.5, 19)	1.0 (Reference)		1.0 (Reference)	
Poorer	41369	21	22.9 (22.2, 23.6)	1.31 (1.18, 1.47)		1.17 (1.07, 1.29)	
Middle	39080	19.9	27.8 (27, 28.6)	1.64 (1.32, 2.04)		1.29 (1.10, 1.51)	
Richer	38234	19.4	35.3 (34.4, 36.3)	2.41 (1.75, 3.31)		1.52 (1.21, 1.91)	
Richest	35923	18.3	46.6 (45.5, 47.7)	4.04 (2.76, 5.92)		1.87 (1.39, 2.52)	
Frequency of reading newspaper					<0.001		<0.001
Not at all	164995	83.9	27.5 (26.9, 28)	1.0 (Reference)		1.0 (Reference)	

Less than once a week	19029	9.7	39.7 (38.6, 40.7)	1.65 (1.48, 1.84)		1.15 (1.06, 1.25)	
At least once a week	12573	6.4	42.9 (41.4, 44.3)	2.02 (1.78, 2.29)		1.23 (1.11, 1.38)	
Frequency of listening to the radio					<0.001		<0.001
Not at all	85569	43.5	22.2 (21.6, 22.8)	1.0 (Reference)		1.0 (Reference)	
Less than once a week	38844	19.8	34.5 (33.6, 35.5)	1.37 (1.26, 1.49)		1.13 (1.05, 1.22)	
At least once a week	72225	36.7	35.8 (35.1, 36.4)	1.64 (1.51, 1.79)		1.23 (1.16, 1.31)	
Frequency of watching television					<0.001		0.002
Not at all	121943	62.1	21.8 (21.2, 22.3)	1.0 (Reference)		1.0 (Reference)	
Less than once a week	25397	12.9	36.2 (35.1, 37.3)	1.51, (1.33, 1.70)		1.11 (1.02, 1.20)	
At least once a week	49181	25	45.8 (44.9, 46.7)	2.27 (1.94, 2.64)		1.25 (1.13, 1.39)	
Lack of money for treatment					<0.001		0.011
No problem	85586	47.1	37.4 (36.7, 38.2)	1.0 (Reference)		1.0 (Reference)	
Big problem	96263	52.9	26.8 (26.1, 27.4)	0.71 (0.66, 0.76)		0.91 (0.86, 0.97)	
Distance to a health facility					<0.001		0.007
No problem	112044	61.6	36.6 (36.0, 37.3)	1.0 (Reference)		1.0 (Reference)	
Big problem	69802	38.4	24 (23.3, 24.7)	0.75 (0.69, 0.81)		0.90 (0.83, 0.98)	
Place of residence					<0.001		0.001
Urban	65269	33.2	43 (42, 43.9)	1.0 (Reference)		1.0 (Reference)	
Rural	131448	66.8	23 (22.4, 23.6)	0.37 (0.28, 0.48)		0.72 (0.62, 0.85)	

6.5 Discussion

Continuity in the use of antenatal care, skilled birth attendance, and postnatal care substantially improve maternal and child health outcomes (5). However, the use of these services is either limited and/or fragmented in many sub-Saharan African countries. In our study, 87% of women-initiated contact with health systems during pregnancy, but only 30% of women completed the continuum of care.

Over half of all maternal and newborn deaths occur during birth and the first few days of life (21). During the first days of life, when mothers and newborns need care and have a higher risk of dying than at any other time, access to care is limited. In our study, only 48% of women reported receiving postnatal care within the first two days. This could be associated with countries' maternal and child health programs, which tend to prioritise improving the rates of skilled birth attendance rather than other maternal and child health services (6). We found higher rates of skilled birth attendance compared to 4+ ANC contacts, and coverage of care was at its lowest during the postpartum period.

We found significant spatial and wealth-related inequalities within and across countries. Spatial inequalities explain the poor access and low healthcare uptake commonly observed across less developed regions characterised by limited health facilities, schools, electricity, and road infrastructure. Low coverage is also common among vulnerable and hard-to-reach communities (22).

We observed significant dropout along the continuum of care. This finding is consistent with previous studies (13, 23, 24). Gaps in the continuity of care from ANC1 to 4+ ANC contacts might be because of delayed initiation and poor content of care women received during early contacts. The majority of women (63%) had delayed ANC initiation. Women also received low

content of care across all countries and socioeconomic levels. Even when women managed to have adequate ANC contacts, only half reported receiving blood sample tests, blood pressure taken, urine sample test, iron supplements, and tetanus protection at birth in the current study. This shows significant gaps in the quality of ANC women received. This is also in line with previous studies in the region (25). WHO now recommends a minimum of eight contacts in the new ANC model introduced in 2016, but increasing the number of contacts alone cannot improve health outcomes without improving the quality of care delivered to women (26).

Substantial gains in maternal health can be made by improving access to care during the postpartum period (2, 27). However, health facilities and providers give less attention to postpartum care. The hours and days after delivery remain a critically dangerous period for both mother and newborn (6, 28). During this period, more than 60% of all maternal deaths occur, and the death of newborns amounts to 47% of all child deaths under the age of 5-years (1). The postnatal period is the period where the continuum of care is most often interrupted. Even when deliveries occur at the healthcare facilities, many mothers and babies are discharged early, sometimes within a few hours (6, 29). We found low coverage of PNC and high dropout between delivery and the postnatal period. The decline in care could be associated with a lack of a clear line of professional responsibilities (5). In many countries, the handover and communication between maternal and child programs are not well established (2).

The overall coverage of the continuum of care was low across countries and socioeconomic levels. Women of low socioeconomic status require affordable, acceptable, and appropriate access to quality health services as they bear the greatest burden of morbidity and mortality

(2, 30). However, this is not always the case, as poor women and children have poorer access. In our analysis, the rates of no contact were higher among the poorest by 14% compared to women in the richest quintile. The rates of women who have not had any care during pregnancy and childbirth were more than 35% among the poorest quintile in countries such as Chad (39%), Angola (40%), Nigeria (43%), and Ethiopia (50%), but this was less than 1% among the richest quintile in 20 of the 25 study countries. The gap in having a full continuum of care was also large, with a difference of 29 percentage points between the poorest quintile (18.4%) and the richest quintile (47.4%).

The fact that almost all women (87%) initiated contact with the health systems presents an opportunity to strengthen maternal, neonatal and child health. This may be accomplished through the delivery of essential interventions that include ANC, skilled care at birth, PNC, and related neonatal and child health services. However, women in many sub-Saharan African countries encounter multiple challenges that limit their access to these services. Poor implementation of service packages, inadequate linking of services in the care package, and neglect of some critical interventions could contribute to the access constraints (2, 6). Delays in seeking care, financial hardships, and poor-quality care in health facilities also contribute to poor maternal and child health outcomes (5, 28).

Several factors contribute to inequalities in maternal and child health services. Older age women, women with lower parity, those who had primary or higher education, women with improved access to mass media, and those from higher wealth status had higher odds of completing the continuum of care.

The influence of maternal education and exposure to media on access to maternal healthcare services could be due to the role education and media play in bridging the knowledge gap by

informing and sensitising women on the benefits of maternal and child healthcare services, which leads to positive attitudes and improves health-seeking behaviour. As a result, women with higher education and exposure to mass media were more likely to initiate ANC early and complete the continuum of care in our analysis. This finding is consistent with previous studies in the area (13, 23, 25, 31).

In our study, women who travelled long distances to health facilities, lacked money for treatment, and lived in rural areas were less likely to complete the continuum of care. Women and children in rural areas, marginalised groups and those living in hard-to-reach and remote areas are the most underserved (32-34). For example, women in rural sub-Saharan African countries were less likely to receive skilled care at birth than their urban counterparts (31). However, disadvantaged women in urban areas do not always have better access, highlighting that poverty is one of the main drivers of inequality in the use of healthcare services. For example, caesarean rates were the lowest among the poorest women in rural and urban areas in many sub-Saharan African countries (31).

Inequity also manifests in other ways. Many women experience mistreatment while attending health facilities for pregnancy and childbirth (35, 36). This is even more common among poor women. For example, in many sub-Saharan African countries, poor women experience verbal and physical abuse from providers in many health facilities (37, 38). Lack of respectful care discourages women from using available services and erodes public trust in the health care systems (35).

6.5.1 Policy implications

Adapting and implementing the continuum of care as a priority strategy effectively achieves high coverage of maternal, neonatal and child health interventions (5). Thus, to improve

health and achieve the greatest reduction in deaths and morbidity, all of these packages must reach mothers and their children at the appropriate level and time period. To that end, we propose the following policy recommendations.

First, improve access along the continuum of care by strengthening the link between place and time of services to reduce dropouts (2, 5, 6). Our analysis revealed that the poorest women living in rural areas and those who had no education or access media had the highest attrition along the continuum of care. Addressing the needs of underserved women would require linking home and community care to quality healthcare services at primary health facilities and district hospitals, which is crucial to bringing care closer to women and women closer care. Establishing or strengthening these ties would increase interactive dialogue within communities, improving service use. These linkages will also help that women and newborns with complications are referred promptly and receive appropriate care at a proper level to improve their survival rate.

Second, improving the quality of care across the continuum of care increases service uptake. Addressing poor quality of care has been a critical challenge to health systems worldwide (39). Poor quality of care is a known cause of delay for women and children in seeking care, more so for poor and marginalised groups, who might receive a service that is not only technically inadequate but also violates their right to respectful treatment at times (35). Disrespectful care is also a known deterrent to women from having subsequent contact with the health systems.

Third, improve access for vulnerable populations to address low coverage. Equity-oriented interventions are vital to target and address the needs of specific groups based on their poverty level, geographical location, and other factors that characterise vulnerability (4, 40).

Fourth, provide economic support for vulnerable women through funding for transport infrastructure and subsidies for service users to encourage demand service the uptake. Conditional cash transfer works by transferring cash to poor households and other vulnerable groups to stimulate uptake of health interventions (41). Evidence suggests that targeted, conditional cash transfer programs can improve the use of healthcare facilities by the poorest women and children (42).

Strengths of our study include the use of nationally representative population-based survey large datasets across multiple sub-Saharan African countries. We used multiple approaches to examine inequalities along the continuum of care for maternal health services. The limitations of our study include using data from the DHSs based on a recall period of 5 years. The latest DHS datasets for some countries date back to 2013, and there may be differences in the current rates for some countries.

Conclusions

Coverage of continuum of care was low across all countries and socioeconomic levels. We found persistent and increasing inequalities along the continuum of care across many countries. Disadvantaged women were more likely to have no contact with the healthcare system and less likely to access the continuum of care than wealthier women. Women who received the continuum of care were educated, wealthy, urban residents who accessed mass media and had no distance problems accessing a health facility. Higher integration and improved access to quality healthcare services are required to enhance women's and children's health outcomes. Initiatives to improve maternal health services should prioritise the needs of communities and groups with low maternal health service coverage.

Chapter Seven: Measuring inequality and drivers of inequality in vaccination coverage in sub-Saharan Africa

Preamble

Maternal and child health services are integrated services. In the previous chapters, we reported inequalities and drivers of inequality in access to maternal health services; antennal care quality (chapter 4), intrapartum care (chapter 5) and continuum of care for maternal health services (chapter 6). In chapter 6, we reported findings of persistent and increasing inequality along the continuum of care across many countries. This set the foundation to see how a lack of consistent use of maternal health services reflect on child vaccination uptake. In this chapter, we decided to measure inequalities in vaccination coverage. Previous multi-country studies in this area have often focused on assessing wealth-related inequalities. However, investigations of inequality should aid in identifying all vulnerable groups in need of vaccination and inform policies and programs that will reach these underserved populations. We have also reported effects of antenatal care, and birth at facility on vaccination uptake.

This chapter contains manuscript four, which measures inequalities in zero doses, incomplete, and full vaccination across 25 sub-Saharan African countries. We have also identified drivers of inequality in vaccination uptake. Based on the findings of chapter seven, we were interested to see whether there were differences in the drivers of inequality at the regional level (sub-Saharan Africa) and a specific country. For this purpose, in chapter eight, we also investigated inequalities in vaccination coverage in Ethiopia using two waves of demographic health surveys.

Citation: **Bobo, F. T.**, Asante, A., Woldie, M., Dawson, A., & Hayen, A. (2022). Child vaccination in sub-Saharan Africa: Increasing coverage addresses inequalities. Vaccine, 40(1), 141-150. doi:10.1016/j.vaccine.2021.11.005

Manuscript four: Child vaccination in sub-Saharan Africa: Increasing coverage addresses inequalities

7.1 Abstract

Background: Vaccines have substantially contributed to reducing morbidity and mortality among children, but inequality in coverage continues to persist. In this study, we aimed to examine inequalities in child vaccination coverage in sub-Saharan Africa.

Methods: We analysed Demographic and Health Survey data in 25 sub-Saharan African countries. We defined full vaccination coverage as a child who received one dose of bacille Calmette-Guérin vaccine (BCG), three doses of diphtheria, pertussis, and tetanus vaccine (DTP 3), three oral polio vaccine doses (OPV 3), and one dose of measles vaccine. We used the concentration index (CCI) to measure wealth-related inequality in full vaccination, incomplete vaccination, and zero-dose children within and between countries. We fitted a multilevel regression model to identify predictors of inequality in receipts of full vaccination.

Results: Overall, 56.5% (95% CI: 55.7% to 57.3%) of children received full vaccination, 35.1% (34.4% to 35.7%) had incomplete vaccination, while 8.4% (95% CI: 8.0% to 8.8%) of children remained unvaccinated. Full vaccination coverage across the 25 sub-Saharan African countries ranged from 24% in Guinea to 93% in Rwanda. We found pro-rich inequality in full vaccination coverage in 23 countries, except for Gambia and Namibia, where we found pro-poor vaccination coverage. Countries with lower vaccination coverage had higher inequalities suggesting pro-rich coverage, while inequality in unvaccinated children was disproportionately concentrated among disadvantaged subgroups. Four or more antenatal care contracts, childbirth at health facility, improved maternal education, higher household wealth, and frequently listening to the radio increased vaccine uptake.

Conclusions: Continued efforts to improve access to vaccination services are required in sub-Saharan Africa. Improving vaccination coverage and reducing inequalities requires enhancing

access to quality services that are accessible, affordable, and acceptable to all. Vaccination programs should target critical social determinants of health and address barriers to better maternal health-seeking behaviour.

Keywords: Vaccination, Immunisation, Socioeconomic factors, Inequality, Sub-Saharan Africa

Highlights

- The objective of this study was to examine inequalities in full vaccination, incomplete vaccination and zero-dose vaccination among 12 to 23 months children in 25 sub-Saharan African countries.
- We found pro-rich inequality in full vaccination coverage in 23 countries, except for Gambia and Namibia, where we found pro-poor vaccination coverage. While zero-dose children were disproportionately concentrated among disadvantaged subgroups in most countries.
- Four or more antenatal care contracts, childbirth at facility, improved maternal education, higher wealth status, and frequently listening to the radio increased vaccine uptake.
- Continued efforts to improve access to vaccination services are required in sub-Saharan Africa.

7.2 Introduction

Vaccination is among the most effective and safest public health interventions preventing 2 to 3 million child deaths each year (241, 242). Vaccines have made a major contribution to the decline of some of the most dangerous diseases and eradication of smallpox (243). Over the past few decades, the expansion of childhood vaccination services has helped achieve significant milestones in child health indicators by reducing illness, disability, and death from several infectious diseases (241). Worldwide, substantial progress has been made to decrease child mortality in the last two decades, with vaccination playing a crucial role in reducing under-five deaths from 12.5 million in 1990 to 5.3 million in 2018 (244).

However, extreme disparities in child mortality continue to exist across regions, within and between countries (244). The sub-Saharan African region has the highest under-five mortality rate globally and accounts for 52% of this age group's total deaths. In 2018, the region had an average under-five mortality rate of 78 deaths per 1,000 live births, which translates to 1 in 13 children dying before their fifth birthday (244). This rate is 16 times higher than the average ratio of 1 in 199 children in high-income countries. The majority of these deaths are preventable or can be treated using affordable and simple interventions such as vaccination, clean water and sanitation, adequate nutrition, and appropriate care by a trained health care provider as needed (171, 244).

This disparity between high and low-income countries can be reduced if all children have equal access to the benefits of vaccines regardless of their geographic, socioeconomic, or demographic status (22, 242). However, this is not always the case; in many countries, children are under-vaccinated or unvaccinated (174). As a result, vaccine-preventable

diseases remain a cause of morbidity and mortality in many low- and middle-income countries (LMICs) (244).

Over the past few decades, while vaccination services have shown progress in sub-Saharan Africa, basic childhood vaccination coverage remains low in many countries in the region (245). The majority of these countries are struggling or unable to reach the most disadvantaged segments of their populations (246). In 2019, 19.7 million children remained under-vaccinated or unvaccinated for DPT 3 vaccine worldwide, of whom 48% were in Africa (246). The majority of these children lived in Nigeria, Ethiopia, the Democratic Republic of Congo, Angola, and Guinea (174, 246).

Ensuring equitable access to vaccination services for all children is a critical target of the Sustainable Development Goals (SDGs) (5). Addressing systematic disparities in access to child vaccination requires careful assessment, monitoring, and targeted interventions. This paper aims to address this gap by systematically examining inequalities in child vaccination coverage within and between 25 sub-Saharan African countries. In addition, we identified the predictors of inequality among receipts of full vaccination.

7.3 Methods

7.3.1 Data

We used the latest Demographic and Health Survey (DHS) data from 25 sub-Saharan African countries. We included all DHS that were conducted from 2013 to 2020. We excluded countries with surveys before 2013, as it may not represent countries' current vaccination coverage. The DHSs are nationally representative, large sample size surveys conducted in over 90 LMICs (67). DHS samples are stratified by geographic region and by rural or urban areas within each region. The DHS uses a stratified two-stage cluster sampling design. In the first stage of selection, the enumeration areas or primary sampling units (PSUs) are selected using probability proportional to size (PPS) within each stratum. In the second stage, a complete household listing is conducted in each of the selected clusters. Following the listing of the households a fixed number of households are selected by equal probability systematic sampling in the selected cluster.

Standard questionnaires are used across all countries to ensure comparability of data (67, 181). Countries are expected to adopt the full standard model questionnaire, but they can add questions of particular interest. However, questions in the model can be deleted if they are irrelevant in a particular country. The DHS uses standard sampling methods and design across all countries. The sampling methods and design have been described elsewhere (67). The sample used for the current analysis was limited to children aged 12 to 23 months at the time of the survey, yielding a final sample of 55,102 caretaker/mother-child pairs.

7.3.2 Measures

Our primary outcome variable of interest is the receipt of all vaccinations, which we defined as a child who had all recommended basic vaccines by the age of 12 months. Ideally, a child

should receive BCG at birth, OPV 3 with an optional dose at birth and mandatory doses at 6, 10, and 14 weeks; DTP 3 at 6, 10, and 14 weeks; and one dose of measles vaccine at 9 months. To estimate the proportion of fully vaccinated children, we created a composite variable for children who had received all of these vaccines at the age of 12 months. *Incomplete vaccination* was defined as a child missing at least one dose of any of the vaccines; and *zero-dose children,* are those who had not received any doses of vaccines. Missed opportunities for vaccination was defined as an occasion when a child who is eligible for vaccination with no contraindications visits a health facility but does not receive one or more recommended vaccines (172, 247). The DHS program determined child vaccination status from two sources. Child vaccination record cards provided by mothers/caretakers were used as a primary source, but if these were not available, mothers/caretakers' verbal reports of children's immunisation status were recorded. The majority (87%) had vaccination record cards. Of those, 35027 (64%) cards were seen by the data collectors, 12% had cards but were not seen by the data collectors, and 11% no longer had cards. The remainder (13%) had no cards at all.

7.3.3 Independent variables

We used the WHO Commission on Social Determinants of Health framework (183) to identify variables that may predict the inequitable coverage of full childhood vaccination. Household wealth index, maternal education levels, and maternal occupational status were used as indicators of mothers' socioeconomic position. The wealth index is a composite measure of a household's cumulative living standard that is calculated using principal components analysis (248). A household's cumulative living standard was determined based on ownership of selected household assets such as television, radio, refrigerator, and vehicle; materials used for housing construction; and access to sanitation facilities and clean water.

We categorised mothers' education levels as (no education, primary, secondary or higher). For this analysis, we grouped related occupations and formed four categories of women's occupation status (not currently working, skilled and professional, agricultural, and sales and services). We include exposure to media as one of the covariates in this study. We categorised frequency of listening to radio and watching television (TV) as not at all, less than once a week, and once a week or more. We categorised distance to a health facility – as a barrier to accessing health services -- as a big problem or not a big problem). We also included the use of reproductive and maternal health services, including the use of antenatal care that we categorised as fewer than four, or four or more contacts), and place of delivery that we categorised as birth at a health facility or home.

7.3.4 Statistical analysis

We used the concentration curve and concentration index to quantify socioeconomic inequalities in full vaccination, incomplete vaccination, or zero-dose children. We used the concentration curve to show inequality in vaccine uptake by plotting the cumulative percentage of the population ranked by wealth status (x-axis) against the cumulative percentage of the vaccination coverage on the y-axis. If all children had an equal uptake of vaccine regardless of their wealth status, then the curve would overlap with the 45° line, which indicates the presence of equality in the coverage of vaccination. If the concentration curve falls below the 45° line of equality, it indicates that the uptake of vaccines is pro-rich, but if the curve falls above equality, it indicates pro-poor vaccine uptake.

Concentration indices are used to measure relative inequality by estimating the distribution of one variable (e.g., full vaccination) over the other (wealth status). Concentration index (CI) is two times the area between the line of equality and the concentration curve. The index

takes a value between −1 and +1; an index of 0 indicates equality in the uptake of vaccines. The concertation index takes on a positive value if there is an uneven concentration of vaccination coverage among the rich, and a negative value of the concentration index implies pro-poor vaccination coverage (193). We used ***conindex*** command to estimate concentration indices in Stata (249). The estimated concentration indices with confidence intervals are presented in figure 6-3. A positive CCI indicates pro-rich full vaccination coverage; if the confidence interval involves zero, inequalities are statistically insignificant, while negative concentration indices suggest a pro-poor full vaccination coverage.

We used a multilevel logistic regression analysis to determine factors driving inequalities in full vaccination among children. We adjusted for sampling design (stratification and clustering) and sampling weights. We specified a 3-level model: at level 1 we adjusted for child, mother, and household factors (46,790 mother-child pairs); at level 2 we adjusted for clustering (12,948 clusters); and at level 3 we adjusted for a country (25 countries). Results are presented with adjusted odds ratios (OR) and statistical significance was declared when the p value was < 0.05. Analyses were conducted using Stata 14.2 and IBM Statistical Package for Social Sciences (SPSS, Chicago, II) version 25.0.

7.4 Results

Our sample included data from 55,102 children aged 12 to 23 months in 25 sub-Saharan African countries. The number of children per country ranged from 655 in Lesotho to 6143 in Nigeria; these reflect the populations of each country. The majority (68.6%) of children were from rural areas; (22.6%) were from the poorest quantile; and 35.1% of their mothers had no

education. The majority, 56% of mothers had four or more antenatal care contacts, and (66.9%) gave birth at a health facility (Table 7-1).

7.4.1 Vaccination coverage

Overall, 56.5% (95% CI: 55.7% to 57.3%) of children received full vaccination; 35.1% (34.4% to 35.7%) received incomplete vaccination; while 8.4% (95% CI: 8.0% to 8.8%) of children received zero-dose. Missed opportunities for vaccination across all countries was 43.5% (95% CI: 42.7% to 44.3%); this ranged from 7.3% in Rwanda to 76.1% in Guinea. Figure 7-1 shows coverage of all recommended vaccinations that all children should receive by the age of 12 months. The BCG vaccine had the highest coverage at 86.2% (95% CI: 85.6% to 86.8%); whereas three doses of oral polio vaccine had the lowest coverage at 68.2% (95% CI: 67.5% to 68.9%).

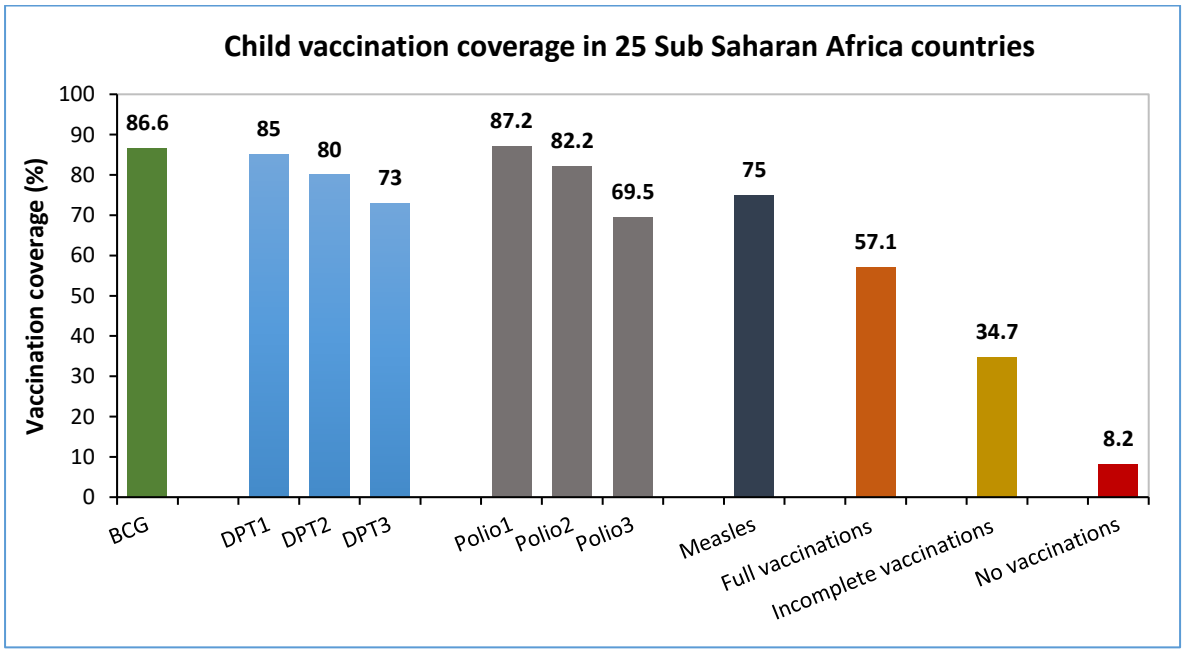

Figure 7-1 Vaccination coverage among children aged 12-23 months in 25 Sub Saharan Africa countries (DHS 2013 - 2018)

There were important differences across the countries in vaccination uptake. For example, in Ghana, Burundi, and Rwanda more than 77% of children received full vaccination; but coverage was less than 40% in Ethiopia, Nigeria, Angola, Chad, and Guinea (Figure 7-2). The highest full vaccination coverage was in Rwanda (93%); while Guinean children received the lowest coverage of full vaccination (24%). The proportion of children who received incomplete vaccination was highest in Chad (56%), while the lowest proportions were registered in Rwanda (7%). In Guinea, 23% of children received zero-dose vaccination, while this was as low as 0.3% in Burundi.

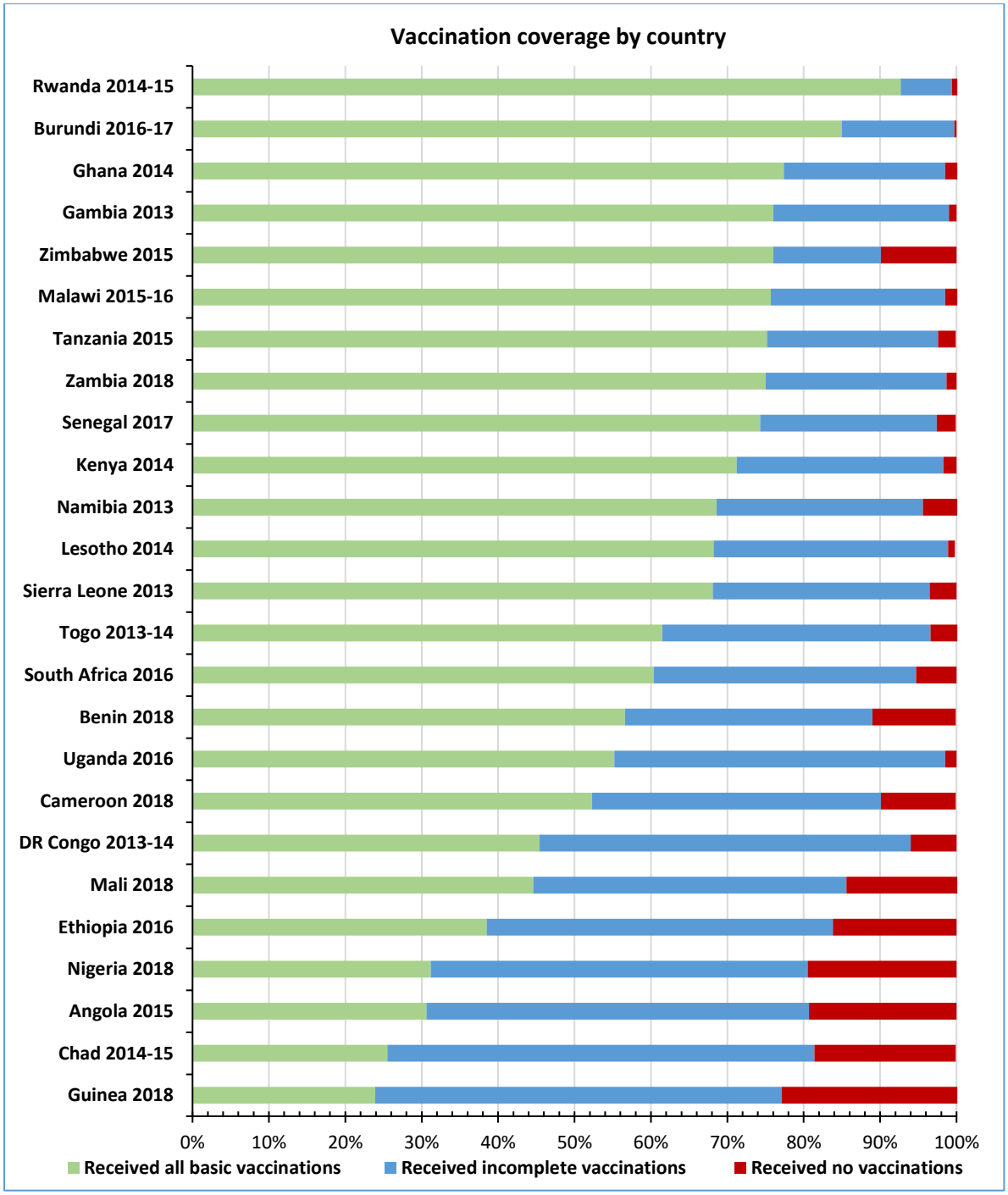

Figure 7-2 Child vaccination coverage in 25 Sub Saharan Africa countries (DHS 2013 - 2018)

7.4.2 Socioeconomic inequalities

Figure 7-3 shows socioeconomic inequalities in child vaccination in 25 sub-Saharan African countries. With increasing child vaccination coverage, socioeconomic inequalities in vaccination uptake decreased in countries such as Rwanda (CCI: 0.019, 95% CI: 0.01 to 0.029), Burundi (CCI: 0.006, 95%CI: -0.005 to 0.017), and Ghana (CCI: -0.003, 95% CI: -0.03 to 0.024). On the other hand, as vaccination coverage decreased, socioeconomic disparities in vaccination uptake increased in countries such as Nigeria (CCI: 0.269, 95% CI: 0.241 to 0.297), Angola (CCI: 0.299, 95% CI: 0.254 to 0.344) and Guinea (CCI: 0.153, 95% CI: 0.074 to 0.231). Receipt of full vaccination was pro-rich across most countries, except in Gambia (CCI: -0.138, 95% CI: -0.185 to -0.092) and Namibia (CCI: -0.05, 95% CI: -0.079 to -0.021).

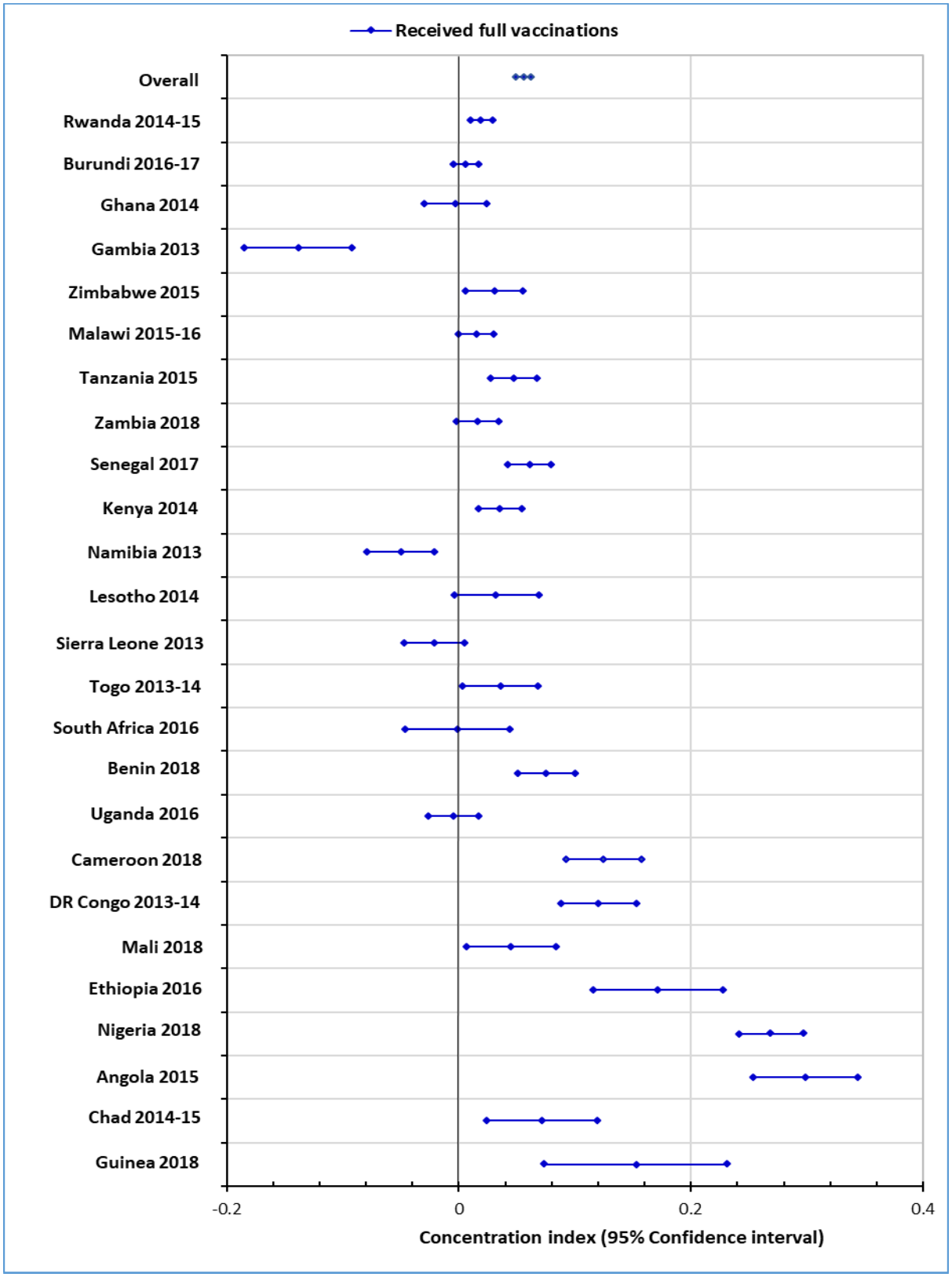

Figure 7-3 concentration indices child vaccination status across 25 Sub Saharan Africa countries (DHS: 2013 - 2018)

We also found that countries had varied distribution in the coverage of incomplete vaccinations. In most countries, incomplete vaccination was either disproportionately concentrated among disadvantaged subgroups (e.g. in Rwanda, Tanzania, Cameroon, and Nigeria) or showed no statistically significant inequalities (e.g. Burundi, Ghana, Zimbabwe, South Africa, and Benin). On the other hand, zero-dose children were disproportionately concentrated among disadvantaged subgroups in most countries. Inequalities in zero-dose children was highest in Benin (CCI: -0.385, 95% CI: -0.474 to -0.297) followed by Angola (CCI: -0.358, 95% CI: -0.416 to -0.300) and Nigeria (CCI: -0.311, 95% CI: -0.351 to -0.272) (Figure 7-3).

We also found variations in full vaccination across different regions of sub-Saharan Africa. The highest inequalities in coverage were registered in the Central African region (CCI: 0.148, 95% CI: 0.127 to 0.169) that include countries such as Cameroon, DR Congo, Angola, and Chad; while the Southern African region showed no inequalities (CCI: -0.009, 95% CI: -0.030 to 0.012) (Figure 7-4).

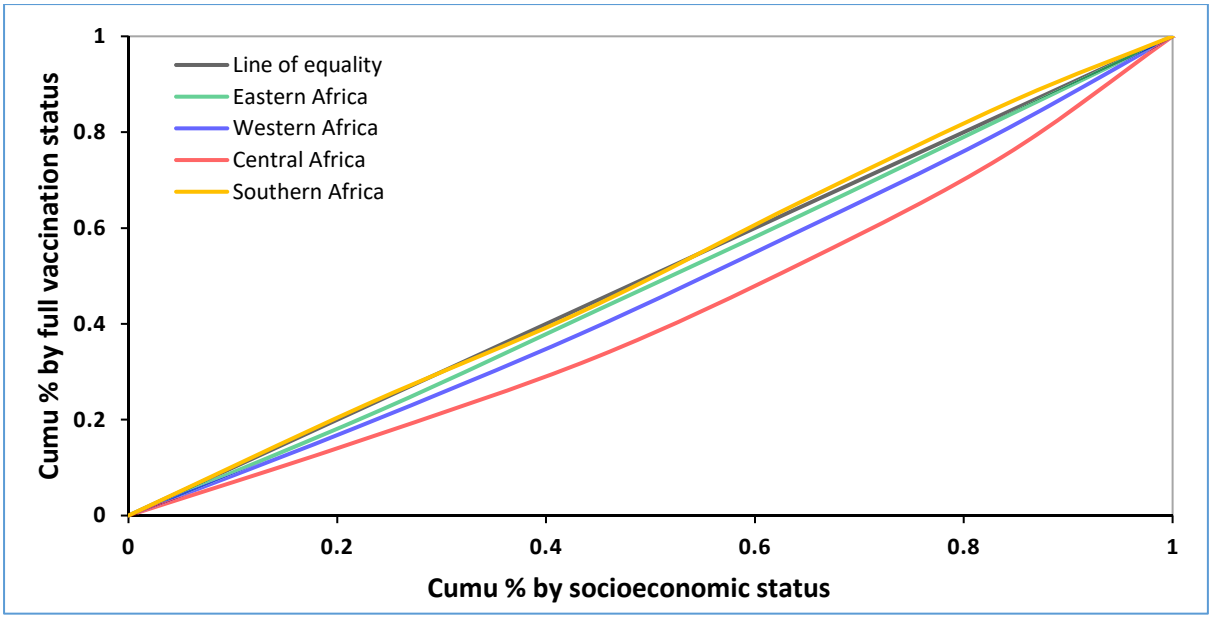

Figure 7-4 concentration curves full vaccination status across Sub Saharan Africa regions (DHS: 2013 - 2018)

Table 7-1 shows predictors of full vaccination in the 25 sub-Saharan African countries. We found multiple factors that were associated with higher odds of full vaccination, including: increasing childbirth order, four or more antenatal care contracts, childbirth at a health facility, improved maternal education, higher household wealth, frequently listening to the radio, and residence in rural areas. Children whose mothers attended four or more antenatal care had higher odds (AOR 1.44, 95% CI: 1.24, 1.68) of receiving full vaccination than those who had fewer than four antenatal care contacts. Children who were born at health facilities had higher odds (AOR 1.79, 95% CI: 1.60, 2.01) of receiving full vaccinations than those who were born at home.

The odds of receiving full vaccination increased with the rising level of mother's education: children of women with primary level education (AOR 1.22, 95% CI: 1.06, 1.40) and those with secondary or higher education had higher odds (AOR 1.49 95% CI: 1.24, 1.80) compared to children of women who had no education. The increasing wealth of women's household also

increased the odds of children receiving full vaccination. Children from the richest (fifth) quantile had the highest odds of receiving full vaccination (AOR 1.66, 95% CI: 1.27, 2.17), followed by those in the fourth quintile (AOR 1.40 95% CI: 1.20, 1.62) compared to children from the poorest household (Table 7-1).

Table 7-1 Factors associated with receiving full vaccinations

Study variables	Number (%) of study participants		Received full vaccinations (95% CI)	Unadjusted OR (95 CI)	P	Adjusted OR (95 CI)	P
	Frequency	Percent					
Parity					0.002		0.005
First	12443	22.6	61.2 (60.0 to 62.4)	1.0 (Reference category)		1.0 (Reference category)	
Second	10598	19.2	59.4 (58.1 to 60.8)	1.01 (0.91, 1.11)		1.13 (1.02, 1.25)	
Third	8846	16.1	58.6 (57.2 to 60.0)	0.98 (0.89, 1.07)		1.14 (1.03, 1.27)	
Fourth	6940	12.6	57.0 (55.5 to 58.6)	0.95 (0.86, 1.06)		1.20 (1.06, 1.34)	
Fifth or more	16275	29.5	50.0 (48.8 to 51.2)	0.79 (0.70, 0.90)		1.05 (0.93, 1.17)	
Antenatal care contacts					<0.001		<0.001
Less than 4 contacts	23146	44.0	48.3 (47.2 to 49.4)	1.0 (Reference category)		1.0 (Reference category)	
Four or more contacts	29490	56.0	63.8 (62.9 to 64.6)	1.78 (1.44, 2.21)		1.44 (1.24, 1.68)	
Place of delivery					<0.001		<0.001
Home	18247	33.1	36.8 (35.6 to 38.0)	1.0 (Reference category)		1.0 (Reference category)	
Health facility	36855	66.9	66.4 (65.6 to 67.2)	2.24 (1.90, 2.64)		1.79 (1.60, 2.01)	
Mother's education levels					<0.001		<0.001
No education	19347	35.1	43.8 (42.5 to 45.1)	1.0 (Reference category)		1.0 (Reference category)	
Primary	19481	35.4	62.6 (61.5 to 63.6)	1.58 (1.30, 1.91)		1.22 (1.06, 1.40)	
Secondary or higher	16273	29.5	64.6 (63.5 to 65.7)	2.44 (1.82, 3.26)		1.49 (1.24, 1.80)	
Mother's occupation					0.034		0.022
Not working	14037	27.4	56.1 (54.7 to 57.5)	1.0 (Reference category)		1.0 (Reference category)	
Skilled and professionals	3760	7.3	61.0 (58.7 to 63.2)	1.31 (1.15, 1.49)		0.99 (0.86, 1.14)	
Sales and services	15446	30.1	53.8 (52.6 to 55.1)	1.07 (0.94, 1.21)		0.97 (0.88, 1.07)	
Agriculture	18008	35.1	60.3 (59.0 to 61.6)	0.97 (0.83, 1.14)		1.17 (1.02, 1.34)	
Household wealth index					<0.001		<0.001
Poorest	12469	22.6	49.6 (48.1 to 51.1)	1.0 (Reference category)		1.0 (Reference category)	
Poorer	11926	21.6	52.8 (51.4 to 54.2)	1.22 (1.10, 1.36)		1.13 (1.02, 1.26)	
Middle	11068	20.1	57.3 (56.0 to 58.7)	1.53 (1.31, 1.80)		1.27 (1.12, 1.44)	
Richer	10230	18.6	60.2 (58.8 to 61.7)	1.86 (1.45, 2.40)		1.40 (1.20, 1.62)	
Richest	9408	17.1	66.1 (64.5 to 67.6)	2.51 (1.64, 3.82)		1.66 (1.27, 2.17)	

Frequency of listening to radio					<0.001		0.005
Not at all	23904	43.4	48.4 (47.3 to 49.6)	1.0 (Reference category)		1.0 (Reference category)	
Less than once a week	10602	19.3	61.5 (60.2 to 62.9)	1.44 (1.29, 1.60)		1.18 (1.05, 1.34)	
At least once a week	20559	37.3	63.6 (62.6 to 64.6)	1.52 (1.41, 1.65)		1.18 (1.06, 1.30)	
Frequency of watching television					<0.001		0.204
Not at all	34992	63.6	54.0 (53.1 to 55.0)	1.0 (Reference category)		1.0 (Reference category)	
Less than once a week	6746	12.3	59.1 (57.4 to 60.7)	1.24 (1.01, 1.53)		0.91 (0.81, 1.02)	
At least once a week	13298	24.2	62.6 (61.3 to 64.0)	1.64 (1.30, 2.06)		1.01 (0.89, 1.15)	
Distance to health facility					0.001		0.083
Not a big problem	31235	61.4	60.3 (59.4 to 61.2)	1.0 (Reference category)		1.0 (Reference category)	
Big problem	19640	38.6	52.8 (51.6 to 54.0)	0.77 (0.69, 0.87)		0.94 (0.87, 1.01)	
Place of residence					0.008		0.017
Urban	17288	31.4	59.0 (57.7 to 60.3)	1.0 (Reference category)		1.0 (Reference category)	
Rural	37813	68.6	55.6 (54.6 to 56.6)	0.70 (0.52, 0.94)		1.19 (1.03, 1.36)	

7.5 Discussion

We systematically examined inequalities in child vaccination in 25 sub-Saharan African countries. We found differences in national full vaccination coverage ranging from 24% in Guinea to 93% in Rwanda. We also observed inequalities in the receipt of full vaccination between and within countries.

COVID-19 pandemic might have worsened the already existing persistent and severe disparities in accessing healthcare services. Routine vaccination disruptions due to Covid-19 maybe even more detrimental for poor households and remote or rural areas in low-income and middle-income countries. Globally, in 2020, an estimated 30 million children might have missed doses of DTP3, and 27·2 million might have missed measles-containing vaccine doses. In Pakistan, there was a daily 52.5% vaccinations decline on average during lockdown compared to baseline (250). In Colombia, an estimated 14.4% reduction was reported in 2020 compared with the same period in 2019 (251). The most significant declines in coverage were observed among children <12 months living in rural areas (251). In Nigeria, WHO confirmed in their preliminary analysis that 362,700 pregnant women missed antenatal care between March and August 2020, and 310 maternal deaths occurred in health facilities in August 2020, nearly twice the number of deaths in August 2019 (252).

The extent of within-country inequality varied by country: most countries showed a substantial pro-rich inequality, except for Gambia and Namibia, where we found pro-poor vaccination coverage. This coverage could partly be explained by the fact that Gambia and Namibia have small populations. As a result, programs may have been able to target and reach vulnerable populations. Further studies are needed to identify what factors contributed to the observed pro-poor vaccination coverage in both Gambia and Namibia.

In Rwanda, Burundi, Ghana, and Zimbabwe, where we found higher vaccination coverage (76% or more), socioeconomic-related inequality was lower. On the other hand, countries such as the Democratic Republic of Congo, Nigeria, Ethiopia, and Guinea had lower child vaccination coverage of 52% or less and higher socioeconomic inequality. The Democratic Republic of Congo, Nigeria, and Ethiopia are also high-priority countries where the proportion of children who remain unvaccinated is the highest in the world (174). The large population of these countries, especially Nigeria and Ethiopia, could partly explain the low vaccination coverage as the volume of children to vaccinate can place pressure on the health systems (242). The struggle to ensure equity in vaccination coverage may continue due to fast growing population in sub-Saharan Africa (253). For example, the population growth rate in Nigeria and Ethiopia has been more than 2% regularly for more than two decades, and in 2018, the population growth rate was 2.6% in Nigeria and Ethiopia (253).

The population size of countries, the rural location of communities and political instability and conflict may have restricted health service activities resulting in low vaccination coverage (254). For example, in northern Nigeria, if an armed conflict occurs within 10 km from where a child resides, the odds that a child receives any vaccination were 47.2% lower (254).

Missed opportunities for vaccination are a key reason for low vaccination coverage in many countries (247). The prevalence of missed opportunities for vaccination across the 25 countries covered in our analysis was 42.9%. Low vaccination coverage disproportionately affects disadvantaged subgroups. The prevalence was 50% among the poorest quintile but only 34% among the richest quintiles. Reasons for missed opportunities include vaccine stockouts, and provider attitudes and practices that may include a reluctance to opening a multi-dose vaccine

vial for fewer children for fear of vaccine wastage (172, 247, 255). For example, an opportunity to vaccinate with measles vaccine is more frequently missed as it is provided in ten-dose vials and must be used within six-hours once opened (256).

The lack of vaccination services due to vaccine stockouts is a longstanding and persistent problem across sub-Saharan African health systems that results in missed opportunities (172, 256). In resource-limited settings, a lack of adequately trained personnel to administer vaccines, coupled with non-existent or intermittent access to electricity to manage the cold chain, presents substantial challenges in most African countries (245). Parents may become discouraged and less likely to return for vaccination if they miss work, have to travel long distances to facilities, experience long waiting times, and fail to receive services (256). In Kenya (256), people were less likely to seek immunisation services because of frequent vaccine stockouts at health facilities when they presented for vaccination.

The mistreatment of mothers by health workers in an unfriendly, disrespectful, or abusive manner may lower the uptake of vaccination services. Recent systematic reviews of the literature (172, 256) reported that health workers chastised mothers who forgot the child's vaccination card, missed a scheduled appointment, or had a dirty or poorly dressed child. This provider mistreatment may result in feelings of humiliation and discourage mothers from vaccinating their children. These attitudes could have negative health consequences for the mothers, as they may contribute to postpartum depression (257). Providers may also refuse to vaccinate eligible children due to fears and false beliefs such as that a child over 12 months is 'too old' for measles vaccination, or a sick child should not be vaccinated (258).

Vaccine hesitancy/refusal can also occur despite the availability of vaccination services because of negative attitudes, or concerns of real or perceived vaccine adverse events (177, 259). Parents' positive attitudes and their belief that vaccination prevents disease and knowledge of when and where the child needs to receive full vaccinations are important factors for improved vaccine uptake (260).

In many countries, the inability to address both vaccine supply and demand has contributed to disparities in service uptake (172). Supply-side hurdles include limited access to services, low quality of care, and poor health worker knowledge and attitudes (172, 256). Demand for vaccination can be affected by fear of the vaccine's potential side effects, parents' conflicting priorities, and lack of practical knowledge of vaccination (172, 256, 261).

Most disadvantaged parents travel longer distances and may wait for long periods for vaccination, despite having work and family responsibilities (176, 262). Other conflicting priorities may include not being able to leave older children while traveling to vaccinate younger children and the need to care for other sick children at home (256). Although vaccination services are free of charge in many low-income countries, parents often incur additional indirect costs including transportation, which can be challenging (22).

Maternal education contributes to improved child health (260, 263, 264); and in this analysis maternal education was associated with immunisation service uptake. Positive perceptions of vaccine safety and importance of vaccination for health are crucial factors in vaccine uptake (260). Formal education improves critical thinking, communication, problem-solving, and other

related skills that are vital to generating income (263). Educated women are also more likely to attend antenatal care, give birth at a facility, or seek health services for sick children (217, 263).

Mass media is an important tool for creating awareness and promoting positive perceptions towards vaccination and health services (209). In our analysis, households or women who frequently listened to the radio had improved vaccine uptake. Radio-based health promotion campaigns are an important strategy to raise community awareness and encourage mothers to vaccinate their children (258). Communication strategies that inform and educate can help address soon-to-be parents and new parents about childhood vaccination, and vaccination sites and schedules (265, 266). Health education can be offered to groups of parents, pregnant women attending antenatal clinics or vaccination services, and during home visits (265, 266). Posters and flyers in clinics and communities can also be used to augment this education. Interventions to remind and recall important health messages can be provided using vaccination cards that serve as reminders for vaccination appointments. Furthermore, local radio announcements and town announcers can effectively work to remind communities about routine immunisation clinic visits in rural settings (265).

The continuum of care has recently become a core principle of programs for maternal, newborn, and child health services to reduce morbidity and mortality (145). This approach helps to avoid divisions between maternal and child health services or places of service delivery by focusing efforts at reducing dropouts (145). Our analysis demonstrated the strong connection between maternal and child health services where the use of antenatal care and institutional delivery was associated with increased odds of vaccination service uptake. During antenatal care, childbirth at a facility, or postnatal care visits women receive counselling on newborn and child health,

improving their awareness about vaccination benefits and service arrangements (23). These service points present an opportunity for creating initial awareness of the benefits of vaccines, vaccination schedules, and vaccination service arrangements.

To address missed opportunities and reduce inequalities in vaccination coverage, one or a combination of strategies can be used (243, 255, 258). Important strategies include enforcing booster vaccinations, screening for vaccination and providing health cards that record immunisation status (255, 258). Studies have demonstrated that screening for all children aged two to five years who are eligible for vaccination during any contact (sick or well) with health services improves immunisation coverage while reducing missed opportunities for vaccinations (258, 267). Effective implementation of this approach could increase vaccination coverage by at least 10% (255). In the United States, a study showed that screening for the vaccination status of children aged 18 months could increase vaccine coverage rates by 27 to 61 percentage points (267). However, there are significant challenges in implementing screening and vaccination of sick and well children (aged over two years) in low-income countries. These challenges include health workforce shortages and a lack of clear guidelines to implement immunisation screening and protect health workers (258).

Campaigns are another effective strategy to provide immediate and widespread access to vaccination services. Campaigns involve communication followed by the administration of vaccine doses to a large population over a short period of time (174, 255). They can be particularly effective in acute situations such as natural disasters, outbreaks, or conflicts (174, 242). The use of campaigns has contributed to increasing vaccination coverage or even eradicating some diseases; in doing so, campaigns have contributed to making progress towards universal coverage

(268). To get the most out of vaccination campaigns, planning for campaigns should be supported by robust evidence of coverage gaps, and efforts to ensure that those people missed by routine immunisation programs are reached (255, 268). However, campaigns are not part of the regular system of health initiatives and countries might lack the resources to ensure sustainability, as priority is given to routine immunisation (174).

Another strategy to reduce vaccination coverage inequalities is implementing regular immunisation outreach programs (174, 243, 255). Outreach activities involve health workers travelling to communities far from health facilities to deliver vaccines. In Ethiopia (269) and Malawi (270), the establishment of routine outreach programs has been effective in reaching remote areas. For communities that move seasonally, this approach ensures better access to health services, including immunisation services (243, 255). However, routine outreach programs are challenging in countries that experience political instability and military conflict as it weakens health systems and puts the safety of health workers in danger.

Our study's strengths include the use of large, nationally representative population-based surveys collected from 25 countries in sub-Saharan Africa. We used two approaches to examine inequality in the uptake of vaccination services. First, we used the concentration curve and index to assess wealth inequalities in full vaccination, incomplete vaccination, and zero-dose children within and across 25 sub-Saharan countries. Second, we used a multilevel logistic regression analysis to determine factors driving inequalities in child full vaccination. However, there were some limitations to the study. If vaccination/health cards were not available, maternal recall was used to identify a child's vaccination status. We used the most recent data available from the Demographic and Health Surveys, dating back to 2013 for some countries. There may be

differences from the current rates for some countries as it may not represent recent vaccination coverage. Although we were able to examine wealth-related inequality in child vaccination for each country, we were unable to identify the predictors of inequality in full vaccination specific to each country. A record card is the "gold standard" source of information to estimate child vaccination coverage. However, cards might not always be seen at the time of interview because of loss, storage at health facilities, misplacement or elsewhere, or other survey-related procedures. In such situations where record cards are not available, maternal reports have been used throughout the literature to estimate coverage. Evidence suggests parental/caregiver vaccination reports should be used to improve coverage estimates where cards are not available (271-274).

Conclusions

Despite global progress in vaccination coverage, we found that substantial numbers of children fail to receive and benefit from all recommended vaccines. We found pro-rich inequality in the coverage of full vaccination and disproportionate levels of zero-dose and incomplete vaccination among disadvantaged population groups. This inequality within countries should be addressed on a priority basis through equity-oriented and context-appropriate policies and practices.

Continued efforts to improve access to vaccination services are required in sub-Saharan Africa. In addition to addressing the vaccine supply issues, health service delivery systems should also target increasing demand for vaccination services by providing targeted health information and education. Health facilities should also focus on addressing vaccine stockouts by securing adequate vaccine doses and ensuring reliable cold chain management. Improved training of

personnel is necessary to strengthen screen and deliver vaccines to all previously unvaccinated eligible children and improve health worker attitudes towards service users.

Vaccination programs and policies should primarily target areas with poor vaccination coverage and directly consider the needs and experiences of poor and vulnerable populations. In addition to education initiatives, areas with critical vaccination coverage gaps can be supported by monetary or material incentives.

7.6 Chapter summary

In this chapter, we measured inequalities in vaccination coverage in sub-Saharan Africa. We found pro-rich vaccination coverage in the majority of the study countries. While zero-dose vaccination showed disproportionate concentration among poorer population groups. We have also identified drivers of inequality in vaccination coverage in sub-Saharan Africa.

In the next chapter, we were interested to see if there were differences in drivers of inequality in vaccination coverage at a regional level and a specific country level. We considered Ethiopia as an example to see country-level drivers of inequality in vaccination coverage.

Chapter Eight: Explaining socioeconomic inequalities in child vaccination: the case of Ethiopia

Preamble

In the previous chapter, we measured inequalities in vaccination coverage in 25 sub-Saharan African countries. We estimated inequalities in zero-dose vaccination, incomplete vaccination, and full vaccination within all countries. We then identified drivers of inequality in vaccination coverage for the pooled data. However, it is also important to understand the drivers of inequality at a country level. The current chapter aimed to address this gap by investigating inequalities in vaccination coverage, taking Ethiopia as an example. Ethiopia is among the top 10 priority countries in the world where children remain unvaccinated, including Nigeria and the Democratic Republic of Congo from Africa.

This time around, we used a different analytic approach to explain inequalities in vaccination coverage using two waves of Demographic and Health Survey data.

Citation**: Bobo, F.T**. & Hayen, A. 2020, 'Decomposition of socioeconomic inequalities in child vaccination in Ethiopia: results from the 2011 and 2016 demographic and health surveys', BMJ Open, vol. 10, no. 10, p. e039617.

Manuscript five: Decomposition of socioeconomic inequalities in child vaccination in Ethiopia: Results from the 2011-2016 demographic and health survey data

8.1 Abstract

Objective: Monitoring and addressing unnecessary and avoidable differences in child vaccination is a critical global concern. This study aimed to assess socioeconomic inequalities in basic vaccination coverage among children aged 12-23 months in Ethiopia.

Design, setting and participants: Secondary analyses of cross-sectional data from the two most recent (2011 and 2016) Ethiopia Demographic and Health Surveys were performed. This analysis included 1930 mother-child pairs in 2011 and 2004 mother-child pairs in 2016.

Outcome measures: Completion of basic vaccinations was defined based on whether a child received a single dose of Bacille Calmette Guerin (BCG), three doses of diptheria, tetanus toxoids, and pertussis (DTP), three doses of polio vaccine (OPV), and one dose of measles vaccine.

Methods: The concentration curve and concentration index (CCI) were used to estimate wealth-related inequalities. The concentration indices were also decomposed to examine the contributing factors to socioeconomic inequalities in childhood vaccination.

Results: From 2011 to 2016, the proportion of children who received basic vaccination increased from 24.6% (95% confidence interval, CI: 21.4 to 28.0) to 38.6% (95% CI: 34.6 to 42.9). While coverage of BCG, DPT, and polio immunisation increased during the study period, the uptake of measles vaccine decreased. The positive concentration index shows that basic vaccination status was favourably concentrated among children from wealthier households CCI= 0.212 in 2011 and CCI= 0.212 in 2016. The decomposition analysis shows that use of maternal health services such as family planning and antenatal care, socioeconomic status, exposure to media, urban-rural residence, and maternal education explain inequalities in basic vaccination coverage in Ethiopia.

Conclusions: Childhood vaccination coverage was low in Ethiopia. Vaccination was less likely in poorer than in richer households. Addressing wealth inequalities, enhancing education, and improving maternal health service coverage will reduce socioeconomic inequalities in basic vaccination uptake in Ethiopia.

Keywords: Inequality, Immunisation, Vaccination, Socioeconomic factors, Ethiopia

Strengths and limitations

- This study used two most recent (2011 and 2016) nationally representative Demographic and Health Surveys (DHS).
- The decomposition of the contributing factors that drive socioeconomic inequalities in vaccination status provided a rich set of analysis for policy interventions to address socioeconomic disparities in child vaccination in Ethiopia.
- Limitations of the current study may include recall bias related to vaccination status as not all children had vaccination cards, and measures had to depend on the mother's verbal report.
- The DHS is a cross-sectional survey; it was not possible to establish temporality between childhood vaccination and explanatory factors, precluding causal inference.

8.2 Introduction

Vaccination is an important public health intervention that helps prevent 2 to 3 million child deaths each year (171). With improved coverage, vaccines have the potential to save many more children, which is why it is necessary to ensure that all children receive all recommended vaccines (170, 275).

In Ethiopia, a child is said to have received full vaccinations if they receive one dose of the Bacille Calmette-Guérin vaccine (BCG, for tuberculosis), three doses of the pentavalent vaccine (penta includes diphtheria, tetanus, pertussis [DTP], hepatitis B [HBV], and Haemophilus influenzae type b [Hib]), three doses of the oral polio vaccine (OPV), three doses of the pneumococcal conjugate vaccine (PCV), and two doses of the rotavirus vaccine (rota), and one dose of measles-containing vaccine (MCV) (262, 276). Basic vaccination is defined as access to a single dose of BCG, three doses of DTP, three doses of OPV, and one dose of measles vaccine by the age of 12 months (276).

In the past decades, global basic vaccination coverage has improved remarkably (20, 22). In 2018, the proportion of the world's children who received three doses of the combined diphtheria, tetanus toxoid, and pertussis-containing vaccine (DTP3) reached 86% worldwide (171). However, there are inequalities in access to childhood vaccination and many children do not receive the basic vaccines worldwide (174, 277).

Many regions of the world continue to have low coverage. The World Health Organisation (WHO) report in 2019 shows that 19.4 million children under the age of one year did not receive basic vaccines; around 60% of these children live in 10 nations, including Nigeria, the Democratic Republic of the Congo and Ethiopia (171). Disparities in vaccination coverage exist within and

between countries, and in some places; the difference is more significant (277). Within countries, inequalities in child vaccination data show that richer subgroups tend to have higher coverage whereas the coverage among poorer subgroups varies across countries. For example, studies in India (278), Nigeria (279) and Brazil (280) indicated that children of mothers who had higher education levels and household wealth status are more likely receive higher vaccination coverage.

Complete lack or incomplete childhood vaccination remains the cause of millions of preventable child deaths each year in many countries (171). Previous studies in the area suggest that there exists a social gradient in child vaccination within countries (281-283). For example, increased vaccination coverage was favourably concentrated among children whose parents are well-educated, wealthy or living in urban areas. Inequalities in access to child vaccination need to be effectively assessed, monitored, and intervened to address systematically missed population groups (62, 63). In 2019, only 43% of children received all recommended vaccines while 19% received none of the vaccines (284). This is way below WHO's 2020 goal of 90% coverage in every country (243). Addressing these gaps requires measuring inequalities in basic vaccination coverage and identifying where gaps exist in routinely delivered vaccines and provide valuable information to introduce effective strategies and policies to address such inequalities. It is equally important those children who receive incomplete or no vaccines be identified to devise equity-oriented immunisation programs to reach disadvantaged populations and reduce Ethiopia's high levels of vaccine preventable childhood morbidity and mortality.

Although there are previous studies (285-287) in Ethiopia that have addressed factors associated with childhood vaccination, there is a need to examine trends and socioeconomic inequalities in

childhood vaccination. The objective of this study is to examine trends and socioeconomic inequalities in childhood vaccination. Moreover, the paper assesses factors that explain socioeconomic inequalities in childhood vaccination in the country using a decomposition approach.

8.3 Methods

8.3.1 Data

We analysed the most recent (2011 and 2016) Ethiopia Demographic and Health Surveys. The Ethiopian Central Statistical Agency (CSA) undertook the surveys in collaboration with the DHS program (288). The DHS are nationally representative household surveys with large sample sizes and high response rates (180). The DHS uses a stratified, two-stage sampling technique to obtain the study participants (179). Standardised questionnaires are used across time and countries to ensure collected data are comparable (181). Sampling methods and design have been described elsewhere (67). For the purpose of this study, data collected on vaccination status of children aged 12-23 months were extracted and analysed. The Ethiopia DHS included information on 11,872 births/women in 2011 and 11,023 births/women in 2016. The sample used for the current analysis was limited to children aged 12–23 months at the time of the survey, yielding a final sample of 1930 mother-child pairs in 2011, and 2004 mother-child pairs in 2016.

*8.*3.2 Measures

The dependent variable is whether a child received all basic vaccinations that is the eight recommended basic vaccines (173). The vaccines included one dose of Bacille Calmette Guerin (BCG) against tuberculosis, three doses of diptheria, tetanus toxoids, and pertussis vaccine (DTP), three doses of oral polio vaccine (OPV), and one dose of measles vaccine. Table 8-1 shows immunisation schedule for children under 12 months in Ethiopia (276). The DHS determined the vaccination status of children from two sources. Primarily immunisation record cards provided by mothers, but if these were absent the DHS data collectors used mothers' verbal reports of children's immunisation status.

Table 8-1 Basic vaccination schedule for children under 12 months in Ethiopia

Vaccine	Diseases	Age
BCG	Tuberculosis	At birth
DPT	Diphteria, Pertussis, Tetanus	6, 10, 14 weeks
OPV	Polio	At birth, 6, 10, 14 weeks
Measles	Measles	9 months

The WHO Commission on Social Determinants of Health framework (183) was used to explain contributing factors of inequalities in vaccination status. In addition, factors identified in the current literature (279, 281, 282, 289, 290) on child vaccination that are available in the DHS surveys were included. The independent variables considered in the current study include 1) maternal and household factors: maternal parity, age, education levels, wealth status, and the use of maternal health services, 2) exposure to media, and 3) place of residence – urban/rural status.

The wealth index is a composite variable that measures the woman's household living standards. It is constructed by collecting and analysing information on ownership of selected materials and assets, such as radio, television, refrigerator, and vehicle; materials used for housing construction; and types of sanitation facilities and water access. Households were ranked into five quintiles (poorest, poorer, middle, richer and richest) depending on their level of wealth.

We grouped education levels of the mothers in to three categories (no education, primary, and secondary or higher). Exposure to media: frequency of listening to radio and watching television (TV): both categorised as (not at all, less than once a week, and once a week or more). Utilisation of reproductive and maternal health services considered in the current study include use of contraceptive, antenatal care contacts, and delivery at the health facility.

8.3.3 Statistical analysis

Socioeconomic inequalities in the coverage of vaccination status were estimated using the concentration curve and concentration index (193). The concentration curve is a plot of the cumulative percentage of the population, ranked by wealth status, from the poorest to the richest (x-axis) against the cumulative percentage of the health variable (vaccination status) on the y-axis. If all children had an equal proportion of vaccination status regardless of their socioeconomic status, then the curve would coincide with the 45° line, which indicates the presence of equality in the coverage of vaccination. If the concentration curve falls below the 45° line of equality, it indicates that the uptake of vaccines is more concentrated among the rich. The opposite is true if the curve falls above the line of equality.

The concentration index is described as two times the area between the line of equality and the concentration curve. The index takes a value between −1 and +1; an index of 0 indicates the presence of equality in the uptake of vaccines. If wealth related inequalities exist, it can be seen in one of the two forms, the first is when there is uneven concentration of vaccine uptake among the rich, and in this case, the concertation index takes on a positive value. The second is negative value concentration index, which implies high concentration of vaccination status among the poor.

The concentration index (CCI) can be computed as follows:

$$CCI = \frac{2}{y} cov(h, r), \qquad (1)$$

where h is the healthcare outcome of interest (i.e. vaccination status), y is the mean of h and r is the fractional rank of an individual in the wealth distribution. We also computed 95% CIs for the concentration index.

8.3.3.1 Decomposing inequalities

The concentration curve and concentration index can only show and quantify the level of inequalities related to wealth in the use of health services. However, policymakers are also interested in the factors that contribute to socioeconomic inequalities in vaccination coverage. This can be done using an approach developed by Wagstaff and colleagues (184). The concentration index of a health variable can be decomposed into the contributions of individual factors to wealth-related health inequality. If we consider a linear regression model for the child's vaccination status, v, is defined according to k explanatory factors, x_k as.

$$v = \alpha + \sum_k \beta_k x_k + \varepsilon, \qquad (2)$$

where α and β are parameters, and ε is the error term. The concentration index for child vaccination status can be decomposed as:

$$C = \sum_k \left(\frac{\beta_k \bar{x}_k}{\mu}\right) C_k + \frac{GC_\varepsilon}{\mu}, \qquad (3)$$

where μ is the mean of y, $\bar{x}_k$ is the mean of x_k, C_k is the concentration index for x_k, (defined analogously to C), and GC_ε is the generalised concentration index for the error term (ε). Equation 3 shows that C is equal to a weighted sum of the concentration indices of the k regressors, where the weight for x_k is the elasticity of y with respect to $x_k (\eta_k = \beta_k \frac{\bar{x}_k}{\mu})$. The residual component—captured by the last term $(\frac{GC_\varepsilon}{\mu})$ reflects the wealth-related inequality in health that is not

explained by systematic variation in the regressors. We used the bootstrap method with 1000 replications to estimate standard errors. All analysis were performed after adjusting for sampling design (stratification and clustering) and sampling weights. STATA (version 14, StataCorp, College Station, Tex) and SPSS (version 26) software packages were used to perform data analysis.

8..3.4 Patient and public involvement

Patients/public were not involved in the design or implementation of this study.

8.4 Results

The sample used for the current analysis was limited to children aged 12–23 months at the time of the survey, yielding a final sample of 1930 mother-child pairs in 2011, and 2004 mother-child pairs in 2016. The majority (85.8% and 88.4%) of respondents were from rural areas in 2011 and 2016 surveys respectively, and more than 42% were from Oromia, which is the biggest region in the country. The percentage of mothers who had no education decreased from 68% in 2011 to 64% in 2016 while antenatal care contacts increased from 42% in 2011 to 60% in 2016 (Table 8-2).

8.4.1 Trends of vaccination coverage

Vaccination coverage showed improvements from 2011 to 2016; BCG vaccine uptake increased from 66% to 69%, DTP3 vaccine from 37% to 57%, OPV3 vaccine from 45% to 57%, and basic vaccination coverage from 24% in 2011 to 38% in 2016. The proportion of children who received all basic vaccinations that include BCG, DPT3, OPV3, and measles increased by 14% from 2011 to 2016. However, measles vaccine coverage decreased from 56% in 2011 to 54% in 2016, while the

proportion of children who received no vaccination increased from 14% in 2011 to 16% in 2016 (Figure 8-1).

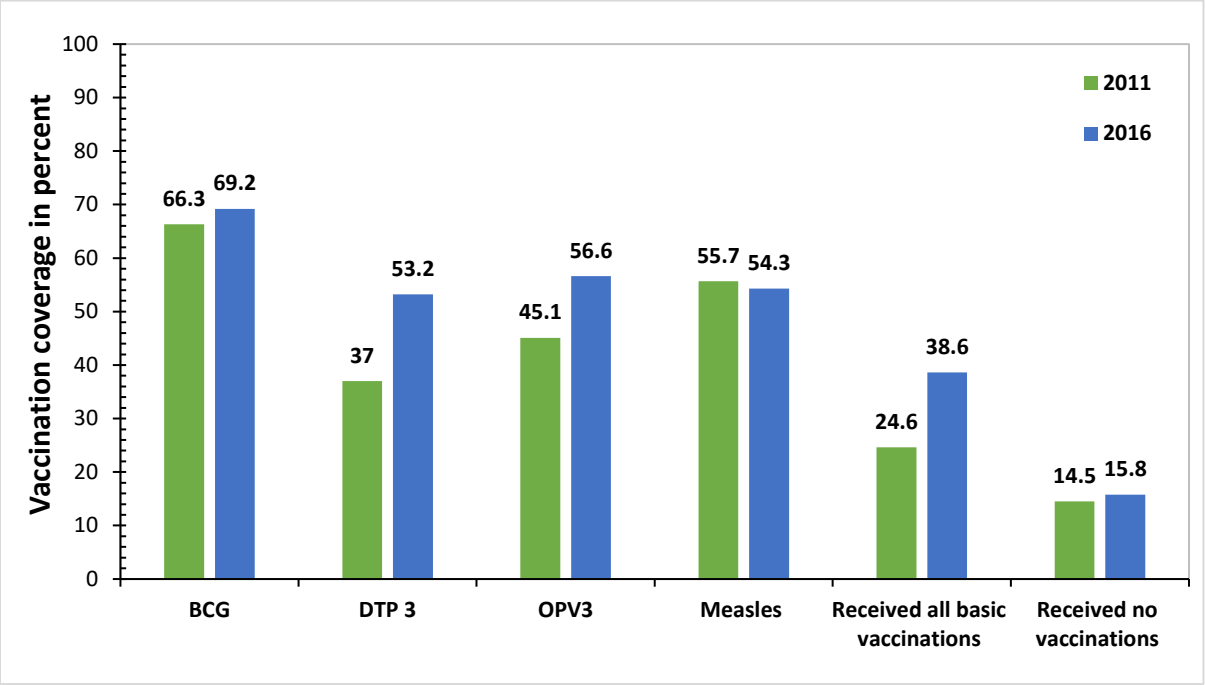

Figure 8-1 Vaccination coverage among children aged 12-23 months in Ethiopia (DHS 2011, 2016).

The urban/rural differential in basic vaccination coverage increased from almost 28% in 2011 to more than 29% in 2016 (Table 8-2). Coverage remained low but showed slight increases from 2011 to 2016 in regions such as Afar (8.5% to 15.2%), Somali (17.1% to 21.8%), and Oromia (15.6% to 24.7%). Basic vaccination coverage also showed disparities between and within the regions of Ethiopia (Table 8-2). For example, in 2016, coverage was 89.2% (95% CI: 82.0%, 93.8%) and 67.3% (95% CI: 57.6%, 75.7%) among children living in Addis Ababa and Tigray regions respectively, whereas in Afar it was 15.2% (95% CI: 8.0%, 26.9%), and Somali 21.8% (95% CI: 13.8%, 32.7%).

Table 8-2 Basic vaccination coverage by maternal and child characteristics in Ethiopia (DHS 2011 – 2016)

	2011				2016			
Study variables	**Number**	**Percent**	**Received all basic immunisation (95% CI)**	**P-value**	**Number**	**Percent**	**Received all basic immunisation (95% CI)**	**P-value**
Sex of child				**0.268**				**0.252**
Male	1010	52.3	23.1 (19.3, 27.5)		926	46.2	36.5 (31.2, 42.1)	
Female	920	47.7	26.1 (22.0, 30.7)		1078	53.8	40.5 (35.4, 45.8)	
Parity				**0.101**				**0.002**
1	358	18.6	30.1 (23.3, 37.9)		372	18.6	45.3 (37.7, 53.1)	
2	318	16.5	26.7 (20.7, 33.7)		322	16.0	47.1 (39.0, 55.3)	
3	306	15.9	22.8 (17.1, 29.8)		282	14.1	40.4 (31.9, 49.5)	
4	230	11.9	24.4 (18.1, 32.0)		243	12.1	39.5 (31.4, 48.2)	
5	220	11.4	15.3 (9.9, 22.8)		216	10.8	30.1 (21.5, 40.3)	
6	497	25.7	23.8 (17.5, 31.6)		569	28.4	28.7 (22.3, 36.2)	
Maternal age				**0.992**				**0.197**
15-24	518	26.8	24.6 (19.6, 30.4)		499	24.9	37.9 (31.6, 44.7)	
25-29	649	33.6	23.8 (19.3, 29.1)		596	29.7	44.1 (37.1, 51.4)	
30-34	386	20.0	24.7 (19.0, 31.5)		456	22.7	35.1 (28.7, 42.1)	
35-39	251	13.0	26.0 (18.9, 34.5)		295	14.7	33.5 (25.7, 42.4)	
40-49	127	6.6	24.8 (16.0, 36.2)		158	7.9	39.9 (29.3, 51.5)	
Contraceptive use				**<0.001**				**<0.001**
Never used	1106	57.3	17.9 (14.5, 21.8)		932	46.5	25.8 (21.3, 30.8)	
Using or used before	824	42.7	33.5 (28.8, 38.5)		1072	53.5	49.8 (44.3, 55.4)	
Antenatal care contact				**<0.001**				**<0.001**
No	1040	53.9	14.8 (11.6, 18.6)		711	35.5	18.6 (13.8, 24.4)	
Yes	815	42.2	37.3 (32.7, 42.1)		1194	59.6	50.8 (45.7, 55.8)	
Place child was delivered				**<0.001**				**<0.001**
Home	1694	87.8	20.6 (17.5, 24.1)		1309	65.3	30.6 (25.9, 35.6)	
Health facility	236	12.2	52.7 (43.3, 62.0)		695	34.7	53.8 (47.6, 60.0)	
Maternal educational levels				**<0.001**				**<0.001**

No education	1307	67.7	20.4 (16.9, 24.5)		1257	62.7	30.9 (26.6, 35.6)	
Primary	522	27.0	28.5 (23.6, 33.9		577	28.8	46.1 (39.8, 52.5)	
Secondary or higher	102	5.3	57.3 (44.7, 69.0)		170	8.5	70.5 (55.9, 81.8)	
Household wealth index in quintiles				**<0.001**				**<0.001**
Poorest	441	22.9	16.8 (12.0, 23.0)		504	25.2	22.2 (16.1, 29.8)	
Poorer	419	21.7	18.7 (13.9, 24.7)		396	19.8	38.1 (30.7, 46.1)	
Middle	394	20.4	18.7 (13.8, 24.7)		450	22.4	37.1 (30.1, 44.7)	
Richer	369	19.1	25.1 (18.7, 32.7)		366	18.3	44.6 (36.4, 53.0)	
Richest	307	15.9	50.7 (41.5, 59.8)		288	14.4	63.0 (52.0, 72.8)	
Place of residence				**<0.001**				**<0.001**
Urban	274	14.2	48.2 (38.8, 57.8)		232	11.6	64.6 (51.1, 76.2)	
Rural	1656	85.8	20.6 (17.4, 24.3)		1772	88.4	35.2 (31.1, 39.6)	
Regions				**<0.001**				**<0.001**
Tigray	129	6.7	59.3 (50.7, 67.5)		152	7.6	67.3 (57.6, 75.7)	
Afar	18	0.9	8.6 (4.9, 14.6)		20	1.0	15.2 (8.0, 26.9)	
Amhara	446	23.1	27.1 (20.0, 35.6)		364	18.2	46.4 (36.7, 56.4)	
Oromia	811	42.0	15.6 (11.1, 21.3)		881	44.0	24.7 (18.9, 31.6)	
Somali	51	2.6	17.1 (10.2, 27.2)		76	3.8	21.8 (13.8, 32.7)	
Benishangul-Gumuz	23	1.2	24.2 (16.8, 33.5)		21	1.0	57.4 (47.1, 67.2)	
Southern Nations, Nationalities and Peoples	391	20.2	24.1 (18.0, 31.4)		419	20.9	46.9 (38.5, 55.5)	
Gambela	8	0.4	17.4 (8.7, 31.8)		5	0.3	41.1 (30.3, 52.9)	
Harari	5	0.3	36.1 (27.3, 46.0)		5	0.2	42.2 (31.1, 54.0)	
Addis Ababa	43	2.2	78.7 (69.1, 85.9)		52	2.6	89.2 (82.0, 93.8)	
Dire Dawa	7	0.4	59.4 (49.3, 68.8)		9	0.5	75.9 (64.2, 84.6)	

8.4.2 Inequalities in vaccination coverage

Inequalities in child vaccination persisted during 2011 and 2016: basic vaccination status was favourably concentrated among children from wealthier households while the distribution of those who received no vaccination remained disproportionately concentrated among poor (Figure 8-2). The uptake of BCG, DTP3, OPV3, measles, and basic vaccination were disproportionately concentrated among children from wealthy households during 2011 and 2016 (Figure 8-3). DTP3 and basic vaccination status had lower coverage and showed the highest inequalities during 2011 and 2016; for example, in 2016, DPT3 had concentration index of (CCI= 0.175) and basic vaccination (CCI= 0.172). The estimate for the distribution of children who received no vaccination in 2011 was (CCI= -0.092), this increased to (CCI= -0.184) in 2016 (Figure 8-3). The negative values for children who received no vaccination confirms pro-poor distributions. Increased vaccination coverage decreased inequalities as vaccinations such as BCG, OPV3, and measles that had higher coverage showed lower inequalities (Figure 8-3).

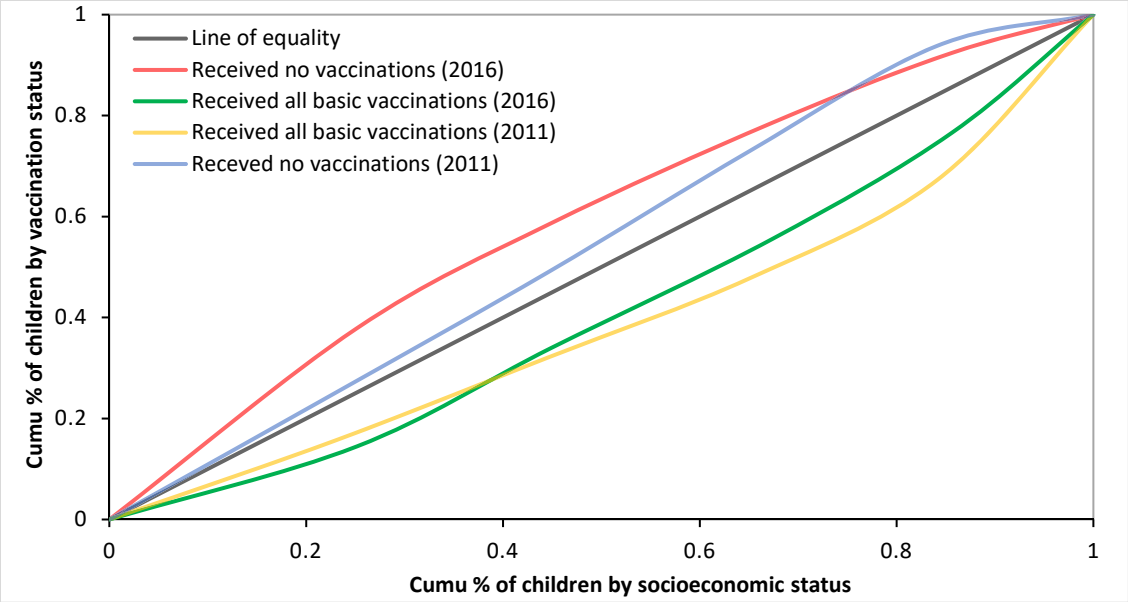

Figure 8-2 Concentration curves for child vaccination status, Ethiopia (DHS 2011, 2016)

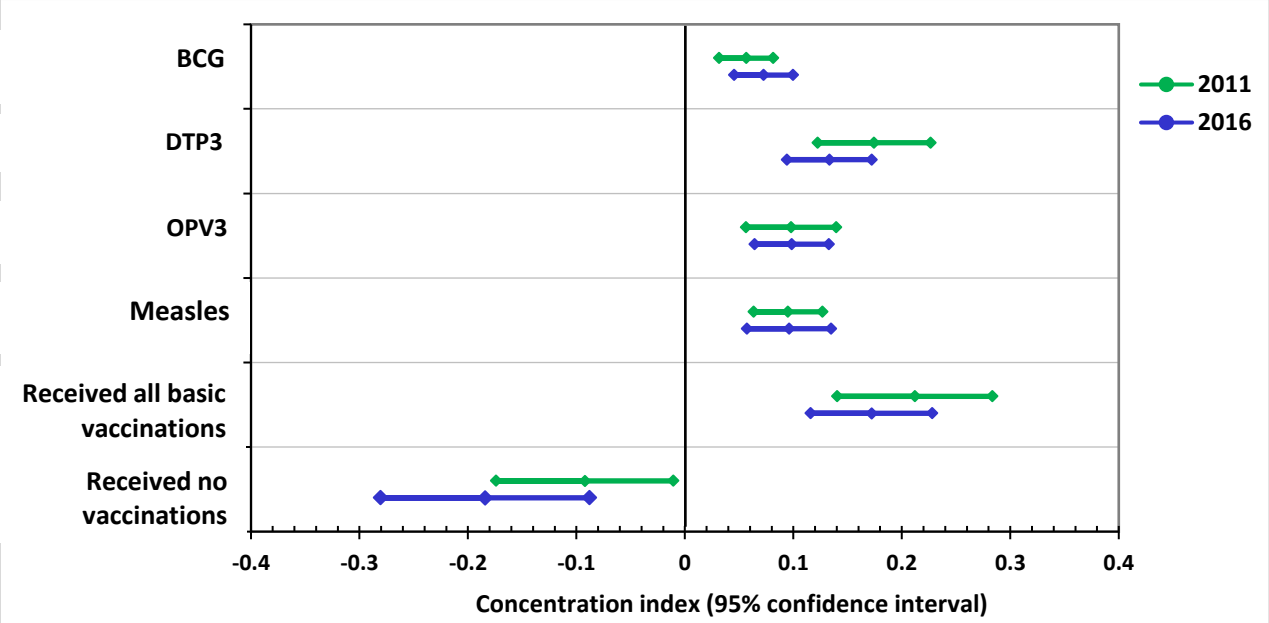

Figure 8-3 Concentration indecies that shows socioeconomic inequalities in child vaccinations, Ethiopia (DHS 2011, 2016)

The decomposition results in (Table 8-3) and (Figure 8-4) show that the significant contributors to socioeconomic inequality in basic vaccination status included, wealth, maternal education, contraceptive use, antenatal care contacts, exposure to media that include radio and television, and place of residence (rural).

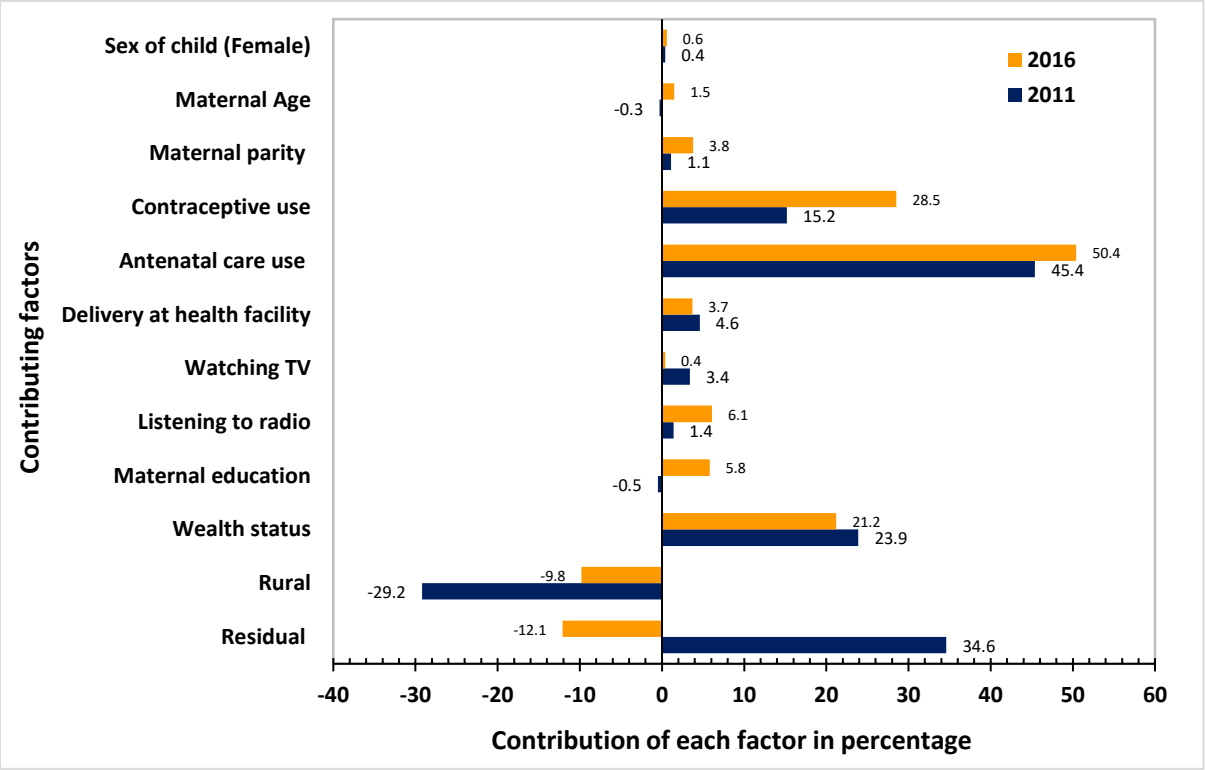

Figure 8-4 Percentage contributions of factors explaining socioeconomic inequalities in full vaccination coverage, Ethiopia (DHS 2011, 2016)

The decomposition analysis showed similar patterns in factors that explain socioeconomic inequalities in child vaccination status on both surveys. The use of maternal health services had the highest significant contributions to socioeconomic inequalities in child vaccination. Antenatal care contacts had 45.4% contribution in 2011 and 50.4% in 2016. Wealth status is the other

significant contributor, 23.9% in 2011 and 21.2% in 2016. On the other hand, rural residence had a negative contribution to socioeconomic inequalities in child vaccination on both surveys.

The overall concentration index for basic child vaccination was positive. Any significant positive contributor in (Table 8-3) and (Figure 8-4) means that socioeconomic inequality in basic vaccination would have been less pro-rich if: (i) the contributing variables (e.g. antenatal care contacts or wealth) were to be evenly distributed among the rich and poor. Negative contributing variables (e.g. rural residence) would cause the opposite effect. The residual or unexplained contributing factors to socioeconomic inequalities in basic vaccination account for 34.5% in 2011 and -12% in 2016.

Table 8-3 Decomposition of socioeconomic inequalities in basic vaccination coverage in Ethiopia, (DHS 2011, 2016)

Study variables	2011				2016			
	Marginal effect	Concentration index	Absolute contribution	Percentage contribution	Marginal effect	Concentration index	Absolute contribution	Percentage contribution
Sex of child								
Male	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)
Female	0.022	0.035	0.001	0.4	0.043	0.034	0.001	0.6
Maternal age								
15-24	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)
25-29	0.052*	0.049	0.003	1.2	0.562	0.073	0.006	2.2
30-34	0.072*	-0.006	0.000	-0.2	0.058	-0.030	-0.002	-0.7
35-39	0.060*	-0.052	-0.003	-1.5	0.052	0.006	0.000	0.1
40-49	0.023	0.019	0.000	0.2	0.057*	-0.009	-0.001	-0.2
Maternal parity								
1	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)
2	-0.004	-0.042	0.000	0.1	0.037	0.066	0.002	0.9
3	-0.033	0.020	-0.001	-0.3	0.014	-0.009	0.000	0.0
4	-0.021	-0.015	0.000	0.1	0.016	-0.034	-0.001	-0.2
5	-0.068	-0.012	0.001	0.4	-0.030	0.008	0.000	-0.1
6	-0.034	-0.048	0.002	0.8	-0.070	-0.123	0.009	3.2
Pattern of contraceptive use								
Never	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)
Using or used before	0.091**	0.348	0.032	15.2	0.235***	0.322	0.076	28.5
Antenatal care contact								
No	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)
Yes	0.242***	0.390	0.094	45.4	0.566***	0.237	0.134	50.4
Place child was delivered								
Home	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)
Health facility	0.030*	0.323	0.010	4.6	0.027*	0.371	0.010	3.7
Frequency of listening to radio								

Not at all	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)
Less than once a week	-0.031	0.104	-0.003	-1.6	0.049	0.127	0.006	2.3
At least once a week	0.026*	0.232	0.006	2.9	0.045	0.219	0.010	3.7
Frequency of watching television								
Not at all	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)
Less than once a week	-0.035	0.066	-0.002	-1.1	-0.008	0.120	-0.001	-0.3
At least once a week	0.042	0.223	0.009	4.5	0.007	0.286	0.002	0.7
Education levels								
No education	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)
Primary	-0.005	0.182	-0.001	-0.4	0.070**	0.127	0.009	3.3
Secondary or higher	-0.001	0.152	0.000	0.0	0.028**	0.235	0.007	2.5
Place of residence								
Urban	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)
Rural	0.143	-0.426	-0.061	-29.2	0.080	-0.323	-0.026	-9.8
Household wealth index in quintiles								
Poorest	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)	(Base)
Poorer	0.005	-0.283	-0.001	-0.7	0.094**	-0.236	-0.022	-8.3
Middle	-0.015*	0.078	-0.001	-0.6	0.061**	0.110	0.007	2.5
Richer	0.032**	0.375	0.012	5.8	0.070**	0.387	0.027	10.2
Richest	0.076***	0.535	0.040	19.4	0.091**	0.492	0.045	16.8
Residual				34.6				-12.1
Total				65.4				112.1

* indicates <p 0.05; ** indicates p < 0.01; *** indicates p < 0.001

8.5 Discussion

This study examined inequalities in vaccination coverage among children aged 12-23 months in Ethiopia. The uptake of all basic vaccinations increased from 24.6% in 2011 to 38.6% in 2016. Coverage improvements from 2011 to 2016 were observed in BCG vaccine uptake by 3%, DTP3 by 16.2%, OPV3 by 11.5%, and all basic vaccinations by 14%. While there were improvements in vaccination coverage from 2011 to 2016, issues that need to be address include a lack of awareness about vaccination, facilities' limited operating hours, maternal time constraints, and the distance to facilities (291, 292).

Ethiopia remains one of the top ten high priority countries in the world where children remain unvaccinated (171). In the current study, more than 15% of children received none of the vaccines, while incomplete vaccinations were 62% in 2011 and 46% in 2016. Possible explanations for under vaccination or no vaccination may include vaccine hesitancy or refusal, lack of access to vaccination services, or missed opportunities (262). Vaccine hesitancy refers to concerns about real or perceived vaccine adverse events among parents that may lead to delayed vaccination schedules or refusal of vaccinations altogether (177). Missed opportunities present another explanation in which children may not receive one or all of recommended vaccines even if they are vaccine-eligible and can attend health facilities, which is commonly refers to missed opportunities (177, 262).

The uptake of BCG, DTP3, OPV3, measles, and receipt of all basic vaccinations were disproportionately concentrated among children from wealthier households. This finding is consistent with multi country studies across low-middle income countries (174, 293). However, a study across three countries (282) that include Gambia, Kyrgyz Republic, and Namibia showed that receipt of all basic vaccinations was disproportionately concentrated

among children from poor households. The coverage of DPT3 and basic vaccination showed the highest inequalities favouring children from wealthy households. More than 14% of children received none of the vaccines during 2011 and 2016. These children were mainly from disadvantaged households; for example, children who remained unvaccinated in 2016 were 8.3% among the richest quantile, while 24% were from the poorest quantile. Basic vaccination coverage also showed significant variations across regions of the country; this ranged from 15% in Afar, and 21% in Somali, to 67.3% in Tigray, and 89.2% in Addis Ababa. Afar and Somali regions are predominantly nomadic pastoralist areas, with relatively weaker health systems compared to Tigray, and Addis Ababa that have improved healthcare coverage (230).

Ensuring access to all recommended vaccines for all children, regardless of sociodemographic or socioeconomic status, saves more lives and facilitates progress towards achieving sustainable development goals (SDGs) (13). SDG target for child mortality aims to reduce neonatal mortality to lower than 12 deaths per 1,000 live births and under-5 mortality to lower than 25 deaths per 1,000 live births across all countries (13). In 2016, the infant mortality rate was 48 deaths per 1,000 live births, and the under-5 mortality rate was 67 deaths per 1,000 live births in Ethiopia (288).

Findings of the current study revealed that the use of maternal health services, maternal education, exposure to media, and wealth had positive contributions to basic vaccination uptake. These findings align with other similar studies (279, 283, 294). Maternal knowledge about vaccinations is a determinant for vaccination status, which may be associated with increased knowledge about benefits of child vaccination because of counselling during family planning, and antenatal care contacts (23, 201, 260). Moreover, based on findings related to

the impact of residence and access to health facilities on vaccination, it may be that a mother with regular access to family planning and antenatal care is also more likely to seek out postnatal care where vaccination of her child can be more readily provided (145).

In the present study, maternal education had contributions to vaccine uptake in 2016, but this was not the case in 2011. Education helps to create improved awareness and knowledge about childhood vaccination (260). Previous studies have also indicated that educated women are more likely to take their child for vaccination (260, 281). Exposure to media can also be a useful tool to reach population at different socioeconomic levels. The findings of this study showed that access to mass media (radio and TV) favourably influences vaccine uptake. Transmitting information about the importance of childhood vaccination is vital to reach not only mothers but also their partners and community leaders (209). Information dissemination that targets mother's partner and community leaders can help to create a conducive environment that can favourably influence mothers to vaccinate their children.

In the present study, the socioeconomic well-being of mothers was associated with higher vaccination uptake. While vaccinations are provided free of charge in many developing countries, mothers sometimes incur indirect costs, for example, transportation costs, which often limit their uptake of these services (22). Mothers at the lower wealth categories are more likely to experience challenges in accessing healthcare facilities as such less likely to take their child for vaccination (279).

Children from rural areas had lower vaccination coverage compared to children from urban areas. In 2011, basic vaccination coverage was 48.2% in urban areas while it was 20.6% in rural areas. This pattern continued in 2016, as 64.6% of children from urban areas had basic vaccination, but only 35.2% in rural areas. This finding is consistent with those of similar

studies (279, 295). This could partly be explained by challenges faced in rural areas due to less developed health infrastructure and fewer skilled providers (242). In rural areas, long-distance to health facilities is another reason for low basic vaccination coverage. People live far away from health facilities and the long-distance, and lack of transportation poses a critical challenge for mothers to take their child for vaccination (242).Vaccines require cold chain management as it is sensitive to high temperatures (296). Health facilities in rural areas face a shortage of electric power supply to keep the cold chain equipment working, which could lead to cancellation of services as lack of cold chain equipment may result in the stock-out of vaccines (283). One study from Nigeria found that 47% of solar fridges for vaccine storage in eight states were broken (297).

The strengths of this study include the use of a nationally representative survey from the two most recent DHS surveys. The decomposition of the contributing factors that drive socioeconomic inequalities in vaccination status provided a rich set of analysis for policy interventions to address socioeconomic disparities in access to basic vaccinations in Ethiopia. Limitations of the current study may include recall bias related to vaccination status as not all children had vaccination cards, and measures had to depend on the mother's verbal report. The DHS is a cross-sectional survey; it was not possible to establish temporality between childhood vaccination and explanatory factors.

Conclusions

The coverage of basic vaccination improved by 14 % from 2011 to 2016, but the overall coverage remained low. Increased vaccine coverage was disproportionately concentrated among children from wealthy households, while the majority of children who had no

vaccination were from disadvantaged households. Utilisation of reproductive and maternal health services, household income status, and maternal education had significant positive contributions to improved vaccination status. Therefore, continued efforts at improving coverage of family planning, antenatal care contacts, institutional delivery, maternal education, and socioeconomic well-being are required to improve vaccination status. Moreover, regions such as Afar, Somali, and Oromia, and rural areas of the country at large require targeting.

8.6 Chapter summary

In this chapter, we reported inequalities in child vaccination coverage in Ethiopia using two waves (2011 & 2016) of Demographic and Health Survey Data. The findings showed disproportionate zero-dose vaccination coverage among disadvantaged subgroups and full vaccination pro-rich coverage.

So far, we reported inequalities in access to quality antenatal care in chapter four; in chapter five, we examined spatial patterns and inequalities in skilled birth attendance and caesarean delivery, and then we looked at inequalities in the continuum of care for maternal health services (chapter six). In chapter seven, we reported inequalities in child vaccination coverage at the region level (sub-Saharan Africa) and a country level (Ethiopia) in chapter eight.

In the next chapter, we present the overall findings and implications by interpreting and discussing common findings across all papers. We also explore implications for health policy and practice and recommendations for future research.

Chapter Nine: Discussion and conclusions

Ending preventable maternal and child mortality requires careful examination of inequalities and drivers of inequality in access to health services. Until recently, global development goals and agendas have lacked a systematic focus to identify and address inequalities in healthcare quality (58). Emphasis has been placed on improving the overall national coverage, with minimal attention devoted to narrowing the existing gaps between population subgroups (45). The MDGs, adopted in the year 2000, called for improvements in national averages but did not address the need for efforts to ensure equity in quality of care (24). Without monitoring inequality, it remains unknown whether countries have narrowed or widened the gap between the advantaged and the disadvantaged. This chapter provides a comprehensive discussion and conclusions on the overall research aim, which was to generate evidence regarding inequalities and drivers of inequality in access to quality MCH services and its implications for the health systems of LMICs.

9.1 Magnitude and drivers of inequality in maternal and child health services

Significant disparities in MCH services have been found. Coverage of health services was lower among the poor and marginalised population subgroups. Findings showed a very high wealth-related inequality between the poorest and richest quintiles across 25 sub-Saharan African countries. For example, the average differences for the pooled data were 28.4 percentage points in having four or more ANC contacts between the poorest (44.3%) quintile and the richest (72.7%) quintile. These differences increased to 46.2 percentage points for skilled birth attendance, with coverage of 44.4% among the poorest quintile and 90.6% among the richest quintile. The gap was much lower for full vaccination coverage, with a difference of only 16 percentage points, with a coverage of 50% in the poorest quintile and 66% in the richest quintile. These findings showed that irrespective of how poor a country is,

those in the richest quintile had the means and mostly managed to have higher coverage of MCH services. However, coverage showed substantial variability based on socioeconomic levels, with individuals in the poorest quintile receiving lower coverage of services.

Education is a critical determinant of health equity (2). This study revealed notable variations in MCH services among women without education and those with secondary or higher education levels. The highest coverage gap was in having skilled birth attendance, which exceeded 39 percentage points among women without education (47.4%) and those with secondary or above education (87%). The highest urban/rural differentials were also observed for skilled attendance at birth (25 percentage points); this was 83.7% among urban residents and 58.7% in rural.

Inequalities can differ depending on various social determinants. As previously stated, certain inequalities may go unnoticed if a particular vulnerability factor and health indicator are used, but they become more evident when other measures are employed. Therefore, failing to consider critical determinants of equity could result in overlooking and neglecting crucial groups that continually miss out on healthcare services.

This thesis highlighted the prevailing inequalities in quality antenatal care, skilled birth attendance, postnatal care and childhood vaccination, along with the factors such as wealth, education, access to media, place of residence and other maternal factors such as age and parity. Although these results cannot establish causality, they provide helpful clue and point to the importance of addressing crucial social determinants of health in formulating maternal and child health policies. To achieve high and equitable levels of coverage, national MCH programs should address geographic barriers, social exclusion, and financial protection for health. Strengthening health systems in remote areas and adapting health services to the needs of marginalised groups should be a priority.

9.2 Patterns of inequality across countries

Inequalities differed across health indicators across and within countries. The largest gaps in coverage were between the richest and poorest, the most and least educated, and urban and rural areas. Within some countries the proportion of births attended by skilled health personnel differed by up to 71 percentage points between the richest and poorest quintiles; this difference was 40 percentage points or higher in half of the study countries. Antenatal care coverage (at least four visits) differed by at least 30 percentage points between both the most and least educated and the richest and poorest in 13 out of 25 study countries. The difference in vaccination coverage exceeded 25 percentage points in countries such as Nigeria, Angola, Ethiopia, Cameroon and the Democratic Republic of Congo.

Overall, countries such as Nigeria, Ethiopia, Chad, Guinea, Angola, and the Democratic Republic of Congo reported lower coverage and higher inequalities across all MCH service indicators. These countries are also known for their weak health care delivery systems (298). The performance of those countries in terms of access and quality of care was among the worst globally in 2018. In a study that measured performance of health systems based on access and quality of care, those countries were ranked among the worst; Nigeria (142nd), Angola (162nd), Democratic Republic of Congo (181st), Ethiopia (184th), Guinea (190th), and Chad (192nd), out of 195 countries (298). Moreover, a report by the World Bank shows that those countries also recorded a lower universal health coverage index. This index measures coverage of essential health services using 14 tracer indicators on a unitless scale of 0 to 100. These tracer indicators include reproductive, maternal, newborn and child health, infectious diseases, non-communicable diseases and service capacity and access among the general and the most disadvantaged populations. Most sub-Saharan African countries had less than 45 universal coverage index: Nigeria (42nd), Angola (39th), Ethiopia (38th), Democratic Republic of

Congo (39th), Guinea (37th), and Chad (28th), which indicates the severe shortage of essential healthcare services in those countries (299). Countries such as South Africa, Rwanda, and Kenya consistently reported higher coverage and lower within-country inequalities in access to quality MCH service indicators. South Africa has one of the strongest economies in Africa, which could explain the high rates of MCH service coverage. The universal health coverage index for South Africa was the highest among sub-Saharan African countries (67 out of 100), which indicates improved access to essential healthcare services (299).

9.3 The need to improve equity in access to quality maternal and child health services

Reducing maternal and child mortality is a persistent challenge that requires more commitment from health systems and related development sectors. This study provides evidence of the need for improving equity in access to quality MCH services in sub-Saharan Africa. In the subsequent paragraphs, summaries of the main findings in this thesis and the urgent need to improve equity in quality of care are provided.

Chapter four identified the large gap between contact and content in antenatal care coverage. More than 90% of women made their first contact with the health care system, but only slightly more than half of these women had four or more antenatal care contacts. Moreover, only one in four women reported having important antenatal care services that include blood sample tests, urine sample tests, blood pressure measures, tetanus protection at a birth, iron supplement, and drug for intestinal parasites. Ensuring access to quality antenatal care sets the foundation for continuity of maternity care by promoting and encouraging women to return for birth at the facility, receive postnatal care, and get their children vaccinated.

Another important component for reducing the high rates of maternal and infant mortality is to ensure that women deliver at facilities with the help of skilled birth attendants, who have the necessary skills and supplies to perform life-saving procedures (11). We investigated spatial patterns and inequalities in skilled birth attendance and caesarean delivery in ***Chapter five***. Although global efforts to improve women's access to facilities for childbirth increased the proportion of deliveries attended by skilled birth attendants in LMICs, home deliveries were still high in many sub-Saharan African countries (14, 300). This study found that the percentage of home deliveries varied greatly across different countries, with an average of 36.1%. South Africa had the lowest rate at 3.3%, while Chad had the highest rate at 75.7%. To improve the rates of skilled birth attendance, both the supply and demand side factors need to be addressed. This involves making facilities and providers more accessible to all women (11, 301).

As discussed in ***Chapter five***, women often face substantial socio-cultural, economic, geographical and infrastructural obstacles to accessing health services. Addressing these issues removes significant challenges women face to decide seeking care and reach health facilities (65, 213, 215, 229). Once at a facility, women may experience delays and poor quality of care, often manifested by disrespect and abuse during childbirth (11, 222). Hence, there is a need to improve the quality of care to ensure the safety of mother and newborn while promoting an improved childbirth experience for women.

In order to reduce the high rates of maternal and child mortality, women and children need to have access to effective evidence-based health interventions that are customised to the needs of specific communities to ensure acceptability (139, 240, 302). There must be access to the continuum of care for maternal, neonatal, and child health services for all women and

children across all countries to ensure equity in health outcomes (25, 141). ***Chapter six*** examined inequalities across the continuum of care for maternal health services. The continuum of care ensures access to care from two dimensions (23, 145, 153). First is the time of care; this means care has to be provided throughout the life cycle as a continuum, from pre-pregnancy to delivery, immediate postnatal period, and childhood (9, 20, 21). Second, the place and approach of care – refers to care provided in a seamless continuum that involves the home, the community, the health centre, and the hospital (9, 20, 21).

All pregnant women are recommended to initiate contact with the health system within the first trimester and are expected and encouraged to receive all the necessary services to ensure their own and their baby's wellbeing (21, 134, 303). However, we found large dropouts across the continuum of care in all study countries. Inconsistent use of maternal health services could be, in part, associated with the failure of the health systems to provide quality maternal health services (9, 304). Efforts to address these gaps underline the need for effective integration of MCH services to eliminate preventable deaths. Women also have their own challenges, including economic, socio-cultural, and geographic, when it comes to accessing services, as demonstrated in our study. Therefore, continued efforts are needed to bring care closer to women.

Vaccination is recognised as one of the most effective public health interventions credited for the reduction and/or elimination of some of the most dangerous diseases (e.g., smallpox and polio) (241, 242, 246, 305). However, the uptake of vaccines is not as high as it should be. In Chapter seven we investigated inequalities in zero-dose, incomplete and full vaccination coverage in sub-Saharan Africa. Full vaccination coverage was 57.1% across 25 sub-Saharan African countries, ranging from 24% in Guinea to 93% in Rwanda. We also examined

differences in patterns of inequality comparing regional (sub-Saharan Africa) and at a specific country level. To address this, we analysed inequalities in vaccination coverage in Ethiopia as an example (chapter eight).

Across sub-Saharan Africa and in the case of Ethiopia, our findings in Chapters seven and eight, showed that zero-dose vaccination was disproportionately concentrated among poor subgroups, while full vaccination coverage showed pro-rich coverage. Zero-dose and under-vaccination can be explained by lack of access to vaccination services, missed opportunities for vaccination or vaccine hesitancy (172, 262). The role of health systems in closing these gaps would be to ensure adequate vaccine supply and providing targeted health information and education on the benefits and safety of vaccines (173, 177, 247). In sub-Saharan Africa, and in the case of Ethiopia, increased vaccine uptake was strongly associated with women's education and wealth status and use of reproductive and maternal health services. The country-level analysis showed that inequalities in vaccination coverage were mainly explained by women's access to and utilisation of contraceptives, antenatal care, and birth at the facility.

In summary, in addition to socioeconomic factors such as education and wealth, long distances to facilities, weak referral systems, and poor communication between the community and health facilities play a significant role in limiting health service uptake among those in need (139, 214). Moreover, health systems sometimes only focus on improving access to health service interventions while neglecting women and community involvement in care (9, 55). However, the engaging the community plays a crucial role for promoting healthy home behaviours and enhance demand for care while the facility is necessary to provide services.

9.4 Policy implications

Addressing health inequities requires committed efforts within the health sector, which include ensuring high-quality health services are available, acceptable and accessible to all (21, 23). This also includes, for instance, making sure that high-quality, gender-sensitive, and culturally appropriate reproductive health services are available to all women, with particular attention to vulnerable subgroups (306). Advancing equity in health necessitates collaboration with non-health sectors (inter-sectoral action) to improve the circumstances in which people are born and where they grow, live and work – including economic, political, environmental, cultural and commercial determinants of health (60, 298, 307).

Health inequities transcend the health sector and need a coordinated multisectoral approach (308). Thus, it is important to remember that redressing inequities in health is not only the sole responsibility of the health sector but also the effort of other sectors included (35). For example, some inequities in health may need improvements in household income or increasing levels of literacy and education. The results of inequality monitoring, our findings included, can be used as an input (with other forms of knowledge and evidence) to determine where efforts are needed to enhance improvements for disadvantaged subgroups.

Based on these findings and on best practices for monitoring health inequalities, we suggest the following recommendations for monitoring equity in access to quality MCH services.

9.4.1 Ensuring equity requires monitoring inequalities

Periodic assessment of health inequality can serve as a warning system and an assessment tool to identify and address those in need. Monitoring MCH inequality is critical to inform, plan and implement strategies that advance equity, improve underserved populations' health, and enhance accountability for these changes (36). In other words, health inequality

monitoring shows where and what gaps affect population subgroups, helping program managers and policy-makers ensure interventions are targeted to those with the greatest needs. The findings of inequality monitoring also show entry points to examine gaps. These examinations enable health systems to identify and tailor interventions addressing specific areas of concern within maternal and child health programs or specific causes of inequality within the affected populations. Regular investigations of inequalities can also suggest where policies and programs succussed or failed in reducing health inequity.

Although the current national coverage and progress over time showed encouraging indications of improvement globally, within countries, reports of inequalities, our findings included, reveal the different experiences between rural and urban residents, the poor and the rich, the educated and the non-educated and other dimensions of inequality. Monitoring health inequality is crucial to identify whether progress in national averages is fairly distributed across population subgroups and address those in need. Establishing goals and targets based on inequality monitoring enforces the orientation of policies, programs and practices to promote health in disadvantaged subgroups.

Monitoring health inequality requires robust equity-oriented health information systems. The big gap in many LLMICs, however, is the lack of reliable health information systems to generate evidence and support health systems in identifying and addressing those in need. Creating equity-oriented health systems requires having strong information systems to collect, analyse and report data about health inequality, which underscores the need for strengthening equity-oriented health information systems at the national level to build capacity for health inequality monitoring. Without a commitment to equity, efforts to improve health increase the risk of intensifying within-country inequality, even as national coverage increases.

9.4.2 Equity orientation of policies, programs and practices

Monitoring the state of inequality draws attention to the existing inequality across population subgroups in different areas of health. It identifies priority areas for further investigation by serving as an alarm system both across and within countries. These would help generate equity-oriented policies, programs, and practices to promote improvement efforts among the most disadvantaged subgroups.

Although coverage is still a problem in some, many study countries have achieved improved health intervention coverage and outcomes at the national level. Improvements, though, were mainly brought about by faster gains among the richer subgroups compared to poorer subgroups in the majority of the study countries. In such cases, health policies, programs, and practices need to be re-oriented to reach those in need and uphold the principle of equity and promote faster improvements among the disadvantaged.

9.4.3 Bridging the gap in access to quality maternal health services

Continued efforts are needed to reach disadvantaged women and their newborns with quality health care. We recommend several strategies to address these gaps.

- Implementing measures of effective coverage as a primary strategy to monitor and address the quality gap in antenatal care services. This approach enables countries to close the large gap between the contact and the content of antenatal care services women receive. Effective coverage requires that performance is measured not only by the number of pregnant women the health system is able to reach but also by incorporating the content of care women received during antenatal care contacts.
- Improving access for vulnerable women: our study showed lower coverage of services among women and children living in rural areas and those who had to travel a long

distance to get to facilities. Poorer women and children and those living in slum urban areas also face an acute lack of access to health services. Access to care for vulnerable women can be improved by expanding primary health care facilities, funding for transport infrastructure and targeted subsidies for services.

- Strong focus on quality improvement at all levels of health facilities, focusing on ensuring and achieving respectful, non-abusive, and high-quality maternity care for all women. There is a need to initiate quality improvement efforts in areas with poor access to maternal health and directly consider the needs and experiences of poor and vulnerable populations. Healthcare initiatives should primarily target addressing the needs of the poor and marginalised subgroups.

9.4.4 Addressing vaccine inequity

Our research shows the need for the following actions:

- **Ensuring adequate vaccine supply:** the African continent suffers from a critical shortage of vital drugs, vaccines, and health technologies due to a lack of manufacturing capacity. Africa imports 99% of its vaccines and consumes 25% of the global vaccine supply. Ensuring adequate vaccine supply and guaranteeing the health security of people may not be possible if Africa keeps importing 99% of vaccines (241). Thus, there is a need to create self-sufficiency or at least contribute to addressing critical vaccine supply shortages. Moreover, health systems should address vaccine stocks by securing adequate vaccine doses and ensuring reliable cold chain management.

- Improved training of personnel is necessary to strengthen screening and delivery vaccines to all previously unvaccinated eligible children and improve health worker attitudes towards service users.
- Targeted vaccination programs: vaccination programs should primarily target areas with poor vaccination coverage and directly consider the needs and experiences of poor and vulnerable populations. In addition to education initiatives, areas with critical vaccination coverage gaps can be supported by monetary or material incentives.

9.5 Strengths and limitations

Large and nationally representative population-based surveys collected from many sub-Saharan African countries were used for this analysis. As studies focused on examining inequalities in coverage of health services, not much is known about inequalities in access to the quality of MCH services. We have provided an in-depth analysis of inequalities and drivers of inequality in access to quality MCH services in sub-Saharan Africa. Most multi-country studies in this area have only focused on addressing wealth-related inequalities, but we used two approaches to examine inequality in the uptake of MCH services. First, we evaluated wealth inequalities in antenatal care quality, skilled birth attendance, caesarean delivery, and vaccination coverage within and across sub-Saharan countries. We then used a multilevel logistic regression or decomposition analysis to determine factors driving inequalities in MCH services.

This thesis has several limitations. First, information on women's last live birth was collected retrospectively, and the birth may have been up to five years before the survey. Thus, recall and self-reporting bias are limitations, as women may not accurately remember whether they

received a service and/or the number of ANC contacts, postnatal care or the number and type of vaccine their child received (among children for whom vaccination data were collected based on maternal recall). There may be differences from the current rates for some countries as they may not represent recent maternal and child health coverage when compared to our analysis. Although we were able to examine wealth-related inequality in MCH services for each country, we were unable to identify the predictors of inequality in full vaccination specific to each country except for our fifth manuscript in chapter eight.

The evaluation of socioeconomic position based on asset indices using a household wealth index might be affected by choice of assets and poor comparability between urban and rural areas. However, such indices are easy to compute and compare well with more complex wealth indicators. The usefulness of wealth indices for classifying subpopulations is evident by their strong association with most coverage indicators. However, wealth quintiles are specific to a given country, and the poorest quintile in a middle-income country might be wealthier than the third or fourth quintile in an impoverished country. Furthermore, irrespective of the actual magnitude of within-country differences in wealth between rich and poor individuals, all samples will be represented as five groups with about 20% of all households each. Despite these limitations, the use of asset indices allows the comparison of inequalities in health that would not be possible with other measures of socioeconomic position.

9.6 Recommendations for future research

There is a lack of strong evidence on the status of equity in access to quality health services in LLMICs. Although we were not able to analyse all dimensions of quality of care women and children received due to lack of data, this study provided evidence of inequalities in quality

MCH services. Thus, we recommend further examination of inequalities in access to quality MCH services using richer sources of data.

Rethinking and redesigning the healthcare delivery system to better serve people and vulnerable subgroups requires understanding gaps in health delivery systems and progress made over time. Therefore, we recommend analyses of changes over time to better understand inequalities and drivers of inequality in access to quality health services.

We examined inequalities across multiple sub-Saharan Africa, but in addition to such evidence, countries also require in-depth analysis and actionable information to design intervention strategies and address context specific inequalities in quality MCH services. Thus, we recommend the examination of the status of equity in access to quality MCH services within each of the countries.

9.7 Conclusions

As we move towards achieving the SDGs, it is important to acknowledge that progress in maternal and child health (MCH) has not been sufficient at the national level, and there are still significant disparities in coverage across different groups. In order to accelerate progress towards UHC by 2030, it is also crucial to focus on improving child immunisation coverage. To achieve this, it is important to consider equity when scaling up interventions and assessing progress. Regular assessments of health inequality can help identify and address the needs of vulnerable populations. Efforts to improve access to MCH services should be targeted towards areas with low coverage, while taking into account the unique needs and experiences of different groups. There are also broader societal factors that can impact MCH utilisation rates, such as maternal education levels and household wealth. Addressing these issues could

lead to increased utilisation rates and better health outcomes for mothers and children. By prioritising these efforts, we can work towards achieving the SDGs and ensuring that everyone has access to quality healthcare. This study contributed to this effort by evaluating the magnitude of inequalities in quality antenatal care, skilled birth attendance, caesarean delivery, continuum of care and vaccination coverage, summarising recommendations for inequality monitoring, and identifying drivers of inequality in access to quality maternal health services. By assessing the status of equity in access to quality MCH services using robust inequality measurements, this study added new insights into policy debates in the area of equity in health and health care.

References

1. WHO. Action on the social determinants of health: learning from previous experiences. 2010.
2. WHO. A conceptual framework for action on the social determinants of health. 2010.
3. WHO. The world health report 2008: primary health care now more than ever. 2008.
4. WHO. World Health Report 2010: health systems financing the path to universal coverage: World Health Organization; 2010.
5. UN. The Sustainable Development Goals Report 2016. 2016.
6. Wagstaff A, Flores G, Hsu J, Smitz M-F, Chepynoga K, Buisman LR, et al. Progress on catastrophic health spending in 133 countries: a retrospective observational study. The Lancet Global Health. 2018;6(2):e169-e79.
7. WHO. Standards for improving quality of maternal and newborn care in health facilities. 2016.
8. WHO. World health statistics 2016: monitoring health for the SDGs sustainable development goals: World Health Organization; 2016.
9. WHO. The World health report: 2005: make every mother and child count: World Health Organization; 2005.
10. World Health Organization. WHO recommendations on antenatal care for a positive pregnancy experience: World Health Organization; 2016.
11. WHO. WHO recommendations on intrapartum care for a positive childbirth experience: World Health Organization; 2018.
12. WHO. Trends in maternal mortality 2000 to 2017: estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division. 2019.
13. UN. Transforming our world: the 2030 Agenda for Sustainable Development. Resolution A/RES/70/1. Adopted September, 2015. Geneva: United Nations, 2015. 2015.
14. WHO. Trends in maternal mortality: 1990-2015: estimates from WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division. World Health Organization; 2015.
15. Crear-Perry J, Correa-de-Araujo R, Lewis Johnson T, McLemore MR, Neilson E, Wallace M. Social and structural determinants of health inequities in maternal health. Journal of Women's Health. 2021;30(2):230-5.
16. Hogan DR, Stevens GA, Hosseinpoor AR, Boerma T. Monitoring universal health coverage within the Sustainable Development Goals: development and baseline data for an index of essential health services. The Lancet Global Health. 2018;6(2):e152-e68.
17. Kuruvilla S, Schweitzer J, Bishai D, Chowdhury S, Caramani D, Frost L, et al. Success factors for reducing maternal and child mortality. Bull World Health Organ. 2014;92(7):533-44B.
18. Baciu A, Negussie Y, Geller A, Weinstein JN, National Academies of Sciences E, Medicine. The root causes of health inequity. Communities in action: Pathways to health equity: National Academies Press (US); 2017.
19. Hernandez LM, Blazer DG. The impact of social and cultural environment on health. Genes, behavior, and the social environment: Moving beyond the nature/nurture debate: National Academies Press (US); 2006.
20. Victora CG, Requejo JH, Barros AJ, Berman P, Bhutta Z, Boerma T, et al. Countdown to 2015: a decade of tracking progress for maternal, newborn, and child survival. 2016;387(10032):2049-59.
21. Boerma T, Requejo J, Victora CG, Amouzou A, George A, Agyepong I, et al. Countdown to 2030: tracking progress towards universal coverage for reproductive, maternal, newborn, and child health. The Lancet. 2018;391(10129):1538-48.
22. WHO. State of Inequality: Reproductive Maternal Newborn and Child Health: Interactive Visualization of Health Data: World Health Organization; 2015.

23. Bhutta ZA, Das JK, Bahl R, Lawn JE, Salam RA, Paul VK, et al. Can available interventions end preventable deaths in mothers, newborn babies, and stillbirths, and at what cost? The Lancet. 2014;384(9940):347-70.
24. WHO. Health in 2015: from MDGs, millennium development goals to SDGs, sustainable development goals. 2015.
25. Kruk ME, Gage AD, Arsenault C, Jordan K, Leslie HH, Roder-DeWan S, et al. High-quality health systems in the Sustainable Development Goals era: time for a revolution. The Lancet Global Health. 2018;6(11):e1196-e252.
26. WHO. Tracking universal health coverage: 2017 global monitoring report: World Health Organization; 2017.
27. Savedoff WD, de Ferranti D, Smith AL, Fan V. Political and economic aspects of the transition to universal health coverage. The Lancet. 2012;380(9845):924-32.
28. Commission on Social Determinants of Health. Closing the gap in a generation: health equity through action on the social determinants of health: Commission on Social Determinants of Health final report: World Health Organization; 2008.
29. McCartney G, Popham F, McMaster R, Cumbers A. Defining health and health inequalities. Public health. 2019;172:22-30.
30. Jones NL, Gilman SE, Cheng TL, Drury SS, Hill CV, Geronimus AT. Life course approaches to the causes of health disparities. American journal of public health. 2019;109(S1):S48-S55.
31. Marmot M. Social determinants of health inequalities. The lancet. 2005;365(9464):1099-104.
32. WHO. Closing the gap in a generation: health equity through action on the social determinants of health: World Health Organization; 2008.
33. Marmot M, Wilkinson R. Social determinants of health: Oup Oxford; 2005.
34. WHO. Social determinants of health. WHO Regional Office for South-East Asia; 2008.
35. Braveman P, Gottlieb L. The social determinants of health: it's time to consider the causes of the causes. Public health reports. 2014;129(1_suppl2):19-31.
36. Adler NE, Glymour MM, Fielding J. Addressing social determinants of health and health inequalities. Jama. 2016;316(16):1641-2.
37. Braveman P, Egerter S, Williams DR. The social determinants of health: coming of age. Annual review of public health. 2011;32:381-98.
38. Haigh F, Kemp L, Bazeley P, Haigh N. Developing a critical realist informed framework to explain how the human rights and social determinants of health relationship works. BMC public health. 2019;19(1):1-12.
39. Doorslaer Ev, Koolman X. Explaining the differences in income-related health inequalities across European countries. Health economics. 2004;13(7):609-28.
40. Wilkinson RG, Marmot M. Social determinants of health: the solid facts: World Health Organization; 2003.
41. Low MD, Low BJ, Baumler ER, Huynh PT. Can education policy be health policy? Implications of research on the social determinants of health. Journal of Health Politics, Policy and Law. 2005;30(6):1131-62.
42. Lahelma E, Martikainen P, Laaksonen M, Aittomäki A. Pathways between socioeconomic determinants of health. Journal of Epidemiology & Community Health. 2004;58(4):327-32.
43. WHO. The world health report 2006: working together for health: World Health Organization; 2006.
44. Council C. A Review of Frameworks on the Determinants of Health. 2015.
45. WHO. Handbook on health inequality monitoring: with a special focus on low-and middle-income countries: World Health Organization; 2013.
46. Sobel HL, Huntington D, Temmerman M. Quality at the centre of universal health coverage. Health policy and planning. 2016;31(4):547-9.

47. Filby A, McConville F, Portela A. What prevents quality midwifery care? A systematic mapping of barriers in low and middle income countries from the provider perspective. PloS one. 2016;11(5):e0153391.
48. Donabedian A. The quality of care: how can it be assessed? Jama. 1988;260(12):1743-8.
49. WHO. Quality of care: a process for making strategic choices in health systems: World Health Organization; 2006.
50. Akachi Y, Tarp F, Kelley E, Addison T, Kruk ME. Measuring quality-of-care in the context of sustainable development goal 3: a call for papers. Bulletin of the World Health Organization. 2016;94(3):160.
51. Donabedian A. Evaluating the quality of medical care. The Milbank memorial fund quarterly. 1966;44(3):166-206.
52. Campbell J, Sochas L, Cometto G, Matthews Z. Evidence for action on improving the maternal and newborn health workforce: the basis for quality care. International Journal of Gynecology & Obstetrics. 2016;132(1):126-9.
53. McDonald KM, Sundaram V, Bravata DM, Lewis R, Lin N, Kraft SA, et al. Closing the quality gap: a critical analysis of quality improvement strategies (Vol. 7: Care Coordination). 2007.
54. Donabedian A. The seven pillars of quality. Archives of pathology & laboratory medicine. 1990;114(11):1115-8.
55. WHO. The world health report 2000: health systems: improving performance: World Health Organization; 2000.
56. Kirby RS. Perinatal quality indicators: yardsticks for quality of care, measures of population health. European Journal of Obstetrics and Gynecology. 2013;1(171):1-2.
57. Zeitlin J, Wildman K, Bréart G, Alexander S, Barros H, Blondel B, et al. Selecting an indicator set for monitoring and evaluating perinatal health in Europe: criteria, methods and results from the PERISTAT project. European Journal of Obstetrics & Gynecology and Reproductive Biology. 2003;111:S5-S14.
58. Victor J, Dzau M. Equity and Quality—Improving Health Care Delivery Requires Both. 2022.
59. WHO. Delivering quality health services: A global imperative: OECD Publishing; 2018.
60. WHO. Inequality monitoring in sexual, reproductive, maternal, newborn, child and adolescent health: a step-by-step manual. 2022.
61. Victora CG, Barros AJD, Axelson H, Bhutta ZA, Chopra M, França GVA, et al. How changes in coverage affect equity in maternal and child health interventions in 35 Countdown to 2015 countries: an analysis of national surveys. The Lancet. 2012;380(9848):1149-56.
62. Sachs JD. From millennium development goals to sustainable development goals. The Lancet. 2012;379(9832):2206-11.
63. Tangcharoensathien V, Mills A, Palu T. Accelerating health equity: the key role of universal health coverage in the Sustainable Development Goals. BMC medicine. 2015;13(1):101.
64. Hosseinpoor AR, Victora CG, Bergen N, Barros AJ, Boerma T. Towards universal health coverage: the role of within-country wealth-related inequality in 28 countries in sub-Saharan Africa. Bull World Health Organ. 2011;89(12):881-90.
65. Cavallaro FL, Cresswell JA, Franca GV, Victora CG, Barros AJ, Ronsmans C. Trends in caesarean delivery by country and wealth quintile: cross-sectional surveys in southern Asia and sub-Saharan Africa. Bull World Health Organ. 2013;91(12):914-22D.
66. Boatin AA, Schlotheuber A, Betran AP, Moller AB, Barros AJD, Boerma T, et al. Within country inequalities in caesarean section rates: observational study of 72 low and middle income countries. BMJ. 2018;360:k55.
67. Rutstein SO, Rojas G. Guide to DHS statistics. Calverton, MD: ORC Macro. 2006;38.
68. Barros AJ, Ronsmans C, Axelson H, Loaiza E, Bertoldi AD, Franca GV, et al. Equity in maternal, newborn, and child health interventions in Countdown to 2015: a retrospective review of survey data from 54 countries. Lancet. 2012;379(9822):1225-33.

69. Sahn DE, Stifel DC. Urban–rural inequality in living standards in Africa. Journal of African Economies. 2003;12(4):564-97.
70. Bhutta ZA, Salam RA, Lassi ZS, Austin A, Langer A. Approaches to improve quality of care (QoC) for women and newborns: conclusions, evidence gaps and research priorities. Reproductive health. 2014;11(2):1-3.
71. Das J, Hammer J. Quality of primary care in low-income countries: facts and economics. Annu Rev Econ. 2014;6(1):525-53.
72. Kendall T, Langer A. Critical maternal health knowledge gaps in low-and middle-income countries for the post-2015 era. Reproductive health. 2015;12(1):1-4.
73. Srivastava A, Avan BI, Rajbangshi P, Bhattacharyya S. Determinants of women's satisfaction with maternal health care: a review of literature from developing countries. BMC pregnancy and childbirth. 2015;15(1):1-12.
74. WHO. Strategies towards ending preventable maternal mortality (EPMM). Geneva: World Health Organization; 2015 2015.
75. WHO. Health in 2015: from MDGs, millennium development goals to SDGs, sustainable development goals: World Health Organization; 2015.
76. WHO. Trends in maternal mortality: 2000-2017: estimates from WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division. 2019.
77. Liu L, Oza S, Hogan D, Perin J, Rudan I, Lawn JE, et al. Global, regional, and national causes of child mortality in 2000–13, with projections to inform post-2015 priorities: an updated systematic analysis. The Lancet. 2015;385(9966):430-40.
78. Bhutta ZA, Chopra M, Axelson H, Berman P, Boerma T, Bryce J, et al. Countdown to 2015 decade report (2000–10): taking stock of maternal, newborn, and child survival. The lancet. 2010;375(9730):2032-44.
79. Arsenault C, Jordan K, Lee D, Dinsa G, Manzi F, Marchant T, et al. Equity in antenatal care quality: an analysis of 91 national household surveys. Lancet Glob Health. 2018;6(11):e1186-e95.
80. Van den Broek NR, Graham WJ. Quality of care for maternal and newborn health: the neglected agenda. BJOG: An International Journal of Obstetrics & Gynaecology. 2009;116:18-21.
81. Souza JP, Gülmezoglu AM, Vogel J, Carroli G, Lumbiganon P, Qureshi Z, et al. Moving beyond essential interventions for reduction of maternal mortality (the WHO Multicountry Survey on Maternal and Newborn Health): a cross-sectional study. The Lancet. 2013;381(9879):1747-55.
82. Campbell OMR, Graham WJ. Strategies for reducing maternal mortality: getting on with what works. The Lancet. 2006;368(9543):1284-99.
83. Carvajal–Aguirre L, Amouzou A, Mehra V, Ziqi M, Zaka N, Newby H. Gap between contact and content in maternal and newborn care: An analysis of data from 20 countries in sub–Saharan Africa. Journal of global health. 2017;7(2).
84. Joshi C, Torvaldsen S, Hodgson R, Hayen A. Factors associated with the use and quality of antenatal care in Nepal: a population-based study using the demographic and health survey data. BMC Pregnancy Childbirth. 2014;14:94.
85. Austin A, Langer A, Salam RA, Lassi ZS, Das JK, Bhutta ZA. Approaches to improve the quality of maternal and newborn health care: an overview of the evidence. Reproductive health. 2014;11(2):S1.
86. Ozumba BC, Onyeneho NG, Chalupowski M, Subramanian SV. Inequities in Access to Maternal Health Care in Enugu State: Implications for Universal Health Coverage to Meet Vision 2030 in Nigeria. Int Q Community Health Educ. 2019;39(3):163-73.
87. Kohler L, Wahlberg H. Inequities in preventive programs for maternal and child health services. Scand J Soc Med Suppl. 1984;34:43-4.
88. Gebre E, Worku A, Bukola F. Inequities in maternal health services utilization in Ethiopia 2000-2016: magnitude, trends, and determinants. Reprod Health. 2018;15(1):119.

89. Ganle JK, Parker M, Fitzpatrick R, Otupiri E. Inequities in accessibility to and utilisation of maternal health services in Ghana after user-fee exemption: a descriptive study. Int J Equity Health. 2014;13:89.
90. Anwar I, Nababan HY, Mostari S, Rahman A, Khan JA. Trends and inequities in use of maternal health care services in Bangladesh, 1991-2011. PLoS One. 2015;10(3):e0120309.
91. UN. Millennium Development Goals Report - the United Nations: United Nations Publications; 2009.
92. Wagstaff A. The Millennium Development Goals for health: rising to the challenges: World Bank Publications; 2004.
93. Ghana Statistical Service GSS, Ghana Health Service GHS, International ICF. Ghana Demographic and Health Survey 2014. Rockville, Maryland, USA: GSS, GHS, and ICF International; 2015.
94. Central Statistical Agency CSAE, Icf. Ethiopia Demographic and Health Survey 2016. Addis Ababa, Ethiopia: CSA and ICF; 2017.
95. National Population Commission NPC, Icf. Nigeria Demographic and Health Survey 2018 - Final Report. Abuja, Nigeria: NPC and ICF; 2019.
96. Yan LD, Mwale J, Straitz S, Biemba G, Bhutta Z, Ross JF, et al. Equity dimensions of the availability and quality of reproductive, maternal and neonatal health services in Zambia. Trop Med Int Health. 2018;23(4):433-45.
97. WHO. WHO recommendations on antenatal care for a positive pregnancy experience: World Health Organization; 2016.
98. Sharma J, Leslie HH, Kundu F, Kruk ME. Poor Quality for Poor Women? Inequities in the Quality of Antenatal and Delivery Care in Kenya. PLoS One. 2017;12(1):e0171236.
99. Kyei NNA, Chansa C, Gabrysch S. Quality of antenatal care in Zambia: a national assessment. BMC pregnancy and childbirth. 2012;12(1):151.
100. Handler A, Rankin K, Rosenberg D, Sinha K. Extent of documented adherence to recommended prenatal care content: provider site differences and effect on outcomes among low-income women. Matern Child Health J. 2012;16(2):393-405.
101. Tran TK, Gottvall K, Nguyen HD, Ascher H, Petzold M. Factors associated with antenatal care adequacy in rural and urban contexts-results from two health and demographic surveillance sites in Vietnam. BMC health services research. 2012;12(1):40.
102. Agho KE, Ezeh OK, Ogbo FA, Enoma AI, Raynes-Greenow C. Factors associated with inadequate receipt of components and use of antenatal care services in Nigeria: a population-based study. Int Health. 2018;10(3):172-81.
103. De Brouwere V, De Brouwere V, Tonglet R, Van Lerberghe W. Strategies for reducing maternal mortality in developing countries: what can we learn from the history of the industrialized West? Tropical medicine & international health. 1998;3(10):771-82.
104. Kerber KJ, de Graft-Johnson JE, Bhutta ZA, Okong P, Starrs A, Lawn JE. Continuum of care for maternal, newborn, and child health: from slogan to service delivery. The Lancet. 2007;370(9595):1358-69.
105. Singh L, Dubey R, Singh S, Richagoel, Nair S, Singh PK. Measuring Quality of Antenatal Care: A secondary analysis of national survey data from India. BJOG. 2019.
106. Ribeiro ER, Guimaraes AM, Bettiol H, Lima DD, Almeida ML, de Souza L, et al. Risk factors for inadequate prenatal care use in the metropolitan area of Aracaju, Northeast Brazil. BMC Pregnancy Childbirth. 2009;9:31.
107. Barros AJ, Ronsmans C, Axelson H, Loaiza E, Bertoldi AD, França GV, et al. Equity in maternal, newborn, and child health interventions in Countdown to 2015: a retrospective review of survey data from 54 countries

The Lancet. 2012;379(9822):1225-12.
108. Okedo-Alex IN, Akamike IC, Ezeanosike OB, Uneke CJ. Determinants of antenatal care utilisation in sub-Saharan Africa: a systematic review. BMJ Open. 2019;9(10).

109. Nguhiu PK, Barasa EW, Chuma J. Determining the effective coverage of maternal and child health services in Kenya, using demographic and health survey data sets: tracking progress towards universal health coverage. Trop Med Int Health. 2017;22(4):442-53.
110. Afulani PA. Rural/urban and socioeconomic differentials in quality of antenatal care in Ghana. 2015;10(2):e0117996.
111. Arroyave L, Saad GE, Victora CG, Barros AJ. Inequalities in antenatal care coverage and quality: an analysis from 63 low and middle-income countries using the ANCq content-qualified coverage indicator. International journal for equity in health. 2021;20(1):1-10.
112. Arroyave L, Saad GE, Victora CG, Barros AJD. A new content-qualified antenatal care coverage indicator: Development and validation of a score using national health surveys in low- and middle-income countries. J Glob Health. 2021;11:04008.
113. Arroyave L, Saad GE, Victora CG, Barros AJD. Inequalities in antenatal care coverage and quality: an analysis from 63 low and middle-income countries using the ANCq content-qualified coverage indicator. Int J Equity Health. 2021;20(1):102.
114. Muchie KF. Quality of antenatal care services and completion of four or more antenatal care visits in Ethiopia: a finding based on a demographic and health survey. BMC Pregnancy Childbirth. 2017;17(1):300.
115. Ejigu T, Woldie M, Kifle Y. Quality of antenatal care services at public health facilities of Bahir-Dar special zone, Northwest Ethiopia. BMC Health Serv Res. 2013;13:443.
116. Konje ET, Magoma MTN, Hatfield J, Kuhn S, Sauve RS, Dewey DM. Missed opportunities in antenatal care for improving the health of pregnant women and newborns in Geita district, Northwest Tanzania. BMC Pregnancy Childbirth. 2018;18(1):394.
117. Tunçalp Ö, Pena-Rosas JP, Lawrie T, Bucagu M, Oladapo OT, Portela A, et al. WHO recommendations on antenatal care for a positive pregnancy experience-going beyond survival. Bjog. 2017;124(6):860-2.
118. Crowe S, Utley M, Costello A, Pagel C. How many births in sub-Saharan Africa and South Asia will not be attended by a skilled birth attendant between 2011 and 2015? BMC pregnancy and childbirth. 2012;12(1):1-9.
119. Bohren MA, Hofmeyr GJ, Sakala C, Fukuzawa RK, Cuthbert A. Continuous support for women during childbirth. Cochrane database of systematic reviews. 2017(7).
120. Women's NCCf, Health Cs. Intrapartum care: care of healthy women and their babies during childbirth. 2014.
121. Freedman LP, Kruk ME. Disrespect and abuse of women in childbirth: challenging the global quality and accountability agendas. The Lancet. 2014;384(9948):e42-e4.
122. WHO. World health statistics 2018: monitoring health for the SDGs, sustainable development goals: World Health Organization; 2018.
123. Damian DJ, Tibelerwa JY, John B, Philemon R, Mahande MJ, Msuya SE. Factors influencing utilization of skilled birth attendant during childbirth in the Southern highlands, Tanzania: a multilevel analysis. BMC pregnancy and childbirth. 2020;20(1):1-11.
124. Doctor HV, Radovich E, Benova L. Time trends in facility-based and private-sector childbirth care: analysis of Demographic and Health Surveys from 25 sub-Saharan African countries from 2000 to 2016. Journal of global health. 2019;9(2).
125. Bailey P, Lobis S, Maine D, Fortney JA. Monitoring emergency obstetric care: a handbook: World Health Organization; 2009.
126. Otolorin E, Gomez P, Currie S, Thapa K, Dao B. Essential basic and emergency obstetric and newborn care: from education and training to service delivery and quality of care. International Journal of Gynecology & Obstetrics. 2015;130:S46-S53.
127. Holmer H, Oyerinde K, Meara J, Gillies R, Liljestrand J, Hagander L. The global met need for emergency obstetric care: a systematic review. BJOG: An International Journal of Obstetrics & Gynaecology. 2015;122(2):183-9.
128. WHO. WHO statement on caesarean section rates. World Health Organization; 2015.

129. Betran AP, Torloni MR, Zhang J, Ye J, Mikolajczyk R, Deneux-Tharaux C, et al. What is the optimal rate of caesarean section at population level? A systematic review of ecologic studies. Reproductive health. 2015;12(1):1-10.
130. Ye J, Zhang J, Mikolajczyk R, Torloni MR, Gülmezoglu A, Betran A. Association between rates of caesarean section and maternal and neonatal mortality in the 21st century: a worldwide population-based ecological study with longitudinal data. BJOG: An International Journal of Obstetrics & Gynaecology. 2016;123(5):745-53.
131. Betran AP, Ye J, Moller A-B, Souza JP, Zhang J. Trends and projections of caesarean section rates: global and regional estimates. BMJ Global Health. 2021;6(6):e005671.
132. Long Q, Kingdon C, Yang F, Renecle MD, Jahanfar S, Bohren MA, et al. Prevalence of and reasons for women's, family members', and health professionals' preferences for cesarean section in China: a mixed-methods systematic review. PLoS medicine. 2018;15(10):e1002672.
133. Shirzad M, Shakibazadeh E, Hajimiri K, Betran AP, Jahanfar S, Bohren MA, et al. Prevalence of and reasons for women's, family members', and health professionals' preferences for cesarean section in Iran: a mixed-methods systematic review. Reproductive Health. 2021;18:1-30.
134. Victora CG, Barros AJD, França GVA, da Silva ICM, Carvajal-Velez L, Amouzou A. The contribution of poor and rural populations to national trends in reproductive, maternal, newborn, and child health coverage: analyses of cross-sectional surveys from 64 countries. The Lancet Global Health. 2017;5(4):e402-e7.
135. Sarrassat S, Meda N, Badolo H, Ouedraogo M, Some H, Bambara R, et al. Effect of a mass radio campaign on family behaviours and child survival in Burkina Faso: a repeated cross-sectional, cluster-randomised trial. The Lancet Global Health. 2018;6(3):e330-e41.
136. Gibbons L, Belizán JM, Lauer JA, Betrán AP, Merialdi M, Althabe F. The global numbers and costs of additionally needed and unnecessary caesarean sections performed per year: overuse as a barrier to universal coverage. World health report. 2010;30(1):1-31.
137. Betrán AP, Ye J, Moller A-B, Zhang J, Gülmezoglu AM, Torloni MR. The increasing trend in caesarean section rates: global, regional and national estimates: 1990-2014. PloS one. 2016;11(2):e0148343.
138. Betrán AP, Merialdi M, Lauer JA, Bing-Shun W, Thomas J, Van Look P, et al. Rates of caesarean section: analysis of global, regional and national estimates. Paediatric and perinatal epidemiology. 2007;21(2):98-113.
139. Bohren MA, Hunter EC, Munthe-Kaas HM, Souza JP, Vogel JP, Gülmezoglu AM. Facilitators and barriers to facility-based delivery in low-and middle-income countries: a qualitative evidence synthesis. Reproductive health. 2014;11(1):1-17.
140. Boerma T, Ronsmans C, Melesse DY, Barros AJD, Barros FC, Juan L, et al. Global epidemiology of use of and disparities in caesarean sections. The Lancet. 2018;392(10155):1341-8.
141. Doctor HV, Nkhana-Salimu S, Abdulsalam-Anibilowo M. Health facility delivery in sub-Saharan Africa: successes, challenges, and implications for the 2030 development agenda. BMC Public Health. 2018;18(1):765.
142. Kinney MV, Kerber KJ, Black RE, Cohen B, Nkrumah F, Coovadia H, et al. Sub-Saharan Africa's mothers, newborns, and children: where and why do they die? PLoS Med. 2010;7(6):e1000294.
143. World Health O. Trends in maternal mortality: 1990-2015: estimates from WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division: executive summary. World Health Organization; 2015.
144. Khan AM, Lassi ZS, Bhutta ZA. Community-Oriented Primary Health Care for Improving Maternal, Newborn, and Child Health2018.
145. Kerber KJ, de Graft-Johnson JE, Bhutta ZA, Okong P, Starrs A, Lawn JE. Continuum of care for maternal, newborn, and child health: from slogan to service delivery. Lancet. 2007;370(9595):1358-69.

146. Kikuchi K, Ansah EK, Okawa S, Enuameh Y, Yasuoka J, Nanishi K, et al. Effective Linkages of Continuum of Care for Improving Neonatal, Perinatal, and Maternal Mortality: A Systematic Review and Meta-Analysis. PLoS One. 2015;10(9):e0139288.
147. Engmann CM, Hodgson A, Aborigo R, Adongo PL, Moyer CA. Addressing the continuum of maternal and newborn care in Ghana: implications for policy and practice. Health Policy Plan. 2016;31(10):1355-63.
148. Mohan D, LeFevre AE, George A, Mpembeni R, Bazant E, Rusibamayila N, et al. Analysis of dropout across the continuum of maternal health care in Tanzania: findings from a cross-sectional household survey. Health Policy Plan. 2017;32(6):791-9.
149. Yeji F, Shibanuma A, Oduro A, Debpuur C, Kikuchi K, Owusu-Agei S, et al. Continuum of Care in a Maternal, Newborn and Child Health Program in Ghana: Low Completion Rate and Multiple Obstacle Factors. PLoS One. 2015;10(12):e0142849.
150. Wang W, Hong R. Levels and determinants of continuum of care for maternal and newborn health in Cambodia-evidence from a population-based survey. BMC Pregnancy Childbirth. 2015;15:62.
151. Owili PO, Muga MA, Chou YJ, Hsu YH, Huang N, Chien LY. Associations in the continuum of care for maternal, newborn and child health: a population-based study of 12 sub-Saharan Africa countries. BMC Public Health. 2016;16:414.
152. Sakuma S, Yasuoka J, Phongluxa K, Jimba M. Determinants of continuum of care for maternal, newborn, and child health services in rural Khammouane, Lao PDR. PLoS One. 2019;14(4):e0215635.
153. Singh K, Story WT, Moran AC. Assessing the Continuum of Care Pathway for Maternal Health in South Asia and Sub-Saharan Africa. Matern Child Health J. 2016;20(2):281-9.
154. Wang, Wenjuan, Hong R. Completing the Continuum of Care for Maternal and Newborn Health in Cambodia: Who Drops Out? 2013.
155. Materia E, Mehari W, Mele A, Rosmini F, Stazi MA, Damen HM, et al. A community survey on maternal and child health services utilization in rural Ethiopia. Eur J Epidemiol. 1993;9(5):511-6.
156. Tarekegn SM, Lieberman LS, Giedraitis V. Determinants of maternal health service utilization in Ethiopia: analysis of the 2011 Ethiopian Demographic and Health Survey. BMC Pregnancy Childbirth. 2014;14:161.
157. Zelalem Ayele D, Belayihun B, Teji K, Admassu Ayana D. Factors Affecting Utilization of Maternal Health Care Services in Kombolcha District, Eastern Hararghe Zone, Oromia Regional State, Eastern Ethiopia. Int Sch Res Notices. 2014;2014:917058.
158. Yaya S, Bishwajit G, Ekholuenetale M, Shah V, Kadio B, Udenigwe O. Factors associated with maternal utilization of health facilities for delivery in Ethiopia. Int Health. 2018;10(4):310-7.
159. Dadi LS, Berhane M, Ahmed Y, Gudina EK, Berhanu T, Kim KH, et al. Maternal and newborn health services utilization in Jimma Zone, Southwest Ethiopia: a community based cross-sectional study. BMC pregnancy and childbirth. 2019;19(1):178.
160. Arunda M, Emmelin A, Asamoah BO. Effectiveness of antenatal care services in reducing neonatal mortality in Kenya: analysis of national survey data. Glob Health Action. 2017;10(1):1328796.
161. Makate M, Makate C. The impact of prenatal care quality on neonatal, infant and child mortality in Zimbabwe: evidence from the demographic and health surveys. Health Policy Plan. 2017;32(3):395-404.
162. Kanyangarara M, Munos MK, Walker N. Quality of antenatal care service provision in health facilities across sub–Saharan Africa: Evidence from nationally representative health facility assessments. Journal of global health. 2017;7(2).
163. Graham WJ, Varghese B. Quality, quality, quality: gaps in the continuum of care. The Lancet. 2012;379(9811):e5-e6.

164. Gajate-Garrido G. The impact of adequate prenatal care on urban birth outcomes: an analysis in a developing country context. Economic Development and Cultural Change. 2013;62(1):95-130.
165. Neupane S, Nwaru BI. Impact of prenatal care utilization on infant care practices in Nepal: a national representative cross-sectional survey. Eur J Pediatr. 2014;173(1):99-109.
166. Starrs AM. Safe motherhood initiative: 20 years and counting. The Lancet. 2006;368(9542):1130-2.
167. Carlo WA, Goudar SS, Jehan I, Chomba E, Tshefu A, Garces A, et al. Newborn-care training and perinatal mortality in developing countries. New England Journal of Medicine. 2010;362(7):614-23.
168. Marsh DR, Darmstadt GL, Moore J, Daly P, Oot D, Tinker A. Advancing newborn health and survival in developing countries: a conceptual framework. Journal of Perinatology. 2002;22(7):572.
169. McCurdy RJ, Kjerulff KH, Zhu J. Prenatal care associated with reduction of neonatal mortality in Sub-Saharan Africa: evidence from Demographic and Health Surveys. Acta Obstet Gynecol Scand. 2011;90(7):779-90.
170. Arsenault C, Harper S, Nandi A, Rodriguez JM, Hansen PM, Johri M. An equity dashboard to monitor vaccination coverage. Bull World Health Organ. 2017;95(2):128-34.
171. World Health Organization. Immunisation coverage 2022. Available at: https://www.who.int/news-room/fact-sheets/detail/immunisation-coverage [accessed January 16, 2022].
172. Rainey JJ, Watkins M, Ryman TK, Sandhu P, Bo A, Banerjee K. Reasons related to non-vaccination and under-vaccination of children in low and middle income countries: findings from a systematic review of the published literature, 1999-2009. Vaccine. 2011;29(46):8215-21.
173. Restrepo-Mendez MC, Barros AJ, Wong KL, Johnson HL, Pariyo G, Franca GV, et al. Inequalities in full immunisation coverage: trends in low- and middle-income countries. Bulletin of the World Health Organization. 2016;94(11):794-805B.
174. Hosseinpoor AR, Bergen N, Schlotheuber A, Gacic-Dobo M, Hansen PM, Senouci K, et al. State of inequality in diphtheria-tetanus-pertussis immunisation coverage in low-income and middle-income countries: a multicountry study of household health surveys. The Lancet Global Health. 2016;4(9):e617-e26.
175. Cata-Preta BO, Santos TM, Mengistu T, Hogan DR, Barros AJ, Victora CG. Zero-dose children and the immunisation cascade: understanding immunisation pathways in low and middle-income countries. Vaccine. 2021;39(32):4564-70.
176. Johri M, Perez MC, Arsenault C, Sharma JK, Pai NP, Pahwa S, et al. Strategies to increase the demand for childhood vaccination in low- and middle-income countries: a systematic review and meta-analysis. Bull World Health Organ. 2015;93(5):339-46C.
177. Sadaf A, Richards JL, Glanz J, Salmon DA, Omer SB. A systematic review of interventions for reducing parental vaccine refusal and vaccine hesitancy. Vaccine. 2013;31(40):4293-304.
178. Fisher AA, Way AA. The demographic and health surveys program: An overview. International Family Planning Perspectives. 1988:15-9.
179. The DHS Program. DHS Methodology. https://dhsprogram.com/What-We-Do/Survey-Types/DHS-Methodology.cfm. 2019.
180. The DHS Program. The DHS Overview. https://dhsprogram.com/What-We-Do/Survey-Types/DHS.cfm 2019.
181. The DHS Program. DHS Questionnaires. https://dhsprogram.com/What-We-Do/Survey-Types/DHS-Questionnaires.cfm. 2019.
182. Owolabi OO, Wong KL, Dennis ML, Radovich E, Cavallaro FL, Lynch CA, et al. Comparing the use and content of antenatal care in adolescent and older first-time mothers in 13 countries of west Africa: a cross-sectional analysis of Demographic and Health Surveys. The Lancet Child & Adolescent Health. 2017;1(3):203-12.

183. Solar O, Irwin A. A conceptual framework for action on the social determinants of health. 2010.
184. Wagstaff A, Doorslaer vE, Watanabe N. On decomposing the causes of health sector inequalities with an application to malnutrition inequalities in Vietnam: The World Bank; 2001.
185. Kruk ME, Gage AD, Arsenault C, Jordan K, Leslie HH, Roder-DeWan S, et al. High-quality health systems in the Sustainable Development Goals era: time for a revolution. 2018;6(11):e1196-e252.
186. Heredia-Pi I, Servan-Mori E, Darney BG, Reyes-Morales H, Lozano RJBotWHO. Measuring the adequacy of antenatal health care: a national cross-sectional study in Mexico. 2016;94(6):452.
187. Benova L, Tuncalp O, Moran AC, Campbell OMR. Not just a number: examining coverage and content of antenatal care in low-income and middle-income countries. BMJ Glob Health. 2018;3(2):e000779.
188. UN. Report of the inter-agency and expert group on sustainable development goal indicators. 2016;13.
189. Countdown Equity Analysis Group, Boerma JT, Bryce J, Kinfu Y, Axelson H, Victora CG. Mind the gap: equity and trends in coverage of maternal, newborn, and child health services in 54 Countdown countries. Lancet. 2008;371(9620):1259-67.
190. Zere E, Tumusiime P, Walker O, Kirigia J, Mwikisa C, Mbeeli T. Inequities in utilization of maternal health interventions in Namibia: implications for progress towards MDG 5 targets. Int J Equity Health. 2010;9:16.
191. Zere E, McIntyre D. Inequities in under-five child malnutrition in South Africa. Int J Equity Health. 2003;2(1):7.
192. Mwase T, Brenner S, Mazalale J, Lohmann J, Hamadou S, Somda SMA, et al. Inequities and their determinants in coverage of maternal health services in Burkina Faso. Int J Equity Health. 2018;17(1):58.
193. O'Donnell O, Van Doorslaer E, Wagstaff A, Lindelow M. Analyzing health equity using household survey data: a guide to techniques and their implementation: The World Bank; 2007.
194. Fagbamigbe AF, Idemudia ES. Assessment of quality of antenatal care services in Nigeria: evidence from a population-based survey. Reprod Health. 2015;12:88.
195. Kruk ME, Leslie HH, Verguet S, Mbaruku GM, Adanu RM, Langer AJTlgh. Quality of basic maternal care functions in health facilities of five African countries: an analysis of national health system surveys. 2016;4(11):e845-e55.
196. Leslie HH, Spiegelman D, Zhou X, Kruk MEJBotWHO. Service readiness of health facilities in Bangladesh, Haiti, Kenya, Malawi, Namibia, Nepal, Rwanda, Senegal, Uganda and the United Republic of Tanzania. 2017;95(11):738.
197. WHO. Global strategy on human resources for health: workforce 2030. 2016.
198. Sumankuuro J, Crockett J, Wang SJBo. Perceived barriers to maternal and newborn health services delivery: a qualitative study of health workers and community members in low and middle-income settings. 2018;8(11):e021223.
199. WHO. Working together for health: the World health report 2006: policy briefs. 2006.
200. Amo-Adjei J, Aduo-Adjei K, Opoku-Nyamah C, Izugbara C. Analysis of socioeconomic differences in the quality of antenatal services in low and middle-income countries (LMICs). PloS one. 2018;13(2):e0192513.
201. Bobo FT, Yesuf EA, Woldie M. Inequities in utilization of reproductive and maternal health services in Ethiopia. Int J Equity Health. 2017;16(1):105.
202. Victora CG, Matijasevich A, Silveira M, Santos I, Barros AJ, Barros FC. Socio-economic and ethnic group inequities in antenatal care quality in the public and private sector in Brazil. Health Policy Plan. 2010;25(4):253-61.
203. Afulani PA, Buback L, Essandoh F, Kinyua J, Kirumbi L, Cohen CRJBhsr. Quality of antenatal care and associated factors in a rural county in Kenya: an assessment of service provision and experience dimensions. 2019;19(1):684.

204. Amo-Adjei J, Anamaale Tuoyire DJTM, Health I. Effects of planned, mistimed and unwanted pregnancies on the use of prenatal health services in sub-Saharan Africa: a multicountry analysis of Demographic and Health Survey data. 2016;21(12):1552-61.
205. Gross K, Alba S, Glass TR, Schellenberg JA, Obrist BJBp, childbirth. Timing of antenatal care for adolescent and adult pregnant women in south-eastern Tanzania. 2012;12(1):16.
206. Iqbal S, Maqsood S, Zakar R, Zakar MZ, Fischer F. Continuum of care in maternal, newborn and child health in Pakistan: analysis of trends and determinants from 2006 to 2012. BMC health services research. 2017;17(1):189.
207. Chukwuma A, Wosu AC, Mbachu C, Weze K. Quality of antenatal care predicts retention in skilled birth attendance: a multilevel analysis of 28 African countries. BMC Pregnancy Childbirth. 2017;17(1):152.
208. Say L, Raine RJBotWHO. A systematic review of inequalities in the use of maternal health care in developing countries: examining the scale of the problem and the importance of context. 2007;85:812-9.
209. Zamawe CO, Banda M, Dube ANJBp, childbirth. The impact of a community driven mass media campaign on the utilisation of maternal health care services in rural Malawi. 2016;16(1):21.
210. Bohren MA, Vogel JP, Hunter EC, Lutsiv O, Makh SK, Souza JP, et al. The mistreatment of women during childbirth in health facilities globally: a mixed-methods systematic review. PLoS medicine. 2015;12(6):e1001847.
211. Bowser D, Hill KJUTP. Exploring evidence for disrespect and abuse in facility-based childbirth: report of a landscape analysis. 2010.
212. Ronsmans C, Etard J-F, Walraven G, Høj L, Dumont A, De Bernis L, et al. Maternal mortality and access to obstetric services in West Africa. Tropical Medicine & International Health. 2003;8(10):940-8.
213. WHO. Strategies towards ending preventable maternal mortality (EPMM). 2015.
214. Montagu D, Sudhinaraset M, Diamond-Smith N, Campbell O, Gabrysch S, Freedman L, et al. Where women go to deliver: understanding the changing landscape of childbirth in Africa and Asia. Health Policy Plan. 2017;32(8):1146-52.
215. Adegoke AA, van den Broek N. Skilled birth attendance-lessons learnt. BJOG. 2009;116 Suppl 1:33-40.
216. Amouzou A, Ziqi M, Carvajal-Aguirre L, Quinley J. Skilled attendant at birth and newborn survival in Sub-Saharan Africa. J Glob Health. 2017;7(2):020504.
217. Bobo FT, Asante A, Woldie M, Hayen A. Poor coverage and quality for poor women: Inequalities in quality antenatal care in nine East African countries. Health Policy and Planning. 2021;36(5):662-72.
218. Yaya S, Uthman OA, Amouzou A, Bishwajit G. Disparities in caesarean section prevalence and determinants across sub-Saharan Africa countries. Glob Health Res Policy. 2018;3:19.
219. Ansu-Mensah M, Mohammed T, Udoh RH, Bawontuo V, Kuupiel D. Mapping evidence of free maternal healthcare financing and quality of care in sub-Saharan Africa: a systematic scoping review protocol. Health Res Policy Syst. 2019;17(1):93.
220. World Bank. Out-of-pocket expenditure (% of current health expenditure). 2019.
221. Molla YB, Rawlins B, Makanga PT, Cunningham M, Ávila JEH, Ruktanonchai CW, et al. Geographic information system for improving maternal and newborn health: recommendations for policy and programs. BMC pregnancy and childbirth. 2017;17(1):1-7.
222. Shiferaw BB, Modiba LM. Why do women not use skilled birth attendance service? An explorative qualitative study in north West Ethiopia. BMC Pregnancy and Childbirth. 2020;20(1):1-14.
223. Assefa Y, Gelaw YA, Hill PS, Taye BW, Van Damme W. Community health extension program of Ethiopia, 2003–2018: successes and challenges toward universal coverage for primary healthcare services. Globalization and Health. 2019;15(1):1-11.

224. Lu C, Chin B, Lewandowski JL, Basinga P, Hirschhorn LR, Hill K, et al. Towards universal health coverage: an evaluation of Rwanda Mutuelles in its first eight years. PloS one. 2012;7(6):e39282.
225. Basinga P, Gertler PJ, Binagwaho A, Soucat AL, Sturdy J, Vermeersch CM. Effect on maternal and child health services in Rwanda of payment to primary healthcareproviders for performance: an impact evaluation. Lancet. 2011;377 North American Edition(9775):1421-8.
226. Bucagu M, Kagubare JM, Basinga P, Ngabo F, Timmons BK, Lee AC. Impact of health systems strengthening on coverage of maternal health services in Rwanda, 2000–2010: a systematic review. Reproductive health matters. 2012;20(39):50-61.
227. Cammack D. Local governance and public goods in Malawi. IDS bulletin. 2011;42(2):43-52.
228. Uny I, de Kok B, Fustukian S. Weighing the options for delivery care in rural Malawi: community perceptions of a policy promoting exclusive skilled birth attendance and banning traditional birth attendants. Health Policy Plan. 2019;34(3):161-9.
229. Thaddeus S, Maine D. Too far to walk: maternal mortality in context. Social science & medicine. 1994;38(8):1091-110.
230. Federal Democratic Republic of Ethiopia [Ministry of Health]. Health Sector Transformation Plan (HSTP) 2015/16-2019/20 (2008-2012 EFY). Federal Democratic Republic of Ethiopia Ministry of Health; 2015.
231. Nigatu AM, Gelaye KA. Factors associated with the preference of institutional delivery after antenatal care attendance in Northwest Ethiopia. BMC Health Serv Res. 2019;19(1):810.
232. Tekle Bobo F, Kebebe Kasaye H, Etana B, Woldie M, Feyissa TR. Disrespect and abuse during childbirth in Western Ethiopia: Should women continue to tolerate? PLoS One. 2019;14(6):e0217126.
233. Arsenault C, Yakob B, Tilahun T, Nigatu TG, Dinsa G, Woldie M, et al. Patient volume and quality of primary care in Ethiopia: findings from the routine health information system and the 2014 Service Provision Assessment survey. BMC health services research. 2021;21(1):1-10.
234. Hanson K, McPake B, Nakamba P, Archard L. Preferences for hospital quality in Zambia: results from a discrete choice experiment. Health Econ. 2005;14(7):687-701.
235. Kruk ME, Mbaruku G, McCord CW, Moran M, Rockers PC, Galea S. Bypassing primary care facilities for childbirth: a population-based study in rural Tanzania. Health Policy Plan. 2009;24(4):279-88.
236. Kruk ME, Hermosilla S, Larson E, Mbaruku GM. Bypassing primary care clinics for childbirth: a cross-sectional study in the Pwani region, United Republic of Tanzania. Bull World Health Organ. 2014;92(4):246-53.
237. Betran AP, Torloni MR, Zhang JJ, Gulmezoglu AM, Section WHOWGoC. WHO Statement on Caesarean Section Rates. BJOG. 2016;123(5):667-70.
238. Joseph G, da Silva ICM, Barros AJ, Victora CGJBgh. Socioeconomic inequalities in access to skilled birth attendance among urban and rural women in low-income and middle-income countries. 2018;3(6):e000898.
239. Lim SS, Dandona L, Hoisington JA, James SL, Hogan MC, Gakidou E. India's Janani Suraksha Yojana, a conditional cash transfer programme to increase births in health facilities: an impact evaluation. The Lancet. 2010;375(9730):2009-23.
240. Koblinsky M, Moyer CA, Calvert C, Campbell J, Campbell OMR, Feigl AB, et al. Quality maternity care for every woman, everywhere: a call to action. The Lancet. 2016;388(10057):2307-20.
241. WHO. Global vaccine action plan, 2011–2020. World Health Organization. 2013.
242. WHO. State of inequality: childhood immunisation. World Health Organization. 2016.
243. WHO. Regional Strategic Plan for Immunisation 2014-2020 World Health Organization; 2015.
244. UN. Levels & Trends in Child Mortality: Report 2019, Estimates developed by the United Nations Inter-agency Group for Child Mortality Estimation. New York,: United Nations Children's Fund; 2019.
245. Machingaidze S, Wiysonge CS, Hussey GD. Strengthening the expanded programme on immunisation in Africa: looking beyond 2015. PLoS medicine. 2013;10(3).

246. WHO. Progress and challenges with achieving universal immunisation coverage. 2019 WHO/UNICEF estimates of national immunisation coverage. World Health Organization: Geneva, Switzerland. 2020.
247. Sridhar S, Maleq N, Guillermet E, Colombini A, Gessner BD. A systematic literature review of missed opportunities for immunisation in low- and middle-income countries. Vaccine. 2014;32(51):6870-9.
248. Rutstein SO. Steps to constructing the new DHS Wealth Index. Rockville, MD: ICF International. 2015.
249. O'Donnell O, O'Neill S, Van Ourti T, Walsh B. Conindex: estimation of concentration indices. The Stata Journal. 2016;16(1):112-38.
250. Chandir S, Siddiqi DA, Mehmood M, Setayesh H, Siddique M, Mirza A, et al. Impact of COVID-19 pandemic response on uptake of routine immunisations in Sindh, Pakistan: An analysis of provincial electronic immunisation registry data. Vaccine. 2020;38(45):7146-55.
251. Moreno-Montoya J, Ballesteros SM, Rojas Sotelo JC, Bocanegra Cervera CL, Barrera-Lopez P, De la Hoz-Valle JA. Impact of the COVID-19 pandemic on routine childhood immunisation in Colombia. Archives of disease in childhood. 2021.
252. WHO. COVID-19 hits life-saving health services in Africa, 2020 [Available from: https://www.afro.who.int/news/covid-19-hits-life-saving-health-services-africa.
253. Roser M, Ritchie H, Ortiz-Ospina E. World population growth. Our World in Data. 2013.
254. Sato R. Effect of armed conflict on vaccination: evidence from the Boko haram insurgency in northeastern Nigeria. Confl Health. 2019;13:49.
255. WHO. Planning guide to reduce missed opportunities for vaccination. 2017.
256. Favin M, Steinglass R, Fields R, Banerjee K, Sawhney M. Why children are not vaccinated: a review of the grey literature. Int Health. 2012;4(4):229-38.
257. Silveira MF, Mesenburg MA, Bertoldi AD, De Mola CL, Bassani DG, Domingues MR, et al. The association between disrespect and abuse of women during childbirth and postpartum depression: Findings from the 2015 Pelotas birth cohort study. Journal of affective disorders. 2019;256:441-7.
258. Hanson CM, Mirza I, Kumapley R, Ogbuanu I, Kezaala R, Nandy R. Enhancing immunisation during second year of life by reducing missed opportunities for vaccinations in 46 countries. Vaccine. 2018;36(23):3260-8.
259. Larson HJ, de Figueiredo A, Xiahong Z, Schulz WS, Verger P, Johnston IG, et al. The State of Vaccine Confidence 2016: Global Insights Through a 67-Country Survey. EBioMedicine. 2016;12:295-301.
260. Burroway R, Hargrove A. Education is the antidote: Individual- and community-level effects of maternal education on child immunisations in Nigeria. Soc Sci Med. 2018;213:63-71.
261. Bangura JB, Xiao S, Qiu D, Ouyang F, Chen L. Barriers to childhood immunisation in sub-Saharan Africa: A systematic review. BMC Public Health. 2020;20(1):1108.
262. Porth JM, Wagner AL, Teklie H, Abeje Y, Moges B, Boulton ML. Vaccine non-receipt and refusal in Ethiopia: The expanded program on immunisation coverage survey, 2012. Vaccine. 2019;37(15):2106-21.
263. Oh JH. Educational expansion and health disparities in Ethiopia, 2005-2016. Soc Sci Med. 2019;235:112316.
264. Bobo FT, Hayen A. Decomposition of socioeconomic inequalities in child vaccination in Ethiopia: results from the 2011 and 2016 demographic and health surveys. BMJ Open. 2020;10(10):e039617.
265. Oku A, Oyo-Ita A, Glenton C, Fretheim A, Ames H, Muloliwa A, et al. Communication strategies to promote the uptake of childhood vaccination in Nigeria: a systematic map. Glob Health Action. 2016;9:30337.
266. Sohn M, Lin L, Jung M. Effects of Maternal Decisional Authority and Media Use on Vaccination for Children in Asian Countries. Medicina (Kaunas). 2018;54(6).

267. McElligott JT, Roberts JR, O'Brien ES, Freeland KD, Kolasa MS, Stevenson J, et al. Improving immunisation rates at 18 months of age: implications for individual practices. Public Health Reports. 2011;126(2_suppl):33-8.
268. Vandelaer J, Bilous J, Nshimirimana D. Reaching Every District (RED) approach: a way to improve immunisation performance. Bulletin of the World Health Organization. 2008;86:A-B.
269. Gavi. the Vaccine Alliance. Gavi, the Vaccine Alliance progress report 2013. Geneva: Gavi, the Vaccine Alliance, 2014. 2014.
270. Hamon JK, Krishnaratne S, Hoyt J, Kambanje M, Pryor S, Webster J. Integrated delivery of family planning and childhood immunisation services in routine outreach clinics: findings from a realist evaluation in Malawi. BMC Health Services Research. 2020;20(1):1-11.
271. Modi RN, King C, Bar-Zeev N, Colbourn T. Caregiver recall in childhood vaccination surveys: Systematic review of recall quality and use in low-and middle-income settings. Vaccine. 2018;36(29):4161-70.
272. Porth JM, Wagner AL, Tefera YA, Boulton ML. Childhood immunisation in Ethiopia: accuracy of maternal recall compared to vaccination cards. Vaccines. 2019;7(2):48.
273. Bercovich S, Anis E, Kassem E, Rubinstein U, Ephros M, Cohen D, et al. Validation of parental reports of rotavirus vaccination of their children compared to the national immunisation registry. Vaccine. 2019;37(21):2791-6.
274. Binyaruka P, Borghi J. Validity of parental recalls to estimate vaccination coverage: evidence from Tanzania. BMC health services research. 2018;18(1):1-9.
275. Arsenault C, Harper S, Nandi A, Mendoza Rodriguez JM, Hansen PM, Johri M. Monitoring equity in vaccination coverage: A systematic analysis of demographic and health surveys from 45 Gavi-supported countries. Vaccine. 2017;35(6):951-9.
276. Federal Democratic Republic of Ethiopia [Ministry of Health]. A ETHIOPIA NATIONAL EXPANDED PROGRAMME ON IMMUNISATION. April, 2015.
277. Arsenault C, Johri M, Nandi A, Mendoza Rodriguez JM, Hansen PM, Harper S. Country-level predictors of vaccination coverage and inequalities in Gavi-supported countries. Vaccine. 2017;35(18):2479-88.
278. Shrivastwa N, Gillespie BW, Kolenic GE, Lepkowski JM, Boulton ML. Predictors of vaccination in India for children aged 12–36 months. American journal of preventive medicine. 2015;49(6):S435-S44.
279. Ataguba JE, Ojo KO, Ichoku HE. Explaining socio-economic inequalities in immunisation coverage in Nigeria. Health Policy Plan. 2016;31(9):1212-24.
280. Branco FLCC, Pereira TM, Delfino BM, Braña AM, Oliart-Guzmán H, Mantovani SAS, et al. Socioeconomic inequalities are still a barrier to full child vaccine coverage in the Brazilian Amazon: a cross-sectional study in Assis Brasil, Acre, Brazil. International journal for equity in health. 2014;13(1):118.
281. Acharya K, Paudel YR, Dharel D. The trend of full vaccination coverage in infants and inequalities by wealth quintile and maternal education: analysis from four recent demographic and health surveys in Nepal. BMC Public Health. 2019;19(1).
282. Hajizadeh M. Decomposing socioeconomic inequality in child vaccination in the Gambia, the Kyrgyz Republic and Namibia. Vaccine. 2019;37(44):6609-16.
283. McGavin ZA, Wagner AL, Carlson BF, Power LE, Eboreime E, Boulton ML. Childhood full and under-vaccination in Nigeria, 2013. Vaccine. 2018;36(48):7294-9.
284. Ethiopian Public Health Institute (EPHI) [Ethiopia] and ICF. Ethiopia Mini Demographic and Health Survey 2019: Key Indicators. Rockville, Maryland, USA: EPHI and ICF.; 2019.
285. Mekonnen AG, Bayleyegn AD, Ayele ET. Immunisation coverage of 12-23 months old children and its associated factors in Minjar-Shenkora district, Ethiopia: a community-based study. BMC Pediatr. 2019;19(1):198.

286. Tamirat KS, Sisay MM. Full immunisation coverage and its associated factors among children aged 12-23 months in Ethiopia: further analysis from the 2016 Ethiopia demographic and health survey. BMC Public Health. 2019;19(1):1019.
287. Wondimu A, Cao Q, Wilschut JC, Postma MJ. Factors associated with the uptake of newly introduced childhood vaccinations in Ethiopia: the cases of rotavirus and pneumococcal conjugate vaccines. BMC Public Health. 2019;19(1):1656.
288. Central Statistical Agency (CSA) [Ethiopia], ICF. Ethiopia Demographic and Health Survey 2016.: Addis Ababa, Ethiopia, and Rockville, Maryland, USA: CSA and ICF; 2016.
289. Ashish K, Nelin V, Raaijmakers H, Kim HJ, Singh C, Målqvist MJBotWHO. Increased immunisation coverage addresses the equity gap in Nepal. 2017;95(4):261.
290. Doherty E, Walsh B, O'Neill C. Decomposing socioeconomic inequality in child vaccination: results from Ireland. Vaccine. 2014;32(27):3438-44.
291. Legesse E, Dechasa W. An assessment of child immunisation coverage and its determinants in Sinana District, Southeast Ethiopia. BMC pediatrics. 2015;15(1):31.
292. Tadesse H, Deribew A, Woldie M. Explorative assessment of factors affecting child immunisation in Wonago district, Gedeo zone, South Ethiopia. Archives of Medical Science. 2009;5(2):233.
293. Hajizadeh M. Socioeconomic inequalities in child vaccination in low/middle-income countries: what accounts for the differences? J Epidemiol Community Health. 2018;72(8):719-25.
294. Mbengue MAS, Sarr M, Faye A, Badiane O, Camara FBN, Mboup S, et al. Determinants of complete immunisation among senegalese children aged 12-23 months: evidence from the demographic and health survey. BMC Public Health. 2017;17(1):630.
295. Raza O, Lodhi FS, Morasae EK, Majdzadeh R. Differential achievements in childhood immunisation across geographical regions of Pakistan: analysis of wealth-related inequality. Int J Equity Health. 2018;17(1):122.
296. Kartoglu U, Milstien J. Tools and approaches to ensure quality of vaccines throughout the cold chain. Expert Rev Vaccines. 2014;13(7):843-54.
297. Ophori EA, Tula MY, Azih AV, Okojie R, Ikpo PE. Current trends of immunisation in Nigeria: prospect and challenges. Trop Med Health. 2014;42(2):67-75.
298. Fullman N, Yearwood J, Abay SM, Abbafati C, Abd-Allah F, Abdela J, et al. Measuring performance on the Healthcare Access and Quality Index for 195 countries and territories and selected subnational locations: a systematic analysis from the Global Burden of Disease Study 2016. The Lancet. 2018;391(10136):2236-71.
299. Universal Health Coverage index [Internet]. 2019 [cited June 19, 2022]. Available from: https://data.worldbank.org/indicator/SH.UHC.SRVS.CV.XD.
300. Cavallaro FL, Cresswell JA, França GV, Victora CG, Barros AJ, Ronsmans C. Trends in caesarean delivery by country and wealth quintile: cross-sectional surveys in southern Asia and sub-Saharan Africa. Bulletin of the World Health Organization. 2013;91:914-22D.
301. Montagu D, Yamey G, Visconti A, Harding A, Yoong J. Where do poor women in developing countries give birth? A multi-country analysis of demographic and health survey data. PloS one. 2011;6(2):e17155.
302. Bohren MA, Hofmeyr GJ, Sakala C, Fukuzawa RK, Cuthbert A. Continuous support for women during childbirth. Cochrane Database of Systematic Reviews. 2017;2017(7).
303. Shibanuma A, Yeji F, Okawa S, Mahama E, Kikuchi K, Narh C, et al. The coverage of continuum of care in maternal, newborn and child health: a cross-sectional study of woman-child pairs in Ghana. BMJ Glob Health. 2018;3(4):e000786.
304. Amouzou A, Jiwani SS, da Silva ICM, Carvajal-Aguirre L, Maiga A, Vaz LME, et al. Closing the inequality gaps in reproductive, maternal, newborn and child health coverage: slow and fast progressors. BMJ Glob Health. 2020;5(1):e002230.
305. Herliana P, Douiri A. Determinants of immunisation coverage of children aged 12-59 months in Indonesia: a cross-sectional study. BMJ Open. 2017;7(12):e015790.

306. WHO. The world health report 2008: primary health care now more than ever: World Health Organization; 2008.
307. Dover DC, Belon AP. The health equity measurement framework: a comprehensive model to measure social inequities in health. Int J Equity Health. 2019;18(1):36.
308. Amri M, Chatur A, O'Campo P. Intersectoral and multisectoral approaches to health policy: an umbrella review protocol. Health Research Policy and Systems. 2022;20(1):1-5.

Appendices

Appendix 1:

Feb 03, 2020

Firew Bobo
University of Technology Sydeny
Australia
Phone: +61
Email: @student.uts.edu.au
Request Date: 02/01/2020

Dear Firew Bobo:

This is to confirm that you are approved to use the following Survey Datasets for your registered research paper titled: "Equity in Maternal and Child Health Services in Sub-Sahara Africa":

Angola, Benin, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Comoros, Congo, Congo Democratic Republic, Cote d'Ivoire, Eswatini, Ethiopia, Gabon, Gambia, Ghana, Guinea, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Namibia, Niger, Nigeria, Nigeria (Ondo State), Rwanda, Sao Tome and Principe, Senegal, Sierra Leone, South Africa, Sudan, Tanzania, Togo, Uganda, Zambia, Zimbabwe

For restricted surveys, you must also request special permission from the Implementing Agencies. If approved, the restricted datasets will be provided to you by FTP.

To access the datasets, please login at: https://www.dhsprogram.com/data/dataset_admin/login_main.cfm. The user name is the registered email address, and the password is the one selected during registration.

The IRB-approved procedures for DHS public-use datasets do not in any way allow respondents, households, or sample communities to be identified. There are no names of individuals or household addresses in the data files. The geographic identifiers only go down to the regional level (where regions are typically very large geographical areas encompassing several states/provinces). Each enumeration area (Primary Sampling Unit) has a PSU number in the data file, but the PSU numbers do not have any labels to indicate their names or locations. In surveys that collect GIS coordinates in the field, the coordinates are only for the enumeration area (EA) as a whole, and not for individual households, and the measured coordinates are randomly displaced within a large geographic area so that specific enumeration areas cannot be identified.

The DHS Data may be used only for the purpose of statistical reporting and analysis, and only for your registered research. To use the data for another purpose, a new research project must be registered. All DHS data should be treated as confidential, and no effort should be made to identify any household or individual respondent interviewed in the survey. Please reference the complete terms of use at: https://dhsprogram.com/Data/terms-of-use.cfm.

The data must not be passed on to other researchers without the written consent of DHS. However, if you have coresearchers registered in your account for this research paper, you are authorized to share the data with them. All data users are required to submit an electronic copy (pdf) of any reports/publications resulting from using the DHS data files to: references@dhsprogram.com.

Sincerely,

Bridgette Wellington

Bridgette Wellington
Data Archivist
The Demographic and Health Surveys (DHS) Program

530 Gaither Road, Suite 500, Rockville, MD 20850 USA +1.301.407.6500 +1.301.407.6501 fax icf.com

Graduate study plan

The Faculty of Health (FoH) Graduate Research Study Plan (GRSP) is a "living" document that research students use to record and guide their candidature progress. It is a formal study plan agreed between supervisors and the graduate research student identifying goals, resources, knowledge and skill development needs and progress tracking from enrolment through the candidature assessment stages, to final submission of thesis, and completion of the degree.

An initial GRSP should be documented and agreed to by the graduate research student and supervisors ***no later than two weeks after enrolment*** and then should be revisited at each stage of candidature. At a minimum you should revise and submit your GRSP at every Review of Progress and Stage assessment.

Reviews of Progress

Review of Progress is undertaken towards the end of each semester. You should review and update your GRSP in discussion with your Supervisory Panel. You will submit your current stage GRSP with the Review of Progress to UTS Health Research Students Office as instructed by the due date.

Stage Assessments

Stage Assessments are organised by the Faculty Research Office and are held towards the end of each stage. The assessment process will ensure that you have completed all of the requirements for that Stage. You will submit your current stage GRSP with the Stage assessment documents to the UTS Health Research Students Office as instructed by the due date. On successful completion of your assessment for that Stage your GRSP for that stage will be finalised and recorded.

GRSP Coversheet

HIGHER DEGREE BY RESEARCH STUDENTS: GRADUATE RESEARCH STUDY PLAN (GRSP)

UTS: HEALTH

Student Information		**Candidature Information**	
Name:	Firew Tekle Bobo	Course Name and Number	PhD Public Health
Student ID:	[redacted]	Course Start Date	March 04 2019
Supervisory Panel		Expected Work Submission Date	March 04 2023
Principal:	Prof Andrew Hayen	Periods of Leave of Absence taken	
Co-Supervisor/s:	Prof Angela Dawson, Dr Augustine Asante, Prof Mirkuzie Woldie	GRSP completed for Semester/Year	

GRSP – STAGE 3

Candidature time taken for this stage is normally 1-2 semesters for full-time study or 2-4 semesters for part-time study. Candidates must complete the activities in the study plan as agreed with the supervisory panel, have presented at least once at the Research Student Forum, successfully undertake the Stage 1 Assessment and had Satisfactory progress over the preceding semester/s to complete this stage. Completion of this stage formally confirms the candidature.

ELEMENT AND OUTCOMES *Research practice, advanced disciplinary knowledge and skills, and research methodologies*	**DATES, ACTIVITIES AND THEIR CONTRIBUTION**	**Completed (Date)**
Contributing to a research community and to advancing disciplinary knowledge Able to demonstrate active engagement with local and institutional research community for scholarly and social purposes.	➢ Attending FOH Orientation program. ➢ Participating in local research group activities. ➢ ***Training sessions to be attended:*** • Graduate Research School HDR Induction • Guest speaker in public health for PhD students • 'Welcome and catch-up' UTS African Community	March 2019
Becoming a responsible and ethical researcher Able to explain relevant policies and processes for the ethical and responsible conduct of research; where appropriate gain certification.	➢ Read University Policy on Responsible Conduct of Research and discussing roles and responsibilities with supervisory panel. ➢ Reading Australian Code for the Responsible Conduct of Research ➢ ***Training sessions to be attended:*** o Preparing for Stage One o Data Management and Research Ethics o Project management	March –April 2019
Developing research skills and knowledge Able to articulate research reasoning and research plans (in written and oral forms) to a critical, informed audience, based on experience, and on developing expertise through engagement with the relevant literature and academics.	• Completing relevant coursework subjects/modules. • Developing skills in literature searching, information retrieval and information management through participation in workshops. • Developing skills and expertise in relevant data collection techniques. • Demonstrate capacity for critical appraisal of literature. • Identify suitable theoretical/conceptual framework.	June – September 2019

GRSP – STAGE 3

Candidature time taken for this stage is normally 1-2 semesters for full-time study or 2-4 semesters for part-time study. Candidates must complete the activities in the study plan as agreed with the supervisory panel, have presented at least once at the Research Student Forum, successfully undertake the Stage 1 Assessment and had Satisfactory progress over the preceding semester/s to complete this stage. Completion of this stage formally confirms the candidature.

ELEMENT AND OUTCOMES *Research practice, advanced disciplinary knowledge and skills, and research methodologies*	**DATES, ACTIVITIES AND THEIR CONTRIBUTION**	**Completed (Date)**
	• Developing skills in academic writing and argumentation through preparation of a literature review. • ***Training sessions to be attended:*** o Writing Effective Paragraphs o Writing Effective Sentences: Wordiness o Tightening up your Writing o What is Critical Writing o Writing Abstracts o Writing Introductions and Conclusions o Writing your Research Narrative: Dissertation Organisation, Structure and Flow o Reading for your Literature Review o Conceptualising your Critique of the Literature	
Planning and organising Able to develop a doctoral study plan appropriate to existing knowledge, skills and expertise; able to develop the research project plan including budget, timeline, and resource and equipment needs.	• Develop a study plan, including identification of resources (e.g. funding etc.), for stage 1 with supervisory panel. • Read University/FOH Policy on preparation for assessment process and discussing with supervisory panel. • Demonstrate skills in files and version management. • ***Training sessions to be attended:*** o 2019 Research student development o Mapping and Organising your Research	March –August 2019

GRSP – STAGE 3

Candidature time taken for this stage is normally 1-2 semesters for full-time study or 2-4 semesters for part-time study. Candidates must complete the activities in the study plan as agreed with the supervisory panel, have presented at least once at the Research Student Forum, successfully undertake the Stage 1 Assessment and had Satisfactory progress over the preceding semester/s to complete this stage. Completion of this stage formally confirms the candidature.

ELEMENT AND OUTCOMES *Research practice, advanced disciplinary knowledge and skills, and research methodologies*	**DATES, ACTIVITIES AND THEIR CONTRIBUTION**	**Completed (Date)**
	○ Design and Analysis of Surveys ○ Course 1: Foundational Issues in Qualitative Research ○ Finding Funding reservation	
Communicating research Able to use the language of the discipline/s in appropriate genres to a critical, defined audience, based on developing expertise.	• Develop skills in scholarly writing, e.g. through engagement in writing group or through workshop. • Develop skills in discussion and presentation. • Act as a co-author if planning to submit thesis by series of publications • ***Training sessions to be attended:*** ○ Preparing your Oral Research Presentation ○ Arguing your Case: Different types of Literature Reviews	May 2019

STAGE 3 – Completion of Stage Assessment - Confirmation of Candidature

SUPERVISORS TO COMPLETE

I acknowledge the student has under taken all the activities as listed under the stage 1 graduate research study plan

Comments	**Signature**	**Date**

RESPONSIBLE ACADEMIC OFFICER (Director Research Students) TO COMPLETE

OUTCOME OF ASSESSMENT ☐ **Confirm candidature** ☐ **Reassess candidature** ☐ **Discontinue candidature**

GRSP – STAGE 3

Candidature time taken for this stage is normally 1-2 semesters for full-time study or 2-4 semesters for part-time study. Candidates must complete the activities in the study plan as agreed with the supervisory panel, have presented at least once at the Research Student Forum, successfully undertake the Stage 1 Assessment and had Satisfactory progress over the preceding semester/s to complete this stage. Completion of this stage formally confirms the candidature.

ELEMENT AND OUTCOMES *Research practice, advanced disciplinary knowledge and skills, and research methodologies*	**DATES, ACTIVITIES AND THEIR CONTRIBUTION**	**Completed (Date)**
Comments	**Signature**	**Date**

Research Integrity for Students

Certificate of Completion

This is to certify that

Firew Bobo [redacted]

has successfully completed

Module 1: Research Integrity and Code of Conduct

Production Note:
Signature removed
prior to publication.

Professor Lori Lockyer,
Dean, Graduate Research School

University of Technology Sydney

Date: 24/01/2020

Research Integrity for Students

Certificate of Completion

This is to certify that

Firew Bobo [redacted]

has successfully completed

Module 2: Plagiarism and Misconduct
Module 3: Risk Assessment
Module 4: Risk Management and Health & Safety
Module 5: Project Management

Production Note:
Signature removed
prior to publication.

Professor Lori Lockyer,
Dean, Graduate Research School

University of Technology Sydney

Date: *24/01/2020*