

Trend of hospitalizations and mortality from surgical causes in Brazil, 2008 to 2016.

Tendência de internações e mortalidade por causas cirúrgicas no Brasil, 2008 a 2016.

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A B S T R A C T

Objective: to evaluate the trend of hospitalizations for surgical procedures and surgical mortality in Brazil, from 2008 to 2016. **Methods:** we conducted an ecological, time-series study. We obtained the data on surgical hospitalizations and mortality between 2008 and 2016 from the Department of Informatics of the Unified Health System (SUS). We performed the trend analysis using polynomial regression models. **Results:** in the period of the study, 37,565,785 surgical procedures were performed in the SUS, an average of 4,151,050 surgeries/year. The mean coefficient of the surgical procedures was 2.12 surgeries per 100 inhabitants/year, with a variation of 1.92 to 2.56 inhabitants/year among the country regions. The surgical mortality rate was 1.63%, ranging from 1.07% to 2.02% between the regions. **Conclusion:** there was a significant trend towards increasing number of surgical procedures carried out and of surgical mortality; however, the coefficient of surgical procedures is lower than recommended by international standards, with regional disparities in access to surgical care and mortality, which undermines the guarantee of universal health coverage expect from the Unified Health System.

Keywords: Surgical Procedures, Operative. Mortality. Health Services Accessibility. Delivery of Health Care.

INTRODUCTION

Surgery is essential for the management of various conditions that affect health and its importance in global public health is indisputable, since evidence suggests that about 11% of years of life lost, when adjusted for disability, are correctable with surgery¹⁻⁴. However, in the global context, comprehensive access and coverage of essential surgical services are not guaranteed⁵⁻⁷, as five billion people do not have readily accessible and safe anesthetic and surgical care when necessary¹. This results in loss of productive lives and reduction of the population's well-being, interfering in the countries' economic development¹. In addition, there are inequities of access to anesthetic and surgical care among countries, since in developed countries the guarantee of access to surgery is greater than in low- and middle-income countries, especially in the population belonging to the poorest social strata^{1,8,9}.

In Brazilian literature, there is a shortage of studies that discuss epidemiological data on access to surgical care¹⁰⁻¹². Among the few, there is a pioneer work covering a period of 13 years (1995-2007), which showed an increasing trend in the number of surgical interventions, related expenses and surgical mortality¹⁰. Another, more recent, study produced essential information for understanding this topic, focusing on geographic regions, though with analysis limited to the year 2014¹².

Thus, considering the importance of surgical care in the context of global public health and the need to fill a knowledge gap to support the reformulation of policies and the elaboration of complementary strategies to improve access and surgical outcomes in the national context, this study aimed to analyze the trend of hospitalizations for surgical procedures and surgical mortality in Brazil from 2008 to 2016.

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METHODS

We conducted an ecological, time-series study on surgical procedures and surgical mortality, within the sphere of action of the Brazilian Public Unified Health System (SUS), according to the five major regions of Brazil, from 2008 to 2016. We obtained the data related to admissions to surgical procedure and mortality from the Department of Informatics of the Unified Health System (DATASUS), in the table of Health Information (TABNET) on Health Care and Hospital Production (SIH/SUS). And in the Demographic and Socioeconomic table, we obtained information on the population living in each region of the country in May 2017¹³.

By means of the variable hospitalization, we established the coefficient of surgical procedures for each Brazilian region. To evaluate only the hospital admissions for surgery, we selected the procedures group ("grupo de procedimentos"), and than the option corresponding only to surgical procedures¹³. After this step, for each year and region, we calculated the ratio between the number of surgical procedures performed and the resident population and multiplied it by the constant 100.

We obtained data on surgical mortality using the variable mortality rate ("taxa de mortalidade"), which corresponds to the ratio between the number of deaths and the number of hospital admission authorizations (AIH) approved in the period, multiplied by the constant 100¹³.

We performed the trend analysis with polynomial regression models, due to their high statistical power, greater ease of formulation and interpretation. The polynomial model aims to find the curve that best fits the data, in order to

describe the relationship between the dependent variable Y (surgical hospitalizations and surgical mortality) and the independent variable X (year of study). To deviate from the serial correlation between the terms of the regression equation, we centered the year variable in X-2012, since 2012 was the midpoint of the historical series.

As a measure of the precision of the model, we used the coefficient of determination (R^2 - the closer to 1, the more adjusted the model is). We considered a trend significant when its estimated model obtained a value of $p < 0.05$. We performed statistical analyzes with the softwares R and Microsoft Excel 2013.

Because it is a study using data obtained from secondary sources, without identification of research subjects and whose access is in the public domain, there was exemption from appreciation by an Ethics in Research Committee.

RESULTS

Based on data from surgical hospitalizations, in the period from 2008 to 2016, 37,565,785 surgical procedures were performed in the public sector in Brazil, which corresponds to the annual average of 4,173,976 surgeries. In absolute values, we found an increase of 9.16%, from 3,801,093 surgeries performed in 2008 to 4,144,539 in 2016. The mean coefficient of surgical procedures was 2.12 surgeries per 100 inhabitants per year. Geographically, we found regional differences, namely: 1.92 surgeries per 100 inhabitants/year in the North region; 2.04 surgeries per 100 inhabitants/year in the Northeast region; 2.06 in the Southeast region; 2.12 in the Midwest region; and 2.56 surgeries per 100 inhabitants/year in the South region (Figure 1).

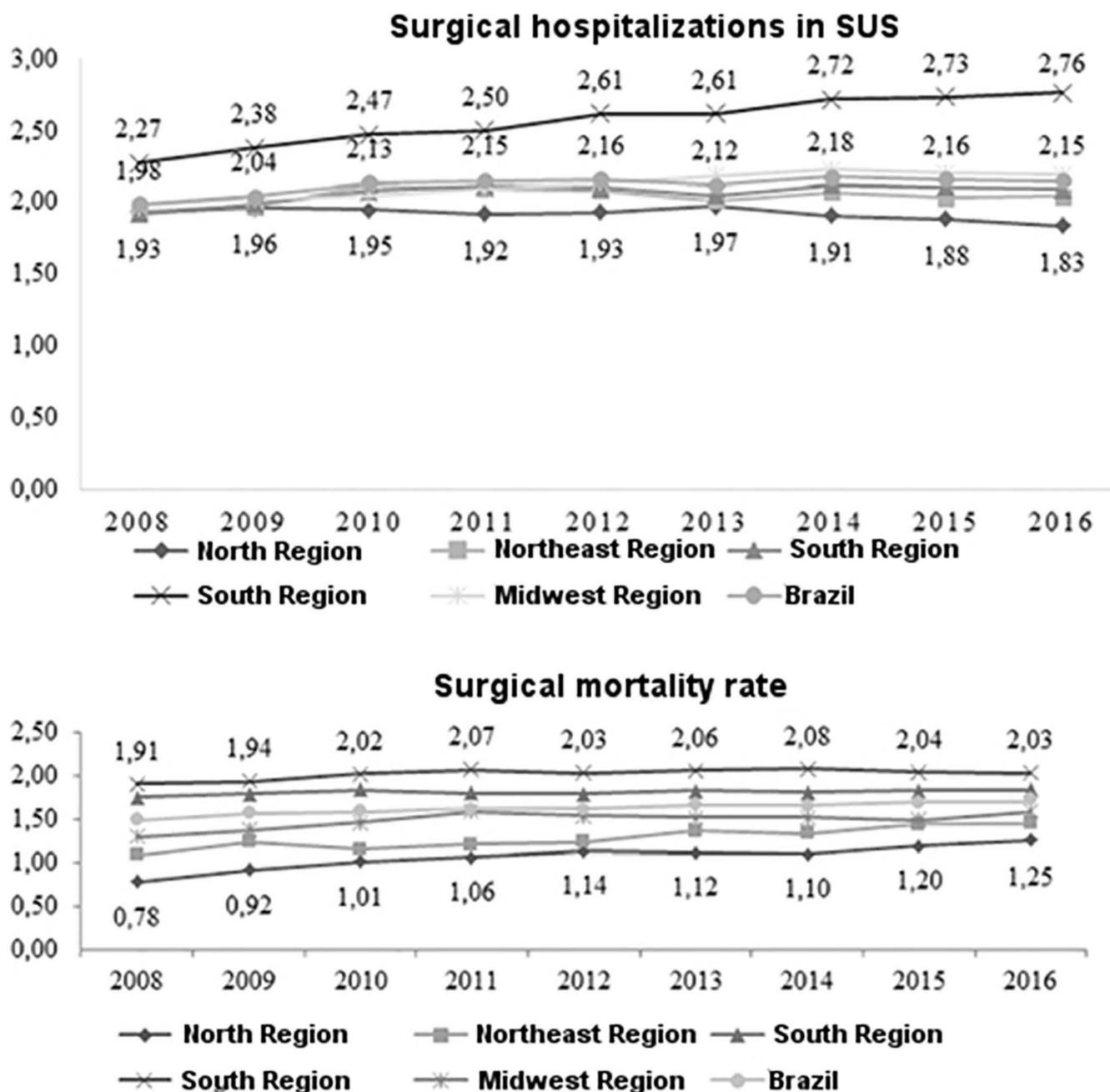


Figure 1. Evolution of hospital admissions and surgical mortality per 100 inhabitants, according to regions. Brazil, 2008-2016.

As shown in table 1 and figure 2, in the nine-year period Brazil showed a significant increasing trend in surgical hospitalizations performed by SUS ($p < 0.01$). Two geographic regions, however, had different results: the North, as the only region with a significant decreasing trend ($p < 0.05$), and northeast region, which remained stable.

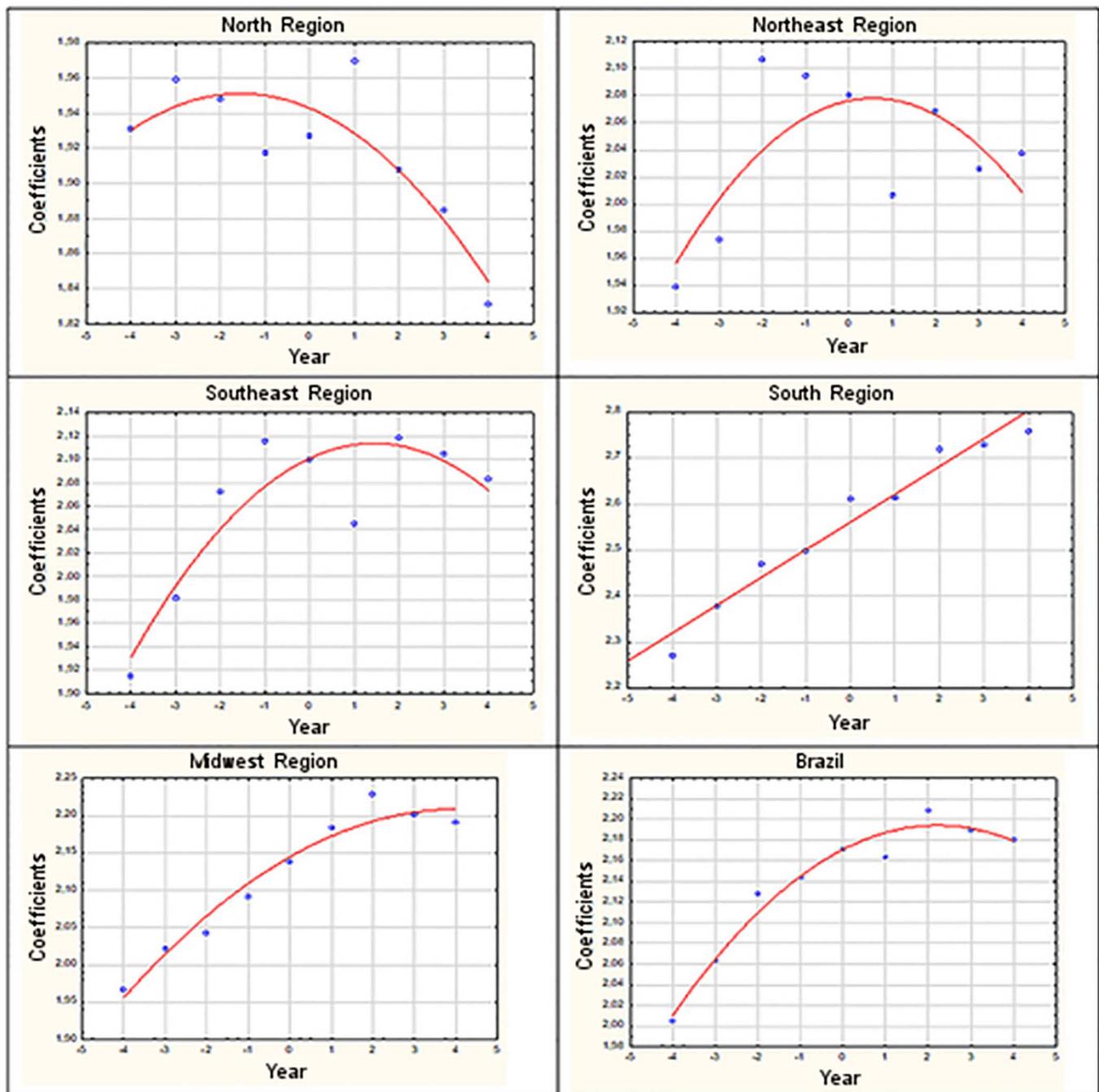
Regarding the coefficient of determination (R^2), the South (0.959) and the Midwest (0.890) displayed positive correlations (growing trend) between the coefficient of surgeries and year. For the South region this correlation was positive and perfect, as shown in table 1 and figure 2.

The scatter plot shows that the surgery coefficient declined in the final years of the survey in

Table 1. Trend of surgical procedures performed by the Unified Health System according to regions, analyzed by Polynomial Regression. Brazil, 2008-2016.

Region	Model	R ² *	p ⁺	Trend
North	$Y=1.94-0.01x-0.003x^2$	0.496	0.034	Decreasing
Northeast	$Y=2.07-0.016x-0.005x^2+0.002x^3$	0.096	0.415	Stable
Southeast	$Y=2.10+0.002x-0.006x^2+0.001x^3$	0.94	0.034	Increasing
South	$Y=2.56+0.06x$	0.959	<0.01	Increasing
Midwest	$Y=2.14+0.031x-0.003x^2$	0.890	<0.01	Increasing
Brazil	$Y=2.17+0.02x-0.004x^2$	0.766	<0.01	Increasing

* R²= Coefficient of determination; + p-value<0.05= Statistically significant trend.

**Figure 2.** Scatter diagrams of the coefficients of surgical procedures per 100 inhabitants according to regions. Brazil, 2008 to 2016.

Brazil and in all regions of the country, except in the South and Midwest (Figure 2).

The surgical mortality rate in Brazil was 1.63%, with regional differences, with the lowest rate in the North region (1.07%), followed by the Northeast (1.29%), Midwest (1.50%), Southeast (1.81%) and the highest rate in the South (2.02%) (Figure 1).

There was a significant increasing mortality trend in all regions, as shown in table 2. The North and Northeast regions, as well as Brazil as a whole, showed high coefficients of determination (R^2), respectively 0.871, 0.879 and 0.919, establishing a positive and near perfect correlation between the coefficients of surgical mortality and year, as shown in table 2 and figure 3.

DISCUSSION

Over nine years, there was a growing and significant trend in surgical hospitalizations by SUS and in mortality in Brazil, with regional disparities for both variables. This study, a pioneer in analyzing the trend of surgeries performed by the Brazilian Unified Health System and mortality rates in the last decade, analyzed geographic and temporal variations in variables' distribution, identifying situations of inequality and trends that demand specific actions, contributing to the adequacy of the volume of surgeries to the needs of the population.

Similarly to the results obtained, a study conducted in Brazil analyzed data on surgeries from 1995 to 2007, evidencing a growing and significant trend in the number of surgeries over the last thirteen years: 32,659,513 non-cardiac surgeries were performed, an increase of 20.42% in the absolute number of procedures and with average surgeries coefficient of 14.51 per 1,000 inhabitants/year¹⁰.

Regarding the absolute number of surgical procedures, the 9.16% increase was lower than the estimates of surgical volume worldwide. In 2004, the estimate was 226.4 million surgical procedures performed and 312.9 million, in 2012, with an increase of 38.2% in eight years, and the estimated surgery coefficient was 4469 surgical procedures per 100,000 people per year^{14,15}. Despite this increase (9.16%), the epidemiology of surgeries in Brazil differs considerably from international standards. Annually, just over 15 million surgeries were performed in high-income countries of North America and about 39 million in Western, Central and Eastern Europe¹⁶, while only close to four million in Brazil¹². This finding suggests that public investment in the country's health system remains unacceptably below desired levels and significantly lower than international standards¹⁰.

Table 2. Trend in surgical mortality according to regions of Brazil, analyzed by Polynomial Regression. Brazil, 2008-2016.

Region	Model	R^2 *	p ⁺	Trend
North	$Y=1.06+0.049x$	0.871	<0.01	Increasing
Northeast	$Y=1.28+0.043x$	0.879	<0.01	Increasing
Southeast	$Y=1.81-0.003x-0.00x^2+0.00x^3$	0.690	0.039	Increasing
South	$Y=2.05+0.01x-0.005x^2$	0.701	0.035	Increasing
Midwest	$Y=1.53+0.02x-0.007x^2$	0.726	0.026	Increasing
Brazil	$Y=1.625+0.024x$	0.919	<0.01	Increasing

* R^2 = Coefficient of determination; ⁺ p -value<0.05= Statistically significant trend.

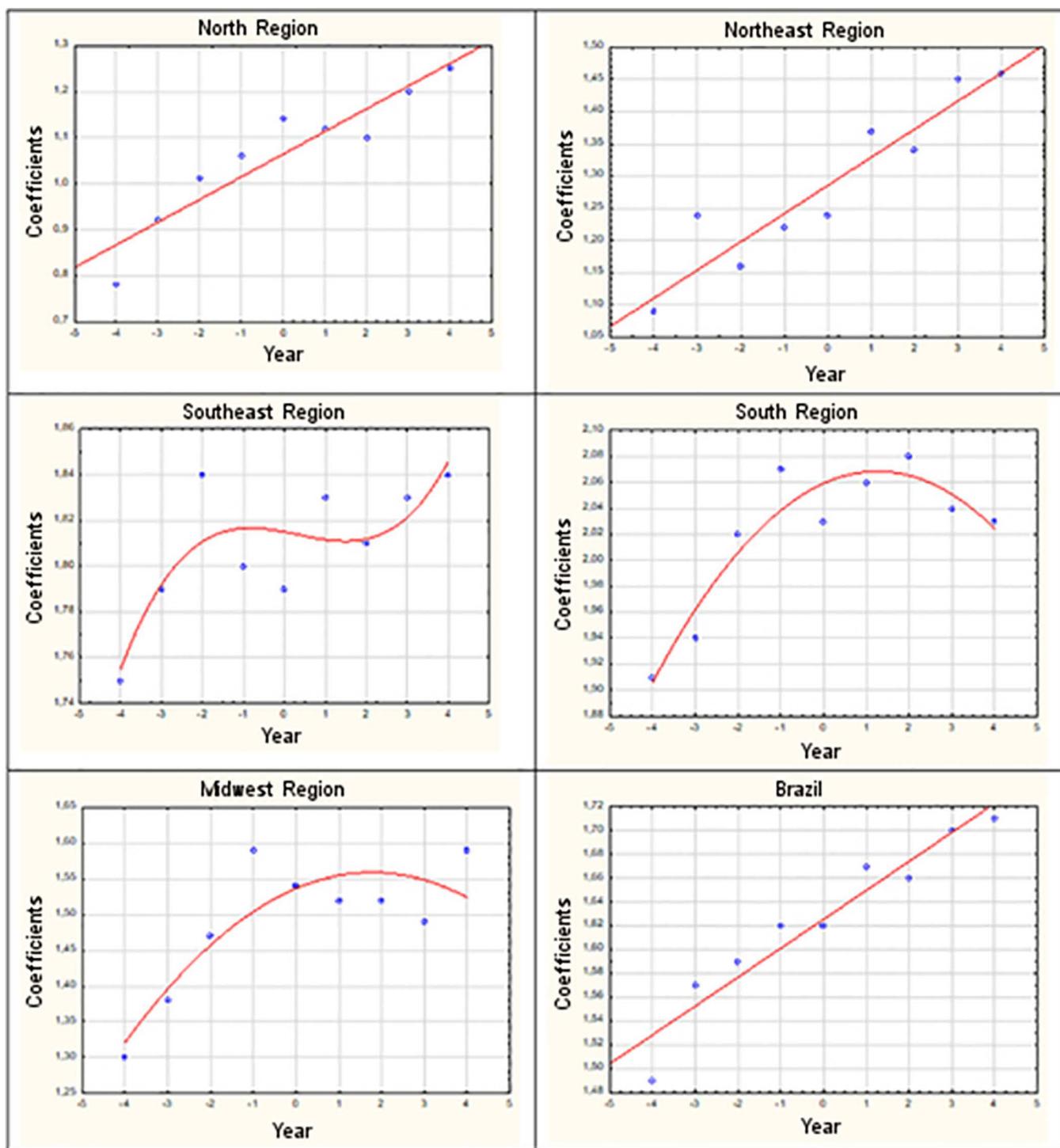


Figure 3. Scatter diagrams of the surgical mortality coefficients according to regions. Brazil, 2008 to 2016.

In Brazil, total health expenditure per capita per year averaged US\$ 427. From this amount, only US\$ 204 were invested by the government, a much lower figure when compared with a per capita global expenditure of developed countries, such as the United States (US\$ 3,076) or Europe (US\$ 1,350).

In addition, the mortality rate in Brazil is higher than in developed countries. Thus, the authors infer that severe underfinancing in health impacts access to surgical interventions, with insufficient number of surgeries performed and worse surgical outcomes in comparison with international standards¹⁰.

In the period analyzed (2008-2016), the coefficient of surgical procedures was 2.02 surgeries per 100 inhabitants per year, which corresponded to a surgical volume of 2020 surgeries per 100,000 inhabitants per year. In view of these results, we can infer that the surgical volume in Brazil is substantially lower than that recommended by the international goal to achieve universal access to anesthetic and surgical care, which established 5000 annual surgical procedures per 100,000 people by 2030¹⁷. This indicator, proposed by the *Lancet Commission on Global Surgery*, in 2013, corresponds to an adequate supply of the needs in anesthetic and surgical care. To reach this goal, it will require a broad expansion of health and surgical systems, which implies hiring twice the surgical workforce by 2030. This expansion of the surgical volume should be accompanied by a strengthening of quality, safety and equity, which should be guaranteed by local health managers¹⁷⁻¹⁹.

It is believed that, despite the disparities in the surgical coefficients between the regions of the country, the regions with more positive results, such as the South, Southeast and Central West regions, also face limitations in the reach of Universal Health Coverage, even with greater socioeconomic development and better care conditions in relation to number of beds, specialized hospitals available and operations per inhabitants when compared with the North and Northeast²⁰.

Worldwide, it is estimated that there are 1,112,727 surgeons, 550,134 anesthetists and 483,357 obstetricians. Low and middle-income countries, which represent 48% of the world's population, have 19% of all surgeons, 15% of anesthetists and 29% of obstetricians. When analyzing the density of these professionals,

low-income countries have an average of four professionals per 100,000 inhabitants, compared with 5.5 in middle-income countries and 56.9 in high-income ones²¹. In Brazil, in 2014, there were 40,808 surgeons, 11,492 anesthesiologists and 18,149 obstetricians, and the density of these professionals was 34.7 per 100,000 people, with geographical variations from 45.81 in the Southeast to 18.4 in the North¹². Of the 22,276 general surgeons certified in the country, the proportion is 11.49 professionals per 100,000 people, most of them located in the Southeast region of the country. When compared, the South, Southeast and Midwest regions have a higher proportion of general surgeons than the North and Northeast regions¹¹.

A similar study conducted in Brazil to map and characterize the distribution of the surgical workforce (surgeons, anesthesiologists and obstetricians), found a density of the surgical workforce of 46.55/100,000 inhabitants. The North Region had 20.21, followed by the Northeast, with 27.10, the Midwest, with 55.41, the Southeast, with 58.46, and South Region, with 60.32/100,000 inhabitants. The authors pointed out that Brazil has a substantial surgical labor force and, as a nation, fulfills the requirement recommended by The Lancet Commission on Global Surgery for the surgical workforce, which should be 20 to 40 per 100,000 population. However, the distribution of this labor force is uneven across regions. The authors emphasized the urgent need to allocate surgeons, anesthesiologists and obstetricians in the states of the North and Northeast, especially in Amapá, Acre and Maranhão, and added that government policies and the involvement of health institutions leadership are important measures to ensure that these professionals are more suitably distributed among the regions²².

Regarding the unequal geographical distribution of these professionals, it is noteworthy that the states of the Southeast, like São Paulo, act as specialized centers, since they are typically the places with the best health infrastructure in general. These states receive residents of other Brazilian states and keep many of them throughout their professional career. The inadequate distribution of specialized human resources throughout Brazil may be due to the lack of attractiveness to work in the more remote regions. The lack of basic infrastructure in these areas is a barrier to the recruitment of surgical labor¹¹. In fact, the unequal distribution of the surgical workforce in Brazil certainly contributes to the poor quality of surgical care in certain regions. With regard to surgeons, there is a shortage in the national public health system and better incentives should be created to ensure an equal public and private workforce. The improvement of the health system should involve investments in infrastructure and creation of sustainable projects to attract health care providers for low-income areas of the country¹¹.

Regarding the surgical mortality rate, the results showed a growing trend in all Brazilian regions, especially in the South and Southeast regions. Corroborating these results, a similar study conducted in 2014 showed that the perioperative mortality rate in Brazil was 1.71%, ranging from 1.12% in the North to 2.13 in the South. In part, this difference can be associated with several factors, such as differences in patient populations, available medical services and underreporting of surgical mortality. In addition, in the South and Southeast, more satisfactorily trained surgeons with greater resources can perform procedures of greater complexity in patients with comorbidities¹². It is also

important to consider that the patients' severity level at the time of care, diagnostic and therapeutic delays and availability of adequate logistics can also strongly influence the mortality rate²³.

In this study of an approximate decade, despite the increasing trend in performed surgical procedures, in line with the increasing demand of the population for surgery, we observed that the surgical volume is below the recommended by the international goal, with regional inequities that may indicate that Universal Health Coverage is not widely guaranteed. In this sense, we believe that health care in Brazil is often contrary to the fundamental assumptions of Universal Health Coverage²⁴, since all people must have equitable access to quality and comprehensive health services and actions, according to their lifelong needs²⁵.

Given these findings, we propose a debate about the challenges to tackle and strategies to improve access to surgical care to the population. As for the governmental aspect, one should improve investment in public health system, a constitutional duty of the State²⁶. It is, however, a great challenge, since Brazil is facing a tough economic scenario, one of its consequences being the approval, in 2016, of the proposed constitutional amendment (PEC 55), consisting of a new fiscal regime, which will reduce the social expenses (adjusted for inflation) over the next 20 years²⁷. As previously mentioned, in the final years of the survey, in Brazil and in some regions of the country the coefficient of surgical procedures declined, perhaps secondary to the decrease in funds to provide adequate infrastructure for health care. Given this, at the national level, we can infer that, as of 2016, this scenario that tends to the decline in surgical volume may remain stable or worsen with the effects of PEC 55/2016 on surgical care.

To improve surgical care, policies should focus on stimulating adequate geographic allocation of resources and surgical workforce, addressing the infrastructure deficit and better distributing surgical volume. The integrated and in-depth analysis of surgical indicators, such as the coefficients of surgical procedures and mortality, may reveal inequalities in the provision of care that should be investigated and addressed. This may involve analyses at the level of the patient and at the level of surgical health system, to better understand the key issues related to geographical access to care and to consider the quality of care once when other indicators benchmarks are met²⁸.

Regarding this study's limitations, the variable "hospitalization" for performing surgery analyzed includes only the paid admissions, and not all that were actually performed by SUS, due to limits in physical and financial schedule of the SUS. In addition, the hospitalization variable is defined by DATASUS as the amount of Hospital Admission Authorizations (AIH)

approved in the period. This is an approximate value of hospitalizations, since transfers and re-admissions are computed. Also, there is a possibility of underreporting in the number of hospitalizations performed in public hospitals financed by direct transfer of resources and not by production of services¹³. Therefore, in this study, these limiting aspects of the data should be considered in interpreting the results.

This study shows that, in Brazil, over nine years, the trend of surgical admissions by SUS and mortality was significant and growing, with regional differences. In comparison, the surgical volume in Brazil is approximately 2.5 times lower than the target set by the international towards achieving universal access to anesthetics and surgical care. We believe that these results can support processes of planning, management and evaluation of public policies aimed at the SUS surgical care, considering regional differences in the direction of Universal Health Coverage, since surgeries improve the quality of life of the population and save lives.

R E S U M O

Objetivo: analisar a tendência de internações para realização de procedimentos cirúrgicos e de mortalidade cirúrgica no Brasil, no período de 2008 a 2016. **Métodos:** estudo ecológico, de séries temporais. Os dados sobre internações cirúrgicas e mortalidade entre 2008 e 2016 foram obtidos do Departamento de Informática do Sistema Único de Saúde. A análise de tendência foi realizada por meio de modelos de regressão polinomial. **Resultados:** foram realizados no período do estudo, 37.565.785 procedimentos cirúrgicos pelo Sistema Único de Saúde, uma média anual de 4.151.050 cirurgias. A média do coeficiente dos procedimentos cirúrgicos foi de 2,12 cirurgias por 100 habitantes/ano, com variação de 1,92 a 2,56 habitantes/ano entre as regiões do país. A taxa de mortalidade cirúrgica foi de 1,63%, com variação de 1,07% a 2,02% entre as regiões. **Conclusão:** constatou-se tendência significativa crescente dos procedimentos cirúrgicos realizados e de mortalidade cirúrgica; entretanto, o coeficiente de procedimentos cirúrgicos realizados é inferior ao preconizado pela meta internacional, com disparidades regionais no acesso aos cuidados cirúrgicos e na mortalidade, o que compromete a garantia da cobertura universal da saúde preconizada pelo Sistema Único de Saúde.

Descritores: Procedimentos Cirúrgicos Operatórios. Mortalidade. Acesso aos Serviços de Saúde. Assistência à Saúde..

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