Equitable Cancer Outcomes for Rural and Remote Communities

Measuring cancer equity globally: harmonising international rural-urban classifications for exploring cancer outcomes

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Summary

Geographic disparities in cancer outcomes represent a critical health equity challenge, with rural populations consistently experiencing poorer outcomes than urban populations. The lack of harmonised rurality measures creates substantial barriers to evidence synthesis and has precluded meta-analyses. This perspectives paper discusses concepts of rurality, identifies rurality classification systems used by cancer researchers in OECD countries that can be harmonised with the OECD Extended Typology, and develops recommendations for consistent rural-urban coding. Targeted searches of grey and published literature on cancer policy and rurality classification systems were conducted. The secondary analysis examined studies identified through systematic database searching of OVID Medline, Elsevier Embase, CINAHL, and Web of Science. From 289 studies across 22 OECD countries, twenty-seven rurality classification systems were identified, with eleven systems harmonised to create the Rural-Urban Classification System Harmonisation Framework featuring a consistent five-point rurality scale and standardised urban-rural dichotomisation. Implementation recommendations address system selection, standardised

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categorisation, and reporting standards. Adopting this harmonisation framework will improve research comparability and strengthen evidence to inform equitable cancer policies.

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Introduction

Geographic disparities in cancer outcomes represent a critical health equity challenge across the Western Pacific region and globally.[1–3] Rural and remote populations consistently experience poorer cancer outcomes compared to their urban counterparts,[4–6] facing barriers that span the entire cancer care continuum from prevention and early detection through to survivorship and palliative care.[1,7–10] These disparities are evident across multiple cancer types and healthcare systems, with rural residents experiencing delayed diagnosis and treatment, reduced access to specialist care, and lower survival rates.[5,6,9,11,12] The need to understand and address these inequitable outcomes has led to rural and remote populations being recognised as a priority group for cancer research and policy.[1–3]

In Australia, for example, five-year cancer survival rates demonstrate a notable gradient, with the lowest survival in very remote areas (55%) compared to major cities (62%), reflecting patterns observed across high income countries.[13] These patterns are evident across multiple cancer types, with rural populations experiencing poorer survival rates for colorectal, prostate, and penile cancers, and Indigenous populations experiencing worse outcomes across various cancer types, partly due to delayed diagnosis and access challenges to timely and specialised treatments.[14–18] These patterns reflect broader and complex challenges faced by rural populations in high-income countries, including geographic barriers to specialised services, limited healthcare workforce availability, lower health literacy, attitudinal barriers, and reduced participation in clinical trials.[13,14,19,20]

The concepts of rurality and urbanicity are fundamental to understanding these disparities, yet they encompass complex, multidimensional characteristics that vary substantially between countries and research contexts. Key definitions that feed into these concepts include geographical distance, accessibility of services, and population density.[21–23] However, some conceptualisations of rurality also consider additional factors including type of workforce, use of land, or sociodemographic characteristics of the population.[24–27]

Two major approaches exist for understanding the meaning of rurality. Cultural conceptualisations of rurality reflect place-based identity, community connections, and lived experiences that shape how individuals and communities perceive rural status.[23,28] In contrast, epidemiological approaches necessarily rely on quantifiable metrics that can be consistently applied across research studies and populations.[23,25,29] These epidemiological measures of rurality often diverge from cultural understandings and serve as operational tools for science, economics, and policy, rather than reflections of community identity.[21,23] Existing epidemiological measures of rurality employed in cancer research contain substantial heterogeneity in concept, measurement, and categorisation. Classification systems used in cancer research in the United States (US), for example, include the US Census Bureau (defined on population size, density, and contiguity [i.e., spatial proximity and relationship between areas]), Rural-Urban Commuting Area Codes (RUCA; defined on population density, urbanisation, and daily commuting), Rural-Urban Continuum Codes (RUCC; defined on population size, urbanisation, and contiguity), the National Centres for Health Statistics classification (NCHS; defined on population size and distribution), Urban Influence Codes (UIC; defined on population density and contiguity), and the Purdue University Index of Relative Rurality (IRR; defined on population density and contiguity).[S30–S32] These measures include both categorical and continuous classifications, distinctions within urban areas or rural areas, or can be grouped or categorised in multiple ways.[S30–S32] The RUCA classification alone has 11 primary and 21 secondary codes, with five different urban-rural categorisation options.[S33]

Addressing geographic cancer inequities requires robust, comparable evidence to inform targeted policy and practice interventions. Yet, the absence of harmonised rurality measures between and within countries creates substantial barriers as studies often use different systems or categorise the same system inconsistently. This variability in the measurement of rurality makes it difficult to reliably compare studies and has precluded meta-analyses, as reported by Afshar et al.[S34] Rurality is just one of many determinants influencing cancer outcomes; therefore, the implications of this methodological limitation go beyond the academic realm and affect policy and healthcare delivery. As acknowledged in the 2023 Australian Cancer Plan, the intersection of rurality with the compounding

effects of social, cultural, commercial, and environmental determinants of health can amplify its impact on equity in cancer care and outcomes.[1]

The Organisation for Economic Co-operation and Development (OECD) Extended Typology represents a potential framework for addressing this harmonisation challenge.[21] The OECD is an international organisation of 38 member countries committed to democracy and market economy, working together to promote policies that improve economic and social well-being. These nations represent economically similar high-income countries with comparable healthcare systems and data collection capabilities, making them particularly suitable for harmonisation efforts in health research (Supplementary Material 1). Developed to enable cross-national comparisons of regional development and economic performance. Despite its potential to address rurality status harmonisation challenges in health research internationally, the OECD Extended Typology has yet to be applied in cancer research, and its conceptual alignment with widely used rurality classification systems in epidemiology remain unexplored. Critical questions remain about how existing rurality status measures may be mapped to OECD Extended Typology categories to enable meaningful evidence synthesis in cancer research. Such synthesis requires consideration of how rurality measures and their categorisations can be harmonised to enable meaningful comparisons across economically similar countries, particularly those within the OECD. Thus, a harmonisation framework is essential for improving the level of evidence available to inform policy and research approaches aimed at reducing geographic cancer disparities across the Western Pacific region and globally.

Aims

This perspectives paper had three aims. First, to discuss the concepts of rurality. Second, to identify which rurality classification systems used by cancer researchers in OECD countries can be harmonised with the OECD Extended Typology classifications. Third, to develop recommendations to enable consistent rural-urban coding in cancer research to improve understanding of cancer outcomes according to rurality status within and across OECD countries.

Methods

This paper draws on the perspectives of the expert authorship team, representing a collaborative group of health researchers with diverse backgrounds and specialisations in rural health, cancer survivorship, systematic reviews, statistics, health economics, medicine, allied health, and psychology. These perspectives are integrated with an evidence-based approach, informed by key literature and two complementary methods. First, a targeted search of both grey and published literature on cancer policy, rurality classification systems, and cancer outcomes was conducted to address the first aim. This was conducted using Google Scholar, supplemented by searches of government websites, organisational reports, and reference lists. Forward and backward citation searching was also employed to identify relevant university and government methodological papers. Then, to address the second aim, a secondary analysis was performed of studies identified in a systematic review (prospectively registered in PROSPERO; CRD42024579591; and published elsewhere).[6] Briefly, this systematic review involved a search of OVID Medline, Elsevier Embase, CINAHL, and Web of Science conducted on 8 August 2024 for observational cohort studies reporting survival outcomes for people (of any age) if they were diagnosed with cancer (of any type) and living in an OECD country (Table S1). Studies were included only if survival was reported for both a rural and urban group as described by the study authors. Studies published in languages other than English were excluded.

For the secondary analysis of identified studies, all studies meeting the eligibility criteria underwent full-text screening in duplicate by two independent reviewers. Screening was managed in Covidence, which automatically assigned two independent reviewers to each record from the author group (AU, CW, EAJ, HB, HJ, HR, MC, RJB, SM, or SR). The country and rurality classification system were extracted by a single author (SM or SR), and quality checked by a second author (SM, SR, CW or MC). Disagreements during full-text screening were resolved by author SM. This adjudication occurred prior to and independently of both quality assessment and data extraction, ensuring that study inclusion decisions were made without knowledge of subsequent assessments and minimising any potential for bias. During data extraction, each newly identified rurality classification system underwent examination (SM). Information about each rurality classification system was gathered from three sources for all methodological details: 1) Any description of the rurality classification system in the included study, 2) the reference cited by the included study, and/or 3) online sources through a targeted search using Google and Google Scholar. Few included studies provided detailed descriptions or accurate references for the classification systems used; consequently, most information was obtained through the online search.

Each newly identified rurality classification system was assessed for conceptual harmonisation with the OECD Extended Typology principles; i.e., whether the classification systems were based upon the same elements of population density and contiguity.[21] This framework classifies regions based on population density and accessibility to urban centres, creating five categories. These categories are predominantly urban (PU), intermediate close to a city (INC), intermediate

remote (INR), predominantly rural close to a city (PRC), and predominantly rural remote (PRR).[21] The typology has been applied across European and North American OECD countries, excluding Iceland, to enable comparative analysis of regional trends and policy impacts. If conceptually aligned, the classification system's categories were examined to determine how they could be mapped to the five OECD Extended Typology categories to achieve consistency in the degree of geographical remoteness. A system was considered harmonised with the OECD Extended Typology if it met both criteria of: a) conceptual alignment, and b) the presence of at least one urban and one rural category that corresponded with the OECD Extended Typology categories. Harmonised systems were developed into a framework to support implementation.

To address the third aim, recommendations were made based on the findings on which rurality classification systems should be used in cancer research within OECD member nations, including guidance on grouping and dichotomising these systems, to promote consistent rural-urban coding and enhance the quality of evidence informing cancer research and policy.

Concept of rurality

This section addresses the first aim, which is to discuss the concepts of rurality. Understanding rurality requires examining both subjective cultural interpretations and objective epidemiological classifications used in research and policy applications.

Cultural concept of rurality

The subjective cultural concept of rurality, tied to the identity of an individual or a community, is an important social construct to consider and recognise in research. Resistant of any consensus definition, sociocultural definitions of rurality lack pre-defined criteria and allow a community or person to self-nominate, or nominate others, as rural, even if epidemiologically categorised otherwise.[23,28,S35] Such identification as rural may be based on culture (e.g., music culture and clothing style) or comparative differences (e.g., 'rural' community of East London).[23,28] The anthropological and societal devaluing of rural life, recently reconceived as geographic narcissism,[S36] has its roots in Marxist theory. While this view is widely challenged, particularly in recent years by strengths-based approaches to rural health research and practice,[S37,S38] it provides both historical and contemporary evidence of how place is tied to identity.[28] The importance of the cultural concept of rurality for people with cancer has recently been exemplified by consumer representatives who expressed that their identity should be primarily described and recognised as persons living in rural and remote areas, areas where they thrive and are offered significant social, environmental, and lifestyle benefits, and subsequently identified as persons with the lived experience of cancer.[S39]

A benefit of using the cultural concept of rurality for research purposes is that it may overcome the challenge of there being no clear geographic boundaries between rural and urban areas.[23] For place-based research, allowing self-nomination as rural may capture important cultural, social, attitudinal, and geographical nuances relevant to the location and better reflect perceived or experiential access to services, but may also not fairly account for the impact of geography on access to healthcare in different cases. However, self-identified rurality can also be influenced by individual perceptions, social desirability, or political identity, and may not align with objective measures. This highlights the importance of integrating cultural perspectives with epidemiological classifications to build a more complete and contextually meaningful understanding of rurality in health research. This is particularly relevant in cancer research, where cultural rural identity may influence screening participation, treatment preferences, and care-seeking behaviours in ways that geographic proximity alone cannot explain.[S40] For instance, individuals who culturally identify as rural may exhibit greater self-reliance in symptom management or preference for local healthcare providers, regardless of their geographic location, potentially affecting cancer detection and treatment outcomes.[S38,S40,S41]

Epidemiological concept of rurality

Rurality classification systems applied in epidemiological research are often criticised through a cultural lens, regardless of the rigour involved in their development and maintenance.[23,S35] However, the classification and coding of cultural constructs such as rurality to obtain consistent quantifiable measures that can be applied across datasets and populations remains necessary for epidemiology and policy applications.[S42] Internationally, there are a vast number of classification systems used to code rurality status; however, most are developed based on one, two, or three key elements: population density, contiguity, and other factors.

Construction of rurality classification systems

Population density, or population size within a specified area, is the most common element in measuring rurality and may be the most important as a large geographical distances and other factors such as agricultural land use cannot align with any cultural notion of rural if a population density is high. Population density is also often used as an indirect measure of accessibility to services. For example, the measurement of access to services in many classification systems only occurs within rural categories but not within urban categories. All classification systems include a measure of population density, and some use population density

alone to define rural or urban status.[S43–S46] Population density may be measured as the number of inhabitants per square kilometre or mile[S43,S45]; however, the more common approach is to measure the number of inhabitants within an administrative unit such as a province or county.[21,22,S44,S46]

Geographical distance is one component of contiguity in epidemiological classification systems, representing the proximity of a rural area to an urban area. Some classification systems measure contiguity as physical distance (e.g., kilometres or miles) or driving time,[21,S47,S48] while others use more complex methods such as network distance or multiple ring buffers.[24] Rurality classification systems may also consider accessibility to key services, such as workplaces or healthcare facilities, in their assessment of contiguity.[S49–S51] Some classification systems are designed to measure access to healthcare,[S52,S53] representing a themed rather than agnostic definition of rurality.

Other factors are included in some rurality classification systems, such as agricultural land use, aligning these more closely with certain cultural notions of rural.[27,S54,S55] Other examples include social determinants that highly intersect with rurality, such as socioeconomic status or environmental pollution.[26,27]

Most rurality classification systems are developed with three or more ordinal categories ranging from most urban to most remote,[22,S47,S56,S57] including the OECD Extended Typology[21]; however, some use continuous scales.[S58] These systems often come with recommended categorisations or groupings, such as the RUCA classification system described earlier.[S49,S50] Many researchers adopt these groupings and label the more rural categories collectively as "rural". However, these groups may not align with widely accepted definitions of rurality nor harmonise with categorisations from conceptually similar systems. These approaches also do not tend to capture the heterogeneity between rural areas and can also change over time as population density fluctuates, further complicating comparisons. For example, the nine RUCC categories are primarily dichotomised as "metropolitan" (codes 1–3) and "non-metropolitan" (codes 4–9).[S47] However, in research studies, the non-metropolitan group is often referred to as "rural", meaning the rural areas have a settlement population up to 250,000.[S47] In contrast, the six categories of the Scottish Government Rurality Index (SGRI) are primarily dichotomised as "Rest of Scotland" (codes 1–4) and "Rural Scotland" (codes 5–6), meaning rural areas have a settlement population up to 3000.[S48] In both these examples, the recommended and most widely used dichotomisation neither align with each other nor with most accepted concepts of rurality. Such differences in the dichotomisation of rurality classification systems are likely due to the intended purpose of the measure and the prevailing cultural concept of rural in the country.

OECD Extended Typology as harmonisation framework

The OECD Extended Typology offers an established approach to harmonising rurality classifications across OECD countries.[21] This framework classifies regions based on population density and contiguity, creating the five ordinal categories of PU, INC, INR, PRC, and PRR (Table 1).[21] Population density alone was used in the original OECD Regional Typology to define urban, intermediate, and rural areas, employing a typology that harmonises across OECD member countries by considering population settlement sizes, inhabitants per square kilometre, and the national administrative units.[S59] The Extended Typology builds upon this by adding a contiguity criterion based on driving time to indicate accessibility.[21] Intermediate and rural regions are further classified as remote when at least 50% of the regional population requires a minimum of 60 min driving time (North America) or 45 min (Europe) to

OECD extended typology category	Criterion: population density[a]	Criterion: contiguity
Predominantly Urban (PU)	Less than 15% of the population lives in rural communities[b]; or if 15–50% it has an urban centre of 500,000 inhabitants.	Not applicable.
Intermediate Close to a City (INC)	If 15–50% of the population lives in rural communities; or if > 50% live in rural communities, it has an urban centre of 200,000 inhabitants.	50% of the regional population needs less than 60 min, in North America, or 45 min, in Europe, to reach a populated centre with at least 50,000 inhabitants.
Intermediate Remote (INR)	If 15–50% of the population lives in rural communities; or if > 50% live in rural communities, it has an urban centre of 200,000 inhabitants.	50% of the regional population needs at least 60 min, in North America, or 45 min, in Europe, to reach a populated centre with at least 50,000 inhabitants.
Predominantly Rural Close to a City (PRC)	If more than 50% of the population lives in rural communities.	50% of the regional population needs less than 60 min, in North America, or 45 min, in Europe, to reach a populated centre with at least 50,000 inhabitants.
Predominantly Rural Remote (PRR)	If more than 50% of the population lives in rural communities.	50% of the regional population needs at least 60 min, in North America, or 45 min, in Europe, to reach a populated centre with at least 50,000 inhabitants.

[a]Population within a territorial level 3 (TL3) which is defined within national borders of OECD member nations, usually corresponding with lower-level administrative regions. There were 1794 TL3 regions for all American and European member nations. [b]Rural communities within TL3 regions identified by population density defined as < 150 inhabitants per square kilometre.

Table 1: **Definitions of the five categories of the OECD Extended Regional Typology.[22,60]**

reach the designated centre.[21] This means that some intermediate areas, previously considered urban, may be reclassified as rural if categorised as INR with the newer contiguity criterion. Operationally, although the five categories have been created, the OECD maps according to four categories only including PU, intermediate (INC and INR combined), PRC, and PRR.[21]

Harmonisation of rurality classification systems used in cancer research

This section addresses the second aim to identify which rurality classification systems used by cancer researchers in OECD countries can be harmonised with the OECD Extended Typology classifications.

Systematic review records assessed

Of 9115 study records sampled from the secondary analysis of the systematic review,[6] 845 were assessed for eligibility via full text and 289 were included for appraisal of their rurality classification systems for harmonisation with the OECD Extended Typology (PRISMA Flowchart Figure S1). These 289 studies represented research from 22 different OECD member nations, as well as two studies which included data from multiple countries (12 South Eastern European countries, only some of which are OECD member nations, and the United States).[S60,S61] Most research was from the United States (n = 175 studies),[S31,S46,S60–S233] followed by Australia (n = 45 studies),[S234–S278] Canada (n = 25 studies),[S279–S303] France (n = 7 studies),[27,S55,S304–S308] Italy (n = 5 studies),[S309–S313] Poland (n = 5 studies),[S60,S61,S314–S316] and Scotland (n = 4 studies).[S317–S320] There were three studies each from New Zealand,[S321–S323] Portugal,[S60,S61,S324] South Korea,[S325–S327] Sweden,[S328–S330] and Switzerland,[S331–S333] two each from Denmark,[S334,S335] Israel,[S336,S337] and Turkey,[S60,S61] and one study each from Germany,[S338] Greece,[S339] Japan,[S340] Mexico,[S341] Norway,[S54] and Spain.[S342] The two studies from Turkey were included only in the studies which sampled multiple countries.[S60,S61]

Outcome

Although authors reported cancer survival according to urban and rural groups, 77 (27%) studies reported no or insufficient rurality classification system or definition and could not be assessed for harmonisation potential. A further 23 (8%) studies used study-specific methodology to define rural and urban groups, none of which conceptually aligned with the OECD Extended Typology (Table 2; Figure S1). Two studies reported their sampling frame in such a way that the areas could be matched to the OECD maps. Following examination of the remaining 187 studies which reported 27 unique rurality classification systems (Table 2), 11 were harmonised with the OECD Extended Typology as they were found to have conceptual alignment and urban/rural categorical alignment for one or more categories (Table 3). A summary description of the 289 studies and their rurality classification systems is provided in Supplementary Material 4.

These harmonised rurality classification systems, along with the recommended rurality scale and recommended dichotomisation of rurality status, were developed into the unifying Rural-Urban Classification System Harmonisation Framework (Fig. 1). The concentric design emphasises the central role of the OECD Extended Typology as the unifying and underlying framework, while the blended and gradient colour scale shows the recommended five-point rurality continuum from remote (dark orange) through to urban (light green), recognising both epidemiological and cultural concepts of rurality. Supported by the three implementation steps and dichotomous coding prompts for each countries included rurality classification systems, the visual framework operationalises the harmonisation findings detailed in Table 3.

Recommendations

To meet the final aim, the following three recommendations were developed based on the above examination and findings.

Recommendation 1: rurality classification systems should be used to consistently measure urban-rural status in cancer research conducted on OECD member nations

Researchers have two implementation pathways depending on their country context and available classification systems.

For research examining cancer outcomes according to rurality status in the United States, Australia, New Zealand, Canada, Scotland, France, or Germany, it is recommended to apply the Rural-Urban Classification System Harmonisation Framework implementation recommendations (Fig. 1). Specifically, rurality should be defined and categorised according to one of the rurality classification systems detailed in Table 3. In countries such as the United States and Australia, where multiple rurality classification systems exist, the choice should be guided by the research question and the dataset compatibility.

Specifically, different cancer research questions may benefit from different classification system strengths. If there are multiple options available for the geographic area and/or dataset compatibility, it is recommended to examine which concepts were included in the rurality classification system. For cancer studies examining with research questions focused on access to specialised

care, rurality classification systems that utilise a measure of contiguity would be ideal, with further specification options such as driving time or physical distance as relevant. For example, in Australia, with a research question focused on accessibility, the Australian Modified Monash Model,[S56] may be preferable to the ASGS-RA, as it was based upon the ASGS-RA but added two additional categories by accounting for road distance and further specification of community size. Alternatively, for cancer screening studies, systems that allow for the largest number of categories according to population density and allow for more precise classifications may be more relevant than contiguity. In the United States, this may mean the RUCA system (11 primary and 21 secondary codes), which allows census tract or ZIP code tabulation is more preferable to the RUCC system (9 codes) which allows country-level classification.[S47] Ultimately, the considered judgement calls should be made by the research team on the most appropriate rurality classification system of those available, harmonised with the OECD Extended Typology, and compatible with their dataset.

For OECD member nations without a rurality classification system harmonised with the OECD Extended Typology, multiple options exist to promote consistency in the measurement and reporting of rurality. The OECD Extended Typology classification system itself (Table 1), although not used in any studies evaluated in the secondary analysis of the systematic review, can be applied and would be ideal for promoting harmonisation and to overcome the challenges with measuring cancer equity. Researchers can also describe sampling frames in ways that enable readers to cross-reference urban and rural areas with the OECD Extended Typology maps. Finally, the harmonisation methodology used in this paper can be applied to identify a nationally relevant rurality classification system for other OECD member nations, thereby extending the findings beyond the 11 identified systems in Table 3.

Recommendation 2: standardised categorisation and dichotomisation of rurality classifications

The 11 rurality classification systems harmonised with the OECD Extended Typology, when dichotomised into rural and urban categories for statistical analysis, should not necessarily follow the original dichotomisation recommended by each system. Instead, categorisation should be based on the groupings outlined in Fig. 1 and the final two columns of Table 3. Although "metropolitan" and "urban" are synonyms across systems, terms such as "non-metropolitan", "non-core", or "remote" are not necessarily equivalent to rural. The recommended dichotomisations by many rurality classification systems are often designed to create two groups of interest such as "core" and "non-core", "metropolitan" and "non-metropolitan", or "non-remote" and "remote", rather than strictly "urban" and

Rural classification systems detected from eligible studies	Number of studies
Australia	**45**
Australian Standard Geography Standard (ASGS) – Remoteness Area[22,b]	39
Modified Monash Model (MMM)[S56,S343,b]	1
National Rural Health Alliance[S344,c]	1
Study-specific: Postcodes	1
Not described	3
Canada	**25**
Organisation for Economic Co-operation and Development (OECD) map[21]	2
Rurality Index for Ontario (RIO)[S52]	6
Statistics Canada Standard Geographical Classification (SGC)[S57,b]	3
Study-specific: Population density: Number of inhabitants per defined area	3
Study-specific: Population density: Number of inhabitants per undefined area	2
Study-specific: Postcodes	2
Not described	7
Denmark	**2**
Danish Ministry of Environment and Food[S345,c]	1
Not described	1
France	**7**
French GeoClasH[S346,b]	1
National Institute of Statistics and Economic Studies (INSEE) definitions[d]	2
Study-specific: Population density: Number of inhabitants per defined area	2
Study-specific: 29 variables including population density, occupation, housing and living characteristics	1
Not described	1
Germany	**1**
Federal Institute for Building, Urban Affairs and Spatial Development[S347,b]	1
Greece	**1**
Study-specific: Population density: Number of inhabitants per undefined area	1
Israel	**2**
Study-specific: Population density: Number of inhabitants per defined area	1
Not described	1
Italy	**5**
Italian Institute for Statistics (ISTAT)[S348,d]	1
Rural Development Programme[S349,d]	1
Not described	3
Japan	**1**
Study-specific: Population density: Number of inhabitants per defined area	1
Korea, South	**3**
Study-specific: Population density: Number of inhabitants per defined area	1
Not described	2
Mexico	**1**
Not described	1
New Zealand	**5**
Urban–Rural Profile Classification[S350]	3
Urban–Rural Profile Standard Classification[S350]	1
Study-specific: Distance to cancer centre	1
Norway	**1**
Study-specific: Areas with/without food production	1
Poland	**3**
Not described	3
Portugal	**1**
Study-specific: Population density: Number of inhabitants per defined area	1
Southern-Eastern Europe (12 countries)	**2**
Not described	2
Spain	**1**
Not described	1

(Table 2 continues on next page)

Rural classification systems detected from eligible studies	Number of studies
(Continued from previous page)	
Sweden	**3**
Not described	3
Switzerland	**3**
Federal Statistics Office Spatial Divisions[S351,d]	2
Not described	1
United Kingdom	**4**
Scottish Government Rurality Index[S48]	4
United States	**175**
California Office of Statewide Health Planning and Development Medical Service Study Area[c]	2
National Centre for Health Statistics Urban–Rural Classification Scheme for Counties[S352]	5
Index of Relative Rurality[S353]	1
Rural-Urban Commuting Area Codes[S49,S50,b]	32
Rural-Urban Continuum Codes[S47,b]	72
Urban Influence Codes[S58]	2
US Census Bureau Urban and Rural[S354]	2
US Census Bureau Metropolitan and micropolitan statistical areas[S355]	1
US Census Bureau Urban Rural Indicator Codes[S356,b]	4
Health Resources & Services Administration[S357]	2
Office of Management and Budget[S358]	2
Study-specific: Population density: Number of inhabitants per defined area	4
Study-specific: Population density: Number of inhabitants per undefined area	1
Not described	48

Bold text identifies the country-level categories and their corresponding total number of studies for that country. [a]Total number of classification systems reported in the table exceeds the number of included studies as some studies applied more than one rurality classification system. [b]Rurality classification system was harmonised with the OECD Extended Typology (Table 3). [c]The reference provided by the study for the classification system was no longer available, e.g., a webpage which no longer exists or a ministry which has since been dissolved; hence the exact version of the classification system used could not be evaluated. The citation provided in the table is for the larger organisation. [d]Could not be assessed for harmonisation due to all methodological documentation being available in a language other than English.

Table 2: **Summary of the rural classification systems detected from the 289 included studies.[a]**

"rural". Therefore, categories within each of the 11 harmonised rurality classification systems were matched with the five OECD Extended Typology categories, enabling consistency on a 5-point ordinal rurality scale. These were then mapped into a dichotomous classification of "urban" (if mapped as urban or inner regional [i.e., analogous to PU or INC]) or "rural" (if mapped as outer regional, rural, or remote [i.e., analogous to INR, PRC, or PRR]), as illustrated in Fig. 1. Dichotomisation recommendation based on the OECD Extended Typology rural and remote categories, justifications, and descriptions.[21]

Recommendation 3: essential reporting standards for rurality status in cancer research

Improved use of rurality classification systems harmonised to the OECD Extended Typology (Fig. 1), and dichotomised as truly rural and urban, as per **Recommendations 1 and 2** will not strengthen the literature exploring rurality as a social determinant of cancer outcomes unless reporting is improved. It is recommended that authors correctly name and reference the rurality classification system used, ensure the most recent and endorsed version of the rurality classification system is selected, specify each of the rural-urban categories and its definition, describe any combining of categories, and clearly describe how categories were dichotomised in analyses. It is recommended that a rural lens is applied to the analysis of cancer data which spans geographical regions. Beyond selecting an appropriate rurality classification system and reporting it correctly, it is recommended that data for urban and rural people are always reported separately; and if supported by sufficient numbers, not only for the dichotomised rural-urban groups but also according to the ordinal rurality scale of the selected rurality classification system to enable greater understanding of the effect of increasing geographical remoteness on outcomes. Furthermore, it is recommended that authors report participant characteristics and explanatory variables for each rural and urban category to promote understanding of the intersectionality of other determinants of cancer outcomes.

Implementation guidance

Implementing the Rural-Urban Classification System Harmonisation Framework requires planning and consideration of both methodological and practical factors; thus, an implementation pathway is recommended in Table 4.

Discussion

This perspectives paper examined the differing cultural and epidemiological concepts of rurality and their roles and importance in cancer research. The construction of epidemiological rurality classification systems was explored, identifying the need for conceptual and categorical harmonisation to support cancer research and policy. To meet the second aim, all rural classification systems which have been applied to cancer survival research across OECD member nations were assessed for harmonisation with the OECD Extended Typology and 11 were harmonised for seven countries, with application and implementation supported by the development of the Rural-Urban Classification System Harmonisation Framework. Furthermore, to address the final aim three recommendations were developed.

Implications

Mapping of existing rurality classification systems to the OECD Extended Typology will enable meaningful evidence synthesis in cancer research across economically and socially similar OECD countries.

This has been recently demonstrated in the first meta-analysis and meta-regression of cancer survival outcome data, which was only possible by applying the

US CENSUS BUREAU URBAN RURAL INDICATOR CODES [S374]	RURAL URBAN COMMUTING AREA CODES [S49,S50]		RURAL–URBAN CONTINUUM CODES [S47]	AUSTRALIAN STATISTICAL GEOGRAPHY STANDARD – REMOTENESS STRUCTURE [22]	MODIFIED MONASH MODEL [S56]	URBAN ACCESSIBILITY CLASSIFICATION [S39]	STANDARD GEOGRAPHICAL CLASSIFICATION [S57]	SCOTTISH GOVERNMENT RURALITY INDEX [S48]	GEOCLASH [26]	FEDERAL INSTITUTE FOR BUILDING, URBAN AFFAIRS AND SPATIAL DEVELOPMENT [S347]	OECD EXTENDED TYPOLOGY CLASSIFICATIONS [21]	RECOMMENDED RURALITY SCALE	RECOMMENDED DICHOTOMISATION OF RURALITY STATUS [a]
United States				**Australia**		**New Zealand**	**Canada**	**Scotland**	**France**	**Germany**	**All OECD Member Nations**		
100% urban (All Urban)	RUCA codes 1, 2, & 3 / Urban [b]	Urban [c]	Metro County Codes 1, 2, & 3	Major Cities of Australia (ASGS-RA1)	Metro area (MM 1)	Major urban area; Large urban area (IUR codes 11 & 12)	Census metropolitan areas (Code A)	Large urban area (Class 1), Accessible urban (Class 2)	Wealthy metropolitan areas; Precarious population districts	Urban (all cats [e])	**Predominantly urban (PU)**	**Urban**	**Urban**
≥50% but <100% (Mostly Urban)	RUCA Codes 4 & 5 / Large Rural [b]		Nonmetro country Codes 4 & 5	Inner Regional Australia (ASGS-RA2)	Regional centre (MM 2)	Medium urban area (IUR code 13)	Census agglomeration (Code B)	Accessible small town (Class 3)	Residential outskirts	Mostly Urban (all cats [e])	**Intermediate close to a city (INC)**	**Inner regional**	
>0% but <50% urban	RUCA Code 6 / Large Rural [b]	Rural [c]	Nonmetro County Codes 6 & 8	Outer Regional Australia	Large rural town (MM 3)	Peri-urban (small urban area, rural settlement, or	Outside census metropolitan areas and census	Remote small town (Class 4)	Agricultural and industrial plains	Rural (very central; central [e])	**Intermediate remote (INR)**	**Outer regional**	**Rural**
(Mostly Rural)				(ASGS-RA3)		rural other with high urban accessibility; IUR code 21)	agglomerations (rural area; Code C)						
100% rural (All Rural)	RUCA Codes 7, 8, & 9 / Small rural [b]		Nonmetro County Code 7	Remote Australia (ASGS-RA4)	Medium rural town (MM 4); small rural town (MM 5)	Rural or rural other (small urban area, rural settlement, or rural other with medium or low urban accessibility; IUR codes 22 & 23)		Accessible rural (six category [d]; Class 5)	Rural margins	Rural (peripheral [e])	**Predominantly rural close to a city (PRC)**	**Rural**	
	RUCA Code 10 / Isolated [b]		Nonmetro County Code 9	Very Remote Australia (ASGS-RA5)	Remote communities (MM 6); very remote communities (MM 7)	Rural or rural other (small urban area, rural settlement, or rural other with remote or very remote urban accessibility; codes IUR 24 &25)		Remote and rural (six category [d]; Class 6); Accessible rural areas (eight category [d]; Class 6); Remote rural areas (Class 7); Very remote rural areas (Class 8)		Rural (very peripheral [e])	**Predominantly rural remote (PRR)**	**Remote**	

ASGS-RA, Australian Statistical Geography Standard – Remoteness Area; Cat, category; IUR, Urban Rural Indicator; INC, Intermediate Close to a city; INR, Intermediate Remote; Metro, metropolitan; MMM, Modified Monash Model; MM, Modified Monash; OECD, Organisation for Economic Co-operation and Development; PRC, Predominantly Rural Close to a city; PRR, Predominantly Rural Remote; PU, Predominantly Urban; RUCA, Rural-Urban Community Area; RUCC, Rural-Urban Continuum Codes; US, United States. a. Dichotomisatation recommendation based on the OECD Extended Typology rural and remote categories, justifications, and descriptions.[18] b. According to Categorisation A of the five recommended RUCA categorisations.[S30] c. According to Categorisation C of the five recommended RUCA categorisations.[S30] d. Classes 5 and 6 has a different label name depending on if the six or eight category version of the Scottish Government Rurality Index is being applied. The six category version does not have class 7 or class 8. e. The German Federal Institute for Building, Urban Affairs and Spatial Development primary classifications have four sub-categories to further distinguish rurality: Very central, central, peripheral, or very peripheral.[23]

Table 3: **Rurality classification systems and their categories harmonised to the OECD Extended Typology rurality scale of categories and the OECD Extended Typology dichotomous rurality status.**

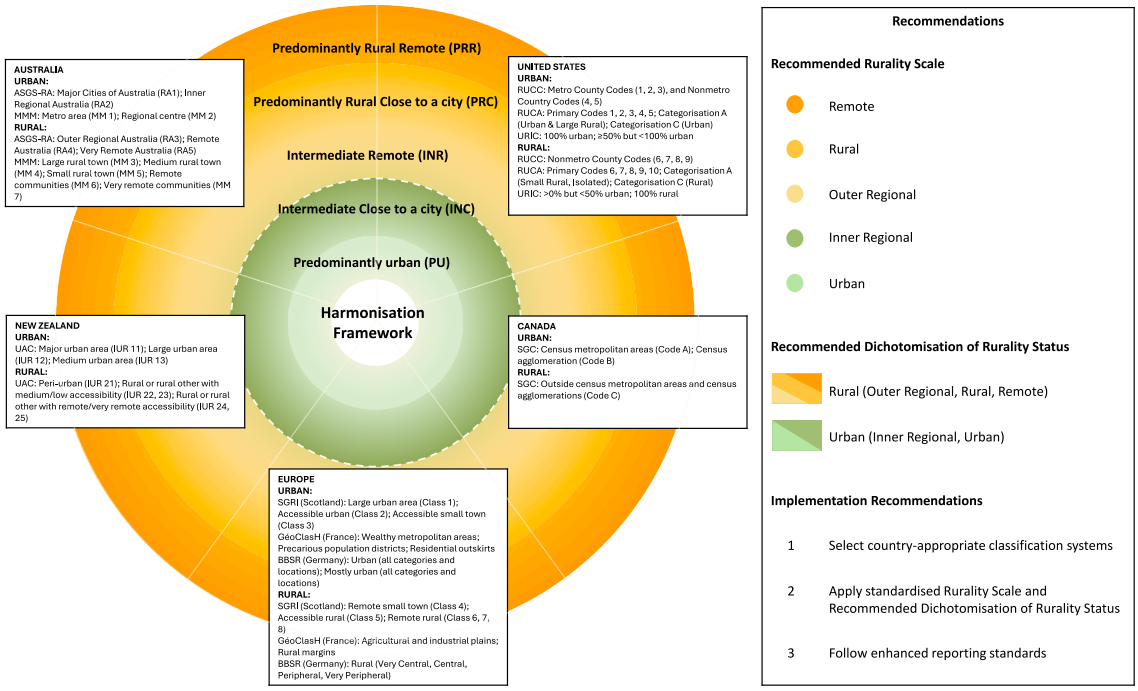

Fig. 1: Rural-Urban Classification System Harmonisation Framework. The framework represents harmonisation of rurality classification systems based on the five OECD Extended Typology categories, surrounded by country-specific classification systems according to geographic region. The colour-coded scale (right) indicates the recommended rurality scale: Remote (darkest orange; corresponding to PRR), Rural (orange; corresponding to PRC), Outer Regional (yellow; corresponding to INR), Inner Regional (green; corresponding to INC) and Urban (light green; corresponding to PU). The dotted line circling the line between yellow and green represents the dichotomisation of the five categories on the rurality scale to the two categories of the rurality status: rural and urban. The colours of each of the five categories are blended and show colour gradient to recognise that despite the epidemiological nature of this rurality classification system, that diversity and variation occur within categories and as recognised by the cultural definition of rurality, there are no true boundaries between categories. The implementation recommendations (right) enable standardised rurality scale classifications and rural-urban categorisation for cancer outcome research across and within OECD member nations. ASGS-RA, Australian Statistical Geography Standard – Remoteness Area; BBSR, Federal Institute for Building, Urban Affairs and Spatial Development; GéoClasH, Geographic Classification for Health; INC, Intermediate Close to a city; INR, Intermediate Remote; IUR, Urban Rural Indicator; MMM, Modified Monash Model; MM Modified Monash; OECD, Organisation for Economic Co-operation and Development; PRC, Predominantly Rural Close to a city; PRR, Predominantly Rural Remote; PU, Predominantly Urban; RUCA, Rural-Urban Community Area; RUCC, Rural-Urban Continuum Codes; SGC, Standard Geographical Classification; SGRI, Scottish Government Rurality Index; UAC: Urban Accessibility Classification; URIC; Urban Rural Indicator Codes.

Implementation pathway steps	Description
Step 1: System Selection and Validation	Identify which of the 11 harmonised rurality classification systems (Table 3; Fig. 1 [country-specific boxes]) are available and appropriate for the study population and geographic area. Ensure the most recent version of the selected classification system is used as many systems undergo periodic updates. For multi-country studies or for studies without a harmonised rurality classification system, consider applying the OECD Extended Typology directly.
Step 2: Data Mapping and Categorisation	When reviewing existing published data to the harmonised framework or grouping multiple categories of a rurality classification system, these should be mapped to the recommended rurality scale (Fig. 1) before dichotomising into urban-rural categories as recommended in Table 3. This intermediate step allows for more nuanced analysis of the effect of rurality and enables comparison between studies using the full ordinal scale. Document all mapping decisions and rationale for transparency and reproducibility.
Step 3: Reporting and Documentation	Enhanced reporting standards as outlined in Recommendation 3 should be followed, enabling a clear understanding of how rurality was defined, measured, and categorised, supported by a justification relevant to their research question and sample.
Additional Considerations	For ongoing studies employing non-harmonised classifications, sensitivity analyses using the harmonised approach are encouraged where feasible. At minimum, clear documentation of how rurality measures correspond to the OECD Extended Typology framework should be provided to support future evidence synthesis. Multi-country collaborations are advised to establish rurality harmonisation protocols early in the study design phase, acknowledging that different countries may require different source classification systems while ensuring consistency within the final analytical framework.

Table 4: **Implementation pathway for the Rural-Urban Classification System Harmonisation Framework.**

harmonisation methodology and recommendations described in this paper.[6] This international meta-analysis found consistent evidence that, following a cancer diagnosis, living in a rural area was associated with 10–15% lower odds of survival, compared to living in an urban area, a finding based on the recommended dichotomisation of rurality status (Fig. 1). Meta-regression using the recommended rurality scale, found that increasing geographical remoteness was associated with 72% lower odds of survival.[6] This systematic review was the first to apply the Rural-Urban Classification System Harmonisation Framework across OECD member nations, highlighting the need for further exploration of other important cancer outcomes beyond cancer survival.

Improved reporting in original research, according to the three recommendations, will vastly increase the volume of research available to examine cancer equity according to rurality. For example, of the 72 studies identified in the systematic review that used the RUCC rurality classification system in the United States, the nine RUCC categories were dichotomised or grouped 12 different ways. Only 14 of these studies were assessed as eligible for inclusion in the meta-analysis due to their grouping methods.[6] Of the 58 excluded RUCC studies, nine did not describe how their categories were dichotomised or grouped at all. Although RUCC does have a more widely used and recommended grouping of metropolitan (codes 1–3) and non-metropolitan (codes 4–9); these findings demonstrate that this is also not consistently deployed, with authors previously lacking guidance on how to group codes to explore rurality. Our new recommendations will enable improved understanding of cancer outcomes according to rurality status across OCED countries in both original research and meta-analyses through a harmonised rural-urban explanatory variable.

Future directions

Future research is needed to explore rurality classification measures in non-OECD countries such as those in the Western Pacific region, and whether harmonisation is possible while recognising differences in economic development. Further, applicability of the Rural-Urban Classification System Harmonisation Framework in health conditions beyond cancer to address broader rural inequity is warranted.

Future harmonisation efforts could incorporate cultural concepts of rurality by integrating qualitative or self-identified rural status alongside epidemiological measures, enabling analyses that capture both place-based identity and objective geographic characteristics. This dual approach would preserve the rigour of standardised classification while enriching interpretation of cancer outcomes in diverse social contexts. Policy pathways to operationalise OECD-aligned harmonisation include its formal adoption by national cancer registries as a standard variable, incorporation into national cancer control plans, and the inclusion of harmonised rurality measures as a funding requirement in competitive research grants. These strategies would embed consistent measurement into routine data collection and incentivise its uptake across the research community.

Limitations

The recommendations promoting harmonisation across OECD member nations may not align with each country's national recommendations nor cultural perceptions of rurality; however, instead represent a step toward a more consistent global coding structure. Although broadly harmonised, fundamental differences exist with how each rurality classification system was developed, defined, and applied. The category definitions do not perfectly match the OECD Extended Typology and should not be considered equivalent across all systems, as this approach acknowledges and allows for country-specific differences. For example, New Zealand's definition of an urban centre used a much lower population threshold than the OECD Extended Typology, reflecting its unique terrain, history, and distribution. Although the recommendations have been demonstrated to facilitate a meta-analysis of global cancer outcomes for the first time, the study was limited by its inability to assess rurality classification systems published in languages other than English or to evaluate systems not detected in the secondary analysis of the systematic review. Although the recommendations represent a move towards global alignment in the measurement of rurality status, this scope was limited to economically and socially similar OECD nations. The harmonisation framework addresses OECD member nations specifically and may not be directly applicable to countries with substantially different population distributions, transportation infrastructure, or cultural concepts of rurality. For example, countries with high baseline population densities or extensive high-speed rail networks connecting rural areas to urban centres may require adapted thresholds and contiguity measures.

Conclusion

Cultural and epidemiological concepts of rurality each have a role in cancer research; however, cancer researchers should measure and report outcomes according to the 11 epidemiological rurality classification systems harmonised with the OECD Extended Typology categories to enable meaningful evidence synthesis. This harmonisation will enhance the robustness of the evidence base and is expected to attract greater policy attention towards addressing geographic inequities.

Contributors

SM and AU developed the study concept with contributions from all authors. SM and CW implemented the search strategy. SM, SR, HR, EAJ, CW, AU, HJ, MC, RJB and HB contributed to record selection. SM

evaluated and coded studies' geographical classification systems. CW, SM, and SR conducted data extraction. MC and SM conducted quality checking of data extraction. SM drafted the manuscript supported by CW. CW produced the framework figure and implementation guidance. All authors, including LL, AC, LA, FCW, NHH, JR, LG, KG, HG, contributed to manuscript revision and approved the final version.

Data sharing statement

Not applicable.

Declaration of interests

JR has received honorarium from Merck Sharpe & Dohme and Pfizer for providing advice, chairing and speaking at clinician educational events. JR is Chair of Royal Australian College of General Practitioners (RACGP) Cancer and Palliative Care Network, Co-chair of the Living with and Beyond Cancer Engine room at the Primary Care Collaborative Cancer Clinical Trials.

Network, Chair of the National Bowel Cancer Screening Program Education and Engagement Advisory Group (NBCSP-EEAG). JR is a member of Australian Government National Bowel.

Cancer Screening Program Advisory Committee and the Australian Government National Lung Cancer Screening Program Expert Advisory Group. LA is supported by the Rural Health Multidisciplinary Training (RHMT) program from the Department of Health and Aged Care. All other authors declare no conflicts of interest.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.lanwpc.2025.101737.

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