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The Urban Bias in Latin American Avoidable Mortality

Jenny Garcia Arias¹

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Abstract

In 1977, Michael Lipton introduced the Urban Bias Thesis as a framework for understanding how most economic policy initiatives have contributed to the overdevelopment of urban areas and the underdevelopment of rural areas. In Latin America, there has historically been a positive correlation between urbanization and mortality decline, as the region's health transition generally began in the main cities and tended to proceed more rapidly in countries with higher levels of urbanization. This paper seeks evidence of a residual urban bias in the region's mortality patterns. Using a sample of Latin American countries over the 2000–2010 period, I analyse the disparities in mortality patterns and avoidable causes of death by looking closely at urban and rural areas using continuum categories. The results indicate that the urban advantage does persist and that rural–urban mortality differentials have consistently favoured the largest cities. The metropolitan advantage in mortality is an outcome of lower mortality in causes of death that are avoidable through primary interventions. Even in scenarios of high mortality at younger adult ages (15–44), the metropolitan advantage remains, due primarily to unsuccessful efforts to reduce mortality in populations aged 45 years and over outside the main and large cities.

Keywords Urbanization · Urban advantage · Mortality decline · Metropolization · Amenable causes of death

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1 Introduction

Inequalities in mortality across socio-economic groups have been widely studied over recent years through income, educational attainment, or other indicators (Wagstaff, 2000) that do not necessarily correspond to spatial categories. However, socio-economic stratification predicts only a small proportion of the variation in mortality (Pradhan et al., 2003). In the case of Latin America, many studies on living conditions have highlighted their unequal development along spatial lines, as rural areas have been left behind by the high concentration of goods and services in cities (Curto, 1993; Prata, 1992; Schkolnik & Chackiel, 1997).

Michael Lipton introduced the Urban Bias Thesis (UBT) as a framework for understanding economic and social inequalities along spatial lines. He identified how most macro- and microeconomic policy initiatives in low- and middle-income countries have led to the overdevelopment of urban areas and the underdevelopment of rural areas (Lipton, 1977, 1984). The UBT asserts that rural areas suffer from too little spending on welfare, creating unfair gaps among the population and inefficient resource distribution (Varshney, 1993). Moreover, urban bias can be traced in the way that rural–urban economics manifest into livelihood strategies (Jones & Carbridge, 2010). Although there is reason to believe that an urban bias persists in certain countries, the magnitude of this bias remains unknown (National Research Council, 2003).

With the strong favouritism shown towards urban areas in Latin American developmental policies, it is no surprise to find large disparities in the capacity of populations to satisfy their basic needs, and particularly in their health outcomes. One common view is that, because quality of life is closely linked to urban development (ECLAC, 2009), spatial differentials in mortality could provide unique insights into levels of regional (under)development. Scholars have investigated disparities in health outcomes across specific cities within various Latin American countries (Bilal et al., 2021). They have also examined the heterogeneity in life expectancy among the populations of some of the region's largest cities (Bilal et al., 2019). This study proposes an analysis that encompasses both intra-country comparisons—distinguishing all settlement along a gradient from rural areas to major cities—and inter-country comparisons over time. This approach aims to provide a comprehensive understanding of the spatial and temporal dimensions of mortality disparities within and between Latin American countries.

To that end, this research seeks to answer the following overarching question: Can urban bias be traced through spatial differences in mortality? To answer this question, I selected data from four Latin American countries: Brazil, Chile, Colombia, and Mexico. These represent diverse situations in terms of life expectancy at birth and percentages of urban population (see Appendix 1). The 2000–2010 period is conducive to this comparative analysis because, first, it adheres to the commonly used 10th Revision of the International Classification of Diseases (ICD) and, second, reliable data is available for all four countries. Moreover, mortality patterns appear to have stabilized between 2000 and 2010 compared to previous decades. This apparent stagnation could arise either from a

general lack of progress in the region or from wider heterogeneities concealed in the national indicators.

My main hypothesis is that the urban bias in Latin America consistently results in resources strategically driving faster mortality declines in urban areas. Without fail, urban populations have better health outcomes because they generally have greater access to healthcare facilities, including hospitals, clinics, and specialized medical services. They also benefit from improved infrastructure, such as clean water and sanitation. In addition, urban populations are often the priority target of health campaigns producing better awareness of health practices and preventive care. Delving into this more deeply, I hypothesize the following. (1) The advantage is concentrated mostly in the largest cities. Thus, relative to the rest of the country, their initial levels and trends during the period of analysis are the most advanced in terms of mortality decline. (2) The urban advantage derives mainly from a reduced impact of avoidable causes of death. (3) The advantage is principally generated by the lower infant mortality found in the most urbanized areas, which more than offsets the higher young adult mortality than in rural areas.

This research applies continuum categories to the term “urban”, rather than the dichotomous concept of urban or rural, using three types of recognizable spatial groups for all countries: main and large cities (more than 500,000 inhabitants); medium-sized and small cities (20,000–499,000 inhabitants); and towns and rural areas (fewer than 20,000 inhabitants). This grouping is based on similarities found in demographic behaviours during urbanization processes (Da Cunha & Rodríguez, 2009; Rodríguez, 2002) and in the deployment of urban infrastructure and equipment (ECLAC, 2005).

2 Urbanization and Mortality

In an attempt to specify a universal model of the spatial distribution of populations, Zelinsky (1971) defined the urban transition as a combination of the demographic transition and the mobility revolution in a particular spatial interaction (Zelinsky, 1971). Accelerated urban growth is driven by rural–urban migration that later decreases, making way for a second stage of increasing natural growth in urban areas (Rogers, 1979). De Vries (1990) and Dyson (2011) expand on the urban transition conceptualization by placing more importance on the role played by mortality in the urbanization process. Dyson identifies a first-stage urban penalty, in which deaths exceed births and urban growth depends entirely on rural–urban migration. Next comes a second stage urban advantage due mainly to a decline in infectious diseases and infant mortality (De Vries, 1990; Dyson, 2011). Mortality declines faster in urban areas because urban populations switch from being the most vulnerable to being the chief beneficiaries of advances in medicine and improvements in public hygiene (Fox, 2012).

In recent times, rapid urbanization has challenged countries’ capacity to provide public goods and services to all populations. What is more, unremitting biases that favour or disfavour urban areas prompt questioning of the linear process described by the urban transition. Nowadays, most subnational mortality analyses take into

account the idea of an urban penalty versus an urban advantage (Champion & Hugo, 2004). Both terms have been the subject of long-standing discussions on macro-level development approaches to explaining socio-economic inequalities and spatial gaps in the living standards of middle- and low-income countries.

2.1 The Over-Urbanization Thesis and Its Consequent Urban Penalty

The term “over-urbanization” was first introduced by Davis and Golden (1954) to describe countries in which the rate of industrialization grew more slowly than their rate of urbanization. Within a developmental paradigm, it is intended to explain rapid urban growth in contexts of continuous poverty and economic stagnation, by ascribing the high concentration of populations in cities to market failures in efficiently allocating labour across urban and rural areas (Davis & Golden, 1954). Scholars studying this developmental paradigm have pointed out that middle- and low-income countries focus on industrialization and are biased toward strategies that develop a modern urban sector. As such, they neglect agriculture and deplete their resources, leading to either stagnation or insufficient economic growth, or both, in rural and urban areas (Gugler, 1982; Rogers & Williamson, 1982; Todaro & Stilkind, 1981). Ultimately, over-urbanization will represent an obstacle to development (Frankman, 1971; Smith, 1987).

When studying mortality, scholars have compared the effect of over-urbanization on mortality to the urban penalty observed during the Victorian era in Europe: in this period, urban populations faced exposure to unhealthy physical environments filled with communicable diseases as well as social instability due to the growing issue of non-communicable diseases, such as mental ill-health, violence, accidents, and chronic disease. Within such environments, the double burden of being affected by communicable and non-communicable diseases is not equally shared by all urban residents, and gaps between social classes establish the guidelines for dealing with health inequalities (Freudenberg et al., 2005). From this perspective, it is expected that, over the long-term, health outcomes in cities, especially the largest ones, end up being worse than those in rural areas.

2.2 The Urban *Bias* Thesis and its Urban Advantage

The core component of the Urban Bias Thesis focuses on how the development process has been systematically biased against the countryside, specifically through insufficient welfare spending and huge differences in taxes, salaries, and food prices (Bates, 1981; Castell, 1977; Lipton, 1977; Varshney, 1993). Consequently, urbanization in middle- and low-income countries must be understood as policies that have promoted hyper-concentration in the largest cities (Smith, 1987), especially in their capitals (Cohen, 2006). The concentration of decision makers in capital cities induces producers and service providers to locate their businesses in these cities also (Keyfitz, 1982; Todaro & Stilkind, 1981). Thus, price distortions are no longer the main expression of urban bias, replaced by public expenditure biases (Lipton, 1984; Lipton & Ravallion, 1993; Eastwood and Lipton, 2000). The spatial concentration of

the population allows for economies of scale as well as greater scope for infrastructure investments (Becker & Morrison, 1999).

Since, its first iteration, the Urban Bias Thesis has been the subject of various reviews and criticisms. Furthermore, various stages have been identified in the way that rural–urban economics manifest into livelihood strategies. New economic geography suggests that most cities grow by exploiting the efficiency gains associated with clustering activity. Ergo, the concentration of some goods and services in urban areas may be an indication of convenience and an efficient use of scarce resources, enabling a reduction in structural inequalities (Jones & Carbridge, 2010).

An urban advantage in health for some low- and middle-income countries can be traced back to the nineteenth century, when cities began providing social services to the colonial settlers (Gould, 1999). This has remained constant in many countries, where amenities, preventive programmes, and medical facilities are concentrated in urban areas (Oris & Fariñas, 2016). The advantages result from a combination of factors. Firstly, absolute poverty and lack of services tend to be mainly rural phenomena. Secondly, urban populations have higher public health coverage rates than their rural counterparts and thus the proximity, dissemination, and uptake of public health interventions make them likely to be more effective in an urban setting (Leon, 2008). Finally, cities tend to attract individuals with higher incomes and higher education, which are reliable predictors of health and determinants of lifestyle (Sastry, 1997).

3 Urban *Bias* and the Metropolization Process in Latin America

Since, the beginning of the twentieth century, the population of Latin America has increased tenfold: from 60 to 161 million between 1900 and 1950, then up to 622 million by 2018. This growth was concentrated mostly in the urban areas and led to Latin America shifting from predominantly rural to predominantly urban in a period of about 50 years (ECLAC, 2011; UN-Habitat, 2012). By the year 2000, most Latin American countries had already achieved urbanization levels (urban populations of around 77%), and 14 percent of the region's urban population now lives in megacities of more than five-million inhabitants (ECLAC, 2011).

Likewise, the metropolization process emerges as a key factor for understanding Latin American urbanization, whereby populations initially concentrate in just one or two major cities that dominate the rest by monopolizing wealth, administrative functions, and political capital (Herrera & Pecht, 1976; Rowley, 1976). Initially, the expansion of social-welfare programmes mostly covered the large cities, leaving rural areas with severe shortages of doctors, services and supplies (Browning, 1967). Urban areas also experienced substantial improvements in the quality of their environmental conditions as a result of gaining access to piped water and toilet facilities in people's homes, an important factor in the reduction of infectious diseases such as diarrhoea, responsible for a large proportion of infant mortality (Timaeus & Lush, 1995).

Throughout the urbanization process, Latin American economies have primarily been exporters of raw materials and basic manufactured products, sectors in which

urban activities have not necessarily generated more resources than rural alternatives (McMillan & Rodrik, 2011). The over-importance of the urban space is related more to the development of tertiary sector activities and to public policy resource re-allocation than it is to real production. The economic activity of the region remains highly concentrated in a small number of urban centres: only 40 major cities in Latin America generate approximately 30% of regional Gross Domestic Product (UN-Habitat, 2012).

When one examines the population's average outcomes in living standards, education, health, and general welfare, the historic advantages of the urban space and capital cities still persist in the region. During the 2000s, 53 percent of the rural population lived in poverty (ECLAC, 2012). This *rural poverty* is associated with peasant family agriculture, the relative absence of the state in remote areas (Jones & Carbridge, 2010), and rural inhabitants having little access to land (Rodriguez, 2002). Rural poverty remains around 25 percentage points higher than urban poverty (Montero & Garcia, 2017). Urban poverty, on the other hand, is characterized by precarious workers living in self-built housing, who may benefit from better investment in schooling and healthcare (Ramirez et al., 2009).

If healthcare provision is superior in urban areas compared with rural areas, particularly in the largest cities, then they should correspondingly have fewer incidences of deaths. This would be especially true for deaths from diseases that are prevented either by eliminating the conditions in which they develop or by their early detection. Alternatively, if the metropolization process leads to negative lifestyle changes that hamper the urban preference in resource allocation, the advantage enjoyed by the largest cities will have shifted to a disadvantage.

4 Data and Methods

4.1 Data

Mortality rates are computed by causes of death and decedents' place of residence for all the minor administrative units (MIAD) in the countries under analysis. The MIAD is the equivalent of a county in the United States of America and of a *département* in France. MIAD are clustered according to the three types of recognizable spatial groups: main and large cities (more than 500,000 inhabitants); medium-sized and small cities (20,000–499,000 inhabitants); and towns and rural areas (fewer than 20,000 inhabitants). Mortality data comes from vital statistics records published by the National Statistics Institutes in Chile, Colombia, and Mexico, and by the Ministry of Health in Brazil, with population estimates being those published by the National Statistics Institutes in each country.

Despite improvements, a proportion of mortality data in most Latin American countries is under-registered or misreported. This research uses Brazil, Chile, Colombia, and Mexico as representative of different scenarios for life expectancy and urbanization levels in Latin America. However, of these countries, only Chile has good quality data. I apply indirect mortality estimates to assess and adjust the completeness of vital statistics in the spatial groups identified in each country, with

the exception of Chile, for which no adjustment is made. I also use data from the United Nations Inter-Agency Group for Child Mortality Estimation (UN IGME) at national levels and further combine these with the city-group differentials found when applying Trussell's variant on the Brass method to the census data, which allowed me to assess the incompleteness in infant mortality when using unadjusted vital statistics.

For assessing adult mortality, I combine two death distribution methods: general growth balance and synthetic extinct generations (Queiroz et al., 2017). I then add the impact of international and internal migration flows on each spatial group. Inter-census migration flows allow estimation of the international and internal migration in these countries and adjustment of the declared census stock by adding the non-surviving migrants during the period (See Appendix 2). All estimates are calculated with the R package DDM, Death Distribution Method (Riffe et al., 2017). Inter-census ratios of vital statistics to indirect estimates are interpolated and extrapolated in order to construct a yearly correction factor for separately adjusting incompleteness in infant and adult mortality estimations (Garcia, 2020a). After adjusting for incompleteness, I take ill-defined causes of death, unknown age, sex, and the MIADs of residency for all the deceased and proportionally distribute them into the known cases.

4.2 Cause of Death Classification

I focus on reported *underlying causes of death* to classify causes by amenability. The terms “avoidable mortality” and/or “mortality avoidable to medical/health care” indicate the important role that public health interventions play in changing mortality patterns, implying that deaths from certain causes should not occur in the presence of timely and effective policies leading to prevention, cure, and care (Rutstein et al., 1976; Nolte & McKee, 2003). I use the Tobias and Jackson (2001) classification of avoidable mortality causes within four categories (Tobias & Jackson, 2001):

- (1) Primary prevention, or preventing the condition from developing. This group includes conditions related to infectious diseases, anaemia, easily detectable neoplasms, car accidents, injuries due to malfunction of public equipment, and suicides, among others.
- (2) Secondary prevention. This means early detection and intervention to delay progression of disease or recurrence of events. Conditions such as diabetes, pregnancy-related complications, and curable neoplasms are in this group.
- (3) Tertiary prevention. This refers to reducing case fatality by means of medical or surgical treatment, such as cases of appendicitis, congenital conditions, and benign cancers.
- (4) Combined measures: This group gathers the causes whose prevention requires combined measures.

This approach is suitable for studying urban bias, because Tobias and Jackson intended to go beyond the traditional concept of avoidable mortality and to measure

the theoretical scope for further population health gains (Nolte & McKee, 2003). I add to the primary avoidable mortality some conditions that regularly affect the countries under study.¹ These additional conditions correspond to the groups categorized as arthropod-borne viral fevers, protozoan diseases, and viral infections (See Appendix 3).

4.3 Deaths-to-Population Proportional Ratios

A national mortality pattern that is evenly spread across the territory would be indicative of nonbias towards a geographical area, as such a distribution implies an equal proportion of death counts and population—by age and sex—in each spatial group when accounting for their national contributions. I calculated a deaths-to-population proportional ratio $DPR^{t,\beta}$ of a spatial group (β) at time t as the quotient of the proportion of the subpopulation’s deaths of the spatial group (β) at age x and $x+n$ at time t (${}_nD_x^{t,\beta}$) to the proportion of the subpopulation’s size of the spatial group (β) at age x and $x+n$ at time t (${}_nN_x^{t,\beta}$)

$$DPR^{t,\beta} = \frac{{}_nD_x^{t,\beta}}{{}_nN_x^{t,\beta}} \tag{1}$$

4.4 Life Expectancy at Birth Decomposition

Decomposing differences in life expectancy at birth reveals the dimensions that contribute to changes in this indicator over time and that are responsible for differences between two populations. Here, I focus on following the discrete approach using the algorithm from the contour replacement decomposition method developed by Jdanov et al. (2017). This algorithm takes the initial differences in the event-rates of the aggregate measure and the differences in trends, and then splits them into additive components. Likewise, the method incorporates three decompositions: the difference between two populations A and B at the initial time point (initial component ($\Delta_{ab|AB}^i$); and two decompositions of their changes (trend component ($\delta_{ab|AB}^i$)) between the initial and final time points (final difference (Δ_{AB}) for the two life expectancies being compared.

$$\Delta_{AB} = \sum_{i=1}^n (\text{Initial}^i + \text{Trend}^i) = \sum_{i=1}^n \left(\Delta_{ab|AB}^i + \delta_{ab|AB}^i \right) \tag{2}$$

¹ Certain causes are added to the classification as deaths preventable through primary intervention. These causes are: 1) viral infections of the central nervous system (acute poliomyelitis, rabies, mosquito-borne viral encephalitis, tick-borne viral encephalitis, viral meningitis); 2) arthropod-borne viral fevers and viral haemorrhagic fevers; 3) protozoal diseases (leishmaniasis, African trypanosomiasis, Chagas disease, toxoplasmosis, pneumocystosis, other protozoal diseases; and 4) viral infections characterized by skin and mucous membrane lesions (herpesviral, varicella, zoster, smallpox, monkeypox, rubella, viral warts, others).

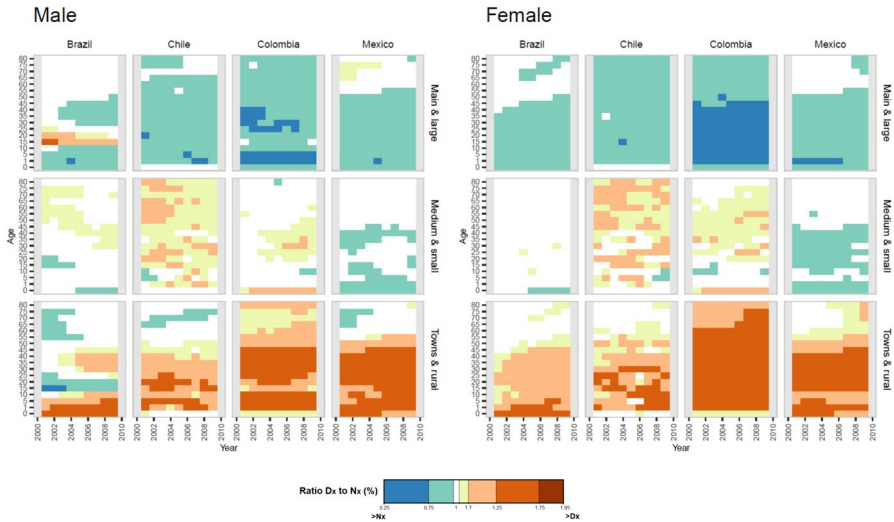


Fig. 1 Ratios of death and population proportions to country counts, by sex and age, among spatial groups. Differences in death vs. population distributions, by age and sex, are scaled around a central value into seven uneven discrete categories. A value of one indicates the same proportions for deaths and population (represented by white in the figure); values above one indicate excess deaths relative to the population (coloured yellow to red, according to differences); and values below one indicate undermortality (coloured blue to green)

5 Results

If national mortality patterns were spread evenly across the territory without any bias toward a (dis)advantaged area, the death count and population distributions would be commensurate. Thus, it is expected that death counts by age and sex would have an equal distribution, proportional to the population, within each spatial group. An unequal distribution would reflect “excess” or “deficit” mortality. Figure 1 shows a yearly ratio of the proportional distributions of death counts to population counts. The results show barely any concordance between numbers of deaths and population distributions by age and sex, with main-and-large cities recording mostly lower proportional mortality-to-population for all countries.

Male and female patterns are alike, the only differences emerging from lower proportional mortality-to-population in the town-and-rural areas group for males and a slightly higher mortality-to-population in main-and-large cities group at older ages. In Colombia and Mexico, excess mortality in the towns-and-rural group persists for the entire period, regardless of age and sex. While, Colombia has a higher concentration of deaths in the under-one-year-old population (and this is even higher in the medium-sized-and-small cities group), the only age-group in Mexico, where a large excess of deaths is not found in the towns-and-rural group is 50 years and over. For both sexes, the disadvantage of Mexican areas outside the main and large cities is reversed after the age of 50. Brazil and Chile display variations in their death and population distributions, depending on age and sex. Brazil shows an excess of male deaths between 15 and 30 years old in the main-and-large-cities group, which also

shifts from an advantageous to an even distribution of male death counts at age 50 and over. Chile is the only country in the sample showing no differences in death distributions across spatial groups in babies under one year of age.

The medium-sized-and-small-cities group does not have a consistent position across all countries. With the exception of females in Brazil, this group remains at an intermediate level between the main-and-large-cities groups and the towns-and-rural groups. However, the medium-sized-and-small-cities groups tend to swing closer to one specific group rather than to the other, depending on the country. For example, in Chile and Colombia, these groups emerge closer to their own towns-and-rural groups than to their main-and-large-cities groups; while in Brazil and Mexico, the medium-sized-and-small-cities groups are more similar to the main-and-large-cities groups. In terms of mortality differentials per country, the most urbanized countries tend to show fewer differences between spatial groups. Dissimilarities in initial mortality levels among cities relate to the residual extent of infant mortality and the contribution of specific age groups (such as those aged 1 to 45 years) in the non-main-and-large-cities groups.

5.1 Avoidable Mortality Among Spatial Groups

Life expectancy at birth has increased—at various paces—across Latin America, since the 1950s (Palloni & Pinto-Aguirre, 2011). Likewise, during the period of analysis, in all selected countries, a slow increase in life expectancy at national level is reflected in mortality trends. Of course, each country has its own pace and initial level; Chile—the most urbanized country in the sample—maintains the highest life expectancy at birth for the 2000–2010 period. Since, cities (especially capital cities) are consistently privileged in terms of regional development, lower mortality levels can be expected in the main-and-large-cities group when compared with the towns-and-rural group, regardless of the country's mortality level as a whole.

Figure 2 decomposes the advantage of the main-and-large-cities group relative to other spatial groups in 2010 (in blue-coloured numbers). The decomposition shows the contributions (in years) to differences in life expectancy at birth that are made by the *initial* difference (in 2000) and by each group's *change* during the period (2000–2010). By considering the main-and-large-cities group's life expectancy at birth as a reference, the share of the initial level and contribution due to changes (in grey-coloured numbers) among the spatial group are positive if they increase the advantage or negative if they reduce it.

For most countries, the total initial contributions are positive because the main-and-large-cities group enjoyed an advantage in all countries at the starting point (2000). However, the overall advantage of the main and large cities in 2010 comes from the larger contributions of the changes during the period, rather than the initial difference between the spatial groups.

Deaths classed as avoidable through prevention of conditions are the main driver of the main-and-large-cities group's initial advantage; along with deaths preventable by early detection, these are the leading contributors to changes in the prevailing superiority of the main and large cities over the period.

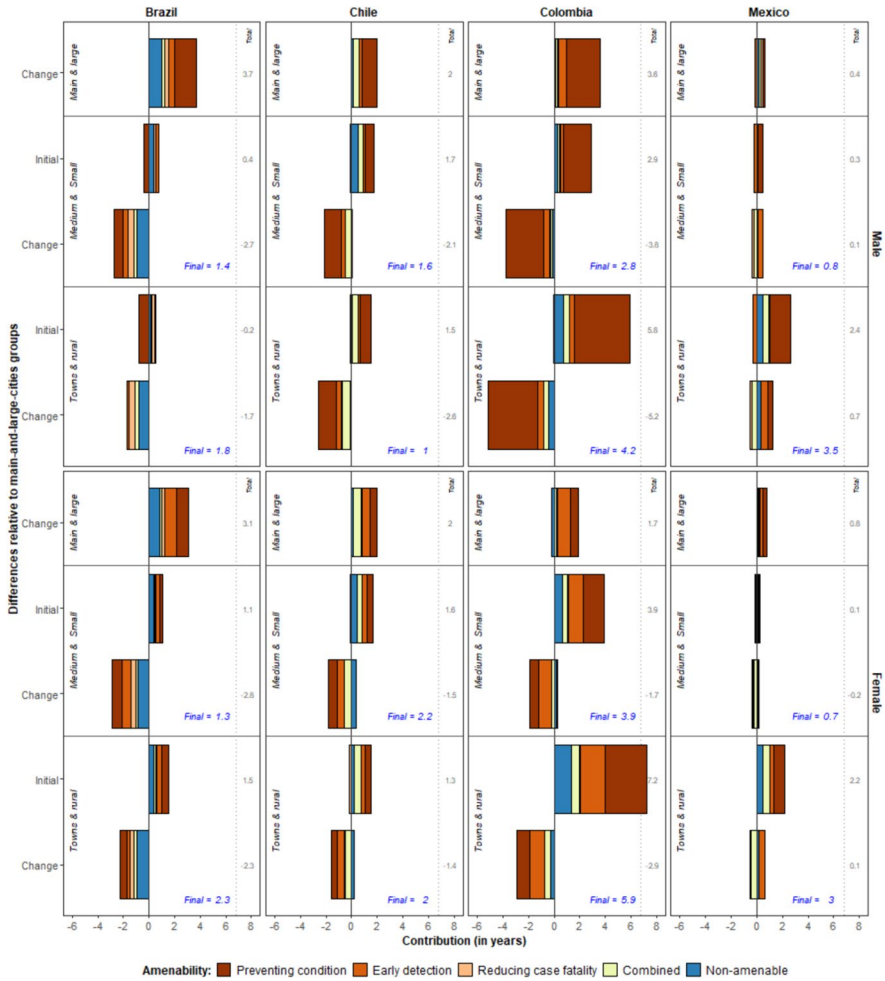


Fig. 2 Contributions (in years) to differences in life expectancy at birth among spatial groups (main-and-large-cities group as reference), by cause of death according to amenability, sex, and country, 2000–2010. Contributions (in years) to differences in life expectancy at birth between main-and-large-cities groups and other spatial groups in 2010, decomposed into each spatial group’s initial difference in 2000 (Initial) and changes during the 2000 to 2010 period (Change), and causes of death according to their amenability avoidable causes are coloured yellow to red, according to their required level of intervention, and non-avoidable causes are coloured blue. The total initial contributions and changes (in years) to differences in life expectancy at birth are in grey-coloured numbers, and the synthetic final differences (in 2010) are in blue-coloured numbers

Exceptionally, the superiority of the main-and-large-cities groups over other spatial groups in Mexico, for males in Chile, and relative to the towns and rural areas in Colombia depends greatly on the contribution of the initial advantage. This initial advantage in life expectancy at birth is due to avoidable causes of death being less prominent, particularly those causes avoidable through primary interventions aimed at preventing diseases or conditions. In lesser proportions, causes of death avoidable

through secondary interventions and by a combination of interventions played a role by contributing to the initial advantage enjoyed by the above-mentioned subpopulations in the main and large cities. Furthermore, the main-and-large-cities group's life expectancy at birth is superior to all other populations in Brazil, due to the contributions afforded by changes in the spatial groups during the period, which are driven by causes of death avoidable through both primary and secondary interventions. The same pattern is recorded for women in Chile.

The contributions of avoidable causes are noticeable regardless of the initial difference or changes during the period, and independently of the proportion of causes avoidable through primary interventions. Although, this is true for both males and females, the primary interventions group nevertheless contained all the external causes, which generally have a greater impact on male life expectancy. In Colombia, where causes of death avoidable through primary interventions are the main drivers of change, all Avoidable contributions are prominent in the differences in female life expectancy.

The towns and rural areas in all countries may catch up with the main-and-large-cities groups, who enjoy an initial advantage from causes of death avoidable through early detection (secondary interventions); thus, changes throughout the period may ultimately act against their final advantage.

Non-avoidable causes of death also contribute to the initial differences in life expectancy, particularly for women in Colombia, medium-and-small cities in Chile, and all groups in Brazil. In Brazil, this contribution is observed both initially and throughout the period of change, whereas the initial difference in Colombia is mostly seen in women.

5.2 The Age Contribution to the Differences

Here Fig. 3 decomposes the age-group contributions (in years) to differences in life expectancy at birth between the main-and-large-cities group and other spatial groups in each country. The advantage of the main and large cities relied on their initially lower levels and on the reduction of avoidable mortality in the population aged 45 and over. Chile was the only country in which there were negative contributions to the advantage through improvements outside the main and large cities, coming from changes in avoidable mortality among those aged 75 and over for both sexes.

Looking in detail at the age-group contribution of avoidable causes, the advantage over the towns and rural areas is due to the lower mortality at all ages in the initial year and, to a lesser extent, to contributions from adult ages. A persistently high rate of infant mortality due to avoidable causes in towns and rural areas contributed to a larger differential in comparison with the main-and-large-cities group. Consequently, the changes during the period that explain the final difference are a result of the towns and rural areas catching up in terms of infant mortality reduction. The only exceptions are Brazilian males and Chilean towns and rural areas: during the initial period in Brazil, males made negative contributions to the final advantage at ages 15–74, and initial contribution of avoidable causes in Chilean towns and rural areas was seen only in adult ages.

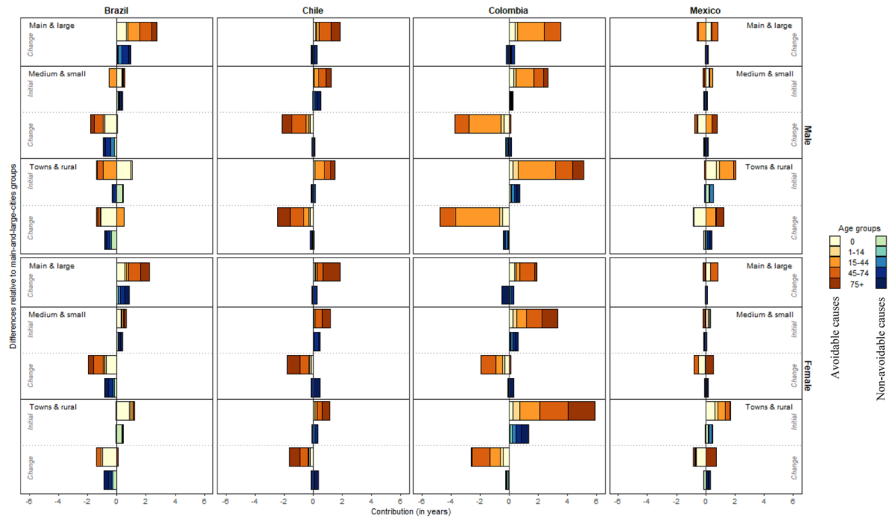


Fig. 3 Contributions (in years) to differences in life expectancy at birth among spatial groups (main-and-large-cities group as reference), by age, avoidable and non-avoidable cause of death, sex, and country, 2000–2010. Contributions (in years) to differences in life expectancy at birth between the main-and-large-cities group relative to other spatial groups in 2010, decomposed into each spatial group’s initial difference in 2000 (Initial) and change during the 2000–2010 period (Change). The age-group contributions to the differences in avoidable causes of death are coloured yellow to red, and non-avoidable contributions are coloured blue to green. (Color figure online)

In medium and small cities, on the other hand, the initial contribution of avoidable causes to the final advantage is concentrated in adult ages (15–44) and, once again, it was only adult (15–44) Brazilian males who made negative contributions to the advantage in the initial year. Changes over the ten-year period contributed greatly to reducing the advantage of the main and large cities with respect to the medium-and-small-cities group. These contributions are larger than the initial advantage in all countries, with the exception of Colombia, where the contribution of the initial advantage was greater. Contributions aimed at reducing the advantage of the main-and-large-cities group derived from changes in avoidable mortality during the period are seen at all ages, but particularly from ages 45–74.

Changes in avoidable mortality at all ages in the main-and-large-cities group during the period contributed positively to its advantage. Positive contributions came from all age groups in Brazil and Chile, whereas the contribution of changes in Colombia was limited to those aged 74 and under. Mexico was the only country with a negative contribution due to changes in avoidable mortality of young male adults (ages 15–44) living in the main and large cities. In this sense, the contribution of the initial difference to this group’s final advantage was certainly smaller than in other countries.

In general, Brazil showed some atypical patterns relative to the other countries, specifically in the contribution of non-avoidable causes to the final advantage of their main-and-large-cities group. Negative contributions to changes in all spatial groups occurred in all age groups. Other than Brazil, only Colombian towns and

rural areas had similar patterns. In the other subpopulations, the contributions of non-avoidable causes were incipient and mainly derived from older age groups.

6 Discussion

In countries experiencing a recent and accelerated urbanization process, both urban advantages and penalties have been observed in recent years when analysing spatial differentials in mortality. My main hypothesis is that, because urbanization and development are tightly linked in Latin America, goods and services are concentrated in the most urbanized areas and faster mortality decline has been consistent in cities relative to the countryside. The results of this analysis show, accordingly, that life expectancy achieved its highest levels in the main and large cities. An urban advantage led by a metropolitan advantage is seen across all countries in this study; it does not extend to all cities but is instead driven by the main and large ones. The fact that the main-and-large-cities group has the highest life expectancy does not mean that all main and large cities have the best performance in the region. Instead, it indicates that the main and large cities have the best performance in their respective countries. Even in Mexico, where the main-and-large-cities group shows a poor performance relative to their counterparts in the region, the group remains superior to the other Mexican subpopulations.

The metropolitan advantage in mortality results mainly from the contributions of avoidable causes of death at all ages, an initial advantage in infant mortality, and declining older adult mortality during the period, all of which characterize this group's final advantage. The positive contributions of avoidable causes to the main and large cities' advantage extend to both men and women, even when men are impacted considerably more by causes avoidable through primary interventions. This means that the advantages of the main-and-large-cities groups in all countries can be attributed to causes of death that should not occur in the presence of timely medical care and basic urban amenities, as well as the population having a minimum standard of living.

An in-depth look reveals that using avoidable cause of death can provide insight into the level of urban (under)development according to city size. Concentrating populations into the main and large cities allows for greater coverage of basic services such as sewage and water systems, adequate housing, and proper roads, among others. Similarly, after investigating the impact of urbanization on health and well-being in China, Hou et al. (2019) found that improved health outcomes in urban areas compared with rural regions might be a function of a planned urbanization process and its associated improved basic infrastructure, such as flushing toilets (Hou et al., 2019). Health outcomes are not driven by underlying differences in socio-economic and behavioural characteristics between urban and rural settings, or between individual and household behaviours, but, rather, concentrating these factors in cities results in better outcomes (Phillimore & Reading, 1992; Sastry, 1997; Haines, 2001; Reher, 2001; Zimmer et al.,). Urban institutions are better organized and have greater power than rural areas, particularly in terms of obtaining the support they need from central governments. The largest cities are generally richer than rural areas, and urban

residents can rely on care through insurance programmes, access qualified medical personnel, and draw on an array of private health resources.

In Latin America, the changes responsible for mortality differentials between subpopulations occur separately at younger adult ages (15–44) and at older adult ages (45–74). These two age groups do not follow the same trends among the spatial groups in most of the countries. Instead, these age groups contribute to the advantage of the main and large cities in a hierarchical catching-up process. In other words, the large initial advantage over towns and rural areas results from infant mortality, which produces the largest negative contribution to the advantage of the main and large cities during the ten-year period of change; whereas the largest initial advantage over the medium and small cities is found in adult ages (45–74), which equally show the greatest reduction over the period. Lastly, the initial and final advantages of the main-and-large cities group rely on better health outcomes for the population aged 75 and over due to lower avoidable mortality.

Before the period of analysis, the improvements in Latin American mortality had been driven mostly by a reduction in the risk of infant death, which is still noticeable in the most disadvantaged subpopulations in the sample: towns and rural areas. However, the importance of reduced infant mortality is not only as the main driver of increasing life expectancy, it also plays a role in balancing the negative impact of premature death among young adults in urban areas. These two opposing forces have led to an apparent stagnation in decreasing mortality. The impact of violence on young adult mortality has been repeatedly highlighted as the key factor behind periods of stagnation and setbacks, hampering increases in Latin American survival curves. Here, I show that, even in scenarios of negative contributions to the advantage at younger adult ages (15–44), the reduction of older adult mortality continues to lever up the main and large cities' advantage. This means that stagnation in increasing life expectancy at the national level may be due mostly to unsuccessful efforts to reduce mortality in populations aged 45 years and over outside the main and large cities. Older adult mortality reduction is related to urbanization, which may be one reason why the most urbanized countries are where the highest survival is found. A composition effect of the urban/rural population distribution at the national level may favour survival after 45 years of age. Thus, there is no evidence of increases in older adult survival in the less urbanized areas studied here during the 2000–2010 period. The only exception to this is Chile, where towns and rural areas contribute to decreasing the advantage of the main and large cities.

The main-and-large-cities group is privileged in terms of policies, as they maintain lower levels of avoidable mortality due to primary interventions at the beginning of the period. What is more, they also benefit the most from reduced mortality due to secondary interventions, which are linked to having basic access to general medical care, medication, and regular treatment. The spatial-group differential by avoidable causes emerges as a gradient for all the countries. However, in some countries—such as Brazil and Mexico—the gap is particularly wide for towns and rural areas compared with all cities, regardless of size; while in Chile and Colombia, the main and large cities endure as the most significantly advantaged group. The impact of the spatial differential in causes of death avoidable through primary intervention may be related to the role played by capital cities as centres of power and wealth within each country's city system. The difference

between these two groups of countries might be the result of strategies for de-concentrating their capital cities. Brazil and Mexico have deployed strategies for de-concentrating their capital cities by creating new planned industrial cities or by consolidating secondary industrial metropolises and agro-industrial regions (Smith & London, 1990; Villa & Rodríguez, 1994). With this expansion, previously isolated or remote medium-sized and small cities have become important to the national population and wealth distribution, and they have been the beneficiaries of large-scale public investments (UN-Habitat, 2012; Villa and Rodríguez 1994; Baeninger, 2002). At the same time, government strategies in Colombia and Chile have led to the accelerated expansion of their larger cities, enlarging the demographic and economic weight of the major metropolises and expanding their areas of influence (Da Cunha & Rodríguez, 2009; Cuervo Gonzalez, 2017).

6.1 Strengths and Limitations of this Research

Demographic studies commonly use political-administrative units when examining differences in local policies. Here, a different strategy is implemented, focussing more on capturing the gaps in demographic phenomena that are introduced by the direct association between development and urbanization. While, assessing the completeness and quality of the data in use, it seems clear that there is a relationship between urbanization and the (under)development of overall data quality: it is in the most urbanized country (Chile) and in main and large cities where data quality is better. Likewise, spatial analysis of spatially-unadjusted data could lead to false conclusions, which may be driven more by the geographical differentials in the completeness of the vital statistics system than by demographic phenomena. Here, it is one of the main strengths of this study, aiming at a fair inter/intra-country comparison.

One limitation to this study pertains to the arrangements for maintaining the comparability of spatial groups by size in all countries. Since, each country defines “urban population” differently, and because I used the minor administrative division (MIAD) unit to link different data sources, properly rural areas could not be distinguished from towns. However, by contrasting dichotomous and continuous approaches to urban–rural differentials in infant mortality for the same countries (García, 2020), we see that the towns-and-rural-area patterns are comparable to those in rural areas alone; this indicates that using the 20,000-inhabitant limit as an urban/ rural dividing line might be accurate when analysing their long-term mortality trends.

7 Conclusion

In order to construct a broader causal explanation, population theories have established inverse and direct links between the urbanization process and rural–urban differentials in mortality. Two outcomes of mortality patterns result from the recent urbanization processes: an *over-urbanization* effect, which is seen as an *urban penalty*; and an *urban bias* effect, evidenced by the persistent *urban advantage* in mortality. This means that rapid urbanization could be either detrimental or beneficial to populations living in urban spaces, and its relationship depends on how the

urbanization process advances and how economic development coincides with the urbanization process. As such, urban (dis)advantages in mortality may indeed not be different stages of a linear process, as suggested by the urban transition. Once, economic and development strategies are considered, urban (dis)advantages may be the outcome of resource re-allocation and livelihood strategies that countries apply as a reaction to rapid population growth and urban concentration.

Furthermore, a framework centred on a rural–urban dichotomy denies the possible effects of other processes linked to urbanization (such as *metropolization*) that may occur as countries experience accelerated urbanization. In the case of Latin America, the concentration of goods and services in the main and large cities may represent a convenient and efficient means for achieving mortality decline. This is because countries in an accelerated urbanization process require a continuous expansion of goods and services to rural areas, while simultaneously intensifying their public policies in increasingly urban areas. One should keep in mind that, while Latin America is one of the most urbanized and “*metropolised*” regions in the world, it is also one of the least populated.

The impact of the urban bias in the macro-level development strategies implemented by Latin American countries in the face of accelerated urbanization is still traceable in their mortality patterns. Even in the absence of an urban bias in resource allocations, the advantages enjoyed by the main and large cities—especially the capital cities—will rely on higher concentrations of non-poor and more educated populations in the metropolis.

Appendix 1

See Table 1.

Table 1 Life expectancy and percentage of urban populations in Brazil, Chile, Colombia, and Mexico, 1995

| % Urban population in 1995 | Life expectancy in 1995 | |
|----------------------------|-------------------------|--------------------|
| | Higher (> 69 years) | Lower (< 69 years) |
| High (> 80%) | Chile | Brazil |
| Medium (60% to 80%) | Mexico | Colombia |

Source CEPALSTAT. Databases and statistical publications, at http://estadisticas.cepal.org/cepalstat/web_cepalstat/estadisticasIndicadores.asp?idioma=iconsulted04.02.2019

Appendix 2

See Fig. 4.

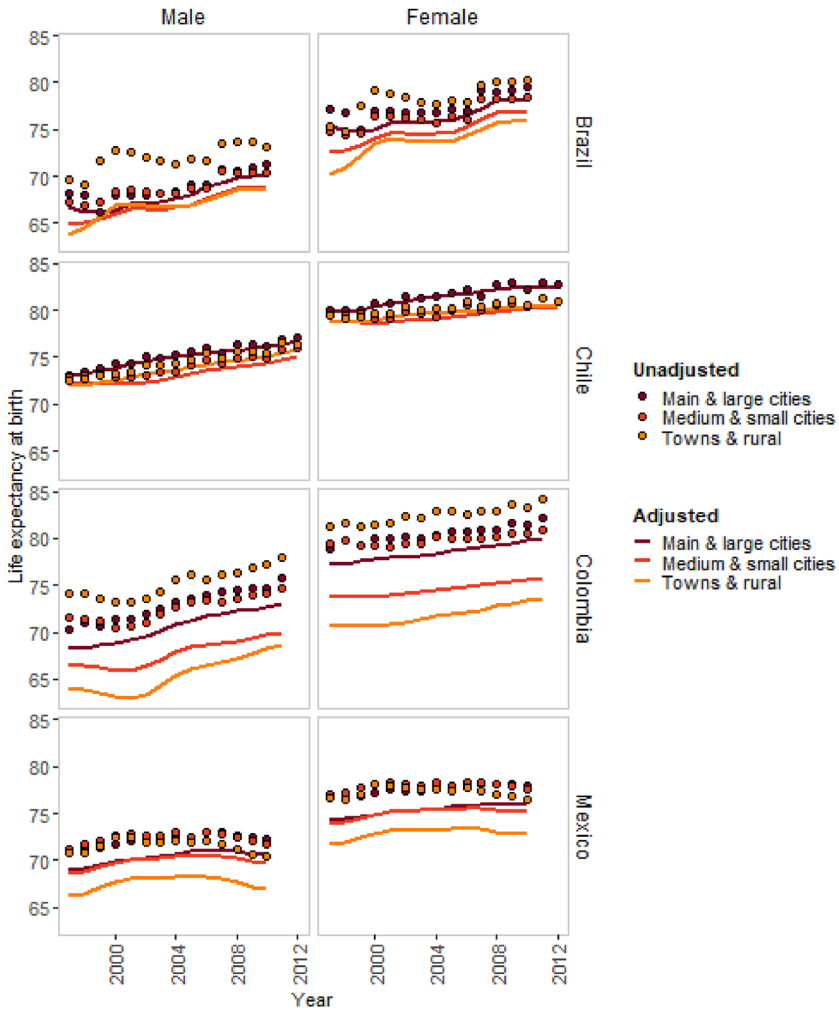


Fig. 4 Adjusted and unadjusted life expectancy at birth by sex, spatial group, and country, 2000–2010

Appendix 3

Tables 2, 3.

Table 2 Avoidable causes of death classification by Tobias and Jackson (detailed)

| Conditions involved | ICD-10 | Group |
|--|------------------|-------|
| Diarrhoeal diseases | A00–A09 | PAM |
| Tuberculosis | A15–A19, B90 | PAM |
| Diphtheria | A36 | PAM |
| Whooping cough | A37 | PAM |
| Tetanus | A33–A35 | PAM |
| Syphilis + gonorrhoea | A50–A64 | PAM |
| Polio | A80, B91 | PAM |
| Measles | B05 | PAM |
| Rubella | B06, P35, P38 | PAM |
| HIV/AIDS | B20–B24 | PAM |
| Hepatitis A, B, C, D, E | B15–B19 | PAM |
| Primary liver cancer | C22 | PAM |
| Lip cancer, melanoma, other skin cancer | C00, C43, C44 | PAM |
| Malignant neoplasm mouth | C01–C06 | PAM |
| Malignant neoplasm pharynx | C10–C14 | PAM |
| Malignant neoplasm larynx | C32 | PAM |
| Malignant neoplasm trachea | C33 | PAM |
| Malignant neoplasm bronchus AND lung | C34 | PAM |
| Nutritional deficits including anaemia | E40–E64, D50–D53 | PAM |
| Psychosis due to alcohol abuse | F10 | PAM |
| Ischaemic heart disease | I20–I25 | PAM |
| Chronic bronchitis and emphysema | J40–J44 | PAM |
| Liver damage due to alcohol | K70 | PAM |
| Other STD | N70–N77 | PAM |
| Ectopic pregnancy | O00 | PAM |
| Prematurity, low birthweight, respiratory disease from prematurity | P05–P07, P27 | PAM |
| Congenital anomalies of brain and spinal cord | Q00–Q06 | PAM |
| Sudden infant death | R95 | PAM |
| Road traffic injury | V01–V89 | PAM |
| Poisoning | X40–X49 | PAM |
| Swimming pool falls and drownings | W67 | PAM |
| Falls from playground equipment, sport injury | W02, W09 | PAM |
| Burns and scalds | X00–X09 | PAM |
| Suicide | X60–X84 | PAM |
| Colorectal cancer | C18–C21 | SAM |
| Cervical cancer | C53 | SAM |
| Congenital hypothyroidism | E00 | SAM |
| Goitre, thyrotoxicosis, hypothyroidism | E01–E05 | SAM |
| Diabetes | E10–E14 | SAM |
| CAH | E25 | SAM |
| PKU | E70 | SAM |
| Galactosaemia | E74 | SAM |
| Epilepsy | G40, G41 | SAM |
| Otitis media and mastoiditis | H65–H95 | SAM |
| Acute rheumatic fever, heart disease | I00–I09 | SAM |

Table 2 (continued)

| Conditions involved | ICD-10 | Group |
|--|-------------------------|-------|
| Hypertensive disease | I10–I16, I67 | SAM |
| Intracerebral haemorrhage or occlusion | I61–I66 | SAM |
| Asthma | J45, J46 | SAM |
| Gastric and duodenal ulcer | K25–K28 | SAM |
| Skin, bone and joint infections | M00, L00–L08, M86 | SAM |
| Complications of pregnancy | O01–O99 | SAM |
| Breast cancer | C50 | TAM |
| Cancer of testis | C62 | TAM |
| Eye cancer | C69 | TAM |
| Thyroid cancer | C73 | TAM |
| Hodgkin's disease | C81 | TAM |
| Lymphoid leukaemia | C91 | TAM |
| Benign cancers | D00–D36 | TAM |
| Appendicitis | K35–K38 | TAM |
| Intestinal obstruction and hernia | K40–K46, K56 | TAM |
| Gallbladder disease | K80–K83 | TAM |
| Acute renal failure | N17 | TAM |
| Other perinatal conditions: respiratory disease, haemolytic disease, jaundice, etc | P08, P22, P25, P26, P28 | TAM |
| Congenital eye, ear, face, and cardiac malformations | Q10–Q19 | TAM |
| Congenital cardiac malformations | Q20–Q28 | TAM |
| Congenital respiratory system malformations | Q30–Q37 | TAM |
| Congenital digestive anomalies | Q38–Q45 | TAM |
| Congenital urinary system anomalies | Q50–Q64 | TAM |
| Congenital musculoskeletal AND OTHER anomalies | Q65–Q99 | TAM |
| Complications of treatment | Y40–Y84 | TAM |
| Brucellosis | A23–A32 | COM |
| Streptococcus | A38 | COM |
| Meningitis | A39, G00, G04 | COM |
| Erysipelas | A46 | COM |
| Malaria | B50–B54 | COM |
| Other transmissible diseases | B96, P35 | COM |
| Stomach cancer | C16 | COM |
| Cancer of uterus | C54, C55 | COM |
| Respiratory infections including pneumonia and influenza | J00–J21 | COM |
| Birth trauma and asphyxia | P10–P21, P24, P50, P51 | COM |
| Congenital Pneumonia | P23, P36–P37, P39 | COM |

PAM = Primary Avoidable Mortality, SAM = Secondary Avoidable Mortality, TAM = Tertiary Avoidable Mortality, COM = Avoidable Mortality using Combined measures

Data Availability All datasets used in this manuscript are publicly available on the National Statistics Office in each country under studied. Analyses are available from the corresponding author on reasonable request.

Table 3 Primary avoidable mortality (PAM) added to Tobias and Jackson classification

| Conditions involved | ICD 10 |
|--|------------------|
| Viral infections of the central nervous system (acute poliomyelitis, rabies, mosquito-borne viral encephalitis, tick-borne viral encephalitis, viral meningitis) | A81–A89 |
| Arthropod-borne viral fevers and viral haemorrhagic fevers | A90–A99 |
| Protozoal diseases (leishmaniasis, African trypanosomiasis, chagas, toxoplasmosis, pneumocystosis, other protozoal diseases) | B55–B64 |
| Viral infectious characterized by skin and mucous membrane lesions (herpesviral, varicella, zoster, smallpox, monkeypox, rubella, viral warts, others) | B00–B04, B07–B09 |

Declarations

Conflict of interest The author declares that they have no competing interests.

Ethics Approval and Consent to Participate Not applicable.

Consent for Publication Not applicable.

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