Rural-Urban health and mortality differentials in Brazil, 2010-2013

## Introduction

By the time of urbanization and industrialization processes in Western countries, residents of urban areas used to exhibit higher mortality rates than their rural counterparts (Davis 1973; Woods 2003). Youth mortality rates played a key role in these urban-rural differentials (Woods 2003). Infant and child mortality rates are sensitive to wealth and socioeconomic characteristics through variables such as sanitation conditions and population dietary intake (Mosley and Chen 1984). Therefore, poor living conditions and high population density of XIX century cities contributed to the spread of communicable diseases, which accounted for the largest share of urban deaths in the period (Davis 1973; Omran 1971).

Living conditions improved in Western cities through socioeconomic development and economic growth (Preston 1975). Thus, deaths by communicable diseases declined and marked the start of the epidemiological transition (Omran 1971). Nevertheless, unequal regional socioeconomic development led to health and mortality differentials within countries. In the United States, for example, rural and non-metropolitan residents are more likely to experience lack of access to health equipment, health illiteracy and other kinds of socioeconomic deprivation which result in a disadvantaged position regarding life expectancy and health indicators in general (Chen et al. 2019; Henning-Smith et al. 2019; Singh and Siahpush 2013; Spencer et al. 2018; Voigt et al. 2019).

The aim of this paper is to further investigate mortality and health differentials across rural and urban population in Brazil. Rural life expectancy advantage expressed in the Brazilian national census of 2010 (Albuquerque 2019) may not reflect a real disease free life expectancy or healthy life expectancy advantage, e. g., people from rural areas might live for longer periods, but they would have to live with disabilities that can mitigate their capacity to develop daily activities. In this sense, we investigate the prevalence of some specific diseases in urban and rural populations and construct disease-free life expectancy estimates for both residents using data from the national census of 2010 and from the national health survey (PNS, from Portuguese *Pesquisa Nacional de Saúde*) of 2013. Our hypothesis is that urban areas may exhibit relative advantages in disease/disability-free life expectancy than rural areas for health problems related to physical effort while a higher prevalence of chronic diseases may be more harmful in the urban environment. By focusing on adult population estimates, this work contributes to the evaluation of urban environment penalties on adult mortality and morbidity in developing countries by analyzing specific groups of diseases and disabilities that result in different mortality outcomes for urban and rural areas (Günther and Harttgen 2012).

The debate over urban and rural mortality differentials in developing countries is usually divided in two components: infant/child mortality and adult mortality. Infant and child mortality are more impacted by community-level characteristics and socioeconomic situation (Mosley and Chen 1984; Sastry 1997, 2004). In Brazil, urban areas exhibit an under-five mortality advantage in comparison to the country’s rural areas, as a result of its better socioeconomic status such as higher schooling levels and higher access to sanitation and public services in general (Sastry 1997, 2004).

Despite the urban advantaged observed in child and infant mortality levels, most studies documented lower adult mortality rates in rural areas of low income countries (Fink, Günther, and Hill 2016; Gould 1998). Metropolitan areas of developing countries present high within-urban mortality gaps among social groups due to the unequal access to essential public services (health equipment, education and sanitation) as a consequence of a rapid urbanization process (Brueckner 2019; Fink, Günther, and Hill 2016; Günther and Harttgen 2012). Living conditions in these developing urbanized centers deteriorate individuals health and expose them to higher mortality risks compared to their rural counterparts in a similar way as observed in the past for more developed countries, resulting in an urban death penalty (Carvalho and Wood 1978).

This is a particular feature of Brazilian mortality differentials. The advantage of urban environments regarding mortality in Brazil prevails on some specific conditions. Carvalho and Wood (1978) showed that urban-rural life expectancy differentials favored the urban areas of wealthier social strata whereas the opposite was observed in poor areas of the country in 1960-70 period. Using 2010 National Census mortality data, Albuquerque (2019) verified a mortality advantage for rural areas, especially for the males . He estimated 73.6 and 69.3 life expectancy at birth for rural and urban male population, respectively, and 77.8 and 77.1 years for females. Pereira (2020) disentangled these findings by looking into social groups of different urban areas. He compared Brazilian mortality levels of urban residents from slums and from out of slums with rural resident’s mortality levels and verified an urban penalty for those living in these marginalized urban environments. The urban periphery of Brazilian metropolitan areas are known for its poor urban assets and damaged social conditions, presenting high violence and criminal rates and deprivation of public assets such as public sanitation (Merrick 1985; Rodella 2015). The result of this scenario is a worsened health and mortality status of the urban periphery adult population of the country (Albuquerque et al. 2017; Pereira 2018; Pereira and Queiroz 2016).

The present work contributes for the evaluation of urban-rural socioeconomic disparities in Brazil. By using national census of 2010 and national health survey data, we estimate life expectancy and disability free life expecatncy for urban and rural residents. Our findings show that, despitepresenting an overall advantage in terms of life expectancy, rural residents present worse indicators of health in regard to muskoesqueletal disorders. Therefore, health indicators reflect differences in dietary intake and in work profile of rural and urban areas.

## Materials and Methods

### Data

We use data from Brazilian national census of 2010 and Brazilian national health survey of 2013 to estimate basic life table functions and implement further extensions on these functions for the evaluation of population health state. Both household inquiries are conducted by the Brazilian National Statistics Office (IBGE).

The PNS was created to describe and assess the health situation and lifestyles of the Brazilian population by collecting information on access and use of services, preventive health behavior and socio-demographic characteristics (Damacena 2015; Szwarcwald et al. 2014). The survey collected information physiological measures - blood pressure, weight, height - and collected biological materials from respondents (Damacena 2015). PNS survey permits to evaluate specific morbidity indicators of the population, such as the prevalence of chronic diseases, by socioeconomic strata or geographic environment (urban-rural) of the household.

The 2010 Population Census provides a unique alternative to study mortality differentials in the country. Its questionnaire included a question about household deaths over a defined period of time, also including information on age and sex of the decesead. This allows one to study and analyse mortality differentials that are not possible using the mortality information system (SIM, from Portuguese Sistema de Informações sobre Mortalidade) data from the Ministry of Health. Despite the SIM data quality improvements (Lima and Queiroz 2014) and coverage expansion of death register(Queiroz et al. 2017), this system data does not provide substantial information about the deceased socioeconomic characteristics which are essential for the evaluation of mortality in sub-national population groups (Queiroz and Sacco 2018; Queiroz and Sawyer 2012; United Nations 2017).

Therefore, most of the mentioned studies developed about Brazilian socioeconomic differentials in mortality before 2010 national census applied indirect methods to construct estimates using census or household surveys data (Carvalho and Wood 1978; Merrick 1985; Sastry 1997, 2004). The addition of mortality inquiry in the 2010 national census enabled the development of several studies on educational mortality differentials (Silva, Freire, and Pereira 2016), indigenous groups mortality (Campos et al. 2017), socioeconomic strata mortality differentials (Pereira and Queiroz 2016) and on urban groups mortality differentials (Pereira 2020).

The national census of 2010 investigated household deaths over the last 12 months before the reference period of the census (August 2009 - July 2010). Household respondents answered questions about age and sex of household’s deceases within this period. The use of death counts from national census for computing death rates has the advantage of considering both numerator and denominator from the same data source, which contributes for the robustness of mortality pattern estimation. However, an individual’s report on the household’s deaths might be mistaken, then mortality levels computed from national census must be corrected. Death counts from national census are under-enumerated in comparison to mortality information system data and present a death coverage rate of about 80-85%, according to death registration coverage estimation methods (Queiroz and Sawyer 2012).

### Methods

In order to answer our main research question, we developed a four stage methodology: 1) estimation of basic life table functions for each population group (urban and rural residents) from 2010 national census mortality data, that involves adjustment for under-reporting of death counts; 2) estimation and analysis of disease and disability age-specific prevalence data from PNS and national census data on disease and disability prevalence; 3) construction of disease/disability-free life expectancy indicators (also known as health expectancy) for each population group; and 4) decomposition of health expectancy differentials among rural and urban populations in terms of overall mortality profiles contribution and specific morbidity profiles contribution.

#### Correction of mortality levels

Brazilian 2010 national census mortality information has death coverage rates ranging from 80-85% (Queiroz and Sawyer 2012). Since death registry coverage is sensitive to regional inequalities53, census mortality data might also exhibit this pattern and is likely to present differences between rural and urban households. We first estimate completeness of death counts enumeration for each of these settings by applying synthetic extinct generations (SEG)(Bennett and Horiuchi 1984), generalized growth balance (GGB) (Hill 1987) and adjusted synthetic extinct generations (SEG-adjusted)(Hill, You, and Choi 2009) methods built in the R package DDM (Death Registration Coverage Estimation) [riffe\_etal2017].

We assume that regional inequalities of death coverage may already account at some extent for urban-rural differences in death coverage, especially because the regions with lower coverage (North and Northeast regions) are the ones with higher proportions of population living in low-density areas63. Afterwards, we estimated regional death coverage rates (DCR) using SEG-adjusted method by sex for the five Brazilian regions (North, Northeast, Central-West, Southeast, South). North (DCR males: 0.89, DCR females: 0.92) and Northeast (DCR males: 0.78, DCR females: 0.84) presented the lowest estimated death coverage rates; South (males: 1.05, females: 0.94) and Southeast (males: 0.98, females: 1.03) presented the highest estimates; and Central-West exhibited an intermediate DCR level among the five regions (DCR males: 0.93, DCR females: 0.94). Census death counts were then corrected for each region by dividing the observed death counts by respective DCR. DCR higher than 1 were considered as 1, since there is no evidence that supports a death over-counting in the 2010 national census at any region of the country. With the adjusted death counts by age and sex for each area, we used standard life-tables methods to calculate life expectancy.

#### Morbidity-free life expectancy estimation by Sullivan method

The second step was to estimate disability-free life expectancy. We use the Sullivan method uses data from diseases prevalence to construct a single index of mortality and morbidity (Jagger, Oyen, and Robine 2014; Sullivan 1971). The index provides an estimate of years of life free of disability that a member of the cohort would experience if the current age-specific rates of mortality and disease/disability prevalence prevailed throughout the cohort’s lifetime (Sullivan 1971).

The basic inputs of the method are the age-specific mortality rates for life table functions estimation and age-specific disease or disability (morbidity) prevalence (). After the estimation of life table functions using mortality rates as inputs, the complement of the morbidity prevalence (morbidity-free prevalence) are multiplied by the person-years lived () for each age group (equation 1).

The Sullivan person-years lived by the age-group represents the person-years free of morbidity or healthy life years of that age interval. This value is used to estimate the remaining functions of the life table (cumulative life-years free of disability expected to be lived at age x - and disease-free life expectancy at age x , also named as health expectancy - ). Therefore, the life expectancy computed by the Sullivan method ( or ) is an estimate of the morbidity-free life expectancy of the respective age-group.

In the process of mortality transition, whilst mortality levels converge among populations, other public health indicators may still differ substantially. Hence, Sullivan’s index for morbidity-free life expectancy can provide further insights to compare those groups with different health standards even though they exhibit similar mortality levels (Sullivan 1971).

We evaluate the morbidity prevalence and compute morbidity-free life expectancy for some specific sets of morbidities grouped in 4 categories available from the two data sources:

* Cardiovascular diseases - high blood pressure, high cholesterol, cerebrovascular accident (2013 National Health Survey);
* Diabetes (2013 National Health Survey);
* Osteopathies - arthritis, rheumatism, chronic spine problems (back pain, neck pain, etc), work-related musculoskeletal disorders (WMSD) (2013 National Health Survey);
* Incapacity/disabilities: to walk, see or listen (restricted to severe or total incapacity) (2010 Brazilian National Census).

Since differences in urban-rural mortality are expected to favor rural residents (Albuquerque 2019), we compare both populations also by a relative measure of morbidity-free life expectancy. That is, we compute the proportion of life expectancy that the synthetic cohort is expected to live free from each related morbidity ( ratio). We adopt this strategy to compare relative measures and avoid distortions that might come from absolute values. We focus our attention to adult mortality differentials (15-69 age-groups) because PNS had disease prevalence data available only for adult population (18+)[[1]](#footnote-26).

#### Decomposition of rural-urban DFLE differentials

In our final stage, we apply decomposition methods developed by Andreev, Shkolnikov, and Begun (2002). The estimation of person-years lived in good health, in Equation 1, requires two variable vectors: person-years lived by age group (), derived from age-specific mortality rates vector (), and age-specific healthy condition or morbidity-free prevalence vectors (). Then, the health expectancy () at age x can be stated a function of age-specific mortality rates and age-specific health prevalence (equation 2).

The urban-rural differences for health expectancy can be decomposed into two components computed by applying the stepwise replacement algorithm. The algorithm’s rationale lies behind the transformation of one population group vector of health expectancy (, for example) into the other population group vector of health expectancy ( in our case). Considering the components of function (equation 2), we can obtain rural health expectancy vector estimates out of urban health expectancy vector by transforming each of its elements and into and which is performed in an age-by-age replacement mode: and are the mortality and morbidity-free prevalence rates vectors composed by rates and at ages and and at ages $ x y$, respectively (Andreev, Shkolnikov, and Begun 2002).

Therefore, the difference is the sum of two components: 1) (equation 3), component of difference due to difference in mortality rates at age x, and 2) (equation 4), component of difference due to difference in morbidity-free prevalence at age x.

## Results

### Urban-Rural mortality differentials

Figure 1 presents age-specific mortality rates by place of residence. We observe that infant and child mortality rates are higher in rural areas than in urban areas and rural adult mortality rates are lower than urban adult mortality rates. This compensatory effect of rural adult mortality advantage in relation to lower under-five mortality indicators results in the higher life expectancy estimates for rural populations (table 2). The estimated rural life expectancy advantage is more pronounced in males than in females and it gets higher for older ages. Female estimates do not show marked urban-rural differentials as male life expectancy estimates.

[ FIGURE 1 : Rural and urban age-specific mortality rates by sex - Brazil, 2010. Source: 2010 Brazilian National Census. ]

These adjusted mortality rates yields different life expectancy estimates from Albuquerque (2019) (table 2). The author used the official life tables estimated for Brazil from IBGE for 2010 as reference to adjust the observed deaths from the 2010 census while we used the SEG-adjusted method taking in account regional differences in death coverage completeness. In this sense, our estimates resulted in higher life expectancy at birth values, since two of the three most populated regions (Southeast - the most populated and South - the third most populated) have census death counts coverage rates close to completeness (100%). Also, IBGE life tables present higher life expectancy values for Northeast states because its death coverage estimates are lower for these areas than when other death distribution methods such as generalized growth balance (GGB) and SEG-adjusted are applied (Queiroz et al. n.d.).

[ TABLE 1 : Rural and urban life expectancy estimates by sex and age - Brazil, 2010. Source: 2010 Brazilian National Census. ]

The sex differentials in mortality also favor females for Brazilian rural areas according to 2010 census data. Nevertheless, the female advantage in rural areas is lower than the urban female mortality advantage. Large differences from male/female mortality ratios are observed between rural and urban areas especially for adult ages. In this sense, the male mortality excess observed in Brazilian young adult males is more evident in urban areas and, in particular, in disadvantaged and suburban areas of cities (Pereira 2018; Pereira and Queiroz 2016).

### Urban-rural health conditions

Urban and rural environments shape the life styles and type of work performed by each population. These environment differences have direct impacts on workers health (Moreira et al. 2015). Disadvantages in self-reported health conditions have been observed in rural populations in addition to their socioeconomic and transportation disadvantages to access public health equipment (Arruda, Maia, and Alves 2018). The difficulties to access health equipment due to distance or lack of resources were mentioned by 56% of rural residents who did not access health services and needed to against 17% of urban residents in the PNS survey of 2013. Urban residents mostly did not access health services when they needed to because of long waiting time (28% against 8% of rural population). Thus, these differentials in access to health services may incur in lower disease diagnosis. Indeed, PNS data shows that rural population had higher percentage of people that never had measured their glycemic levels (21% against 10% for urban residents) or blood pressure (6% against 3% for urban residents). This scenario could have been worse if the Family Health Strategy of the Brazilian Ministry of Health was not successful in reaching remote communities of the countryside of Brazil (Albuquerque et al. 2017; Bhalotra, Rocha, and Soares 2020; Malta 2016). Even though rural residents showed lower diagnosis rates than urban residents, we still had sufficient data to evaluate disease prevalence of urban and rural populations.

For the adult population as a whole, there are rural penalties (higher rural-urban prevalence ratios) in prevalence of osteopathies and physical incapacity for males and of cardiovascular diseases and physical incapacity for females. Also, adult women from rural environments had higher prevalence rates of all morbidities investigated. Figure 3 extends the analysis by age group. We present the prevalence rates estimated in the PNS survey of 2013 for cardiovascular diseases, diabetes and osteopathies and in the national census of 2010 for physical incapacity and their respective smoothed estimates[[2]](#footnote-31). The smoothing methods were used to minimize the high variability of prevalence rates, especially for PNS lower counts of rural residents. Smoothing of incapacity prevalence for census information are presented, but the original prevalence rates were used for Sullivan method estimation of next section, since they showed very low variability.

[ FIGURE 3 : Rural and urban disease and disability prevalence by sex and age - Brazil, 2010-2013. Source: 2010 Brazilian National Census 2010 and 2013 National Health Survey.]

As expected, rural males presented higher prevalence rates of osteopathies, especially in advanced ages. For women, there is no clear pattern due to high data variability for rural residents. On the opposite direction, rural men are in better off situation in regard to diabetes prevalence rates, which presented a wide gap for advanced ages, and also for cardiovascular diseases prevalence rates, which presented a small but continuous gap from age group 30-34 and above. Female prevalence curves for diabetes did not present any significant gap while the prevalence curves of cardiovascular diseases for women in rural areas exhibited higher rates than urban curves. For both males and females, the prevalence rates of physical disabilities declared in the national census of 2010 were slightly higher in rural settings. Hence, results are in conformity with previous analysis performed for rural workers in Brazil (Moreira et al. 2015). Significant decreases observed in PNS morbidities prevalence for the elderly may be related to poor disease diagnostic of this age-group in rural populations.

### Morbidity-free life expectancy

Table 2 presents the results of morbidity-free life expectancy or heath expectancy () estimates for males and females of rural and urban areas at birth, at 20 years old, at 40 years old and at 60 years old. For males, rural-urban disease-free life expectancy ratios show a continuous increase in the rural-urban gap through advanced ages. Indeed, these results corroborate to the idea of an existing urban mortality penalty in lower income countries and announces also a morbidity penalty for the urban elderly. These absolute values present worse scenarios in urban areas for life expectancy without cardiovascular diseases and without diabetes estimates. These two groups of diseases exhibited higher prevalence for the urban population for the adult and the older age groups. Female absolute values estimates reported negligible difference between urban and rural areas, even though a slight rural advantage was observed for diabetes-free life expectancy at ages 40 and 60.

Absolute differences highlight rural advantages in mortality and morbidity indicators. We now turn our attention to relative differences in healthy life expectancy estimates, e. g., we evaluate the ratio of morbidity-free life expectancy by life expectancy ( ratio) (table 2). This ratio can be interpreted as a proxy of the proportion of life expected to be lived free from morbidity for a synthetic cohort with a set of age-specific morbidity prevalence rates and age-specific mortality rates. Relative estimates of health expectancy changes the rural advantage observed for all groups of morbidity so far. The rural advantage prevails only for cardiovascular diseases and diabetes whereas a relative urban advantage is observed for osteopathies and physical disabilities. These results confirms that rural residents are more prone to develop physical incapacity and disabilities and suffer of musculoskeletal pain due to the physically demanding labor required in agriculture (Maia 2010; Moreira et al. 2015). The absolute advantages observed in health expectancy numbers may not reflect in actually better life conditions in terms of life span relative measures. Therefore, we decompose differences in health expectancy into its mortality and morbidity components to investigate positive or negative contributions and provide further evidence on what might seem as a mortality exclusive advantage or mortality and morbidity advantage of rural residents.

[ TABLE 2 : Rural and urban health expectancy estimates and health expectancy to life expecanty ratios by sex and age - Brazil, 2010-2013. Source: 2010 Brazilian National Census 2010 and 2013 National Health Survey. ]

### Decomposition of health expectancy

Figure 3 presents the results of decomposition of differences in health expectancy from rural and urban settings by related morbidity. For males, positive values of mortality contribution to rural-urban health expectancy differentials shows that the overall mortality curve differences among rural and urban populations favors the first ones. However, as expected by morbidity prevalence curves, ostheopaties and physical disabilities have negative impacts on the health expectancy differences between rural and urban populations. These differences are, however, lower than the differences of the overall mortality shape. Hence, positive differences in rural-urban health differentials are still evident even though some morbidities act towards reduction of rural advantages. Estimated differences from rural to urban morbidity-free life expectancy at 20 years old of these two morbidities resulted in a 0.5 difference for osteopathies and 2.4 for physical disabilities. For osteopathies, the disease prevalence profiles difference accounted for -2.4 of the estimated difference and the mortality shape differences accounted for 2.9 of the differences. Therefore, muscoeskeletal and physical morbidities are responsible for slowing down the rural mortality curve advantaged condition. For census reported disabilities, the difference in morbidity profiles accounted for -0.5 of rural-urban health expectancy difference, much lower than morbidity contribution of osteopathies, but also in the opposite direction of the mortality profiles difference contribution.

This decomposition exercise highlights that health expectancy differences observed between rural and urban populations are not only due to overall mortality difference but also related to differences of age-specific morbidity prevalence. The results are in consonance with the bibliographic review, which show that cardiovascular diseases and diabetes are city related morbidities and physical disabilities and osteopathies are rural related morbidities that result from physically harming work performed at rural areas. Hence, rural residents present a double advantage (in mortality and in morbidity) when we compare health expectancy for cardiovascular diseases and diabetes, however, this advantage becomes exclusively a mortality profile advantage when we decompose differences for osteopathies and physical disabilities.

For women, cardiovascular diseases and diabetes prevalence seems to damage the health expectancy of urban elderly, but minor differentials were found among physical or muscoeskeletal related morbidities. However, we must evaluate this results with caution, since there is a lower diagnosis of morbidities in rural areas due to lack of measurement and lower quality of reported information on the elderly.

[FIGURE 3: Decomposition of rural-urban health expectancy differentials by sex and age - Brazil, 2010-2013. Source: 2010 Brazilian National Census and 2013 National Health Survey.]

## Discussion

This paper extends the discussion on rural-urban mortality differentials by adding health life expectancy. Mortality differentials have already been addressed in previous research (Albuquerque 2019; Carvalho and Wood 1978; Pereira 2020) and our results reflect those previous findings. The main contribution of the paper is to look at health status based on available age-specific prevalence data of the PNS survey of 2013 and decompose differences into mortality shape difference contribution and morbidity profiles contribution.

Over the last 30 years, Brazil has experienced substantial changes on its public health policy represented by the implementation and consolidation of the country’s unified health system (SUS, from Portuguese *Sistema Único de Saúde*) (Castro et al. 2019). SUS guaranteed a massive expansion of the health care assistance for the most vulnerable social groups through an universal and free of charges health services. Moreover, the gradual implementation of the family health strategy (ESF, from Portuguese *Estratégia de Saúde da Família*) - a public health policy approach focused on primary care at the community level - provided several positive outcomes such as the reduction of infant mortality rates (Aquino, Oliveira, and Barreto 2009; Bhalotra, Rocha, and Soares 2020; Macinko, Guanais, and Fátima Marinho de Souza 2006; Rocha and Soares 2010), improvement of child health (Santos 2017), reduction of maternal mortality rates (Bhalotra, Rocha, and Soares 2020) and reduction of hospitalizations due to causes sensitive to primary care (Pimenta et al. 2018). ESF policy approach is oriented towards the needs of poorest regions and most vulnerable social groups, therefore, its positive outcomes were mostly visible in regions and areas of the country with worsened health and socioeconomic conditions (Guimarães 2018; Rocha and Soares 2010). Additionally, ESF community-level policy provides further positive spillover effects on other socioeconomic variables such as education and employement (Rocha and Soares 2010).

In 2013, 54.4% of Brazilian households were registered in the local family health unit, 74.9% of rural households and 50.6% of urban households (Malta 2016). This higher ESF coverage and primary care assistance in rural areas might account for the favorable results of rural residents in regard to mortality and cardiovascular diseases and diabetes morbidity differentials, since ESF professionals provide not only health care support, but also health information, enhancing health literacy levels of local communities. Nevertheless, these numbers also indicate that rural communities have a higher reliance on public health services and lower access to higher complexity health services and health insurance than urban residents (Travassos 2007).

Such as in the case of USA, Brazilian rural residents experience higher deprivation in access to services and health facilities and usually report worse health status conditions and are in worse economic situation than urban residents (Arruda, Maia, and Alves 2018; Camarano 2002; Soares et al. 2016; Wanderley and Neil 2008). This scenario echos the higher vulnerability condition of rural areas and other territories with lower economic integration (Soares et al. 2016; Travassos, Oliveira, and Viacava 2006; Viacava 2019). The distance of health equipment, lack of resources to pay for the transportation, the lack of health professionals or unavailability of higher complexity health services are barriers to the access of public health systems by the rural population (Kassouf 2005; Travassos 2007; Viacava 2019). This situation is worsened for the elderly, population group with higher demand for such services [Travassos (2007)}. Moreover, the access to health services of rural residents relies almost exclusively on the public health system and on visits of family-care doctors of the Family Health Strategy while urban residents have higher access to health insurance and to a higher diversity of health equipment from both private and public health systems (Albuquerque et al. 2017; Arruda, Maia, and Alves 2018; Kassouf 2005; Malta 2016).

The differences of health expectancy observed in diet related morbidities (cardiovascular diseases and diabetes) provide insights on cultural differences of living conditions in rural and urban settings, especially in regard to different diets. In the developing world, diet changes are increasing the consumption of fat and sugar and the result is the increase of excess weight in populations from both urban and rural (in a lower extent) settings (Mendez and Popkin 2004). In Brazil, higher consumption of ultra-processed food is associated with higher prevalence of obesity and excess weight (Canella et al. 2014) and it has been increasing through time (Martins 2013). Ultra-processed food consumption is usually higher among higher income households and accounts for diet quality deterioration (Louzada et al. 2018; Santos Simões et al. 2018). In general, urban household diets in Brazil rely on supermarket food and are composed by a large share of processed food whereas rural diets have considerable shares of local and minimally processed food on its composition (Nardoto et al. 2011, 2006).

However, there is evidence that the on-going nutritional transition in some rural communities and lower income groups in Brazil is leading to a higher supermarket dependence on food consumption, resulting in lower demand local and unprocessed food (Reinaldo et al. 2015; Rodrigues et al. 2016). Further, cardiovascular mortality has been spreading throughout the countries’ less developed areas (Baptista and Queiroz 2019). In this sense, public health policies and especially family health professionals must take into account this changing diet movement in order to avoid an increase of processed food-related non-communicable diseases such as cardiovascular diseases and diabetes in rural communities.

In regard to the investigated physically related morbidities, our results show that rural residents are penalized by the higher physically demanding lifestyle of rural activities (Alessi 1997; Hegney 1993; Moreira et al. 2015; Thelin et al. 2009). The results are in consonance with studies from other countries, which found rural mortality and morbidity advantages except concerning muscoeskeletal disorders (Thelin et al. 2009). Despite physical health hazards of rural activities, there are also several other hazards such as chemical exposure (pesticides) or biological threats (zoonoses) that were not part of our analysis that must be taken into account by health policy designers (Hegney 1993; Moreira et al. 2015; Soares 2003).

The different tasks and activities demanded by the living environment also shapes the mortality and morbidity outcomes of a population. Rural populations observe higher prevalence of specific disabilities and diseases such as chronic pains, back pains, arthritis and urban populations are usually more susceptible to diabetes, high blood pressure, heart diseases and depression (Camarano 2002). Further, rural residents are more prone to report worsened health status (Arruda, Maia, and Alves 2018; Camarano 2002; Maia 2010; Paiva, Stivali, and Rangel 2018). Moreira et al. (2015) found that back pain, rheumatism, arthritis and high blood pressure were associated to the agricultural activities and results from intense physical effort in work. The difference in social status also plays a key role in the self-perception of health state (Viacava 2019). Then, rural populations usually declare poor health conditions than urban ones (Arruda, Maia, and Alves 2018; Maia 2010). However, looking into social groups, rural residents from lower social strata have higher probability of referring a good state of health than their identicals from urban areas (Maia 2010).

The results of this work support the efforts of family health strategy towards health coverage of most vulnerable and remote areas of the country (Guimarães 2018). ESF expansion provides diagnosis and follow-up of chronic diseases in rural populations and provides an enhancement of its health literacy which might also have contributed for further mortality improvements of this groups (Bhalotra, Rocha, and Soares 2020; Rocha and Soares 2010). Also, lower exposition to urban-related mortality causes such as violence and accidents is likely to play a key role for lower mortality observed in rural areas (Pereira 2020).

This paper results should be analyzed with caution. As mentioned, rural population lower access to health services reflects in lower diagnostic rates of health indicators such as glycemic level and blood pressure. Then, prevalence rates for rural groups might be underestimated due to lack of diagnosis. In spite of this important detail, the data collected is robust enough and results are in consonance with previous studies on rural and urban health and mortality differentials. We verified the existence of an urban adult mortality penalty and also in an urban adult morbidity penalty for cardiovascular diseases and diabetes. Finally, we verified a rural morbidity penalty related to physical disabilities (to walk, see and listen) and osteopathies. This penalty contributes for lower health expectancy differences in regard to these two morbidities, but it is compensated by the rural mortality advantage. Therefore, rural residents exhibit higher life expecancies, but a significant share of this life expectancy co-occur with physical and muscoeskeletal related morbidities.

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1. Even though PNS had prevalence data available only for adults aged over 18 years old, we considered the prevalence distribution of diseases for age group 15-19 equal to the rates observed for the age group 18-19. For age groups 0-14 the prevalence rates for PNS survey were considered equal to 0 in order to get estimates of morbidity-free life expectancy at birth. [↑](#footnote-ref-26)
2. Prevalence rates of diseases and disabilities were smoothed by apply the localy estimated scatter plot smoothing method (LOESS) [↑](#footnote-ref-31)