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Traces of population aging in Southern Brazil: demographic and epidemiological dynamics of the New Millennium

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ABSTRACT

Objective: To explore the demographic and epidemiological implications of population aging in Southern Brazil from 2000 to 2019.

Methods: An ecological series study of retrospective temporality, with a quantitative and descriptive approach. We took as units of analysis the three states that make up the Southern Brazilian region, namely: Rio Grande do Sul (RS), Paraná (PR), and Santa Catarina (SC), as well as their corresponding capitals (Porto Alegre, Curitiba, and Florianópolis, respectively). Sociodemographic and territorial data were extracted from official institutes (at the state level) and the Brazilian Institute of Geography and Statistics (at the national level). Data was retrieved from the System of Health Indicators and Monitoring of Public Policies for the Elderly, in order to trace the epidemiological profile. We then

clustered the data according to state of origin and performed simple descriptive statistical analyses, using measures of dispersion and percentage differentiation.

Findings: The majority of elderly in Southern Brazil are women, self-declared white, and with low levels of schooling. The region went from an aging rate of 32.13% in 2000 to 52.82% in 2010, with Paraná being the most populous state. Positive values were observed in the socioeconomic and social fragility dimensions, as well as in the contextual and environmental aspects. Despite the decrease in cognitive impairments and difficulties in activities of daily living, visual, hearing, and physical impairments are increasing in worrying proportions. In both geriatric morbidity and mortality, the highest values were concentrated in diseases of the circulatory and respiratory systems and neoplasms. Thus, the region follows the national and international patterns of morbimortality in the elderly.

Conclusions: It is believed that structural and organizational improvements in local public health systems and programs have had a positive effect on the survival of the elderly in Southern Brazil. Coupled with this, the constant improvement and qualification of health professionals reinforce the practices and health care for the aging population, reflecting on the better health rates seen in this population segment.

KEYWORDS

Aging Epidemiology; Demographics; Health of the Elderly; Population Health Management.

1. INTRODUCTION

One of the greatest triumphs and challenges for humanity has been aging, although it has not had the same connotations over the histories of Western and Eastern civilizations. The socio-health realities of past centuries indicated that common human beings, in the best of cases, managed to live about 30 to 40 years [1]. Such statistical projections are based mainly on the precarious and unhygienic conditions that characterized people's daily lives during the 17th and 18th centuries. What are more, the emergence and rapid spread of infectious and communicable diseases further lined-down life expectancy at birth [1, 2].

From scientific and technological discoveries dating back to the beginning of the 20th century, the idea of living for more than 40 years began to take shape. In the technological field, novel hallmarks of work and production mechanisms led to a brief expansion of societies, bringing better labor and social guarantees. Thus, with more feasible environments for human development, the world began to

experience what could be called 'a structural modification of the demographic bases' [3]. Along with that, scientific advances and impeccable medical improvements (including all applied areas and subareas) have now allowed the contemporary human being to expect to live longer than 60 years and, in some cases, to exceed the age of 80 [4].

In both precedents, the scientific and technological fields ended up justifying the 'Baby-Boom' phenomenon and attained responsible for an increased number of persons aged 65 or older [5]. It should be noted that "beginning in 2030, the numbers of adults over age 85 will rise quickly. By 2050, the number of adults over age 80 around the globe will triple from 2015 numbers" [6:1p].

When looking at population aging in the case of Latin American countries, Brazil stands out as a major player in this field. One fact is undeniable, Brazil has been at the top of the most aged countries, according to the latest world reports on health and aging launched by the World Health Organization [7]. These reports highlight the complexity of human aging, reflecting the heterogeneous and subjective quality that defines it and, therefore, the fact that there is no single pattern to be followed along with its comprehension. For Brazil, this position exceeds the health understanding of the social phenomenon of population aging, insofar as it amplifies the challenges in the economic, political, environmental, and social scopes, with the same appropriateness.

To that extend, national studies display regional disparities related to the index of population aging. Hence, it is a proven reality that population aging does not occur with the same firmness in the five geographic regions that make up the Brazilian territorial extension [8]. As a matter of fact, "the population growth in Brazil has been selective, both from a spatial and social point of view" [9:3p]. The imbalances inflicted by the demographic transition have given rise, so to speak, to a series of multidimensional challenges (**Figure 1**).

The issue is even broader than it appears, as for that, two analytical approaches are privileged, at times, proposing complementary readings, although excluding radical interpretations in their central points of study. At the outset, it is recognized that demographic changes are directly influenced by the mechanisms of social development adopted in each nation [10]. This, in turn, establishes a list of factors that have the potential to propel or hold back age expansion (fertility and birth rates). In the related literature, it is common to see a positioning that favors temporal observations, mostly advocated by public policy formulators and analysts. Here, the point to be noted is precise that this vision does not guarantee that immeasurable elements will be taken into consideration at tight moments, such as changes in the political agenda or the enactment of laws and national policies on aging [10].

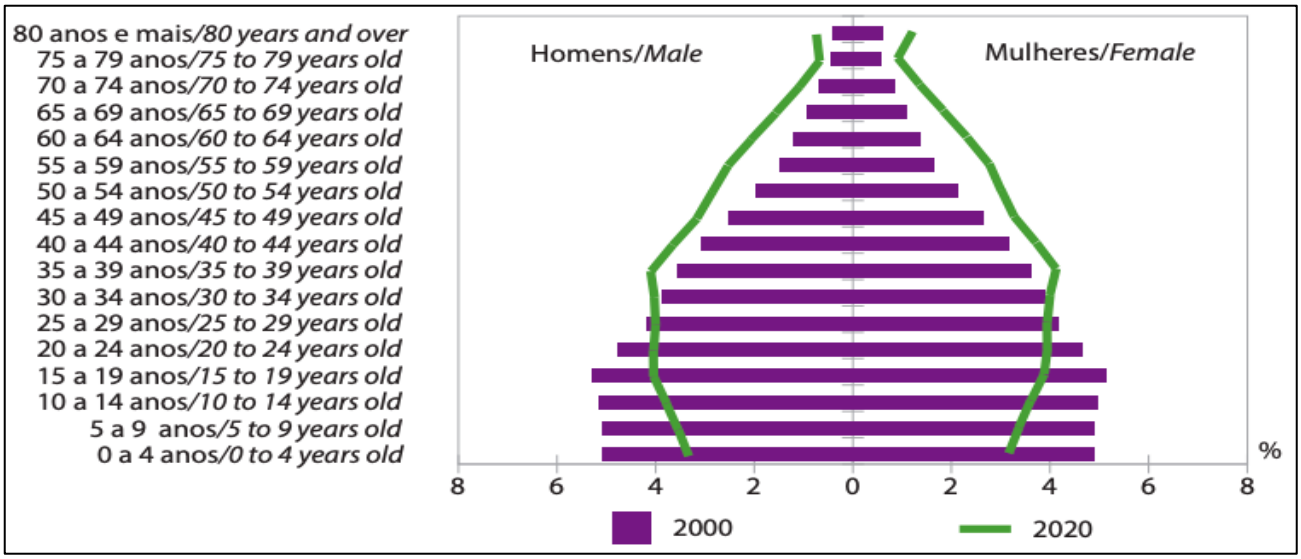


Figure 1. Projected population in Brazil, 2000 to 2020. **Source**: Brazilian Institute of Geography and Statistics [11].

On another thoroughfare, demographers propose long-term interpretations, since half a century would only be half a period of analysis. However, it is worth mentioning that a projection of fifty years would impede the development and strengthening of the social guarantees attributed to older age, as stipulated by public policymakers. Contributing to this discussion, Brito [10] proposes an articulated dialogue and a change of attitude between public policymakers and demographers, to articulately understand the visions on population aging in the short, medium, and long term. This would not be an unreasonable thought, considering that the Brazilian geriatric population was 2.6 million in 1950, grew to 29.9 million in 2020, and is expected to reach 72.4 million in 2100 [10, 12].

Ergo, the dynamics observed in the country suggest that the Brazilian *demographic bonus* has occurred more rapidly in regions with a higher degree of urbanization and better social and health profiles [13]. Analyses on the most varied aspects of the health of older adults were carried out in Brazil, many of them in population-based studies [14]. An example is given by the National Health Survey (*Pesquisa Nacional de Saúde*, from Portuguese), carried out in 2013, which revealed significant social inequalities in the way Brazilian elderly grow old according to sex, race/skin color, level of education, per capita family income and possession of a private health plan [15]. Specific to the study of the social determinants of aging, previous works have shown the importance of describing and analyzing yearly and geographical differentials in the population, including causes and motives of illness and premature death.

Thus, it is relevant to understand how, and to what extend population aging has impacted Brazil. This theme is important also because it addresses a global matter with a progressive trend that invites us to take the necessary actions. From the assertions highlighted, this paper aims to explore the

demographic and epidemiological implications of population aging in Southern Brazil from 2000 to 2019. Particularly, it tests one conditional hypothesis: the better the health and social indicators, the higher the rate of population aging in their corresponding State.

2. METHODS

This is an ecological series study of retrospective temporality (from 2000 onwards), with a quantitative and descriptive approach. The main advantage of this type of study is that it can be carried out quickly and at a low cost, as it is based on the readily available information (e.g., censuses, mortality registries, cancer registries, etc.). Nevertheless, conclusions of this type of design refer only to populations and not to individuals. It is not possible to extrapolate them to the individual's exposure and risk of presenting the condition/disease (known as the "ecological fallacy"). Ecological studies also cannot control for the presence of confounding variables [16].

In this study, we took as units of analysis the three states that make up the Southern Brazilian Region: Rio Grande do Sul (RS), Paraná (PR), and Santa Catarina (SC), as well as their corresponding Capitals (Porto Alegre, Curitiba, and Florianópolis, respectively). Sociodemographic and territorial data were extracted from official institutes (at the state level) and the Brazilian Institute of Geography and Statistics (at the national level). These data made it possible to draw up the individual profile for each state and, subsequently, to carry out comparative analyses between them:

- In the case of the state of Paraná, we consulted '*Instituto Paranaense de Desenvolvimento Econômico e Social'* [17] (Paraná Institute of Economic and Social Development);
- In the case of the state of Rio Grande do Sul, we consulted '*Fundação de Economia e Estatística Siegfried Emanuel Heuser'* [18] (Siegfried Emanuel Heuser Economics and Statistics Foundation) and;
- In the case of the state of Santa Catarina, we consulted '*Secretaria de Desenvolvimento Econômico Sustentável*' [19] (Secretariat of Sustainable Economic Development).

The decision to choose the period from 2000 to 2010 for the demographic reading was based mainly on the fact that the new population census for Brazil has not yet been carried out, and therefore not yet published, making it impossible to trace down comparisons from 2010 onwards. Although there are already projections elaborated by official institutes and even demographic perspectives defended by some authors, the truth is that these data are merely symbolic and have not yet been made official.

Regarding the epidemiological profile of older adults, we chose to analyze the causes of morbidity and mortality as of 2010, precisely because there are already official reports up to 2020. By doing so, we scrutinized data from the System of Health Indicators and Monitoring of Public Policies for the Elderly (*Sistema de Indicadores de saúde e Acompanhamento de Políticas Públicas do Idoso – SISAP-Idoso*, from Portuguese). Briefly put, SISAP-Idoso comprises a system for consulting indicators via the Internet at the federal, state, and municipal levels on the health of older adults. Its purpose is to offer a tool for the Unified Health System (hereafter UHS) management that allows both to know the health situation of the older population and to establish continuous follow-up processes (monitoring of implementation and evaluation of results) [20].

For both mortality and geriatric morbidity, we focused attention on the eight leading causes in both sexes. We then chose to define dependent and independent variables that would allow us to establish the socio-health profiles of Brazilian older adults (**Chart 1**). Abovementioned, we clustered the data according to the state of origin and performed simple descriptive statistical analyses, using measures of dispersion and percentage differentiation.

Chart 1. Description of the selected dependent and independent variables, according to the proposed categories.

Dependent variables	Independent variables
Health determinants, risk factors and demographic conditions*	***Contextual and environmental***: adequate housing; piped water; sewage system; garbage collection service. ***Socioeconomic and social fragility***: illiterate; economically active; living alone; without education or with 1 to 7 years of study; with more than 15 years of study. ***Demographic:*** aging population index; old-age dependency ratio; total elderly population.
Health conditions of older adults**	Disabilities (mental, motor, visual, hearing and physical); causes of hospitalization; causes of avoidable hospitalization; causes of mortality; causes of avoidable mortality, all according to ICD-10.
Access to health services**	Number and proportion of elderly people enrolled in the FHS according to SIAB; proportion of elderly people vaccinated against influenza; number and proportion of medications provided by UHS; average value of value of hospitalization of the elderly in Reais; value paid by UHS with hospitalization of the elderly in Reais; value paid by UHS with medication reais; value paid by UHS with medications provided to the elderly.

**Statistics from 2000 to 2010. **Statistics from 2010 to 2019. FHS: Family health strategy. UHS: Unified health system.*

In order to calculate Population Aging Indexes, we followed the chronological-age criterion (See **Measurement 1**). In line with what has been stated by Skirbekk, Staudinger, and Cohen [21:137], "population aging is measured to inform fiscal and social planning because it is considered to indicate

the burden that an elderly population presents to the economic, social security, and health systems of a society". In the meantime, we readjusted the geriatric age to 60 years, as this is the age decreed in Brazil for the onset of old age. According to its conventional interpretation, it is an indicator associated with intergenerational transfers and its systematic increase implies a superior investment in health and social security for the older populational segment.

$$PopulationAgingIndex: \frac{Peopleaged60 \geq}{Peopleaged0 \dashv 14} \times 100$$

Measurement 1.

For the comparative presentation of the Population Aging Indexes, we created heat maps in Microsoft Excel to display percentage differences according to each state. The population aging index for the Southern Region was obtained by using the simple average formula, gathering the individual values and dividing by the three-unit fields (PR, SC, and RS). The initial hypothetical definition of this study is given as follows:

- H_0= The better the health and social indicators of Southern Brazil, the higher the rate of population aging in its corresponding States.

Therefrom, for this hypothesis to be validated, the mortality and geriatric morbidity coefficients must show negative growth trends during the observed period, which, in turn, would point to an exponential increase in the survival of older adults, expressing higher rates of population aging. Conversely, H_0 will be rejected if worse health and social indicators are verified, along with lower aging rates.

In compliance with national and international guidelines for scientific research, this work did not need to be reviewed and approved by an Ethics Committee, since the data processed are of secondary origin and are available in the institutional repositories consulted. To verify this, the links for each database consulted were reported in the corresponding references.

3. RESULTS AND DISCUSSION

Considering that the present study contains data regarding two public health pillars, namely demography, and epidemiology, we divided the results into two sections (3.1 and 3.2). Initially, we offer a thorough discussion of the main demographic changes that the Southern States of Brazil have experienced since the beginning of the new millennium. In the second section, explanations of the

foremost reasons of illness and death in southern Brazilian older adults are provided. To this effect, we highlight the individual and regional particularities, which allows us to have a more concise idea of the territories observed. Furthermore, it should be clear that this implies a detailed reading of the main social and health indicators used in gerontological analyses.

3.1. Regionally united, yet divergently aged: observations on demographic changes in Southern Brazil

The process of demographic transition in Brazil is heterogeneous and associated, in great part, with the unequal social conditions observed in the country [22]. Geographically speaking, Brazil is a very divergent country in terms of nature, population concentration, and economic activities, and this is no different in the Southern Region. For instance, Filho and Gargioni [23] explain that "from an eminently agricultural base, following the national process, industrialization took place in each of the Southern States, resulting in economies strongly based on activities in the primary and secondary sectors". In addition, Mattei and Mattei [24] observed that the most significant economic sectors in the number of workers for the three states are the transformation industry, services, commerce, and public administration, respectively. More specifically, the State of Paraná stands out in agriculture and cattle-raising; Rio Grande do Sul in public administration and industrial services; and Santa Catarina in mineral extraction and transformation industries.

It has been seen that the demographic dynamics in these three states reflect a decrease in population concentration in the rural environments (that is, a housing transition for the urban zone), while also showing reductions in poverty rates, with Paraná being the state facing the greatest difficulties and Santa Catarina the one with the best living conditions for its population [25]. It is worth noting that about 15% of the Brazilian population is gathered-up in this region.

The demographic analysis conducted in this research allowed us to identify an estimated population of 29.975,984 inhabitants in the Southern Region of Brazil, according to official data from the 2010 Census. Based on these estimates, we found the following population weights for each state: Paraná (38.14%); Rio Grande do Sul (37.95%), and Santa Catarina (23.91%). It is noteworthy that, despite Santa Catarina being the state with the lowest number of inhabitants, it had the highest population density and the highest Human Development Index (**Table 1**). Indeed, elements such as formal employment, sectoral electricity consumption residential, spending on health, education, sports, leisure, welfare and assistance, establishments with areas of natural and artificial forests, and green

area per inhabitant, justify the fact that the Southern Region expresses better living conditions when compared to the other Brazilian regions [26].

Table 1. Characterization of the sociodemographic profiles of the Southern-Brazilian States and their corresponding Capitals.

	Southern-Brazilian States		
Variables	**Paraná**	**Rio Grande do Sul**	**Santa Catarina**
Territorial Area*	199.305,236 km^2	281.707,149 km^2	95.730,921 km^2
Projected population**	11.433.957 hab	11.377.239 hab	7.164.788 hab
Registered municipalities	399	497	296
Demographic density***	52,40 hab/km²	29,79 hab/km^2	65,29 hab/km^2
HDI***	0,749	0,746	0,774
	State Capitals		
Variables	**Curitiba**	**Porto Alegre**	**Florianópolis**
Territorial Area*	434.892 km^2	495.390 km^2	674.844 km^2
Projected population**	1.963.726 hab	1.492.531 hab	516.524 hab
Registered municipalities	45	90	17
Demographic density***	4.021,04 hab/km^2	2.837,53 hab/km^2	623,68 hab/km^2
MHDI***	0,823	0,805	0,847

2018 projections; **2021 projections; ***2010 projections.* ***HDI**: Human Development Index;* ***MHDI****: Municipal Human Development Index.*

Source: The authors, based on Brazilian Institute of Geography and Statistics [11, 27].

In tandem, Table 2 groups the values that individually describe the age structure of older adults, according to each State and sex. Accordingly, the data indicate that in the 2010 census, the age groups with the highest concentration were those between 60 to 79 years of age (n= 17.053,740), with the female sex being predominant (56.47%). This demographic reading reflects the phenomenon of the 'feminization of old age', which is characterized by a greater number of male births, however, with greater survival in women. Possible causes include lower adherence among men to health services and programs, as well as better self-care practices and medical accompaniment on the part of women [15, 22].

Overall, Southern Brazil registered 3.357,808 elderly people during the 2010 census. Among the states, Rio Grande do Sul had the highest number of aged people in the region (n= 1.619,940; 48.2%), followed by Paraná (n= 1.080,955; 31.2%) and Santa Catarina (n= 656,913; 19.5%). As in the national scenario, there was a predominance of the female sex in all the states studied. Nevertheless, when taking as a reference the age range of 60 to 79 years, we found a major presence of the male sex,

with a differential of +4.2% (males= 89.4%; females= 85.2%). Another observation that deserves to be made is the exponential increase of those individuals who exceed the age of eighty. Be that said passage, that number reached a total of 427,787 people, representing 12.74% of the total number of elderly people in the region, in 2010 (**Table 2**).

Table 2. Aging profiles, according to each Southern State in the latest census of 2010.

Age groups	Paraná		Rio Grande do Sul		Santa Catarina		Brazil	
	Males	**Females**	**Males**	**Females**	**Males**	**Females**	**Males**	**Females**
100 ±	313	620	248	791	126	279	7,245	16,987
95 ¬ 99	1,273	2,538	1,271	3,917	564	1,350	31,528	66,804
90 ¬ 94	4,945	8,998	5,887	14,732	2,517	5,149	114,961	211,589
85 ¬ 89	15,588	23,876	17,730	38,252	7,960	14,612	310,739	508,702
80 ¬ 84	36,887	50,561	42,599	76,474	18,552	29,628	668,589	998,311
75 ¬ 79	64,121	80,272	73,926	113,162	32,789	45,583	1.090,455	1.472,860
70 ¬ 74	99,314	114,342	112,895	149,150	52,332	64,645	1.067,289	2.074,165
65 ¬ 69	133,729	151,451	155,838	187,741	73,382	83,975	2.223,953	2.616,165
60 ¬ 64	180,838	201,289	217,076	247,908	106,909	116,561	3.040,897	3.467,956
Total	**447,008**	**633,947**	**787,470**	**832,127**	**295,131**	**361,782**	**8.555,656**	**11.433,539**

Source: The authors, based on Brazilian Institute of Geography and Statistics [11].

The celerity at which the aging of the population has been occurring is a factor that ought to be looked into and approached with the caution it entails, in a multisectoral and multidimensional perspective, once a governmental involvement becomes binding, to mitigate the impacts on societies and their most diverse organizational forms. The foregoing becomes even more important when we see, by way of example, that in 2000 the Population Aging Index in the Southern Region was given at 32.13%, which meant that there were more young people than old people (**Figure 2**).

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Paraná	28.94	30.15	31.49	32.94	34.52	36.2	38.01	40.06	42.37	44.91	47.63
Santa Catarina	27.78	29.03	30.42	31.91	33.53	35.26	37.18	39.34	41.78	44.48	47.41
Rio Grande do Sul	39.66	41.2	42.88	44.64	46.49	48.49	50.76	53.38	56.41	59.78	63.42
Southern Region	32.13	33.46	34.93	36.5	38.18	39.98	41.98	44.26	46.85	49.72	52.82

Figure 2. Time evolution of the population aging index, by State and Region, 2000 to 2010.

Source: The authors, based on SISAP-Idoso data [20].

Thence, said elucidation should be read as 32 elderly people for every 100 young people, which is a relatively positive value in terms of economically active population and lower health care costs for the social protection and health systems, mainly related to the management and control of chronic non-communicable diseases. Albeit, the reality was different in 2010, now more shouting and inserting many more challenges, in all social spheres. The values were now that, for every 100 young people, there were 53 elderly people.

Viewed through other lenses, these figures translate into two young people for every elderly person. Therein, if the trend seen until 2010 continues unabated, Brazil can expect to have an older adult population that will outnumber the younger population by 2050, or perhaps even earlier. With a smaller population of young people, the country could face social difficulties that would directly impact the distribution of global income, since there would be fewer citizens of productive age, while the economic dependence of the elderly on conditions such as retirement would increase. This situation calls for the development of demographic, social, and political strategies to mitigate the impact of this sociodemographic change in the country.

Moreover, when proposing an individual interpretation of the impact that population aging had on these states, we see that Paraná and Santa Catarina experienced a similar demographic changing process, with akin values in almost all the years observed in this study. The same could not be attributed to Rio Grande do Sul, since this state has been aging very rapidly, with values almost comparable to those of developed countries. In summary, the differences in population aging weights between 2000 and 2010 were as follows: Paraná (+19.23%), Santa Catarina (+19.63%), and Rio Grande do Sul (+23.76%).

Closs and Schwanke [28] describe Rio Grande do Sul as the Brazilian state with the highest aging index and the highest number of long-lived people. The authors rely on data from the 2010 census to make such notes and, at the same time, highlight that Brazil suffered an increase of 268% in its national aging index, from 1970 to 2010. One reason for the marked longevity in Rio Grande do Sul is the qualified health management mechanism for the control of infectious diseases in childhood (which concomitantly led to a reduction in premature mortality), in addition to the strengthening of the actions carried out in the primary care area, which ultimately improves the forms of care offered to the elderly population [29].

3.2. Living conditions and human development among older adults in Southern Brazil

The basic conditions in which individuals are born, grow up and develop strike forthwith on the quality of life in old age. It is, in fact, necessary that the actions conceived at the federal level respect the vital flow of the human being, which goes from conception to the last phase of life, old age. Proposing immediate actions, based on the fragile contexts of an unhealthy and inactive old age, will not bring about the required changes. It is an aspect that involves all spheres of human development (e.g., housing and decent employment, access to education, entertainment, access to health services and programs, political participation, among others).

Social determination in health acquires an added value when discussing the quality of life and life satisfaction among older persons. In our study, we found interesting contextual differences between the observed states, yet, it can be said that all of them showed notable improvements in living conditions and human development from 2000 to 2010 (**Chart 2**).

The majority of the elderly population in Southern Brazil is female (82 males per 100 females), self-declared whites (82.83%), with a low level of schooling (75.9%). The predominance of white people is mainly due to the fact that the Southern is where most European immigrants settled after the great post-war migratory waves. This historical event created an effect of restructuring and recomposition of the population, which can still be seen today, mainly in Santa Catarina (88.41%) and Rio Grande do Sul (87.2%).

Chart 2. Description of independent variables, according to analysis category and location, Brazil, 2000 to 2010.

Variables Observed	**Paraná**		**Santa Catarina**		**Rio Grande Sul**		
	2000	**2010**	**2000**	**2010**	**2000**	**2010**	**OPSR** [2010-2000]
Socioeconomic Aspects and Social Fragility							
Sex ratio*	89.0%	85.0%	82.0%	82.0%	74.0%	75.0%	[80.67 – 81.67] = -1.0%
Self-declared whites	78.0%	72.9%	91.3%	88.4%	89.0%	87.2%	[82.83 – 86.1] = -3.27%
Self-declared indigenous	0.4%	0.3%	0.3%	0.2%	0.4%	0.2%	[0.23 – 0.37] = 0.24%
Self-declared Asian-descents	2.0%	2.1%	0.1%	0.4%	0.1%	0.4%	[0.97 – 0.73] = -0.14%
Self-declared browns	15.8%	21.3%	5.4%	8.7%	6.0%	7.9%	[12.63 – 9.06%] = 3.57%
Self-declared Afro-Brazilians	3.5%	3.5%	2.4%	2.3%	4.3%	4.3%	[3.37 – 3.4] = -0.03%
With 15± years of study	3.76%	6.7%	3.43%	7.1%	4.96%	7.9%	[7.23 – 4.05] = 3.18%
With 1<7 years of study	86.77%	78.5%	87.15%	77.2%	83.74%	72.0%	[75.9 – 85.87] = -9.97%
Illiterate rate	30.52%	21.53%	23.69%	16.38%	19.6%	13.45%	[17.12 – 24.6] = -7.48%
Economically actives	22.4%	28.53%	19.62%	27.8%	22.47%	29.29%	[28.54 – 21.5] = 7.04%
Living alone	12.04%	14.19%	10.99%	13.13%	14.42%	16.89%	[14.74 – 12.48] = 2.26%
Dependence ratio	13.48%	17.01%	12.63%	15.53%	16.49%	20.84%	[17.79 –14.2] = 3.59%
Contextual and Environmental Aspects							
Suitable home for living	69.96%	78.99%	58.7%	70.72%	65.71%	74.47%	[74.73 – 64.79] = 9.94%
Piped water supply	82.18%	86.29%	68.28%	76.69%	76.27%	83.42%	[82.13 – 75.58] = 6.55%
With sewage service	52.47%	63.69%	71.0%	74.06%	66.18%	72.56%	[70.10 – 63.22] = 6.88%
With garbage collection	80.29%	88.22%	76.91%	89.92%	78.85%	89.91%	[89.35 - 78.68] = 10.67%

Functional Status (Impairments/Disabilities)							
Cognitive	3.72%	2.53%	3.57%	2.22%	3.59%	2.79%	[2.51 – 3.63] = -1.12%
Visual	32.37%	45.63%	33.02%	44.41%	30.09%	43.32%	[44.45 – 31.83] = 12.62%
Hearing	18.3%	22.38%	19.37%	22.53%	18.68%	22.79%	[22.57% – 18.78] = 3.79%
Physical	24.74%	32.3%	27.26%	32.57%	26.8%	32.25%	[32.37 – 26.27] = 6.1%
Difficulty with ADLs	6.65%	5.6%	6.14%	2.45%	6.29%	4.8%	[4.28 – 6.36] = -2.08%

***Reference value for elderly females. **ADLs:** Activities of daily living. **OPSR**: Overall percentage for the Southern-Brazilian Region in 2010.*

Source: The authors, based on data from SISAP-Idoso [20].

This study found representative advancements in the economic and environmental domains. The illiteracy rate projected a constant reduction curve, with a total differential of -7.48%. In addition to this, it was possible to observe that the participation in the economy, both family and regional, expressed a raise of 7.04%, from 2000 to 2010. Such statistics are close to the objectives proposed at the regional level, which seek to reduce social gaps between generations, in view of access to decent and well-paid employment and comprehensive educational programs [30]. From a theoretical standpoint, Serra and Furtado underlined that "the legislation in force leads to a reflection on the insertion of the elderly in school and non-school contexts, as a guaranteed right and, above all, as a matter of exercising citizenship, in which the conditions for equality are built, understood as isonomy and qualified in the common right to action and opinion, that is, in the recognition of the right of each and everyone to participate in life" [31:152p].

Addressing the environmental and contextual eventualities for older adults in Southern Brazil, improvements in all areas could be identified. All the indicators in this dimension exhibited positive differentials, with special attention given to 'garbage collection' (+10.67%) and 'suitable home for living' (+9.94%), for obtaining better scores over the years inquired. Being the case, "older adults have the right to decent housing, within the natural family or substitute, or unaccompanied by their relatives, when so desired, or in a public or private institution" [32: Art.º 37].

At the same time, the region still faces significant challenges, considering that the economic indicators presented lower values in Paraná and, in the long run, better values in Rio Grande do Sul. Similar setbacks are found in the lifestyles imposed by the processes of globalization which, in a certain way, are responsible for the disintegration of family nuclei. The findings of this study confirmed an increase of 2.26% in the elderly living alone and a 3.59% dependency ratio. A significant number of older adults are living alone, which could constitute a mortality risk for events such as falls,

polypharmacy, malnutrition, and the emergence of depressive symptoms, especially in the context of widowhood [33].

Although impairments in old age are expected due to loss of organ function, they can be mitigated with access to early diagnosis and support. Of the four impairments analyzed, visual impairment stands out, increasing from 31.83% in 2000 to 44.45% in 2010. This means a spherical gain of 12.62% for this type of functional limitation among the Southern elderly. Furthermore, this impairment extrapolates to other functional levels, such as mobility, particularly by bringing out walking difficulties [34]. About the other impairments, the following figures were found: cognitive (-1.12%); hearing (+3.79%), and physical (+6.1%). There is also a contradictory finding at this point since a retrenchment was seen in the self-reported difficulty to perform ADLs (-2.08%). Even though they were not measured empirically, these outcomes could be attributed to public strategies to lessen sedentary lifestyles and chronic non-communicable diseases, promoting the practice of physical activity and healthy aging, along with the maintenance of functional capacity and autonomy [22, 28].

3.3. The impact on morbidity and geriatric mortality in the Southern Brazil

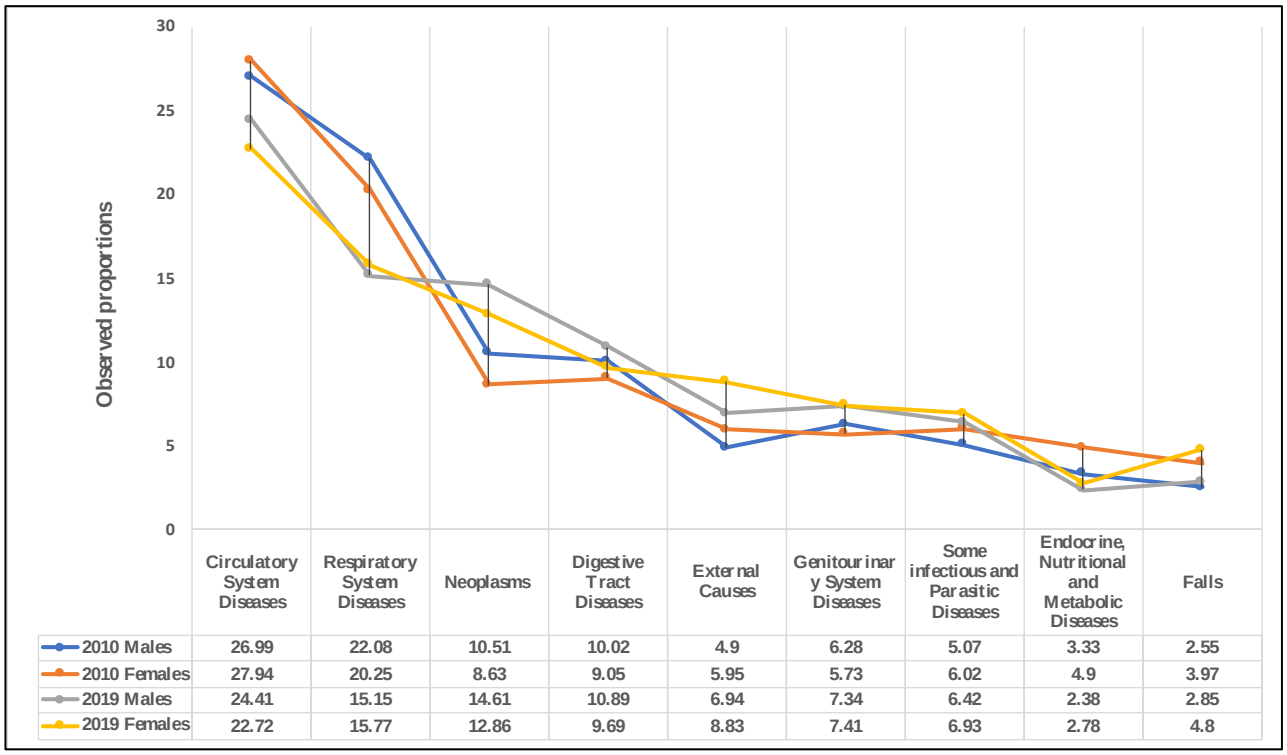
The findings of this study converge with the notes from '*The World Health Statistics 2019: Monitoring Health for the Sustainable Development Goals – SDGs*', which allude to preventable non-communicable diseases (NCDs) as the main causes of illness and consequent premature death in older adults. This document stresses "the SDG targets concerning NCDs are twofold; namely, improving health outcomes and lowering the exposure to NCD risk factors. Target 3.4 is assessed on the reduction in risk of premature death between the ages of 30 and 70 years from cardiovascular disease, cancer, diabetes and chronic respiratory disease, and reduction in suicide mortality rates" [35:31p].

This epidemiological picture places the Southern Region in a context of immense complexity since the profile of illness and premature death has changed drastically, shifting from infectious diseases to more common pathologies in old age [36]. As part of this process, public health systems have registered several obstacles that limit the institutional response capacity and the quality of geriatric-gerontological care provided to the population [15, 21, 24].

Results from this study indicate that the causes of geriatric hospitalization are precisely those NCDs (**Figure 3**), as has been widely reported in national and international gerontological literature [6, 29, 35]. For instance, in 2010, the eight leading causes of geriatric hospitalization accounted for 91.73% in men and 92.44% in women, of the total number of hospital admissions computed amongst Southern older adults. However, a slight decrease occurred in 2019, in both genders, presenting figures

of 90.99% in men and 91.79% in women. Within the top eight causes, the first three places went to the following, respectively: circulatory system diseases; respiratory system diseases; and neoplasms. Amid the first and third leading causes of geriatric hospitalization, the values were higher in the male population, and only in the case of respiratory system diseases, the impact on hospital admissions was similar between both genders (a difference of 0.62%).

Gender differences for these causes of hospitalization in Brazil have already been postulated by Santos et al., whose findings infer that as age increases, the greater the chance of hospitalization in men for circulatory diseases and neoplasms [37]. Risk factors found in the male population, such as less frequent physical activity, poorer/inadequate eating habits, higher rates of smoking and alcohol consumption, and unhealthier working conditions, may be contributing factors in these estimates [37, 38, 39].



	Circulatory System Diseases	Respiratory System Diseases	Neoplasms	Digestive Tract Diseases	External Causes	Genitourinary System Diseases	Some infectious and Parasitic Diseases	Endocrine, Nutritional and Metabolic Diseases	Falls
2010 Males	26.99	22.08	10.51	10.02	4.9	6.28	5.07	3.33	2.55
2010 Females	27.94	20.25	8.63	9.05	5.95	5.73	6.02	4.9	3.97
2019 Males	24.41	15.15	14.61	10.89	6.94	7.34	6.42	2.38	2.85
2019 Females	22.72	15.77	12.86	9.69	8.83	7.41	6.93	2.78	4.8

Figure 3. Proportional eight leading causes of geriatric hospital admissions in Southern Brazil, according to gender, 2010 to 2019.

Source: The authors, based on SISAP-Idoso data [20].

Findings from this study are in line with those advocated by Marques and Confortin [40], in confirming circulatory system diseases as the leading cause of geriatric hospitalization in the Southern Region. Indeed, this issue is more daunting than it appears, as it is the top cause of illness and death in older adults, in all Brazilian regions. The challenge of dealing with this type of disease lies in the

aggravated cost for public health systems, and the need to qualify health personnel to approach the patient holistically, understanding the complexity of care and the implications for the quality of life of those who live with them.

The linear trend of increase in the other causes of hospitalization should not go unnoticed. Thus, special attention should be paid to external causes, genitourinary system diseases, and falls, once they have been showing exponential increases since 2010, gaining overall differentials of +2.46%, +1.37%, and +0.56% in 2019, respectively. Given the case of external causes, the gender issue is perceived to be an inner element in this discussion. Women were more likely to attend hospital services to receive care for accidents of external causes, with an overall differential of +1.89%, in 2019. As possible explanations, the exercise of domestic activities performed by women (retired or housewives), the architectural barriers of the environment, and the predominant polypharmacy in women, should be deemed [41:510p].

On the other hand, falls represent a great public health problem in the aging population as their incidence shows higher values every year. A nationwide study by Siqueira et al. found a prevalence of falls in the elderly of 27.6%, with the Midwest and Southeast regions being the most impacted by this type of occurrence. Being overweight/obese, having a previous record of attempted falling, living in inadequate environments, and using more than two drugs daily were the main factors found for predisposition to falls in the elderly [42].

Furthermore, to be considered is the increase in impairments, as was well shown in **Chart 2**. Visual and hearing impairments have been recognized as potential contributors to the onset of falls and a consequent increase in hospital admissions and geriatric mortality, mainly among the oldest elderly. According to Choi et al., [43:8p], to meet this onus "fall prevention should target risk factors that are specific to serious injuries requiring costly care. Strategies for implementing scalable, adaptable, and measurable fall prevention models by primary care and emergency medical service providers and ED staff are needed".

In this study, the causes of mortality were in line with the reasons for geriatric hospitalization. Diseases of the circulatory system, neoplasms, and diseases of the respiratory system were the three leading causes of death among the elderly in both genders (**Figure 4**).

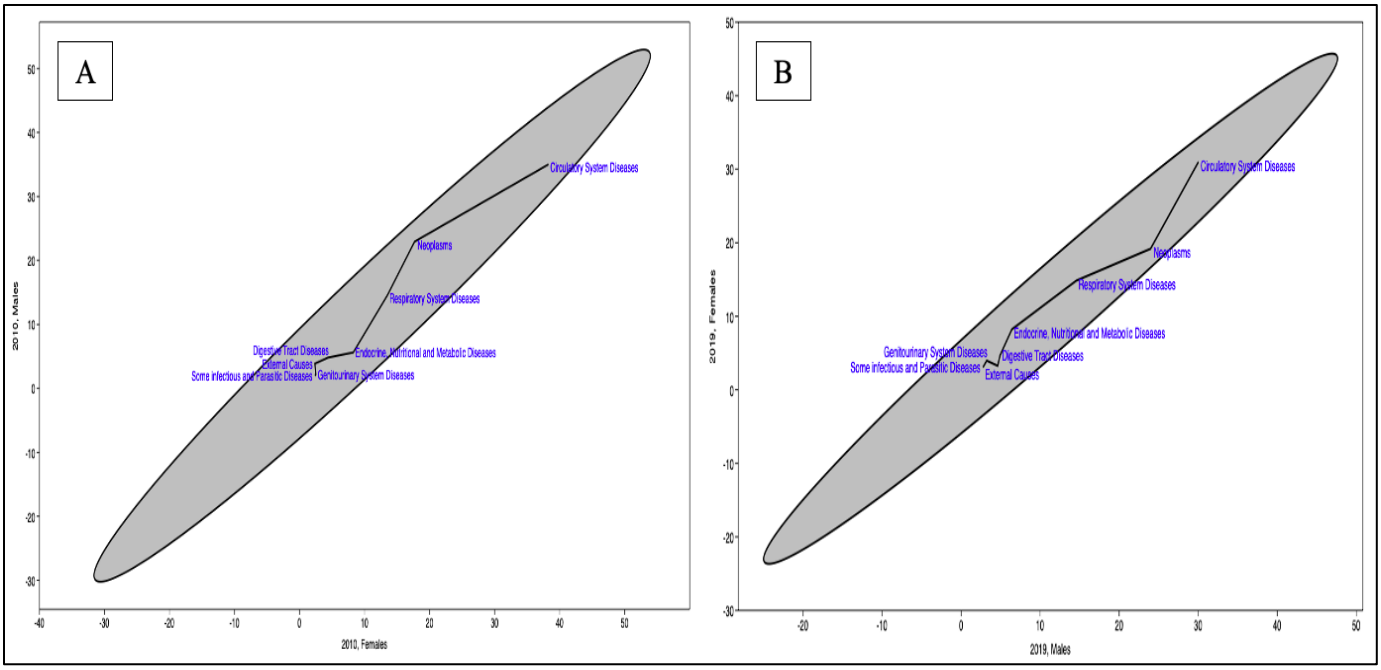


Figure 4. Proportions of geriatric mortality, according to sex and analysis period (**A**: 2010) and (**B**:2019), in the Southern Region, Brazil.

Source: The authors, based on SISAP-Idoso data [20].

Our results confirm that the Southern Region follows the national and international profile of geriatric mortality, with diseases of the circulatory system being responsible for the utmost number of deaths [38, 39, 40]. A nationwide study in China highlighted the impact of such diseases on the maintenance of healthcare systems, once they are accountable for the highest public health expenditures, involving high costs in surgery, rehabilitation, and pharmacological accompaniment [44]. In Brazil, studies show higher mortality rates from diseases of the circulatory system in elderly women, blacks, and those with previous smoking and alcoholism habits [7, 9, 14]. Specifically, in the Southern, an exponential increase in geriatric mortality from preventable causes denotes the need to strengthen health promotion and disease prevention actions [45].

As the second leading cause, neoplasms account for a significant proportion of overall mortality, with a marked predominance among men. Within European countries, this type of disease has been causing serious problems for public health systems and has aroused special interest among public policymakers who, in turn, admit that the mechanisms for combating the reduction of its incidence and prevalence are based, above all, on actions that reflect long-term results and require significant public investment [46]. Both genders are divergently affected by this kind of disease. In men, the most prevalent types are prostate, trachea, bronchus and lung, and colon and rectum. In the case of women, there are more deaths due to breast, colon and rectal, and cervical cancer [47].

In both cases, circulatory diseases and neoplasms, the underlying issue is that these diseases claim early lives, which could be avoided if the population, in general, endorsed healthy lifestyles. Although it is expected that with the organic degradation that occurs in the organism as an effect of natural aging, some studies underpin the importance of active and healthy aging, which allows the exercise of an autonomous life, even with the coexistence of these diseases [48, 49]. In addition, side benefits can also be mentioned, such as the reduction of the burden among caregivers (relatives or professionals), and the decongestion of institutional demand in geriatric and gerontological hospital departments [45, 46, 47].

Except for diseases of the circulatory system, all other causes of death showed proportionally increasing behavior from 2010 to 2019 (**Figure 4B**). Amongst women, some causes were higher, as in the case of respiratory system diseases (+0.26%), endocrine, nutritional and metabolic diseases (+1.8%), genitourinary system diseases (+0.73%), some infectious and parasitic diseases (+0.29%), and falls (+0.71%). These diseases do not have a high weight in the overall mortality value, even when grouped, but they greatly limit the quality of life and the self-perception of health status among elderly women [48, 49].

Southern Brazilian states recognize the complexity of the preventive and curative approach to these diseases and have therefore joined forces to develop guidelines and protocols for care, mainly aimed at primary health care. In Paraná, the Health Guideline for the Elderly was made official in 2017, aiming to provide Paraná citizens with the opportunity of active and healthy aging, with quality of life, autonomy, and independence for as long as possible. As of 2014, the State of Paraná incorporated the risk classification for frailty among the elderly, as an immediate measure to identify early the needs of its population. This has allowed interventions performed in primary care to follow an efficient flow together with the other levels of care [50].

The Comprehensive Healthcare Guideline for the Elderly was validated and made an official instrument for health professionals in Santa Catarina, in 2018, to support the State and municipalities of Santa Catarina in the reorganization of care and the development of strategic health actions for the elderly, with emphasis on health promotion, disease prevention, treatment, and rehabilitation, guided by the Health Care Network [51]. Unfortunately, the State of Rio Grande do Sul has not yet issued a specific instrument to address the health of its elderly, so it is understood that geriatric and gerontological strategies follow the guidelines and norms in force at the national level. Thus, the lack of this instrument could represent an institutional fragility for the strengthening and expansion of the health care network for the elderly, considering that national standards do not cover the particularities of each territory and the customs and needs of their corresponding aging populations.

Based on the results of this study, the initial hypothesis (H_0) is accepted that the lower the morbidity and mortality rates among older adults, the higher the population aging index in all Southern States. It is believed that structural and organizational improvements in local public health systems and programs have had a positive effect on the survival of the elderly in Southern Brazil. Coupled with this, the constant improvement and qualification of health professionals reinforce the practices and health care for the aging population, which can also be a reflection of the better health rates seen in this population segment.

Despite what was pointed, very thoroughly, more drastic changes in the geriatric morbimortality profile will only be achieved by raising the awareness of the population, even during the early ages. It is worth remembering that most of the clinical conditions faced by the elderly are the result of unhealthy lifestyles, widely sharped by social inequalities. In parallel, the discussion on social determinants in/of health could not escape mention. The Southern States must redouble their efforts to ensure decent living conditions among their elderly inhabitants, validating the fundamental rights granted to these individuals and uniting the links between the different generations that coexist in their societies. Even though it is not an easy task, Brazil has one of the most robust public and social assistance systems in the Americas, and one of the highest global rates of assistance coverage for the aging population.

4. CONCLUSIONS

To better understand the challenges of the topics under discussion, one must recognize the myriad of critical elements embroiled, ranging from the pathophysiological prism to the social field and its derived areas. In this study, our main objective divided itself into two components, one that sought to trace the demographic changes of the aging population in the Southern Brazilian states, and another that was concerned with analyzing the main causes of disease and death. In both cases, the study findings allowed us to see that the region follows the national pattern, in which women make up the majority of the elderly population and in which chronic non-communicable diseases are the main causes of illness and death among the elderly.

The information contained in this study can be of great contribution to the management and planning of population aging in the Southern Brazilian states, since it addresses the main demographic changes and the impacts that the increase in the elderly population has implied in the public health systems. In addition, they serve as a basis for proposing multisectoral actions to promote the integrity and quality of life of the elderly. Considering the existing scientific gap in the region, this information

could also be used by academic institutions interested in the study of the social phenomenon of aging, as a basis for the elaboration of further research.

As for the methodological limitations, we admit that some points ought to be mentioned. The type of study carried out could present the glitch of information filling and handling, with the global characteristics observed in the mortality and lethality coefficients. However, it should be recalled that these are official data made available by competent public bodies, a fact that validates the veracity of their source. This argument is not new, studies at the national level have already highlighted this challenge for health information systems, and recommend that awareness and qualification actions for the personnel in charge be carried out at all levels of health management, from the municipal, state and, federal levels. Taken together, the outcomes presented in this paper refer to a collective reality, in other words, they do not allow us to identify subjective characteristics among the observed populations. These are data that favor the generalization of results and do not represent the particularities of the participants.

Despite these shortages, the study had the potential to draw a longitudinal profile of the elderly and to observe the main reasons for illness and death. At length, this information becomes undoubtedly relevant for population health management and planning processes, as it justifies the implementation of gerontological interventions and the qualification of the health workforce. Being aware that the next census will be carried out during the year 2022, future studies that consider the demographic impacts of aging from the cut-off date of this study are recommended, that is, that expose the results observed from the year 2011 onward.

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AUTHOR CONTRIBUTIONS

All authors have made substantial, direct and intellectual contribution to the work, and approved it for publication.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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APPENDIXES

1. **Proportions of inpatient geriatric morbidity, according to year of registration and state of origin (A: Paraná; B: Santa Catarina and; C; Rio Grande do Sul), 2010-2019.**

A.

Causes of Hospital Geriatric Admission	PARANÁ					
	2010		2015		2019	
	Males	Females	Males	Females	Males	Females
Circulatory System Diseases	28.27	28.21	27.52	26.81	26.4	24.88
Respiratory System Diseases	20.97	21.91	17.43	18.26	13.33	14.76
Neoplasms	9.81	8.06	12.96	11.7	14.57	13.06
Digestive Tract Diseases	9.33	8.0	9.66	8.49	10.33	9.2
External Causes	5.49	6.59	7.34	8.81	8.01	9.6
Genitourinary System Diseases	5.54	4.91	6.02	5.69	7.02	6.49
Some infectious and Parasitic Diseases	5.31	6.03	5.57	6.14	6.28	6.58
Endocrine, Nutritional and Metabolic Diseases	3.59	4.98	2.64	3.2	2.18	2.56
Falls	2.45	3.48	2.26	3.39	2.32	3.68

B.

Causes of Hospital Geriatric Admission	SANTA CATARINA					
	2010		2015		2019	
	Males	Females	Males	Females	Males	Females
Circulatory System Diseases	27.3	28.91	24.49	24.24	23.16	21.31
Respiratory System Diseases	22.37	18.81	18.14	17.01	16.23	16.44
Neoplasms	10.52	8.53	13.41	10.91	15.5	13.13
Digestive Tract Diseases	10.67	9.64	11.3	10.17	11.58	10.15
External Causes	4.87	6.57	6.04	7.61	6.41	8.22
Genitourinary System Diseases	6.28	6	7.16	7.71	7.4	8.65
Some infectious and Parasitic Diseases	4.6	5.97	5.33	5.88	5.64	6.41
Endocrine, Nutritional and Metabolic Diseases	2.81	4.49	2.68	3.62	2.4	2.99
Falls	2.97	4.91	3.35	5.44	3.57	6.08

C.

Causes of Hospital Geriatric Admission	RIO GRANDE DO SUL					
	2010		2015		2019	
	Males	Females	Males	Females	Males	Females
Circulatory System Diseases	25.42	26.7	24.18	23.47	23.68	21.96
Respiratory System Diseases	22.9	20.03	18.67	17.65	15.91	16.1
Neoplasms	11.2	9.29	12.93	11.11	13.75	12.38
Digestive Tract Diseases	10.07	9.5	10.35	9.74	10.76	9.72
External Causes	4.35	5.58	5.72	7.88	6.39	8.68
Genitourinary System Diseases	7.01	6.29	7.65	6.87	7.61	7.08
Some infectious and Parasitic Diseases	5.31	6.06	5.97	6.53	7.34	7.79
Endocrine, Nutritional and Metabolic Diseases	3.6	5.22	3.03	3.72	2.55	2.8
Falls	2.23	3.53	2.66	4.54	2.65	4.65