RPPI
Revista Brasileira de Políticas Públicas e Internacionais

The influence of the SUS assistance network on local supplementary health

A influência da rede assistencial do SUS na saúde suplementar local

Lucas Carrilho do Couto[1]
José Willer do Prado[2]
Ednilson Sebastião de Ávila[3]
Antônio Carlos dos Santos[4]

DOI:10.22478/ufpb.2525-5584.2026v11n1.67611

Received: 11/08/2023
Approved: 06/11/2026

Abstract: This article investigates the relationship between the structure of the healthcare network linked to the Brazilian Unified Health System (SUS) and the penetration of supplementary health insurance in the municipalities of Minas Gerais in 2019. Based on multiple regression applied to 853 municipalities, the effect of the number of physicians, other healthcare professionals, equipment, hospital beds, municipal spending, and GDP per capita on the number of beneficiaries per 1,000 inhabitants was examined. The results reveal expected negative effects for professionals and equipment, an unexpected positive effect for physicians, and signals consistent with the hypotheses formulated for GDP (positive) and municipal spending (negative). Finally, methodological limitations are discussed, and paths for public policies aimed at strengthening the public supply as a strategy to mitigate the unequal expansion of supplementary health insurance are indicated.

Keywords: Beneficiaries; supplementary health; health care network; multiple regression; unified health system (SUS).

[1] Universidade Federal de Lavras (UFLA). Email: lucascarrilho@yahoo.com.br
[2] Universidade Federal de Lavras (UFLA). Email: jose.prado@ufla.br
[3] Universidade Federal de Lavras (UFLA). Email: ednilson.avila@ufla.br
[4] Universidade Federal de Lavras (UFLA). Email: acsantos@ufla.br

Resumo: O artigo investiga a relação entre a estrutura da rede assistencial vinculada ao SUS e a penetração da saúde suplementar nos municípios de Minas Gerais em 2019. Com base em regressão múltipla aplicada a 853 municípios, examinou-se o efeito do número de médicos, demais profissionais de saúde, equipamentos, leitos, gastos municipais e PIB per capita sobre o número de beneficiários por 1.000 habitantes. Os resultados revelam efeitos negativos esperados para profissionais e equipamentos, efeito positivo inesperado para médicos e sinais consistentes com as hipóteses formuladas para o PIB (positivo) e os gastos municipais (negativo). Por fim são discutidas limitações metodológicas e indicados caminhos para políticas públicas voltadas ao fortalecimento da oferta pública como estratégia de mitigação da expansão desigual da saúde suplementar.

Palavras-chave: Beneficiários; saúde suplementar; rede assistencial de saúde; regressão múltipla; Sistema Único de Saúde (SUS).

1. CONTEXT AND RESEARCH PROBLEM

Supplementary health in Brazil, which refers to private health plans and insurance, covers approximately 47 million people. This means that nearly one quarter of the population is enrolled in private medical care plans. In addition, the Brazilian supplementary health sector collects hundreds of billions of reais annually to finance its operations and coverage. Comparatively, these figures make Brazil the world's second-largest health insurance market, behind only the United States (Andrade et al., 2015; Bahia & Scheffer, 2018; Baird, 2017; Maia, 2012).

At the same time, this segment of the population has dual coverage; that is, it is covered by both public and private healthcare structures. Meanwhile, there maining share of the population, approximately three quarters, relies exclusively on Brazil's public healthcare system. Created in 1988 and known as the Unified Health System (Sistema Único de Saúde - SUS), this system is established by the Federal Constitution and guarantees every citizen the fundamental right to access healthcare (Constituição da República Federativa do Brasil de 1988, 1988).

SUS is regarded as one of the world's most substantial and important healthcare systems, serving more than 200 million people. Its foundation rests

essentially on three major principles: universality, comprehensiveness, and equity. The first principle, universality, centers on guaranteeing the right to health for all Brazilians, without distinction or discrimination, through access to healthcare services provided by SUS. Comprehensiveness, in turn, is understood as an articulated and continuous set of preventive and curative actions and services, both individual and collective, required in each case at all levels of complexity. Finally, equity is characterized by fairness, impartiality, respect for equal rights, and other aspects associated with this concept (Abreu et al., 2017; Santos, 2009).

From this perspective, SUS must encompass an extensive and comprehensive network of services and physical resources to fulfill its purpose. Fundamentally, the components of the system include health centers and clinics, public hospitals, agreements with private institutions, laboratories and blood centers, health surveillance services, epidemiological surveillance, environmental surveillance, foundations and institutes for academic and scientific research, as well as numerous other branches (Abreu, 2020). Thus, given the complexity and scope that SUS is intended to cover, the high proportionofsupplementaryhealthbeneficiaries (one quarter of the population) may be questioned, since the State itself has a duty to provide the means for and promote healthcare for all.

An important point already identified in previous studies is that the segment of the population with some form of private health plan uses healthcare facilities, whether public or private, more frequently than the segment without such coverage (Manski et al., 2014; Porto et al., 2011; Santos et al., 2008). Considering that people with greater purchasing power are those able to pay for a privateplan, Macinkoand Lima-Costa (2012) observedthat, given their needs, healthcare utilization among wealthier groups appears to be above and beyond what would be expected. Consequently, this group tends to have better health conditions than individuals without private health plans (Moraes et al., 2011). It is also the case that, in certain locations, people with lower purchasing power often do not find healthcare services that are

organized, comprehensive, and of good quality, as prescribed by law. This circumstance, together with other factors related to education, geographic location, age, race, and other individual and/or environmental characteristics (Bahia et al., 2006; Kassouf, 2005; Kilsztajn et al., 2001; Marcinko & Lima-Costa, 2012; Maia, 2012), may affect the health conditions of lower-income individuals.

Although previous studies have investigated public-private coexistence and supplementary health coverage in Brazil, there is little empirical evidence directly linking the physical and professional structure of the SUS healthcare network at the municipal level to the penetration of supplementary health coverage. This article addresses this gap by estimating, for all 853 municipalities in Minas Gerais in 2019, the effect of structural SUS indicators (physicians, healthcare professionals, equipment, hospital beds, and expenditures) on the number of private health plan beneficiaries, while controlling for municipal income. (GDP per capita). The study therefore seeks to answer the following question: how does the structure of the SUS healthcare network affect the number of supplementary health beneficiaries in the municipalities of Minas Gerais? To achieve this purpose, the study seeks to: identify indicators of the SUS-linked healthcare network in municipalities in the State of Minas Gerais in 2019; identify the number of supplementary health beneficiaries in municipalities in the State of Minas Gerais in 2019; and analyze the impact of the SUS-linked healthcare network structure on the number of supplementary health beneficiaries in municipalities in the State of Minas Gerais in 2019.

A combination of public and private healthcare systems may facilitate access to and use of health services, but it may also lead to higher healthcare expenditures, greater social inequalities in access to care, and unfair competition between public and private providers (Pilotto & Celeste, 2019; Viana et al., 2015). In one of the studies addressing this issue in the South American context, Bahia and Scheffer (2018) highlight an important aspect of this relationship. The authors argue that the operational translation of the

broader concept of health, relating the public and private sectors, is not well understood in Brazil. This issue can also be observed in other studies (Porto et al., 2011; Santos, 2009; Santos et al., 2008; Serapioni & Tesser, 2019). Bahia and Scheffer (2018) note that Brazil is the only South American country with a universal healthcare system, yet it “is not the country on the continent that spends the most public resources on health. There is a structural contradiction: despite the universal system, health expenditures are lower than those of neighboring countries, while private expenditures are higher than public expenditures" (Bahia & Scheffer, 2018, p. 162). To the best of current knowledge, this interaction between access to and use of public and private services has been little explored both in Brazil and in other countries with mixed systems (Andrade et al., 2013; Pilotto & Celeste, 2019; Viana et al., 2015). Accordingly, the proposal presented in this article highlights relevant aspects and existing gaps in the relationship between the structural composition of the SUS - linked municipal healthcare network and the number of health plan beneficiaries in these locations. This perspective makes it possible to understand more deeply the influence generated by the presence or absence of SUS components.

Regarding the structure of the article, in addition to this Introduction, which presents the context and the research problem, the study is organized into three further sections. The next section presents the path followed in developing the article's proposal, namely, the methodological procedures. It specifies the econometric model used, describes the source and main characteristics of the selected variables, and presents the theoretical/empirical evidence identified in previous studies. The third section presents and discusses the results of the econometric analysis in relation to the research proposal, as well as tests for possible problems of normality, heteroscedasticity, multicollinearity, and autocorrelation. Finally, the fourth section presents the final considerations, revisiting the article's main ideas, limitations, and proposals for future research.

2. METHODOLOGICAL PROCEDURES

With respect to the classification of the research, the study is descriptive in terms of its objectives. Regarding procedures, because it uses secondary data, thestudyisdocumentary in nature. In terms of approach, the study adopts a quantitative research design.

According to the Brazilian Institute of Geography and Statistics (IBGE) portal, IBGE Cidades (2020), the State of Minas Gerais comprises 853 municipalities. Some reasons for focusing on municipalities in Minas Gerais are presented below:

- The State Of Minas Gerais had an estimated population of 21,168,791[5] in 2019, representing approximately 10.07% of Brazil's 210,147,125 in habitants (IBGE, 2019a);
- The State of Minas Gerais has the third-largest Gross Domestic Product (GDP) in the country, accounting for approximately 8.75% of the wealth generated in Brazil (IBGE, 2019b);
- The State Of Minas Gerais has the largest number of municipalities among Brazil's federative units. Its 853 municipalities jointly represent 15.31% of the 5,570 municipalities in the country (IBGE, 2020);

To understand and analyze how the structure of the SUS-linked healthcare network in municipalities in Minas Gerais affects local supplementary health coverage, the study used the quantitative method of multiple regression analysis.

According to Hair et al. (2009), this method is appropriate when there search problem involves a single dependent (explained) variable related to two or more independent (explanatory) variables. The purpose of multiple regression analysis is to predict changes in the dependent variable in response to changes in the independent variables.

Accordingly, the data used to construct the multiple regression model developed in this article were obtained from the portals of the National Supplementary Health Agency (Agência Nacional de Saúde Suplementar -

[5] According to the 2022 Census, the population of Minas Gerais was 20,538,718 inhabitants.

ANS), the Department of Informatics of the Unified Health System (DATASUS), the Brazilian Institute of Geography and Statistics (IBGE), andthePublic Health Budget Information System (SIOPS). Data were collected from these websites in June and July 2020.

The database used to estimate the model contains one dependent variable and six independent variables. The number of supplementary health beneficiaries (*Benef*) is the dependent variable, while the number of physicians providing care through SUS (*Med*), the number of healthcare professionals providing care through SUS (*Prof*), the number of SUS-linked items of equipment (*Equip*), the number of hospital beds serving SUS patients (*Leit*), the amount spent by municipalities on health(*Gast*), and Gross Domestic Product (GDP) (*Pib*) are the independent variables. The variables, together with their characteristics and sources, are shown in Figure 1.

Figure 1: Type, description and source of variables

Type	Variable	Variable description	Source
Dependent	Beneficiaries (*Benef*)*	Number of supplementary health beneficiaries	ANS
Independent	Physicians (*Med*)*	Number of doctors serving the SUS	DATASUS
Independente	Professionals(*Prof*)*	Número de profissionais da saúde que atende pelo SUS	DATASUS
Independente	Equipment(*Equip*)*	Number of healthcare professionals who provide services through the SUS (Unified Health System)	DATASUS
Independente	Hospital beds(*Leit*)*	Number of beds available through the SUS (Unified Health System)	DATASUS
Independente	Healthcare spending (*Gast*)**	Amount spent by municipalities on healthcare	SIOPS
Independente	PIB (*Pib*)**	Gross Domestic Product	IBGE

Note: *data per 1,000 inhabitants; ** per capita data expressed in logarithms

All variables, except GDP and the amount spent by municipalities on health, which are expressed on a per capita basis, were divided by population

and multiplied by 1,000 to avoid disparities across municipalities and enable appropriate comparative analysis. Without this adjustment, municipal data would differ substantially in scale and representativeness, preventing meaningful comparison and biasing the results. In addition, because Gastand Pib are non-zero monetary variables, they were log-transformed to improve the model and reduce potential estimation problems (Wooldridge, 2007). Population figures were obtained from the IBGE portal (IBGE, 2019a) and represent the population estimates for 2019. The equation representing the estimated model is as follows:

$$Benef = \beta_0 + \beta_1 Med + \beta_2 Prof + \beta_3 Equip + \beta_4 Leit + \beta_5 log(Gast) + \beta_6 log(Pib) + u_i \quad \textbf{(1)}$$

Based on the theoretical/empirical evidence identified in previous studies, all explanatory variables (*Med, Prof, Equip, Leit*, and *Gast*), with the exception of GDP (*Pib*), are expected to have an inverse relationship with the explained variable (*Benef*); that is, all corresponding coefficients are expected to be negative. Over the decades, several studies have indicated that government inefficiency, combined with inadequate healthcare infrastructure and the public sector's limited capacity to finance healthcare, has allowed supplementary healthcare systems to occupy a substantial share of the resulting gap (Bahia & Scheffer, 2018; Filho & Oliveira, 1990; Pinto &Soranz, 2004; Silva, 2003). Thus, a lower presence of public healthcare structures generally intensifies demand for alternative private systems. Consequently, the number of supplementary health beneficiaries increases. It is therefore expected that a lower presence of structural healthcare components (*Med, Prof, Equip,* and *Leit*) within municipal public healthcare systems, together with lower public spending (*Gast*) in this area, will be associated with a greater share of supplementary health beneficiaries. The relationship between GDP (*Pib*) and the explained variable (Benef), by contrast, is expected to be positive. Greater economic concentration is associated with a larger number of supplementary

health beneficiaries (Bahia et al., 2006; Kilsztajn et al., 2001; Maia, 2012). A summary of this theoretical/empirical evidence is presented in Figure 2.

Figure 2: Hypotheses to be tested

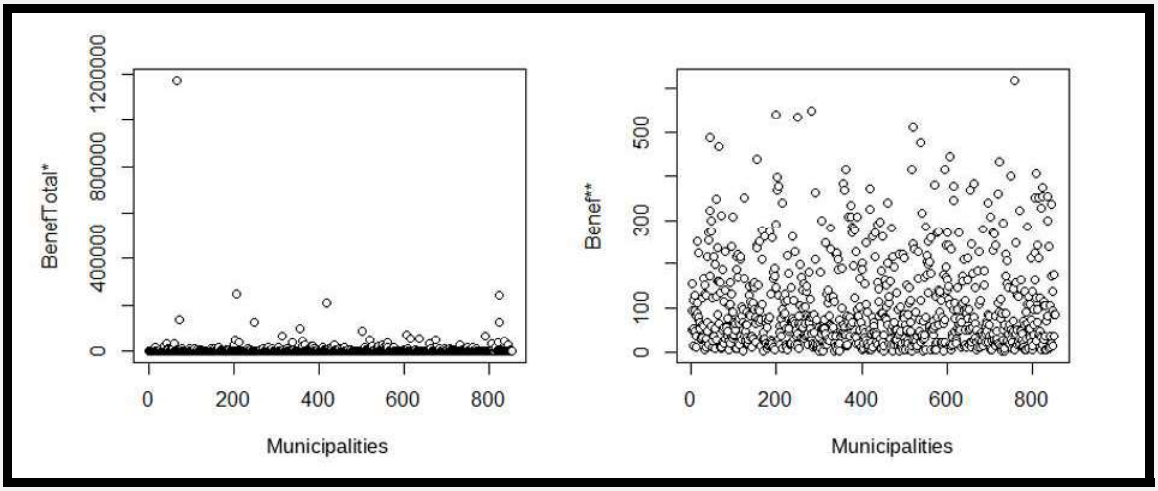
Variable	Theoretical/empirical evidence	Expected signal
Med	Filho and Oliveira (1990), Silva (2003), Pinto and Soranz (2004), Bahia and Scheffer (2018)	(-)
Prof	Filho and Oliveira (1990), Silva (2003), Pinto and Soranz (2004), Bahia and Scheffer (2018)	(-)
Equip	Filho and Oliveira (1990), Silva (2003), Pinto and Soranz (2004), Bahia and Scheffer (2018)	(-)
Leit	Filho and Oliveira (1990), Silva (2003), Pinto and Soranz (2004), Bahia and Scheffer (2018)	(-)
log(Gast)	Filho and Oliveira (1990), Silva (2003), Pinto and Soranz (2004), Bahia and Scheffer (2018)	(-)
log(Pib)	Bahia et al. (2006), Kilsztajn et al. (2001), Maia (2012)	(+)

Following these guidelines, the data were organized in an electronic spread sheet and subsequently processed and analyzed using *R Project for Statistical Computing*®. The results are presented below.

3. RESULTS

A graphical analysis of the dependent variable, corresponding to the number of supplementary health beneficiaries in the municipalities of Minas Gerais, was first conducted. This assessment illustrates the importance of standardizing certain variables. As shown in Figure 3, the first graph, which presents the total number of beneficiaries by municipality (BenefTotal), clearly indicates that municipalities with larger populations naturally also have a greater number of beneficiaries.

Figure 3: Dependent variable



Note: *data in absolute values (*BenefTotal*); ** data per 1,000 inhabitants (*Benef*)

The isolated municipality highlighted in the graph is Belo Horizonte, the capital of Minas Gerais, which has the largest population in absolute terms (2,512,070) and, consequently, the largest number of beneficiaries (1,171,079). However, when the second graph is considered, using the number of beneficiaries per 1,000 inhabitants (Benef), comparability across municipalities becomes more consistent and equitable, providing a more robust and faithful comparative representation of local conditions.

A descriptive analysis of the variables of interest was then conducted. The analysis examined the mean, median, standard deviation, and maximum and minimum values of each variable. To facilitate understanding of local conditions, the variables related to health expenditures (Gast) and GDP (Pib) are also presented without logarithmic transformation. With regard to variables related to the structure of the SUS-linked healthcare network, Table 1 shows that some municipalities have no physicians or hospital beds within their healthcare structure. The median indicates that more than half of the municipalities in Minas Gerais have no hospital beds. With respect to physicians, the same median-based analysis indicates that at least 50% of the municipalities in Minas Gerais have at least one physician providing care through SUS. For healthcare professionals and equipment available in the municipalities, the averages are 12.04 and 2.60 per 1,000 inhabitants,

respectively. Considering their means and standard deviations, these variables show a certain degree of balance, with relatively few discrepancies among the municipalities studied.

Table 1: Descriptive analysis of the variables

Variable	Mean	Median	Standard Deviation	Minimum	Maximum
*Benef**	102,49	65,36	103,71	0,91	617,71
*Med**	0,79	0,66	0,59	-	5,24
*Prof**	12,04	11,26	4,01	3,99	32,42
*Equip**	2,60	2,20	1,80	0,23	15,68
*Leit**	0,85	-	1,20	-	9,10
*log(Gast)***	6,72	6,70	0,35	5,26	8,33
*log(Pib)***	9,63	9,53	0,57	8,71	12,58
*Gast****	889,09	808,74	365,97	192,01	4.148,93
*Pib****	18.817,81	13.721,36	19.437,23	6.087,87	289.925,44

Note: *data per 1,000 inhabitants; **per capita data transformed into logarithms; ***per capita data

Regarding supplementary health beneficiaries, the mean is 102.49 people per 1,000 inhabitants covered by this system. This variable ranges from a minimum of 0.91 to a maximum of 617.71, indicating a substantial gap between these two municipalities. The same occurs with GDP, which ranges from a minimum of 6,087.87 to a maximum of 289,925.44. Health expenditures, in contrast, show greater balance, as indicated by their mean and standard deviation.

To identify the locations with the most extreme values for each variable, Table 2 presents the municipalities with the most widely dispersed values relative to the others. São João do Pacuí and São Sebastião do Oeste had, respectively, the lowest (0.91) and highest (617.71) number supplementary health beneficiaries per 1,000 inhabitants. With regard to the variables related to the structure of the SUS-linked healthcare network, 34 and 470 municipalities had no physicians and no hospital beds, respectively, in 2019. The

municipalities of Araporã (5.24) and Passabém (9.10) recorded the highest values for these two variables. Marmelópolis had the lowest number of SUS healthcare professionals per 1,000 inhabitants (3.99), while Grupiara had the highest (32.42). Dores do Turvo (0.23) had the lowest proportional number of SUS-linked items of equipment, whereas Simão Pereira (15.68) had the highest. The municipality with the lowest per capita allocation of financial resources to health was Itaipé, at R$192.01 per inhabitant, while Serra da Saudade, the least populous municipality in Brazil, allocated R$4,148.93. Finally, with regard to GDP, São João das Missões (6,087.87) had the lowest per capita value, while São Gonçalo do Rio Abaixo (R$289,925.44) had the highest.

Table 2: Descriptive analysis of the municipalities with minimum and maximum values for the variables

Variable	Minimum		Maximum	
	Municipality	**Value**	**Muniipality**	**Value**
*Benef**	São João do Pacuí	0,91	São Sebastião do Oeste	617,71
*Med**	34 municípios	-	Araporã	5,24
*Prof**	Marmelópolis	3,99	Grupiara	32,42
*Equip**	Dores do Turvo	0,23	Simão Pereira	15,68
*Leit**	470 municípios	-	Passabém	9,10
*Gast***	Itaipé	192,01	Serra da Saudade	4.148,93
*Pib***	São João das Missões	6.087,87	São Gonçalo do Rio Abaixo	289.925,44

Note: *data per 1,000 inhabitants; ** per capita data

Subsequently, tests were conducted to detect possible problems of normality, heteroscedasticity, multicollinearity, and autocorrelation. According to Gujarati and Porter (2011, p. 441), there is no single test “that has been regarded as unquestionably the best [the most efficient in the statistical sense], and therefore the analyst is still left in the unenviable position of considering several testing procedures” for detecting possible problems involving a regression. Accordingly, as a precaution, this study applied at least two different

tests for each hypothesis assessment. The tests and results are presented in Tables 3 and 4.

Table 3: Results of the tests applied

Test	Type	Hypothesis(H_0) e Variables (FIV)	Results
Normality	Jarque-Bera	H_0 = The residuals follow a normal distribution	2,20E-16
	Shapiro-Wilk	H_0 = The residuals follow a normal distribution	2,20E-16
Heteroscedasticity	Breusch-Pagan	H_0 = Homoscedasticity	2,20E-16
	White	H_0 = Homoscedasticity	2,20E-16
Autocorrelation	Durbin-Watson	H_0 = Absence of autocorrelation	0,7588 (DW=1,9796)
	Breusch-Godfrey	H_0 = Absence of autocorrelation	0,7848
Multicollinearity	FIV	Med	1,491925
		Prof	2,332215
		Equip	1,288839
		Leit	1,178213
		log(Gast)	2,233420
		log(Pib)	1,445870

The first assessment examined the normality assumption using the Jarque-Bera and Shapiro-Wilk tests. As shown in Table 3, the null hypothesis was rejected in both tests; that is, the model residuals do not follow a normal distribution. However, according to Hair et al. (2009), the normality assumption plays a fundamental role only in small samples. In samples with “50 or fewer observations, and especially when the sample size is less than 30, significant deviations from normality can have a substantial impact on the results. For samples with 200 or more observations, however, these same effects can be neglected" (Hair et al., 2009, p. 83). This reasoning is also adopted by Wooldridge (2007) and Gujarati and Porter (2011). Although Wooldridge (2007,

p. 163) does not specify a minimum number of observations, he states that samples shouldhave “sufficiently large sizes” for this purpose. Gujaratiand Porter (2011), in turn, provide a lower threshold than Hair et al. (2009). They state that a sample is considered small if it has fewer than 100 observations and that, otherwise (more than 100 observations), the normality assumption may be relaxed (Gujarati& Porter, 2011). Therefore, considering the criteria proposed by these authors together with the sample of 853 municipalities used in this study, the model can be regarded as having no normality problems that materially affect the results.

The presence or absence of heteroscedasticity in the model was then assessed using the Breusch-Pagan and White tests. As shown in Table 3, the null hypothesis of homoscedasticity was rejected in both tests. This indicates the presence of heteroscedasticity in the model. Its occurrence does not eliminate the unbiasedness and consistency properties of the estimators; however, the estimators cease to be efficient even in large samples. This loss of efficiency therefore casts doubt on the reliability of conventional hypothesis-testing procedures (p-values), requiring corrective measures for subsequent interpretation and analysis (Gujarati& Porter, 2011). In this article, robust standard errors were applied directly to correct for the effects of heteroscedasticity and provide reliable significance analyses (p-values) for the model.

Possible autocorrelation in the model residuals was subsequently assessed using the Durbin-Watson and Breusch-Godfrey tests. In these tests, the null hypothesis is the absence of autocorrelation, while the alternative hypothesis is the presence of autocorrelation (Gujarati& Porter, 2011; Wooldridge, 2007). As shown in Table 3, the null hypothesis was not rejected in either test, indicating the absence of autocorrelation. Therefore, based on the results of these tests, no adjustment or correction to the model was required.

An analysis was also conducted to determine whether there was strong multicollinearity. AccordingtoHair et al. (2009, p. 22), multicollinearity refers to the “extent to which one variable can be explained by the other variables in the

analysis. As multicollinearity increases, interpretation of the statistical variable becomes more complicated because it becomes more difficult to identify the effect of anyone variable due to its interrelationships with the others." Thus, the issue is not the mere presence of multicollinearity, but rather a high degree of multicollinearity. The analysis initially used the Variance Inflation Factor (FIV), an indicator that "directly expresses the degree of multicollinearity in terms of its impact on the estimation process" (Hair et al., 2009, p. 191). According to Gujarati and Porter (2011, p. 441), if a variable has a FIV greater than 10, it is considered highly collinear. As shown in Table 3, all variables returned FIV values below 10, ruling out the presence of severe multicollinearity. It should also be noted that even considering Hair et al.'s (2009, p. 192) observation that the threshold presented by Gujarati and Porter (2011) (FIV> 10) "allows substantial collinearity" and that the "researcher may wish to be more restrictive," all observed FIV values remain well below and appropriate relative to that threshold.

Table 4: Correlation matrix among the variables

	Benef	*Med*	*Prof*	*Equip*	*Leit*	*log(Gast)*	*log(Pib)*
Benef	1,0000	0,3710	-0,0351	-0,0717	0,0964	0,0797	0,6547
Med	0,3710	1,0000	0,4078	0,1505	0,,2646	0,1931	0,3601
Prof	0,0351	0,4078	1,000	0,4418	0,1386	0,6196	0,9993
Equip	0,0717	0,1505	0,4418	1,0000	0,1075	0,3847	0,0967
Leit	0,0964	0,2646	0,1386	0,1075	1,0000	-0,1112	0,1080
log(Gast)	0,0797	0,1931	0,6196	0,3847	-0,1112	1,0000	0,3541
log(Pib)	0,6547	0,3601	0,0993	0,0967	0,1080	0,3541	1,000

In addition, despite the preceding assessment, the correlations between pairs of regressors were also examined to determine whether they were excessively high. According to Gujarati and Porter (2011), if the correlation between pairs exceeds 0.8, multicollinearity may constitute a serious problem. However, as shown in Table 4, the highest correlation among the variables occurs between Benefandlog (Pib), with an association of 0.6547, which is below the 0.8 threshold established by Gujarati and Porter (2011). Accordingly, the model can also be considered free of serious multicollinearity problems, and no adjustment or correction was required.

After the assessment and analysis described above, robust standard errors were applied directly to correct for the effects of heteroscedasticity. The results of the estimated regression model are shown in Table 5. Based on the reported F-statistic (2.2E-16), the hypothesis that all parameters are jointly equal to zero is rejected. The adjusted R^2 indicates that the model explains 48.92% of the variation in the number of beneficiaries (Benef). According to Gujarati and Porter (2011), although adjusted R^2 is a general measure of the goodness of fit of a model to a given dataset, its importance should not be overstated. "What matters fundamentally are the underlying theoretical expectations regarding the model in terms of the a priori signs of the coefficients of the variables included in the model and (...) their statistical significance" (Gujarati& Porter, 2011, p. 230)

Table 5: Regression results

	Coefficient	*Standard error*	*t-statistic*	*p-value*
Intercept	-796,6098	62,9723	-12,650	2E-16***
Med	37,4032	5,2410	7,137	2,06E-12***
Prof	-2,0125	0,9683	-2,078	0,03796*
Equip	-5,0620	1,6050	-3,154	0,00167**
Leit	-1,7405	2,2996	-0,757	0,44935
log(Gast)	-31,2229	10,7472	-2,905	0,00377**
log(Pib)	116,093	5,3922	21,53	2E-16***
Adjusted R^2 = 0,4892				
F-statistic = 2,2E-16				

Nota: ***p<0,001, **p<0,01, *p<0,05

With respect to the estimated model, all variables except *Leit* were statistically significant. This indicates that the independent variables exert an important influence on the dependent variable and contribute to the model. Only the variable corresponding to hospital beds (*Leit*), because it is not statistically significant, has little influence on the number of beneficiaries (*Benef*). Regarding coefficient signs, the variables associated with the SUS healthcare structure relating to professionals (*Prof*), equipment (*Equip*), and hospital beds (*Leit*) showed a negative relationship with the dependent variable (*Benef*). This finding is consistent with the theoretical/empirical evidence reported in previous studies (Bahia & Scheffer, 2018; Filho & Oliveira, 1990; Pinto &Soranz, 2004;

Silva, 2003). However, the variable related to physicians providing care through SUS (Med) showed a positive relationship with the number of beneficiaries (Benef). This result, in contrast, contradicts the theoretical/empirical evidence discussed in this article (Bahia & Scheffer, 2018; Filho & Oliveira, 1990; Pinto & Soranz, 2004; Silva, 2003).

Regarding the expected sign of the variable associated with the amount spent by municipalities on health (*Gast*), the model produced the expected negative coefficient. Lower public health expenditures are associated with greater participation in supplementary health coverage (Bahia & Scheffer, 2018; Filho & Oliveira, 1990; Pinto &Soranz, 2004; Silva, 2003). According to Figueiredo, Prado, Medina, and Paim (2018, p. 38), “SUS financing has not been sufficient to ensure adequate financial resources for the public system, thereby allocating a smaller volume to meet the population's healthcare needs than had been envisioned when the system was created.” At the same time, over the past 20 years, private-sector health expenditures have exceeded public-sector expenditures, reversing the pattern observed in earlier decades, when the governmental located more resources than the private sector (Figueiredo et al., 2018; Rotta & Silva, 2012). In this sense, reduced public spending on healthcare encourages the expansion of the supplementary segment by filling gaps left by public provision. The population, particularly wealthier groups, therefore seeks alternative arrangements to meet its healthcare needs.

GDP (*Pib*) alsodisplayedtheexpectedsign, but in a positive direction. Greater economic concentration indicates greater purchasing power and, consequently, a larger number of supplementary health beneficiaries. As Bahia et al. (2006) emphasize, greater economic capacity is one of the main factors associated with the purchase of a private health plan. More generally, this relationship also directly affects access to public and private health services. Andrade and Noronha (2011) argue that the concentration of health plans among higher socioeconomic groups means that poorer individuals face greater difficulties in accessing health services. This does not occur because

lower-income individuals lack private healthcare alternatives, but because they are not always able to access public services due to government ineffectiveness. In this sense, “inequity in the healthcare system reflects a structural problem in society, namely income inequality” (Andrade & Noronha, 2011, p. 99). Thus, the direct relationship observed in the model between the number of supplementary health beneficiaries and GDP is unavoidable. Public policies are therefore needed to produce effective, rather than merely apparent, universality, comprehensiveness, and equity, which are fundamental principles of a public healthcare system.

After analyzing the significance and signs of each coefficient, the finding related to physicians can be regarded as a result specific to this study, since no studies were found that supported this relationship; only positions contrary to this finding were identified. However, it should be noted that some studies have sought to explain physicians' locational choices when deciding where to practice (Campoy et al., 2020; Girardi et al., 2011; Póvoa & Andrade, 2006). Póvoa and Andrade (2006), for example, in a study on the geographic distribution of physicians in Brazil, concluded that locations with higher GDP per capita also have the highest numbers of physicians per 1,000 inhabitants. Although that study (Póvoa & Andrade, 2006) does not provide evidence directly related to the number of supplementary health beneficiaries, it supports the observation that more economically developed municipalities have proportionally more physicians. Girardi et al. (2011) point to severe socio-regional inequalities in the distribution of the medical workforce in Brazil. Alongside a concentration of physicians in the country's wealthier cities and regions, severe shortages persist in municipalities with less economic capacity. This pattern is also reported in other publications (Bahia & Scheffer, 2018; Campoy et al., 2020). Because the model presented in this study shows a direct relationship between the number of beneficiaries and municipal wealth, it is possible that the finding concerning physicians is explained by GDP. However, this possibility can not be isolated on the basis of the present analysis and must be examined in future studies before it can be confirmed or rejected. It is also

worth noting that the studies cited regarding physicians' locational choices do not necessarily distinguish between physicians who provide care through SUS, those who do not, and those who work in both systems.

Finally, in light of the objective of understanding and analyzing how the structure of the SUS-linked healthcare network in municipalities in Minas Gerais affects local supplementary health coverage, the model results can be summarized as confirming most of the hypotheses concerning the effects of the explanatory variables, with the exception of the hypothesized negative influence of the number of physicians present in the municipalities.

4. CONCLUSIONS

Supplementary health coverage in Brazil encompasses a considerable share of the population. In addition, it mobilizes hundreds of billions of reais annually, placing the country as the world's second-largest health insurance market, behind only the United States (Andrade et al., 2015; Bahia & Scheffer, 2018; Baird, 2017; Maia, 2012). Considering that a public healthcare system exists alongside this private market and is intended to cover the entire population, this article aimed to determine how the structure of the SUS-linked healthcare network in municipalities in Minas Gerais affects local supplementary health coverage. Using the State of Minas Gerais as the reference, the study sought to: identify indicators of the SUS-linked healthcare network in municipalities in the State of Minas Gerais in 2019; identify the number of supplementary health beneficiaries in municipalities in the State of Minas Gerais in 2019; and analyze the impact of the SUS-linked healthcare network structure on the number of supplementary health beneficiaries in municipalities in the State of Minas Gerais in 2019.

Through descriptive, documentary, and quantitative research using multiple regression, a model with six dependent variables (*Med*, *Prof*, *Equip*, *Leit*, *Gast*, *Pib*) was estimated in an attempt to explain the relationship of interest. The theoretical/empirical evidence indicates that government inefficiency, combined with inadequate healthcare infrastructure and the public

sector's limited capacity to finance healthcare, allowed supplementary healthcare systems to occupy a substantial share of the resulting gap (Bahia & Scheffer, 2018; Filho & Oliveira, 1990; Pinto &Soranz, 2004; Silva, 2003). Thus, a lower presence of public healthcare structures generally intensifies demand for alternative private systems and, consequently, increases the number of private healthcare beneficiaries. The relationship between the local economic variable (*Pib*) and supplementary health coverage is direct. Greater concentration of wealth is associated with a larger number of supplementary health beneficiaries (Bahia et al., 2006; Kilsztajn et al., 2001; Maia, 2012).

From this perspective, the model results showed that the variables corresponding to healthcare professionals (*Prof*), equipment (*Equip*), and hospital beds (*Leit*) behaved as expected, that is, inversely to the number of beneficiaries. In contrast, the variable related to physicians (*Med*) showed a positive relationship, contrary to the theoretical/empirical evidence. The variables related to GDP (*Pib*) andtheamountspentbymunicipalities (Gast) displayedtheexpectedsigns, with the former positive and thelatter negative. All model variables, except *Leit*, were statistically significant. This indicates that the independent variables exert an important influence on the dependent variable and contribute to the model.

The findings largely confirm that the number of beneficiaries is affected by the SUS structure available in the municipalities. In this context, the growth and expenditures observed in recent years among private health operators, alongside the decline experienced by the public sector in this area (Figueiredo et al., 2018; Rotta & Silva, 2012), reinforce this interpretation and foster the expansion of supplementary health in Brazil. This pattern is evident in the growing number of beneficiaries in recent years (ANS, 2020; Campoy et al., 2020) in relation to the financial dynamics observed (Figueiredo et al., 2018; Rotta & Silva, 2012). It can also be seen in the growing tendency of healthcare professionals to work in the private rather than the public sector (Campoy et al., 2020).

At least in the short to medium term, a different scenario is difficult to foresee. Restrictive measures imposed on SUS, such as the recent legislation responsible for freezing public expenditures for 20 years (beginning in 2019), may perpetuate the current situation and create significant barriers to the sustainability of a universal healthcare system (Campoy et al., 2020; Rasella et al., 2018). Consequently, considerations of this nature threaten progress toward the United Nations (UN) Sustainable DevelopmentGoals (SDGs) related to improving health and reducing inequalities (ONU, 2020; Rasella et al., 2018). This indicates that austerity measures may compromise further gains in health outcomes, particularly among lower-income Brazilians (Rasella et al., 2018) who lack private health coverage. Public policies are therefore needed to deliver effective, rather than merely apparent, universality, comprehensiveness, and equity, principles enshrined in the Brazilian Constitution and foundational to an effective universal public healthcare system. As Gragnolati, Lindelow, and Couttolenc (2013, p. 106) state, problems of implementation, access, and quality contribute "to the continued demand for private health plans and reliance on direct private expenditures to obtain care outside SUS, which, in turn, is undermining the goals of universality and equity".

Accordingly, the results suggest that public investments in healthcare professionals and equipment are associated with lower penetration of supplementary health coverage. Policies that prioritize the efficient allocation of hospital beds, strengthen primary care, and provide incentives for physicians to remain in SUS (for example, recruitmentandretentionprograms, remuneration, and infrastructure) may therefore reduce dependence on private health plans and promote equity. In addition, continuous monitoring of municipal structural indicators and coordination between supplementary health regulation and local public healthcare provision policies are recommended.

These findings provide scholars in the field with new perspectives and evidence regarding the quantitative behavior of beneficiaries in relation to the structure provided by SUS. Research of this nature and with this purpose also creates new opportunities for the field, promotes greater maturity, helps resolve

unresolved issues, and broadens the limited interpretations that isolated figures may suggest. Accordingly, dialogue, discussion, convergences and divergences across studies, and other aspects involving the comparison of data and results are highly relevant to advancing understanding of the breadth and complexity of healthcare in both national and international contexts.

Several limitations were identified during the development of the study and may be addressed in future research. The first concerns the one-year time frame used in the regression. Future studies should apply the same methodology using panel data, thereby covering a larger number of observations for the same locations across different periods and allowing more robust and representative results. The second limitation concerns the geographic scope, which is restricted to a single stateand does not include comparisons with other federative units or the macroregions of Minas Gerais. The model should therefore be replicated in different states or regions to identify possible contextual variations. In addition, the reality investigated is recognized as multifactorial and may involve cultural, institutional, and socioeconomic dimensions, as well as spatial dependence among municipalities, aspects not considered in this analysis. Future research should therefore explore spatial models and incorporate additional contextual variables, such as education, urbanization, and age structure, to refine understanding of the interaction between the public healthcare network and supplementary health coverage across different regional contexts.

As a further recommendation for future research, the information incorporated into the econometric model should be expanded, both through the inclusion of additional variables related to the SUS structure and through the consideration of variables adjacent to the object of study, such as education, age group, and type of health plan, among others. This study does not aim to exhaust the topic, nor is it able to present all studies and literature available on the subject. Nevertheless, integrative reviews of supplementary health drawing on both national and international references are also recommended. Existing studies on the topic often present broad literature reviews while placing greater

emphasis on their empirical results, and there is considerable repetition of authors across similar studies. Integrative reviews can provide broader theoretical foundations and reflective evidence supporting multiple dimensions of the global reality of supplementary health, as well as new theoretical and empirical propositions for future research on the topic.

Finally, it is expected that this research will represent a theoretical and practical advance in the field of supplementary health, opening new perspectives for the conduct and development of studies and for the implementation of public policies. In this way, the study seeks not only to broaden the characterization of supplementary health, but also, at an incipient stage, to contribute to the preparation and improvement of health policies in both the public and private sectors.

REFERÊNCIAS

Abreu, L. C. (2020). Integrated actions and strengthening of Public Health System in Brazil in a time of pandemic. *Journal of Human Growth and Development*, 30(1), 05–08. https://doi.org/10.7322/jhgd.v30.9980

Abreu, L. C. de, Pereira, V. X., Silva, R. P. M., Macedo Jr, H., & Bezerra, I. M. P. (2017). The right to scientific information: one of the main elements of the unified health system. *Journal of Human Growth and Development*, 27(3), 258–261. https://doi.org/10.7322/jhgd.141485

Andrade, M. V., Maia, A. C., Ribeiro, M. M., Lima, H. W., & Carvalho, L. R. de. (2015). *Estrutura de concorrência no setor de operadoras de planos de saúde no Brasil*. ANS.

Andrade, M. V., Maia, A. C., & Rodrigues, C. G. (2013). Indicadores de gastos com serviços médicos no setor de saúde suplementar no Brasil. *Revista Brasileira de Estudos de População*, 30(SUPPL), S103–S117. https://doi.org/10.1590/S0102-30982013000400007

Andrade, M. V., & Noronha, K. (2011). *Uma Nota sobre o Princípio da Integralidade do SUS. In Brasil: a nova agenda social* (p. 94–103). LCT.

ANS. (2020). *Agência Nacional de Saúde Suplementar*. Agência Nacional de Saúde Suplementar. http://www.ans.gov.br/anstabnet/notas_beneficiario.htm

Bahia, L., Luiz, R. R., Salm, C., Costa, A. J. L., Kale, P. L., & Cavalcanti, M. de L. T. (2006). O mercado de planos e seguros de saúde no Brasil: uma abordagem exploratória sobre a estratificação das demandas segundo a PNAD

2003. *Ciência & Saúde Coletiva*, 11(4), 951–965. https://doi.org/10.1590/S1413-81232006000400017

Bahia, L., & Scheffer, M. (2018). O SUS e o setor privado assistencial: interpretações e fatos. *Saúde em Debate*, 42(3), 158–171. https://doi.org/10.1590/0103-11042018s312

Baird, M. F. (2017). *Redes de influência, burocracia, política e negócios na Agência Nacional de Saúde Suplementar (ANS)* [Tese de Doutorado, Universidade de São Paulo]. https://doi.org/10.11606/T.8.2017.tde-01082017-182440

Brasil, Constituição da República Federativa do Brasil de 1988. (1988). http://www.planalto.gov.br/ccivil_03/constituicao/constituicao.htm

Campoy, L. T., Ramos, A. C. V., Souza, L. L. L., Alves, L. S., Arcoverde, M. A. M., Berra, T. Z., Arroyo, L. H., Santos, D. T. dos, & Arcêncio, R. A. (2020). Spatial distribution and temporal trend of National Health System and Supplemental Health Sector human resources, Brazil, 2005-2016. *Epidemiologia e Serviços de Saúde*, 29(2), 1–13. https://doi.org/10.5123/S1679-49742020000200020

Figueiredo, J. O., Prado, N. M. de B. L., Medina, M. G., & Paim, J. S. (2018). Gastos público e privado com saúde no Brasil e países selecionados. *Saúde em Debate*, 42(spe2), 37–47. https://doi.org/10.1590/0103-11042018s203

Filho, P. F., & Oliveira, P. J. de. (1990). A universalização excludente: reflexões sobre as tendências do sistema de saúde. *Planejamento e Políticas Públicas*, 3, 139–162. http://repositorio.ipea.gov.br/bitstream/11058/7358/1/ppp_3_Universalizacao.pdf

Girardi, S. N., Carvalho, C. L., Araújo, J. F., Farah, J. M., Wan der Maas, L., & Campos, L. A. de. (2011). Índice de escassez de médicos no Brasil: estudo exploratório no âmbito da Atenção Primária. In *O trabalho em saúde: abordagens quantitativas e qualitativas* (p. 171–186). Centro de Estudos e Pesquisa em Saúde Coletiva.

Gragnolati, M., Lindelow, M., & Couttolenc, B. (2013). Twenty Years of Health System Reform in Brazil : An Assessment of the Sistema Único de Saúde. In *Workd Bank*. World Bank. https://doi.org/10.1596/978-0-8213-9843-2

Gujarati, D. N., & Porter, D. C. (2011). *Econometria Básica* (5o ed). AMGH.

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2009). *Análise Multivariada de Dados* (6o ed). Bookman.

IBGE. (2019a). *Estimativas da População. Instituto Brasileiro de Estatística e Geografia*.

https://www.ibge.gov.br/estatisticas/sociais/populacao/9103-estimativas-de-populacao.html?=&t=resultados

IBGE. (2019b). *Produto Interno Bruto dos Estados*. Instituto Brasileiro de Estatística e Geografia. https://www.ibge.gov.br/explica/pib.php

IBGE. (2020). *IBGE Cidades*. Instituto Brasileiro de Estatística e Geografia. https://cidades.ibge.gov.br/

Kassouf, A. L. (2005). Acesso aos serviços de saúde nas áreas urbana e rural do Brasil. *Revista de Economia e Sociologia Rural*, 43(1), 29–44. https://doi.org/10.1590/S0103-20032005000100002

Kilsztajn, S., Silva, D. F. da, Camara, M. B. da, & Ferreira, V. S. (2001). Grau de cobertura dos planos de saúde e distribuição regional do gasto público em saúde. *Saúde e Sociedade*, 10(2), 35–46. https://doi.org/10.1590/S0104-12902001000200004

Macinko, J., & Lima-Costa, M. F. (2012). Horizontal equity in health care utilization in Brazil, 1998–2008. *International Journal for Equity in Health*, 11(1), 33. https://doi.org/10.1186/1475-9276-11-33

Maia, A. C. (2012). *Ensaios sobre a demanda no setor de saúde suplementar brasileiro*. Tese de Doutorado, Universidade Federal de Minas Gerais.

Manski, R. J., Moeller, J. F., & Chen, H. (2014). Dental Care Coverage and Use: Modeling Limitations and Opportunities. *American Journal of Public Health*, 104(10), 2002–2009. https://doi.org/10.2105/AJPH.2013.301693

Moraes, J. R. de, Moreira, J. P. de L., & Luiz, R. R. (2011). Associação entre o estado de saúde autorreferido de adultos e a área de localização do domicílio: uma análise de regressão logística ordinal usando a PNAD 2008. *Ciência & Saúde Coletiva*, 16(9), 3769–3780. https://doi.org/10.1590/S1413-81232011001000013

ONU. (2020). *Sustainable Development Goals (SDGs)*. United Nations. https://www.un.org/sustainabledevelopment/

Pilotto, L. M., & Celeste, R. K. (2019). The relationship between private health plans and use of medical and dental health services in the Brazilian health system. *Ciência & Saúde Coletiva*, 24(7), 2727–2736. https://doi.org/10.1590/1413-81232018247.24112017

Pinto, L. F., & Soranz, D. R. (2004). Planos privados de assistência à saúde: cobertura populacional no Brasil. *Ciência & Saúde Coletiva*, 9(1), 85–98. https://doi.org/10.1590/S1413-81232004000100009

Porto, S. M., Ugá, M. A. D., & Moreira, R. da S. (2011). Uma analise da utilização de serviços de saúde por sistema de financiamento: Brasil 1998 -2008. *Ciência & Saúde Coletiva*, 16(9), 3795–3806. https://doi.org/10.1590/S1413-81232011001000015

Póvoa, L., & Andrade, M. V. (2006). Distribuição geográfica dos médicos no Brasil: uma análise a partir de um modelo de escolha locacional. *Cadernos de Saúde Pública*, 22(8), 1555–1564. https://doi.org/10.1590/S0102-311X2006000800004

Rasella, D., Basu, S., Hone, T., Paes-Sousa, R., Ocké-Reis, C. O., & Millett, C. (2018). Child morbidity and mortality associated with alternative policy responses to the economic crisis in Brazil: A nationwide microsimulation study. *PLOS Medicine*, 15(5), 1–20. https://doi.org/10.1371/journal.pmed.1002570

Rotta, C. V., & Silva, C. L. da. (2012). O dilema da universalidade e financiamento público do Sistema Único de Saúde no Brasil. *Educação*, 11(2), 333–345.

Santos, I. S. (2009). *O Mix Público-Privado no Sistema de Saúde Brasileiro: elementos para a regulação da cobertura duplicada* [Tese de Doutorado, Escola Nacional de Saúde Pública Sérgio Arouca]. https://bvssp.icict.fiocruz.br/pdf/25446_Isabela_S_Santos.pdf

Santos, I. S., Ugá, M. A. D., & Porto, S. M. (2008). O mix público-privado no Sistema de Saúde Brasileiro: financiamento, oferta e utilização de serviços de saúde. *Ciência & Saúde Coletiva*, 13(5), 1431–1440. https://doi.org/10.1590/S1413-81232008000500009

Serapioni, M., & Tesser, C. D. (2019). O Sistema de Saúde brasileiro ante a tipologia internacional: uma discussão prospectiva e inevitável. *Saúde em Debate*, 43(5), 44–57. https://doi.org/10.1590/0103-11042019s504

Silva, A. A. da. (2003). Relação Entre Operadoras de Planos De Saúde e Prestadores de Serviços: Um Novo Relacionamento Estratégico. *Fórum de Saúde Suplementar do Ministério da Saúde e da Agência Nacional de Saúde Suplementar*, 1–76.

Viana, A. L. d'Ávila, Miranda, A. S. de, & Silva, H. P. da. (2015). *Segmentos Institucionais de Gestão em Saúde: Descrição, Tendências e Cenários Prospectivos*. Fundação Oswaldo Cruz.

Wooldridge, J. M. (2007). *Introdução à econometria: uma abordagem moderna*. Thomson Learning.