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## Hiring of workers in the municipal public sector: A projection of the demographic need by Brazilian municipality, 2020 to 2030

*Contratação de trabalhadores no setor público municipal: Uma projeção da necessidade demográfica por município brasileiro, 2020 a 2030*

*Contratación de trabajadores en el sector público municipal: Una proyección de la necesidad demográfica del municipio brasileño, 2020 a 2030*

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### ABSTRACT

Given the context of demographic changes and population aging, this article aimed to estimate the need (ND) for hiring municipal public workers in Brazil, between 2020 and 2030, for the professional categories of Education, Health and Others. Based on data from the Annual Social Information List (RAIS, 2018), the methodology used was the Brazilian municipalities' microsimulation model for projecting civil servants. The results suggest that the ND will increase for the set of professional categories and be higher in the Southeast and Northeast regions. However, it remains negative for the Education category and positive for the Health category. It was concluded that the DN of workers in the municipal public sector is affected by the demographic dynamics of the municipalities and the dynamics of the population of workers.

**Keywords:** projections; civil servants; population aging; need for hiring; professional categories.

### RESUMO

Dado o contexto de mudanças demográficas e envelhecimento populacional, este artigo teve como objetivo estimar a necessidade (ND) de contratação de trabalhadores públicos municipais no Brasil, entre 2020 e 2030, para as categorias profissionais Educação, Saúde e Outros. Com base em dados da Relação Anual de Informações Sociais (RAIS, 2018), a metodologia utilizada foi o modelo de microsimulação para projeção de servidores por município brasileiro. Os resultados sugerem que a ND será crescente para o conjunto das categorias profissionais e maior nas regiões Sudeste e Nordeste, porém, se mantém negativa para a categoria Educação e positiva para a categoria Saúde. Concluiu-se que tanto a dinâmica demográfica dos municípios, quanto a dinâmica da população de trabalhadores afetam a ND de trabalhadores do setor público municipal.

**Palavras-chave:** projeções; servidores públicos; envelhecimento populacional; necessidade de contratação; categorias profissionais.

### RESUMEN

Dado el contexto de cambios demográficos y envejecimiento de la población, este artículo tuvo como objetivo estimar la necesidad (ND) de contratación de trabajadores públicos municipales en Brasil, entre 2020 y 2030, para las categorías profesionales Educación, Salud y Otros. Con base en datos de la Lista Anual de Información Social (RAIS, 2018), la metodología utilizada fue el modelo de microsimulación para la proyección de servidores por municipio brasileño. Los resultados sugieren que el DE aumentará para todas las categorías profesionales, además de ser mayor en las regiones Sudeste y Nordeste, negativo para la categoría Educación y positivo para la categoría Salud. Se concluyó que la DN de los trabajadores del sector público municipal se ve afectada tanto por la dinámica demográfica de los municipios como por la dinámica de la población de trabajadores.

**Palabras clave:** proyecciones, funcionarios, envejecimiento de la población, necesidad de contratación, categorías profesionales.

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## 1 INTRODUCTION

The demographic transition experienced by Brazil results in an aging population and changes in the demand for public services such as Education, social security and Health. In addition to changes in the demand for these services, there are also changes in the number of public servants who perform these services, who move from active servants to inactive servants due to population aging. Given this context, this article aims to show how the change in the profile of municipal populations affects the demographic need to offer public services and the hiring of workers in the municipal public sector in Brazil for the period from 2020 to 2030, considering both the health dynamics of workers in the activity regarding the population's demand for types of public services at the municipal level.

The study of the number of municipal public workers was carried out based on data from the DRAA (SPREV, 2020), the Social Security Secretariat, and the Munic base (IBGE, 2019). The number of municipal public workers in Health and Education was defined based on studies by Rossel (2016) and Morales (2015). For workers in other professional categories, the number of municipal public workers per 100,000 inhabitants was considered. These indicators were applied to the projected population each year, for each municipality, by Freire, Gonzaga & Queiroz (2019).

Changes in the dependency ratios between population groups, caused by changes in the number of young people, adults and the elderly (IBGE, 2018a), require adaptations in managing and providing public services to these populations. Changes in the number of young people, adults and the elderly cause changes in family arrangements, a relative increase in the number of elderly people, and increased longevity (F. Brito, 2007), challenges for public Health and social security management (Alves, Vasconcelos & Carvalho, 2010), given that the increase in the number of elderly people tends to increase the demand for resources spent on Health. Furthermore, the increase in the number of elderly people tends to increase the number of beneficiaries of the social security system. On the other hand, the decrease in the number of young people tends to reduce the demand for resources invested in Education (Alves, Vasconcelos & Carvalho, 2010).

The present study is justified by the evidence of demographic changes in the Brazilian population, which should lead to changes in the number of workers in the Brazilian public sector and the demand for workers in the areas of Health and Education. According to Santos et al. (2017a), these demographic changes also tend to cause changes in the number of civil servants (public sector workers with statutory employment), given that these changes modify not only the social security of these civil servants but also the demand for public services. The authors, therefore, expect a decline in the number of active

servants (Santos et al., 2017b). However, changes in specific areas, such as Health, Education and public safety, can affect the functioning of the public machine (Santos et al., 2017b).

Given this context, states and municipalities need to maintain a number of civil servants that guarantee, on the one hand, the provision of essential public services to the population and, on the other hand, the proper management of social security resources in order to guarantee the payment of benefits of pension funds of their servants (Santos et al., 2017b). Schettini, Pires & Santos (2018) investigated how policies to replace civil servants can impact the payroll size in the scope of the federal public service. The authors' results suggest that, due to changes in the population age structure, a significant volume of civil servants will become eligible for retirement benefits in the coming decades, which will increase public spending on social security benefits and demand the replacement of these civil servants.

Based on the literature consulted it is observed that some authors were concerned with analyzing the size of the population of public servants (OECD, 2010; Lassance, 2017) or of the population of employees in a given area, as in the 2006 World Health Report (OMS, 2006), or even the financial impacts, for the government, of the aging population of civil servants and future beneficiaries (Schettini, Pires & Santos, 2018). However, there is a need for more investigations on the need for future hiring of workers in the municipal public sector, given the context of population aging. Based on these presentations, the relevance of the analysis of how these workers will be replaced (including public servants with a statutory bond and other workers in the municipal public sector) is evident to verify aspects related to the proportionality of workers and demand for municipal public services.

The results showed that, by 2030, although most municipalities require the hiring of municipal public workers in the areas of Health and Education, there is a small number of municipalities in which the number of municipal public workers will be sufficient to maintain the standards of care observed in 2018, even with the evidence of demographic changes and in the population of municipal public workers. Some municipalities, such as Acará-PA, showed a need for negative hiring in Education and positive hiring in the health area. It is expected, therefore, that the results of this work will contribute to municipal planning related to public policies for hiring personnel, social security, Education, and Health carried out by Brazilian municipalities and to the improvement of public services with a focus on the need and quality of services to the population. At the same time, the results presented here demonstrate the close relationship between demography and public policy and how demographic projection methods can contribute to social development and well-being.

## 2 DEMOGRAPHIC CHANGES AND DEMANDS FOR PUBLIC POLICIES

Changes in fertility, mortality and migration lead to changes in population size (Nielsen, 2016) and their main consequence is population aging. In Brazil, the demographic transition began with a decline in fertility in the 1970s (Paiva & Wajnman, 2005) and a subsequent decline in mortality. The aging of the age structure is the result of the transformation of a predominantly young population (with a broad base of the age pyramid and a narrow top) into a population with a high percentage of elderly people (with a narrow base of the age pyramid and a wide top) (Miranda, Mendes & Silva, 2016).

IBGE population projections (2018a) showed that in 2020 the Brazilian population may reach more than 211 million people. According to estimates by the agency, this number may reach more than 224 million in 2030. By 2030, the elderly population should represent more than 13% of the population. The young and adult populations should represent, in 2030, 19% and 67.5%, respectively. The Brazilian population should show positive growth until the 2050s. However, from 2060, population projections show population declines, due to the decline of the young and adult populations, since the elderly population will continue to grow (IBGE, 2018a).

In Brazil, the process of demographic transition occurred unevenly across different regions, states and municipalities. In the North and Northeast regions, the decline in fertility was observed later compared to the other regions of Brazil (Fernandes, Gonçalves, & Santos, 2016). In addition, the decline in mortality occurred more rapidly in these regions. As a result, the South and Southeast regions are more advanced in the demographic transition process (Fernandes, Gonçalves & Santos, 2016).

These population changes impact the demands for different public services offered to these populations, especially in the areas of Education, Health and social security (Moreira, 2014). Thus, population aging, or even population decline, generate significant challenges for federal, state and municipal governments. The problem is even more relevant at the municipal level, as municipal entities, especially the smaller ones, depend more on government subsidies from higher spheres (Medeiros, Albuquerque, Tavares, & Souza, 2017).

Given the above, it becomes necessary for public policies intended to guarantee essential public services to citizens to consider such changes (Martins, 2010) to meet the population's demands based on its size and indicators of the target population. (Rios-Neto, Martine, & Alves, 2009). Therefore, knowing the population's age profile is relevant to highlight the changes in the social demands of an increasingly aging population. This concern becomes even more significant at the municipal level since these changes are heterogeneous among municipalities, which

can make the demands for public services even more specific between different locations in the country.

### 2.1 Education public policies

In its text, the Federal Constitution of 1988 (CF/88) (Brasília, DF: Federal Senate: Graphic Center, 1988) assigns municipalities the responsibility for offering public services of early childhood and fundamental Education. Kindergarten and elementary Education include individuals up to 15 years old. Kindergarten generally applies to children up to 5 years old, while primary Education applies to children aged 6 to 15. The states were assigned responsibility for the stages of primary and secondary Education.

Reducing the population from 0 to 14 years old (young population) reduces the demand for public education services. This reduction contributes to implementing public policies aimed at Education, which tends to improve the quality of teaching and the universalization of school coverage (Brito, 2007; Rios-Neto, Martine & Alves, 2009).

For Brazil, the evolution of the proportion of enrollments in each stage of Education (kindergarten, elementary, secondary, technical and EJA), according to data from the School Census (2013 to 2018), shows that there was a reduction in the number of enrollments in all stages of Education, except in kindergarten, which went from 5.3 million in 2013 to 6.3 million in 2018 (INEP, 2019), showing a growth of 17.6%, although the population growth of 0 to 5 years was only 0.9%, according to IBGE data (2018)

The statistical report of the 2018 School Census (INEP, 2019) states that, in Brazil, the increase in enrollment in early childhood education was mainly due to the increase in enrollment in daycare centers, which increased from 1.7 million to 2.4 million between 2013 and 2018. On the other hand, Brito et al. (2020), this increase is attributed to the mandatory enrollment of children aged four until March, starting in 2013. According to the authors, this obligation is reflected in public policies aimed at expanding the number of places offered in early childhood education. Costa, Silva & Braga (2020), in turn, attribute the increase in the number of enrollments to the increase in resources allocated to Education from the Fund for the Maintenance and Development of Elementary Education and the Valorization of Teaching (FUNDEF) and lately, from the Basic Education Maintenance and Development Fund (FUNDEB). According to the authors, these resources made it possible to increase the number of children enrolled, increase the number of daycare centers and preschools, increase the hiring of teachers and improve the infrastructure of the facilities.

Despite this expansion, the vacancies are still lower than the demand (Costa, Silva & Braga, 2020). In 2013, according to data from the School Census made available by Inep (2013-2018) and population estimates made available by IBGE (2018a), only 30.7% of children aged 0 to

5 years were enrolled in municipal or state schools, that is, almost 70% of the children were enrolled in other types of institutions (private, for example) or were not enrolled in any educational institution at all. This proportion grew to 35.7% by 2018. However, it is still low, and the number of vacancies must be further expanded to reach the universalization of this teaching stage (Brito et al., 2020) but without reducing the quality of the teaching (Silva & Lima, 2019). For this reason, in Brazil, despite the declining trend of the young population, investments in public education policies are still necessary, especially at the municipal level. However, for smaller municipalities, the fiscal issue is still an obstacle to financing education services (Costa, Silva & Braga, 2020), which can hinder investments and the hiring of teachers and other education professionals, whether by statutory or temporary bond.

According to data from the 2018 School Census, 52% of teachers had a statutory job in Brazil that year. The highest proportion of statutory teachers was evidenced in the Federal education network (81%), followed by municipal (65%) and state (64%) education networks.

With the reduction in fertility, the dependence rate on Education decreases, requiring fewer physical and human resources to obtain the same schooling rate (Saad et al., 2009). With the results of this article, what is expected is to contribute to the understanding of changes in the demand for education professionals, considering the population that requires these services. With this, municipal public policies will use a parameter concerning the need to hire education professionals at each teaching stage.

## 2.2 Public health policies

Concerning health services, the municipalities are competent to provide these services, while the States and the Union are responsible for providing technical and financial support to the municipalities (Brasil, 1990). In Brazil, public health services are provided through the Sistema Único de Saúde – SUS (Brasil, 1988). In an aging population (with a high percentage of elderly people), the demand for health services tends to be higher.

The increase in the number of elderly tends to increase the expenditure on health services, especially for people aged 80 and over (Saad, Miller & Martínez, 2009). It turns out that the costs of clinical procedures tend to be higher the older the user is (Rios-Neto, Martine & Alves, 2009). In addition, the epidemiological transition results in a more significant burden of chronic diseases in the population, mainly affecting the elderly.

Chronic diseases can generate physical disabilities, which may result in the need for care from other people (Harwood et al., 2004) from the family or specialized people in the health system. The elderly receive the most health care assistance compared to other individuals, except for newborns (Matthews & Channon, 2006), since the demand for care increases with age.

According to data from DataSus, in Brazil, between 2007 and 2018, the number of professionals, nursing technicians, nurses and dentists experienced the most growth over these years. Pharmacists and nursing assistants showed a decline. On the other hand, other health professionals remained steady in the analyzed period. Viacava, Oliveira, Carvalho, Laguardia & Bellido (2018) attributed the evolution in the number of health professionals to public health policies such as the More Doctors Program and the National Primary Care Program. The increase in health professionals was more significant in the private sector than in the public. Between 2007 and 2018, the percentage of health professionals working in the private sector grew from 47% to 52%. This measure decreased from 39% to 33% at the municipal level.

The increase in the elderly population tends to increase the demand for gerontological health services (Rivadeneira, 2000) and recreation for the elderly. On the other hand, reducing the young population tends to reduce the demand for daycare centers, preschools and obstetric and pediatric services (Jannuzzi & Pasquali, 1999; Tuirán, 2002). Faced with such changes, the analysis of population dynamics becomes relevant, especially regarding the elderly population, for the planning of public policies.

## 3 HIRING OF MUNICIPAL PUBLIC WORKERS

Amongst countries that are members of the Organization for Economic Cooperation and Development (OECD), the average percentage of civil servants in the workforce is 22%. In Brazil, this percentage varies between 11% and 12%. Related to the total population, 3.20% of individuals are municipal civil servants, while 1.58% and 0.35% are state and federal civil servants, respectively. The greater representation of municipal servants, compared to state and federal servants, is explained by the responsibility of municipalities for the execution of most public services and social policies (Lassance, 2017). The report by the Organization for Economic Cooperation and Development (OECD, 2010) states that the number of public servants in Brazil should continue to grow, and this increase is justified by the improvement of public services provided.

In Brazil, statutory servants are hired through public tenders (Pessoa, Mattos, Britto & Figueiredo, 2009), guaranteeing the characteristics of stability to these employees, among other differences from other workers hired through temporary contracts, including all workers in the municipal public sector (statutory and other workers). According to data from the Munc database (IBGE, 2019), between 1999 and 2018, the number of municipal statutory servants in Brazil increased from more than 2 million in 1999 to more than 4 million in 2018. The number of municipal statutory servants increased linearly since 1999, with a small decrease from 2017 to 2018, during which the number of non-statutory workers increased again (having declined

between 2015 and 2017). In this period, the total population also increased, but at a slower pace than the number of public sector workers in municipalities, as the percentage of public sector workers in municipalities over the total population increased during the period under analysis.

According to Cardoso & Nogueira (2011), expanding employment in the municipal public sector indicates the increasing supply of public services at the municipal level. The expansion of municipal public functions results from municipalizing and decentralizing public services such as Health, Education and assistance (Carvalho, 2011; Cardoso & Nogueira, 2011). It so happens that, with the decentralization of the 1988 Constitution, municipalities began to receive a large part of the provision of public services to the population. Furthermore, the increase in the number of public sector workers in the 1990s can be explained by the generalization of basic social services after the enactment of the 1988 Constitution and the creation of new municipalities after 1988 (Carvalho, 2011). These periods of a large volume of jobs (1990s and 2000s) may be due to the large number of retirees, which requires the replacement of statutory servants (Cardoso & Nogueira, 2011).

The economic situation of the federal entities also impacts hiring workers in the public sector. During periods of economic expansion, governments tend to spend more on investment and staffing; in times of crisis, it is common for efforts to be made to contain these expenses (Cardoso & Nogueira, 2011). Therefore, moments of economic crisis/expansion also affect the employment of human resources and their age pyramid in the future.

In addition, technology can also play a relevant role in organizations. Thanks to technological innovations, it is possible to mechanize, rationalize and improve the execution of operations. On the other hand, using these innovations can make the labor of some services obsolete (Barbosa et al., 2020), reducing the need for specialists because they totally or partially replace the previously employed labor. However, some specific services can not (and should not) be replaced by these resources, as is the case with health services: technology facilitates the work of professionals in this area but only partially replaces them. For example, information technology (IT) reduces jobs in several sectors of the economy. However, in the health area, even with this practice, the number of professionals has increased (Viacava, Oliveira, Carvalho, Laguardia & Bellido, 2018).

## 4 METHODOLOGICAL PROCEDURES

### 4.1 Type of research

Based on the definitions by Gerhardt & Silveira (2009), the present study can be classified in terms of approach as quantitative research, as its results can be quantified, among other characteristics. As for the nature,

the research can be classified as applied because it can generate knowledge for practical application. Furthermore, regarding the objectives, the research is classified as explanatory, as it seeks to associate factors that determine the occurrence of certain phenomena.

### 4.2 Data source, temporal and geographic clippings

The main data source used in this study is the 2018 Annual Social Information Report (RAIS, 2018), applied to all municipalities in Brazil, which provides information about municipal public servants in that year. The year 2018 was used because it is the most recent period available in Rais (2018) at the beginning of this study. Rais (2018) is an excellent source of information about employees, but it has limitations due to a large amount of incorrectly reported information. These differences did not prevent using these data, but modifications were necessary.

Incorrect observations from Rais (2018) were corrected based on information considered correct from the Rais (2018) database. For the variables age and length of employment, incorrect observations were replaced by the measure of central tendency (in this case, the median). For the variable professional category, generated according to the Brazilian Classification of Occupations, all the observations were estimated based on the proportion of individuals previously observed in each category of the variable. In addition, the population size and composition of the statutory civil servants in the municipalities were corrected based on data from the Munic (IBGE, 2019) and DRAA (SPREV, 2020) databases.

After the adjustments, 5,469,154 workers in the municipal public sector were identified in 5,548 municipalities. Of the total, 34.5% (1,888,258) were men, 65.5% (3,580,896) were women, 4,891,230 were statutory, and 577,924 were non-statutory. According to the nomenclature of the position, individuals were classified into professional categories: Education, with 1,691,633 individuals (30.9%); Health (17.9%), with 976,594 individuals; and Others, with 2,800,927 individuals (51.2%). Additionally, workers were classified as teachers (27.6%, 1,508,482) and non-teachers (72.4%, 3,960,582) due to different rules in the retirement function used. Within the classification of the category Others, workers from the following professional areas were observed: Infrastructure, Security. Administration, Engineering works, Urban mobility, Information technology. Assistance, Financial, Fiscal/Tax, and Legal, emphasizing the administrative area, with almost 20% of the workers.

### 4.3 Projection model of the population of workers in the municipal public sector: Microsimulation

After correcting the number of workers in the municipal public sector, the number of active workers in the municipal public sector was obtained, in each professional category, at each time. To this end, the population of assets

was projected, at each time, in each professional category. Based on these numbers, the need to hire new workers between 2020 and 2030 was calculated.

This study considered the microsimulation model adapted from the Actuarial-Demographic Simulator of Special Welfare Policy (SADEPrev), based on Corrêa (2014). SADEPrev is a microsimulation model with Monte Carlo sampling. From the estimates of the probabilities of leaving the multiple decrements tables, by random drawings for each individual, at each age and for each sex, compared with the probability of leaving the multiple decrements table due to disability or death, the time T that the individual takes to leave the activity. Finally, the random time T, added to the initial age of the individual, was compared with the retirement age, calculated initially, to define the age and reason for leaving the activity. For each simulation performed, there is a different T for each individual.

From SADEPrev, the retirement functions were adapted, differentiating the statutory employees linked to RPPS (Special Welfare Policy) and other workers, and the routines used to project the population of each professional category in each municipality separately were adjusted to, finally, save the information of the number of active workers in the municipal public sector in each category, at each time, in each municipality. The same model was used for statutory servants and non-statutory workers, changing only the retirement eligibility criteria for each group.

In the model adopted, a number of 2,500 rounds were used for the populations of all municipalities in all categories, an amount considered adequate after analyzing the results with some numbers of rounds. Thus, it was possible to obtain mean, minimum and maximum results within 95% confidence intervals, which were adopted to represent the analyzed populations. The routines used in the microsimulations can be consulted in the repository through the link: <https://github.com/ArtigosSubmissao/Dissertacao-RotinasR>.

Based on the number of active workers in each year of the projection and each professional category, it was possible to estimate the demographic need for hiring workers in the municipal public sector.

#### 4.4 Assumptions Used in the Model

In population projection models, it is necessary to adopt future population behaviour assumptions. The premises for the retirement of workers derive from the legislation. For statutory servants linked to RPPS, the function that calculates the retirement age was based on the constitutional text prior to EC No. 103 of November 12, 2019 (Constitutional Amendment No. 103, of November 12, 2019, 2019), and the adaptation of what was used in Corrêa (2014). It is noteworthy that the innovations brought by EC No. 103 of 2019 were not considered in the calculation of the retirement age of civil servants linked to RPPS,

considering that, as it is a recent federal government rule for federal civil servants and that municipalities have the autonomy to adopt it or not, most municipalities have not adopted such a rule yet or may never adopt it. For non-statutory workers and statutory servants whose municipality does not have an RPPS, the function of the eligibility age for retirement was based on the current legislation that regulates the retirement of workers linked to the General Social Security System (RGPS), Law 8.213, of July 24, 1991 (Law 8.213, of July 24, 1991, 1991). The differentiation between statutory workers who were or were not linked to municipal RPPS was made through the information contained in the DRAA (SPREV, 2020), which presents the municipalities that have municipal RPPS.

For mortality, the present study used the mortality tables designed by (Gonzaga, Queiroz, Freire & Silva, 2019), for the year 2018, for each Brazilian municipality, for both genres. One advantage of using these results is the possibility of considering differentials in the structure and level of mortality experienced by the municipalities, which would not be possible with a single average table for all municipalities.

The disability retirement age is the age after each individual becomes disabled. In the present study, for decrementing disability, the Álvaro Vindas disability table was used. According to Gomes, Fígoli & Ribeiro (2010), the Álvaro Vindas disability entry table is one of the main tables used in the pension market, in addition to being the minimum established by the Social Security Secretariat for the probability of entering disability retirement.

In this work, dismissal by exoneration was disregarded for statutory or non-statutory employees. As the work is dedicated to the analysis of the number of vacancies for these workers and not their characteristics or the nature of the bonds of the occupants of these vacancies, this assumption would not invalidate the results either, assuming that a statutory servant could occupy the vacancy and which was not due to government issues, and not due to demand for work. It is considered, therefore, that the results of the present study are more aimed at discussing the number of vacancies in the municipal public sector than the characteristics of those who occupy them.

#### 4.5 Total population of municipalities

The data on the populations of the municipalities by age groups used in this article were the result of the work of Freire, Gonzaga & Queiroz (2019). The findings are part of the Brasil 3 Tempos Project results, and the detailed methodology used can be consulted in Freire, Gonzaga & Gomes (2019), a publication resulting from the aforementioned project. These projections are based on the population of the 2010 Demographic Census.

In 2010, according to the Demographic Census, the Brazilian population was 190,755,799, of which 93,406,990 were men (49%), and 97,348,809 were women (51%).

According to IBGE projections (2018a), in 2018, the Brazilian population had 208.5 million inhabitants, with 106.5 million women (51%) and 102 million men (49%). For 2030, these projections indicate that the population will be 224.9 million, with 109.7 million males and 115.1 million females (IBGE, 2018). Considering the projections by Freire, Gonzaga & Queiroz (2019), it was shown that between 2018 and 2030, 4.9% of the municipalities had total population growth rates greater than 2% per year. The lowest rates are observed in municipalities in Pará, Maranhão and Bahia, with the lowest rate observed in Jacareacanga (PA). 47% of municipalities show population decline between 2018 and 2030.

Furthermore, the municipalities with the highest growth rates for the total population were those with the highest growth rates for those aged 0 to 14 years. Most of the municipalities that presented negative rates for the total population presented positive rates for the elderly population, which indicates that the population decline is caused by the decline of either the young or adult population. These changes indicate an inversion and aging of the population structure of these municipalities, which, on the one hand, may increase the demand for workers in the health area due to the increase in the elderly population and,

on the other hand, may reduce the demand for workers in other categories.

With regard to population groups, the young population (from 0 to 14 years old) in 2018 was estimated at 21.3% of the total population (44.5 million), while the adult and elderly populations were 69.4% (144.8 million) and 9.2% (19.2 million), in that order (IBGE, 2018) for Brazil. The need for workers in Education must be affected by the population linked as a demander of education services (0 to 14 years old) and by the aging of the population of workers. Between 2018 and 2030, the municipalities that showed the highest growth rates in this population group were in the North region. Most municipalities had negative rates, with the lowest rates observed in Maranhão, Rio Grande do Norte, Bahia and Pará.

#### 4.6 Methods for Estimating the Need to Hire Workers in the Municipal Public Sector

With the projected population of workers in the municipal public sector and the population of the municipalities, it was possible to estimate the need for hiring between 2020 and 2030. Indicators were used that showed the situation in the municipalities in 2018, as shown in Table 1.

**Table 1**

Methods for calculating indicators and demographic needs in Education, Health and Others.

Area	Indicator Formula and Demographic Need (ND)	Meaning of the Indicator
Education	$IEM = 40$ $ND(IEM)_i^t = \frac{15P_{0,i}^t}{IEM} - S_{Education,i}^{Projected,t}$	Indicator of 40 individuals for each education professional, based on Morales (2015)
	$IE_i^t = \frac{15P_{0,i}^t}{S_{Education,i}^t}$ $ND(IE)_i^t = \frac{15P_{0,i}^t}{IE_i^{2018}} - S_{Education,i}^{Projected,t}$	Relationship between the number of people from 0 to 14 years old and the number of education professionals
	$IS-OMS = 2,54$ $ND(IS - OMS)_i^t = \frac{(2,54) P_{Total,i}^t}{1,000} - S_{Health,i}^{Projected,t}$	Indicator of 2.54 health professionals per thousand inhabitants, based on the IS-WHO indicator
Health	$IS_i^{2018} = \frac{5P_{0,i}^{2018} + \omega P_{85,i}^{2018} + 0,5(5P_{5,i}^{2018} + 10P_{75,i}^{2018})}{S_{Health,i}^{2018}}$ $ND(IS)_i^t = \frac{5P_{0,i}^t + \omega P_{85,i}^t + (5P_{5,i}^t + 10P_{75,i}^t) 0,5}{IS_i^{2018}} - S_{Health,i}^{Projected,t}$	Relationship between the population in need of care and the population of municipal public health workers, based on Rossel (2016)
	$IO_i^{2018} = \frac{S_{Others,i}^{2018} 100.000}{P_{Total,i}^{2018}}$ $ND(IO)_i^t = \frac{IO_i^{2018} P_{Total,i}^t}{100.000} - S_{Others,i}^{Projected,t}$	Number of workers in the municipal public sector per 100,000 inhabitants

Source: Own elaboration.

Where:

$S_{Category,i}^{Projected,t}$  is the number of active workers in the category, projected for year t, in municipality i.

$nP_{x,i}^t$  is the population projected by Freire, Gonzaga and Queiroz (2019) for municipality i, between ages x to x+n years, for year t.

$P_{Total,i}^t$  is the total population projected by Freire, Gonzaga and Queiroz (2019) for year t and municipality i;

$ND(Index)_i^t$  is the demographic need calculated based on each indicator, in year t, for municipality i.

Initially, for the Education category, a constant indicator called "IEM" was used for all municipalities. This indicator was chosen based on the study by Morales (2015), who used a parameter of 40 students per teacher based on the regulations of Honduras (the locality analyzed in the study). As no regulation was found in Brazil that matches the one used by Morales (2015), the same indicator used by the author was adopted in the present study. In 2018, 4,861

municipalities had a ratio between the number of people from 0 to 14 years old and the number of education professionals below 40.

Additionally, the objective was to identify the relationship between the demander and offerer population of the education service observed by each municipality in 2018, with the index "IE". For Brazil, the result of this indicator was 26 individuals from 0 to 14 years old for each municipal public worker in the area of Education. For the municipalities that presented the highest values for this indicator, the results indicate that more individuals were demanding the education service for each municipal public worker.

Considering only health workers, the 2006 World Health Report (WHO, 2006) analyzed the need for health workers, considering both the public and private sectors. The report defines a minimum necessary between 2.02 and 2.54 health professionals per 1,000 inhabitants to reach a coverage level of 80%. Considering only health professionals who are municipal public workers, 585 of the municipalities analyzed do not exceed this limit, according to data from Rais (2018). In 2018, in Brazil, there were 4.7 health professionals, within the scope of municipal public Health, for every thousand inhabitants, with variation in this value between municipalities. Based on this WHO indicator (called IS-OMS), initially, in order to establish a single parameter for all municipalities, the minimum defined by the WHO (2.54) was adopted for estimating the demographic need (ND) for public health workers.

In order to estimate the demand for health care in the context of population aging, Rossel (2016) presented a demand indicator that assigned different weights to certain population groups. For example, groups of children and the elderly had a greater weight in the demand for care than adults. This indicator reveals how many people would need care for each potential formal and informal caregiver. In the present study, a relationship based on what was proposed by Rossel (2016) was used, considering health professionals as the potential caregiver population to estimate the IS indicator. To this end, the ratio between the population in need of care and the population of municipal public health workers in 2018 was calculated. Then the number of workers needed for this ratio to be maintained was calculated constant over the projection horizon. Taking this relationship as a constant, the objective was to obtain an estimate of the demand for health workers for each municipality so that the relationship between the number of individuals in need of care and the number of potential professional caregivers remained constant. Making this calculation for Brazil, with the information of municipal public health workers contained in Rais (2018), it is obtained that

2018 has a value of approximately 27 individuals who need care for each professional in municipal public Health (considering statutory workers and other workers).

With the IS indicator, the demographic need shows the number of workers necessary for the numerical relationship between the number of workers and the population of the municipality in 2018 to remain constant throughout the analyzed period. It is a measure to replace the population of workers based on the dynamics of the municipal population. Thus, each municipality will present a different parameter in calculating the demographic need to maintain the situation observed in 2018.

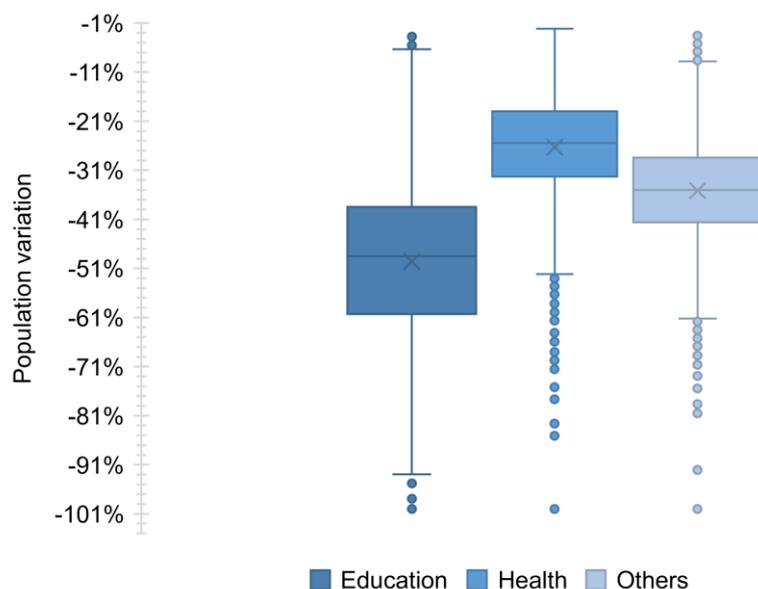
It is noteworthy that municipalities that observe, over the analyzed period, just due to demographic dynamics, an increase in the ratio between the number of workers and the number of individuals needing care may observe improvements in the public service provided. On the other hand, the municipalities that observe, just due to demographic dynamics, a reduction in the ratio between the number of workers and the number of individuals who need care may present declines in the quality of the services provided, thus necessitating the hiring of new workers.

For workers in the municipal public sector in the Other category, the number of workers in the municipal public sector per 100,000 inhabitants was used.

## 5 RESULTS

### 5.1 Results of Microsimulations

Graph 1 shows the variations in the populations of workers in the municipal public sector between 2018 and 2030, related to the populations of workers in the municipal public sector observed in 2018 in each professional category. This measure was calculated using the quotient between the population changing between 2018 and 2030 and the population of workers in the municipal public sector observed in 2018. Between 2018 and 2030, 2,132,097 workers in the municipal public sector retired, died or became disabled (39% of the total observed in 2018). As a consequence, they left the asset group. In the Education category, the population change was minus 790,804 (-46.7%) workers in the municipal public sector. In the Health category, this variation was minus 304,547 (-31.2%). In the category Others, the population had a negative change of 1,036,746 workers in the municipal public sector (-37%). Although the absolute variation was greater in the Others category, in percentage terms, the variation was more intense in the Education category, and this can be explained by the differentiated retirement rules for teachers, which makes these workers eligible for retirement five years earlier than the others.



**Graph 1.** Proportional variation in the population of workers in the municipal public sector, by professional category and Brazilian municipality, between 2018 and 2030.

Source: Results of population projections based on Rais data, 2018.

According to the results obtained, considering the average results, in the Education category, the municipalities that presented the smallest and largest negative proportional variation were São Miguel do Aleixo-SE (2.1%) and Iporá-GO (100%), respectively. On average, this category's population of municipal public sector workers decreased by 49.6%. The median of these values was -48.5%, and half of the values varied between -60.3% and -38.5%. In the Health category, the smallest variation was observed in São Paulo de Olivença-AM (-2.2%) and the largest variation was identified in the municipality of Triunfo-PE (-100%). In this category, the municipal public sector workers' population varied, on average, -26.3%. The median of these values was -25.4%, and 50% were concentrated between -32.3% and -19%. In the category Others, Santa Tereza-RS (-2.2%) and Guairaçá-PR (-100%) presented the lowest and highest variation in the population. On average, the population varied -35.1%. The median of these values was -35%, and half of the values varied between -41.6% and -28.5%.

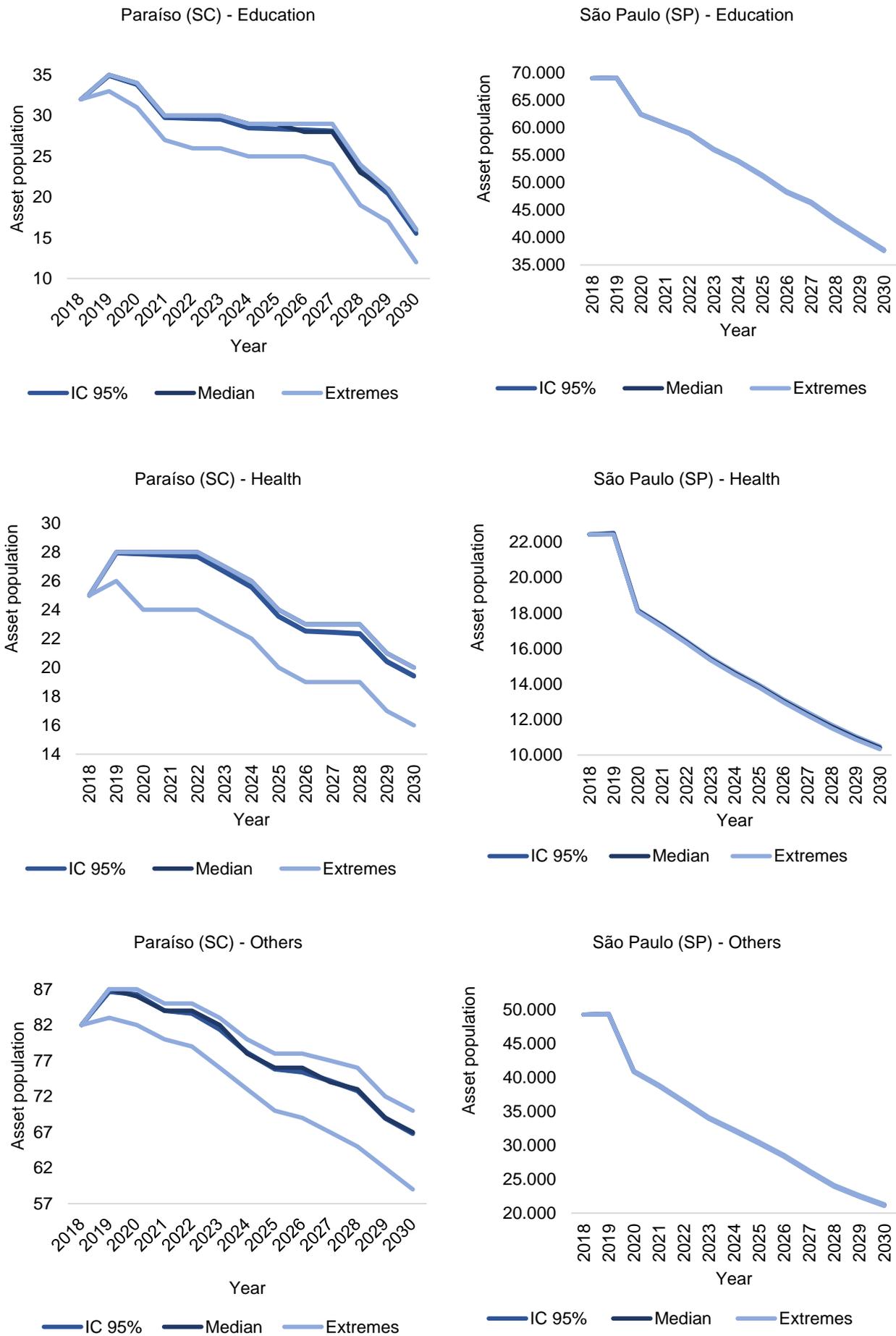
These results show that initially, it will be necessary to replace the population of workers in the municipal public sector in Education, composed mostly of teachers, who retired five years earlier than other workers. However, due to the reduction in the number of young people, it may be possible that workers from other areas will replace workers in the municipal public sector in Education.

The use of the microsimulation model with a Monte Carlo approach is justified, among other things, by the results' variability. With the large number of microsimulations performed, it was possible to obtain, for

each category and municipality, average results within a 95% confidence interval constructed based on the 2.5 and 97.5 percentiles of the observations.

Figure 1 presents, by way of example, the distributions of the results of the projections of the populations of municipal public sector workers for 2030: Paraíso-SC and São Paulo-SP. In 2018, the municipality of Paraíso-SC had 150 workers, of which 35 were from the Education category, 28 were from the Health category, and 87 were from the Other category. The municipality of São Paulo had 141,888 workers in the municipal public sector in 2018, of which 69,371 were in the Education category, 22,685 were in the Health category, and 49,832 were in the Other category.

The results in Figure 1 show that in larger populations, such as the population of workers in the municipal public sector in the city of São Paulo-SP, the results of population projections present a more concentrated distribution around the median, which does not occur with very small municipalities, as in Paraíso-SC. In this municipality, most results were concentrated in values greater than or equal to the median value, which meant that the average result was also close to these values. It was observed that the dispersion around the median values is greater the smaller the population of the municipality, which confirms that the larger the municipality, the smaller the variability of the results. Furthermore, in most municipalities, the amplitude of the confidence intervals increased over time. This increase is due to the reduction in the population of workers in the municipal public sector over time.



**Figure 1.** Distribution of the results of the projections of the population of workers in the municipal public sector, by professional category, in Paraíso-SC, Imperatriz-MA and São Paulo, 2030.

Source: Results of population projections based on Rais data, 2018.

## 5.2 Results of demographic need indicators

Table 1 presents a descriptive summary of the results by professional category.

**Table 1**

Descriptive summary of the results of demographic need by professional category from 2020 to 2030.

Category	Indicator	Year	Results			
			Minimum	Maximum	Average	Median
Education	IEM	2020	-11.043 (Rio de Janeiro-RJ)	6.135 (Salvador-BA)	-86	-39
		2025	-4.939 (Goiânia-GO)	5.820 (Salvador-BA)	-37	-22
		2030	-2.483 (Goiânia-GO)	14.927 (São Paulo-SP)	20	-4
	IE	2020	-44 (Fonte Boa-AM)	7.350 (Rio de Janeiro-RJ)	33	9
		2025	-101 (Monte Alegre-PA)	15.173 (São Paulo)	81	26
		2030	-164 (Monte Alegre-PA)	25.451 (São Paulo)	133	45
Health	IS-OMS	2020	-10.054 (Belo Horizonte-MG)	12.702 (São Paulo-SP)	-75	-36
		2025	-7.548 (Belo Horizonte-MG)	17.408 (São Paulo-SP)	-52	-30
		2030	-5.057 (Belo Horizonte-MG)	21.044 (São Paulo-SP)	-25	-21
	IS	2020	-11 (Santo Antônio de Itá-AM)	4.721 (São Paulo-SP)	16	4
		2025	-29 (Santo Antônio de Itá-AM)	9.448 (São Paulo-SP)	41	10
		2030	-35 (Monte Alegre-PA)	13.443 (São Paulo-SP)	70	18
Others	IO	2020	-26 (Jacareacanga-PA)	9.310 (São Paulo-SP)	53	18
		2025	-75 (Jacareacanga-PA)	São Paulo-SP (20.542)	135	51
		2030	-102 (Jacareacanga-PA)	São Paulo-SP (30.026)	222	86

Source: Results of population projections based on Rais data, 2018.

A negative population demand in a given category means that the demand for municipal employees is less than the number of existing municipal employees, and no new employees need to be hired. On the other hand, a positive score indicates the need to hire new workers. That is, the demand for workers is greater than the supply.

Using the IEM, by 2030, 2,979 municipalities had a negative need for hiring, indicating that they already have the necessary number of workers to meet the population's demand for education services. Most of these municipalities showed a similarity in the significant decline in the population from 0 to 14 years of age. These results are also due to the fact that many municipalities already had less than 40 individuals aged 0 to 14 years for each education professional, which had implications for the demand for new workers in this area.

For example, the municipality that presented the lowest result (Goiânia-GO) obtained a quantitative of 19 individuals from 0 to 14 years old for each professional in the field of Education in 2018. With the variations in the population of workers in this area and in the population that demands this service (0 to 14 years old), this quotient increased to 29 individuals from 0 to 14 years old for each professional in the area of Education, that is, a quantity smaller than 40, which resulted in a negative need for new hires, since this need would only be positive if this quotient were greater than 40, according to the indicator defined in the previous chapter.

The IE considered changes in the municipality's population aged 0 to 14 years and the situation of the municipality in 2018. Based on this measure, by 2030, only 135 municipalities required hiring less than zero, indicating no need to hire new employees. These municipalities had in common, among other things, a decline in the population

aged 0 to 14 between 2018 and 2030, which affected the result of the need for hiring. For example, the municipality of Monte Alegre-PA presented a result of -164 workers for the need to hire, having shown a decline in the population aged 0 to 14 years of more than 5% per year between 2018 and 2030.

The municipalities that presented the highest annual population growth rates, between 2018 and 2030, of the population aged 0 to 14 years were among the municipalities that presented the highest figures for demographic need, which confirms that the larger the population aged 0 to 14 years, the greater the need for workers in the municipal public sector in the Education category.

For the category of workers in the municipal public sector in the health area, the demographic need was initially calculated considering the total number of inhabitants in the municipality based on the IS-OMS. The demographic need calculated using the IS-OMS was calculated considering the variations in the total populations of the municipalities and a quantity of 2.54 health professionals per thousand inhabitants. Based on this indicator, 4,433 municipalities had negative demographic needs. These results were obtained, among other things, because most municipalities already had more than 2.54 health professionals per thousand inhabitants in 2018.

Subsequently, the demographic need for workers in the municipal public health sector was calculated considering the dynamics of the elderly population using the IS indicator. With the IS, the demographic need was calculated considering the variations of the populations that demand care in the municipalities. As a result, only 78 municipalities had a negative result, showing that the vast majority of municipalities will require new hires due to the

dynamics of the population that demands care. The municipalities that show negative values have in common a decline in the population that requires care by 2030, which confirms that the larger the population that requires care, the greater the demand for hiring health professionals.

The municipalities that presented the highest values for the demographic need in the area of Health were among the municipalities with older workers in the municipal public sector in this category and among the municipalities that presented the highest population growth rates of the elderly population between 2018 and 2030.

Finally, the demographic need for workers in the municipal public sector was calculated in the category Others, considering the dynamics of the municipality's total population. The municipalities that presented the highest annual population growth rates between 2018 and 2030 were among the municipalities that presented the highest values for the need to hire workers in the municipal public sector.

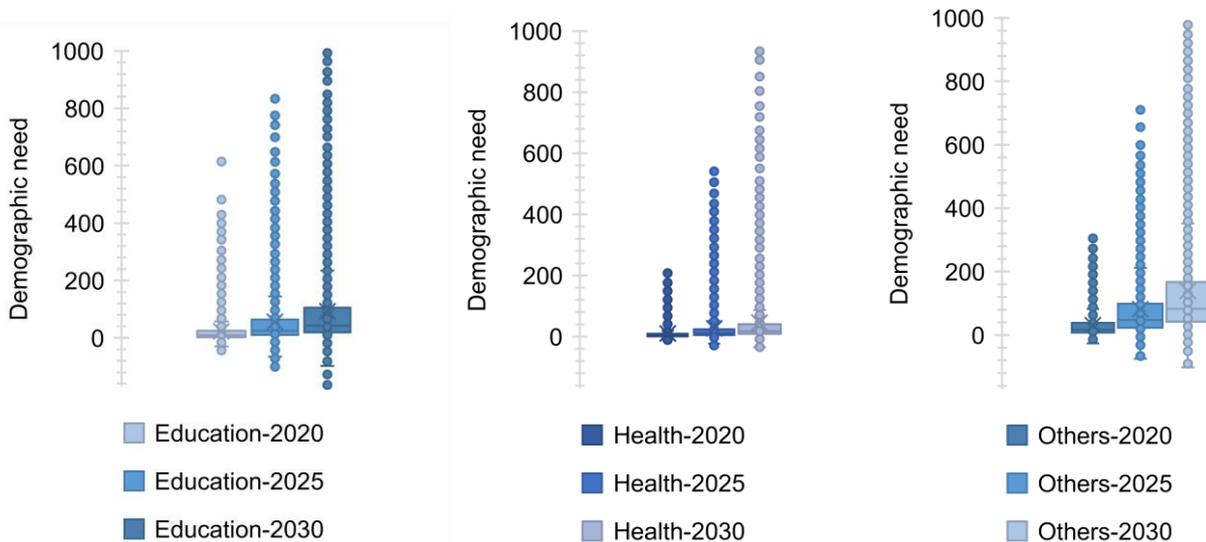
Figure 2 shows the distribution of demographic need values for 2020, 2025 and 2030 professional categories. In all years, demographic need values are more dispersed for the Education category, followed by the Others and Health categories. This result may reflect the mismatch in the transition process between the different municipalities. While the population aged 0 to 14 is still growing in some municipalities, in older municipalities this population group already shows a tendency to decline, which generates different results with opposite signs. In addition, some municipalities had a greater volume of workers in the municipal public sector in the area of Education, which generated a greater volume for the need to hire in this

category, even with evidence of a decline in the population aged 0 to 14.

The demographic need is growing in all categories in most municipalities between 2020 and 2030. In the Education category, in 207 municipalities, the demographic need variation and the population from 0 to 14 years old were negative between 2020 and 2030. In this category, in 4,077 municipalities, the variation in demographic need was positive, even when the variation in the population from 0 to 14 years of age was negative, which can be explained by the decline in the population of workers in the municipal public sector in this category. In the other cases in this category, the variation in demographic need and the population from 0 to 14 years old were positive.

In Health, in 125 municipalities, the demographic need declined between 2020 and 2030. These municipalities have in common the decline of the population that needs care. In this category, in the other cases, the demographic need was positive due to the increase in the population in need of care and the decline in the number of workers in the municipal public sector in this area.

In the category Others, all the municipalities that presented negative variation for the demographic need presented negative variation for the total population. In the other cases, for this category, the demographic need has grown due to the growth of the total population and the decline in the population of workers in the municipal public sector in this area. These results show that, although some aggregated average results for Brazil have shown negative values, the vast majority of Brazilian municipalities will need new hires by 2030 in all professional categories.



**Figure 2.** Dispersion of the observations of the demographic need of workers in the municipal public sector, in the professional categories of Education, Health and Others, using the IE, IS, and IO, by Brazilian municipality, 2020, 2025 and 2030.

Source: Own elaboration based on the results of the demographic need indicators based on data from Rais (2018) and Freire, Gonzaga & Queiroz (2019).

Caption: For the elaboration of these graphs, observations greater than 1,000 were excluded for better visualization of the results.

The proportion of demographic needs related to the number of workers in the municipal public sector in 2018, considering the IE, IS and IO, ranged from -47% to 255%. Values ranged from -47% to 255% in the Education

category. In the Health category, values ranged from -45% to 219%. In the Other category, values range from -38% to 251%. These values indicate that the need for replacement can reach up to 2.6 times the number of workers in the

municipal public sector observed in 2018. The results of the demographic need until 2030 by category and municipality can be consulted in the repository: <https://github.com/ArtigosSubmissao/ResultadosOnline/blob/main/Tabela%20com%20resultados%20 finais.xlsx>.

For Brazil as a whole, by 2030, the demographic need was for more than 2.3 million workers in the municipal public sector, with 707 thousand in the Education category, 369.9 thousand in Health and 1.2 million in the Others category. Considering the results of the demographic need by professional category by region of Brazil, until 2030, in the Education category, the demographic need was greater in the Southeast region (286.7 thousand), followed by the Northeast region (222.3 thousand), South (105.9 thousand), North (48.3 thousand) and Midwest (43.8 thousand). In the Health category, by 2030, the demographic need was greater in the Southeast region (181.1 thousand), followed by the Northeast region (88.3 thousand), South (54.7 thousand), Midwest (23.6 thousand) and North (22.2 thousand). By 2030, in the category Others, the demographic need was greater in the Southeast region (506.3 thousand), followed by the Northeast region (357.9 thousand), South (157.5 thousand), North (111.4 thousand) and Central-West (97.6 thousand).

The results show that the demographic need is greater in the Southeast and Northeast regions in all categories, which reflects the greater volume of workers in the municipal public sector in these two regions. Figures show that, by 2030, to replace the population of workers in the municipal public sector in the Southeast region, it will be necessary to hire more than 500,000 workers in the municipal public sector, which is more than four times the number of workers in the municipal public sector needed in the North region (more than 120 thousand). Furthermore, in all regions and all years, the demographic need is greater in the Others category. That occurred due to the greater volume of workers in the municipal public sector in this category, which generated a greater volume of workers leaving the activity and vacant positions.

Considering the results of the demographic need based on the sizes of municipalities in 2018 (up to 50,000 inhabitants, between 50,000 and 100,000 inhabitants and more than 100,000 inhabitants), by 2030, in municipalities with up to 50,000 inhabitants, the demographic need was of 913.4 thousand workers in the municipal public sector, while in municipalities with a population between 50 thousand and 100 thousand inhabitants and with more than 100 thousand inhabitants it was 294.9 thousand and 1.1 million, respectively. In the Education category, by 2030, this measure was 278.4 thousand, 96.3 thousand and 332.4 thousand workers in the municipal public sector in municipalities with up to 50 thousand, between 50 and 100 and with more than 100 thousand people, respectively. By 2030, in the Health category, the demographic need was 112.7 thousand, 41.5 thousand and 215.7 thousand workers in the municipal public sector, respectively, in municipalities with up to 50 thousand, between 50 and 100, and more than

100 thousand people. In the Others category, by 2030, this measure was 522.3 thousand, 157.1 thousand and 551.3 thousand workers in the municipal public sector in municipalities with up to 50 thousand, between 50 and 100 and with more than 100 thousand people, respectively.

The total demographic need is greater in groups of municipalities with more than 100,000 inhabitants and with up to 50,000 inhabitants. This result is explained by the greater volume of municipal public sector workers in these groups of municipalities. In all groups and years, the demographic need is greater in the Others category, followed by the Education and Health category. That can be explained by the greater volume of workers in the municipal public sector in the Other category, which generated a greater volume of departures and vacant positions and, consequently, a reduction in the number of active workers in the municipal public sector.

The tables with all the results detailed by municipalities and professional categories can be consulted in a repository at the link: <https://github.com/ArtigosSubmissao/ResultadosOnline/blob/main/Resultados%20 finais%20 detalhados.xlsx>.

Finally, it is emphasized that the supply of workers in the municipal public sector and public services also affects the behavior of the demographic components: mortality, fertility and migration. According to Tiebout (1956), individuals generally tend to migrate to locations that offer the services demanded by these individuals. Thus, families with young people and children tend to seek residence in locations offering services for these population groups. Families with elderly people tend to look for locations that best offer public services for these individuals, such as health services.

In addition, demographic components can also affect the demand for workers in the municipal public sector and municipal public services. The immigration of adults (15 to 64 years old) should initially affect the demand for workers in the municipal public sector of the professional category, which the indicator used and the calculation of the demographic need for workers in the municipal public sector considers the total population: the greater the number of immigrants, the greater the demand for workers in the municipal public sector, since an increase in the population due to the entry of immigrants into the population increases the demand for workers in the municipal public sector in this professional category. The immigration of young people must initially affect the demand for workers in the municipal public sector in the area of Education: the greater the immigration of individuals up to 14 years old, the greater the demand for workers in the municipal public sector. In the medium and long term, immigration should affect the demand for workers in the municipal public sector in the health area since individuals who migrate tend to age. This aging should lead to an increase in demand for health services.

## 6 FINAL CONSIDERATIONS

The objective of this study was to show how changes in the population of municipalities between 2020 and 2030 affect the population's demand for the provision of public services and the employment of workers in the municipal public sector in Brazil. For this purpose, data from workers in the municipal public sector over time from Rais (2018) was used, adjusted based on the DRAA (SPREV, 2020), from the Social Security Secretariat, and on the Munic base (IBGE, 2019). Rossel (2016) and Morales (2015) recommendations were used as criteria to determine the minimum number of workers in Health and Education. For other public workers in the municipality, the total population of each municipality was considered. For each municipality, such indicators were applied to the estimated yearly population by Freire, Gonzaga & Queiroz (2019).

The main conclusion is a preliminary estimate of the number and composition of the municipal public sector workforce in 2018. After adjustments to Rais data (2018), more than 5.4 million municipal public sector workers were identified in 2018, of which 34.5% were men and 65.5% were women. 51% of municipal civil servants belong to other categories, 31% to Education and 18% to Health. In addition, approximately 28% of employees in the municipal public sector are teachers, so different social security rules apply.

According to the results of the projections of the population of workers in the municipal public sector, between 2018 and 2030, the population had a negative variation of 2,132,097 (39%). In the Education category, the population variation was minus 790,804 (-46.7%) workers. In the Health category, this variation was minus 304,547 (-31.2%). In the category Others, the population had a negative change of 1,036,746 workers in the municipal public sector (-37%). The results show that although the absolute variation was greater in the Others category, in percentage terms, the variation was more intense in the Education category, and this can be explained by the differentiated retirement rules for teachers, which makes these municipal public sector workers eligible for retirement five years earlier than others.

By 2030, the total demographic need was more than 2.3 million workers in the municipal public sector, with 707 thousand in the Education category, 369.9 thousand in the Health category and 1.2 million in the Others category. It was also verified that the demographic need was growing in all categories, with the largest volumes presented by the Southeast and Northeast regions and municipalities with up to 50 thousand inhabitants and more than 100 thousand inhabitants.

Based on these results, it can be concluded that in the residual category "Others", the need to hire workers in the municipal public sector was modified both due to the dynamics of the total population of the municipalities and due to the dynamics of the population of workers in the municipal public sector of that category. In municipalities

that still have significant growth in their total population, the tendency is for this demand to increase even more over time.

The demand for municipal public health sector workers has increased due to the aging of the municipality's population, combined with the aging and departure of municipal public sector workers who worked in this category. In this category, hiring needs were greater than the number of professionals who left the active group, which indicates an increase in demand for these professionals in the analyzed period. This result points to possible demands for municipal public policies that aim to apply a greater volume of resources in the health area, both for the cost of treatments and for hiring professionals, which aligns with the results obtained by Rossel (2016).

The results found, mainly for the Education and health sectors, corroborate those found in the literature, such as Rossel (2016) and Alves, Vasconcelos & Carvalho (2010). The authors pointed out changes in the demands for health and education professionals, respectively. Furthermore, Santos et al. (2017a) predicted changes in public servants resulting from population aging. Other authors analyzed changes in the population of workers in the municipal public sector, such as (Schettini, Pires & Santos, 2018), and, as in the present study, obtained as main results evidence of changes in the demand and supply of workers in the public sector, caused both by the aging population of workers and by changes in social demands caused by the aging population in general.

In the professional category of Education, the demographic need for workers in the municipal public sector was affected by the departure of workers from the municipal public sector from active worker status and the dynamics of the population aged 0 to 14 years. Notably, only the Education category needed new hires lower than the volume of workers in the municipal public sector who left their positions, indicating a downward trend in demand for these workers, as pointed out by Alves, Vasconcelos & Carvalho (2010). Overall, this result reflects the decline in the population that demands this service (from 0 to 14 years old). This result is relevant for formulators of municipal public policies since this reduction in the demand for professionals in the field of Education may allow the application of public resources in other areas, such as in the area of Health, where the demand for professionals is rising. However, institutional factors can make it difficult to redistribute these resources destined for Education, even if they are used in investments in public services at the municipal level.

Among the main limitations faced during the preparation of this study, the limitations of the Rais database (2018) stand out, which, as it depends on sending information from each employing institution, does not contemplate the same quality for all municipalities, being necessary to the use of correction methods for the variables to be used in the population projection model. Despite this limitation, it was considered possible to reduce the errors of

incorrect observations in the database through single imputation data imputation methods.

Another limitation of the work concerns the short analysis period since the ten years analyzed (2020 to 2030) can be considered short for the effects of retirement and demographic changes. However, data from municipal population projections used were only available for this period, and future studies can be carried out extrapolating the period analyzed here.

Despite the limitations encountered, the social contribution of the discussion proposed in this study is considered important. It is hoped that the results of this study can serve as a subsidy for formulating public policies for hiring workers within the scope of the municipal public sector in light of the demographic changes experienced by municipalities over time.

It is also believed that studies like this are relevant in the scientific field since, among other things, methods of population projections for small populations were addressed, addressing their advantages and disadvantages. An attempt was made to relate the literature on population aging with the demand for different types of public services, and based on the literature, indicators of demand for hiring were proposed to capture demographic variations over time.

Finally, as proposals for future studies, there is a financial analysis of the effects of demographic changes within the scope of the municipal public service; that is, given the demographic need presented in the results of this study, how much would it cost, on average, for municipal governments to hire these numbers of workers in the municipal public sector? Analyzes as these could further reinforce the subsidy for formulating public policies for hiring new workers in the municipal public sector so that it would be possible to analyze not only the number of professionals needed but how much this would cost the public purse. Furthermore, it would be interesting to disaggregate the Others category and analyze the demand for other public services, such as public transport services and garbage collection. With changes in the young and adult populations, the demand for these services also tends to be affected.

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