

THORACOLUMBAR FUSION IN THE UNIFIED HEALTH SYSTEM: PRE-COVID-19 TEMPORAL

ARTRODESE TORACOLUMBAR PELO SISTEMA ÚNICO DE SAÚDE: ANÁLISE TEMPORAL PRÉ-COVID-19

TRENDSARTRODESIS TORACOLUMBAR EN EL SISTEMA ÚNICO DE SALUD: ANÁLISIS TEMPORAL PRE COVID-19

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ABSTRACT

Objective: To evaluate the temporal trends of thoracolumbar fusion procedures performed by the United Health System in Brazil from 2009 to 2019. **Methods:** This was an observational ecological study based on data collected from the information systems under the aegis of DATASUS, especially the Hospital Information System, which manages the Hospital Admission Authorizations (Autorizações de Internação Hospitalar - AIHs). All patients who had undergone the procedures of interest, that is, elective and emergency short and long thoracolumbar arthrodeses, were included. The temporal trends of the procedures performed in Brazil and in its five regions were calculated using polynomial regression. **Results:** The temporal trend of elective thoracolumbar arthrodesis decreased, while that of emergency arthrodesis increased, with the peak in 2015, followed by a marked decline. Short fusions were more frequent in both elective and emergency modalities, and the South and Central-West Regions had the highest indices of procedures per million inhabitants during the entire 2009 to 2019 period. **Conclusions:** The temporal trends of thoracolumbar fusions performed by SUS have decreased over the last decade, a phenomenon which may be explained by the growing criticism of indications of the procedure in the current literature. **Level of evidence III; Retrospective Comparative Study.**

Keywords: Spatio-Temporal Analysis; Spinal Fusion; Spinal Fractures; Spondylolisthesis.

RESUMO

Objetivo: Analisar a tendência temporal dos procedimentos de artrodesse toracolombar realizados pelo Sistema Único de Saúde no Brasil entre os anos de 2009 e 2019. **Métodos:** Trata-se de estudo observacional de delineamento ecológico, baseado em dados secundários coletados a partir dos sistemas de informação sob guarda do DATASUS, em especial do Sistema de Informações Hospitalares, que gerencia as Autorizações de Internação Hospitalar (AIHs). Foram incluídos todos os pacientes submetidos aos procedimentos de interesse, de caráter eletivo e de urgência, correspondentes às artrodeses toracolombares curtas e longas. A tendência temporal foi avaliada através da regressão polinomial dos procedimentos realizados no Brasil e em suas cinco regiões federativas. **Resultados:** A tendência temporal das artrodeses eletivas foi decrescente e a das artrodeses de urgência foi crescente, com pico em 2015, seguida de franco declínio. As artrodeses curtas foram mais frequentes em ambas as modalidades de urgência e eletiva, e as regiões Sul e Centro-Oeste obtiveram os maiores índices de procedimentos por milhão de habitantes em todo período de 2009 a 2019. **Conclusão:** A tendência temporal das artrodeses toracolombares realizadas pelo SUS tem caráter decrescente na última década, fenômeno que pode ser justificado pela crescente criticidade perante as indicações do procedimento na literatura contemporânea. **Nível de evidência III; Estudo Retrospectivo Comparativo.**

Descritores: Análise Espaço-Temporal; Fusão Vertebral; Fraturas da Coluna Vertebral; Espondilolistese.

RESUMEN

Objetivo: Analizar la tendencia temporal de los procedimientos de artrodesis toracolumbar realizados por el Sistema Único de Salud en Brasil entre 2009 y 2019. **Métodos:** Se trata de un estudio observacional de diseño ecológico, basado en datos secundarios colectados de los sistemas de información en poder de DATASUS, en particular por el Sistema de Información Hospitalaria, que gestiona las Autorizaciones de Admisión Hospitalaria (AIH). Se incluyeron todos los pacientes sometidos a procedimientos de carácter urgente y electivo, correspondientes a artrodesis toracolumbar corta y larga. La tendencia temporal se evaluó mediante regresión polinomial de los procedimientos realizados en Brasil y sus cinco regiones federativas. **Resultados:** La tendencia temporal de la artrodesis electiva fue decreciente y la de la artrodesis de urgencia fue creciente, alcanzando el pico en 2015, seguido de un fuerte descenso. Los casos de artrodesis cortas fueron más frecuentes tanto en las modalidades de urgencia como en las electivas, y las regiones Sur y Medio Oeste tuvieron las tasas más altas de procedimientos por millón de habitantes en todo el período de 2009 a 2019. **Conclusión:** La tendencia temporal de las artrodesis toracolombares realizadas por el SUS tiene un carácter decreciente en la última década, fenómeno que puede justificarse por la creciente criticidad de las indicaciones del procedimiento en la literatura contemporánea. **Nivel de evidencia III; Estudio Retrospectivo Comparativo.**

Descriptor: Análisis Espacio-Temporal; Fusión Vertebral; Fracturas de la Columna Vertebral; Espondilolistesis.

Study conducted at the Universidade do Sul de Santa Catarina, Tubarão, SC, Brazil.

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INTRODUCTION

Arthrodesis of the thoracolumbar spine is defined as the fusion of two or more vertebral bodies, and is described as short, when the fusion involves up to three segments, or long, when it involves more than three segments.¹

Spinal fusion can be performed in orthopedic/neurological emergencies and as elective procedures.² The main indication for lumbar arthrodesis is to treat degenerative spine diseases, which include conditions such as degenerative symptomatic spondylolisthesis, degenerative disc disease with chronic low back pain refractory to conservative treatment, foraminal stenosis with nerve root compression, lumbar canal stenosis, and degenerative scoliosis.³

Outside the core of degenerative etiologies, it is indicated for the treatment of conditions such as infectious diseases of the spine, vertebral fractures, traumatic and isthmic spondylolistheses, traumatic extruded herniations, recurring disc herniations, post-discectomy collapse, post-laminectomy instability, and after spinal tumor resections.³ Other indications are pseudoarthrosis and adjacent segment disease.³

With the advent of the Unified Health System (SUS), Brazil became the largest country to have a public health system, and it is estimated that 80% of the Brazilian population is SUS-dependent for health care.⁴

Thus, the present study was conducted with the aim of filling a knowledge gap and producing information to assist in the reformulation of policies and the elaboration of strategies to implement surgical assistance in Brazil. For this, the annual frequency of thoracolumbar spinal fusions by SUS and its evolution from 2009 to 2019 in the regions of Brazil were evaluated.

METHODS

This was an observational ecological study based on secondary data. The medical records of patients over 18 years of age who underwent thoracolumbar fusion surgery during the period from 2009 to 2019 in public, philanthropic, or private hospitals in Brazil, and whose procedures were financed by SUS, were evaluated. The data were collected from information systems under the aegis of DATASUS (via the link <http://datasus.saude.gov.br>), especially from the Hospital Information System, which manages the AIHs (Hospital Admission Authorizations).

Using the "Procedures" option, we obtained the types of surgical procedures available during the period January 2009 and December 2019. All the patients (census) who underwent the following procedures by SUS were included in the study: POSTERIOR/POSTEROLATERAL INTERBODY FUSION OF ONE, TWO, THREE, OR FOUR LEVELS; POSTERIOR THORACO-LUMBAR-SACRAL FUSION OF ONE, TWO, THREE, FOUR, FIVE, SIX, OR SEVEN LEVELS.

The data were categorized by state and region of Brazil, by the emergency or elective nature of the service, and by the short or long extent of the arthrodesis. The population coefficients of hospitalizations/procedures (per one million inhabitants) were calculated from the mean number of hospitalizations/procedures that occurred in the period from 2009 to 2019 divided by the census of the resident population (2009-2012) and by the IBGE annual population projection (2013-2019).

The proposed study was based on the ethical terms of National Health Council Resolution 466/12. Because the study data was obtained from secondary sources, without identification of the study subjects and available in the public domain, the review by the Institutional Review Board and the Informed Consent Form requirements were waived.

The data were tabulated using MS-Excel software and analyzed by the Statistical Package for the Social Sciences (SPSS) program, version 20.0. The qualitative data were presented as frequencies (absolute and proportional) and the quantitative data as measures of central tendency (mean or median) and their respective measures of variability/dispersion (standard deviation). The temporal trend analysis was conducted using polynomial regression models, given that they have high statistical power and are easier to formulate and

interpret. The coefficient of determination (R^2), the β (mean annual variation of the time series from Pearson's simple linear regression), and the p-value from the variance analysis (ANOVA) were used for the temporal analyses.

RESULTS

Between 2009 and 2019, 79,529 thoracolumbar arthrodeses were performed in Brazil by SUS, 38,835 of which were elective and 40,694 were emergency procedures. In this period, the temporal trend of the elective thoracolumbar arthrodeses was decreasing, with a seasonal increase up until 2014, followed by a decline, as shown in Figure 1. The trends of the regions of Brazil are also found in Figure 1, and it is noteworthy that only the Central-West Region had an upward trend during that period. Regarding the emergency thoracolumbar arthrodeses, there was an upward temporal trend in the period, with a peak in 2015 and a downtrend since then, as shown in Figure 2. The trends of the regions of Brazil are also shown in Figure 2, where only the South and Northeast Regions experienced upward trends during the period.

Among the 38,835 elective arthrodeses, 30,293 were short and 8,452 were long. Both short and long elective fusion had a downtrend in Brazil, with an uptrend observed only in the Central-West Region. Seasonal peaks were observed in short elective arthrodeses in 2014 and in long elective arthrodeses in 2012, as shown in Figures 3 and 4. The trends of the remaining regions are shown in Figures 3 and 4.

Among the 40,694 emergency arthrodeses, 27,620 were short and 13,704 were long. Both short and long emergency fusions trended up in Brazil, with downtrends observed only in the Central-West and South Regions. Seasonal peaks were observed in both modalities in 2015, declining since that time, as shown in Figures 5 and 6. The trends of the remaining regions are also shown in Figures 5 and 6.

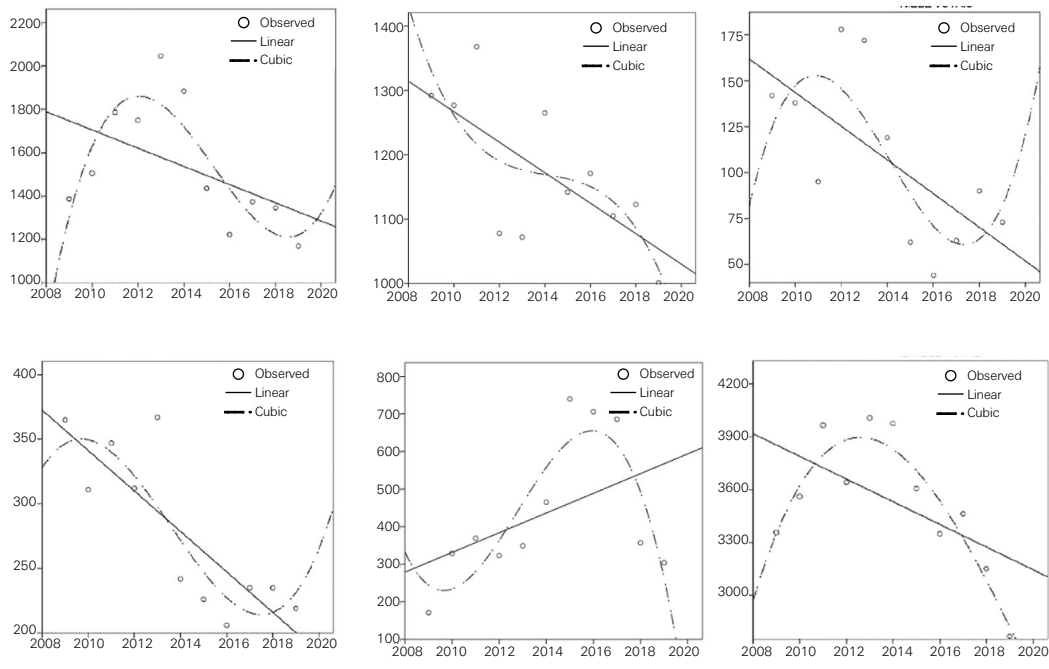
The South and Southeast Regions had the highest absolute numbers of arthrodeses performed in the period in both modalities, with 30,461 and 27,041 procedures, respectively. As regards the frequency of arthrodeses per million inhabitants, the South and Central-West Regions had the highest indices during the entire period from 2009 to 2019. The other frequencies per million inhabitants in the Brazilian regions are found in Figure 7.

DISCUSSION

In Brazil, between 2009 and 2019, emergency thoracolumbar arthrodeses (40,694) were more frequent than elective ones (38,835), and both had a consistently downward temporal trend after 2015. The incidence of arthrodeses in Brazil was 34.9 procedures per million inhabitants in 2009 and 27.7 procedures per million inhabitants in 2019, representing a decrease of 20.63%. The rise followed by the decline is similar to the temporal trend observed in North America in the same period.⁵

The first instrumented vertebral body fusion was performed in 1891 using silver wire for fixation.⁶ During that period, it was mainly indicated for spinal trauma, severe scoliosis, and Pott's disease.⁶ In 1929, Hibbs performed the first vertebral fusion with silver wire for degenerative diseases of the lumbar spine, which proved unsatisfactory due to the high degree of associated pseudarthrosis.⁷ However, in the late 1940s the orthopedist King adapted the Hibbs technique incorporating the use of facet screws,^{8,9} a device improved by Boucher in 1959.¹⁰ Thus, after the advent of screws and the 1934 publication of the article by Mixter and Barr that advocated the addition of intervertebral fusion in disc herniation surgeries,¹¹ the first wave of thoracolumbar arthrodeses was observed in the United States.

Thus, the incidence of the procedure doubled between 1979 and 1990, and its rise substantially intensified after the advent and approval of interbody devices (cage) by the Food and Drug Administration (FDA) in 1996.¹² According to Deyo et al., during the period between 1990 and 2001 there was a 220% increase in the incidence of arthrodeses per 100,000 inhabitants in the United States.¹³



Regions	No.	Model	R ²	p	Trend
South	16,901	$y=798.227+602.476x-103.045x^2+4.706x^3$	0.758	0.015	Downward
Southeast	12,894	$y=1430.864-117.24x+18.262x^2-0.998x^3$	0.529	0.133	Flat
North	1,176	$y=81.030+55.604x-12.617x^2+0.688x^3$	0.581	0.014	Flat
Northeast	3,065	$y=327.848+27.822x-9.635x^2+0.573x^3$	0.757	0.015	Downward
Central-West	4,799	$y=332.409-133.258x+48.795x^2-3.38x^3$	0.762	0.014	Upward
Brazil	38,835	$y=2970.379+435.405x-58.240x^2+1.583x^3$	0.060	0.002	Downward

*No. = number, R² = Coefficient of determination, p-value >0.05 = Flat, p-value <0.05 and b1+ = upward, p-value <0.05 and b1- = downward. Observed, Linear, Cubic.

Figure 1. Temporal trends of elective arthrodeses in Brazil and its regions from 2009 to 2019.

Regarding elective thoracolumbar arthrodeses, the upward trend of intervertebral fusions observed at the end of the 20th century continued into the first decades of the 21st century, as demonstrated in the North American study by Martin et al., who observed an increase of 62.3% in the procedures in the period between 2004 and 2015.⁵ However, regarding the incidence of elective arthrodeses by indication, Martin et al. observed a drop in procedures for disc herniations and disc degeneration around 2015.⁵

This drop was attributed to the questionable and controversial level of evidence of the procedure for degenerative diseases of the lumbar spine, as well as spondylolistheses,⁵ a factor which may also have contributed to the decline in elective thoracolumbar arthrodeses in Brazil after 2014 observed in our study. The recognition of non-drug treatment as the first line for chronic low back pain intensified after the publication of the American,¹⁴ European,¹⁵ and Danish¹⁶ guidelines and can also be associated with the decline in intervertebral fusions. In addition, the role of thoracolumbar fusion for chronic low back pain without neurological involvement is considered uncertain in the article by Foster et al. published in *The Lancet* in 2018.¹⁷

Regarding emergency thoracolumbar arthrodeses, the indication of conservative treatment for traumatic vertebral fractures rather than surgery is also in vogue in the current scientific scenario,¹⁸

and may be associated with the decline in incidence observed in the present study after 2015. According to Spiegl et al., the conservative approach can be used in thoracolumbar fractures with <10° of scoliotic deformity, <15° of kyphotic deformity, without neurological deficit, without relevant disc damage, and in the A0, A1, and A2 fracture subtypes of the AOSpine Thoracolumbar Spine Injury Classification System.¹⁸

All five regions had drops in the incidence of arthrodeses per million inhabitants during the period from 2009 to 2019. The North Region had the largest drop (38.53%), followed by the Northeast (29.22%), Central-West (23.12%), South (20.08%), and Southeast (18.27%) Regions. Only the Central-West Region had an upward trend for elective arthrodeses, with a peak in 2017 followed by constant decline. Only the South and Northeast Regions had upward trends for emergency fusions, with peaks in 2015 and 2016, respectively, followed by decline. In summary, all regions showed a decline in all fusion modalities in the final years of the period evaluated. Once again, the drop in the number of procedures performed can be attributed to the uncertain and controversial level of evidence of thoracolumbar arthrodesis in the contemporary literature.¹⁴⁻¹⁸ The different seasonality of the peaks and declines among the regions can be explained by the multiple factors that motivate surgeons to perform intervertebral

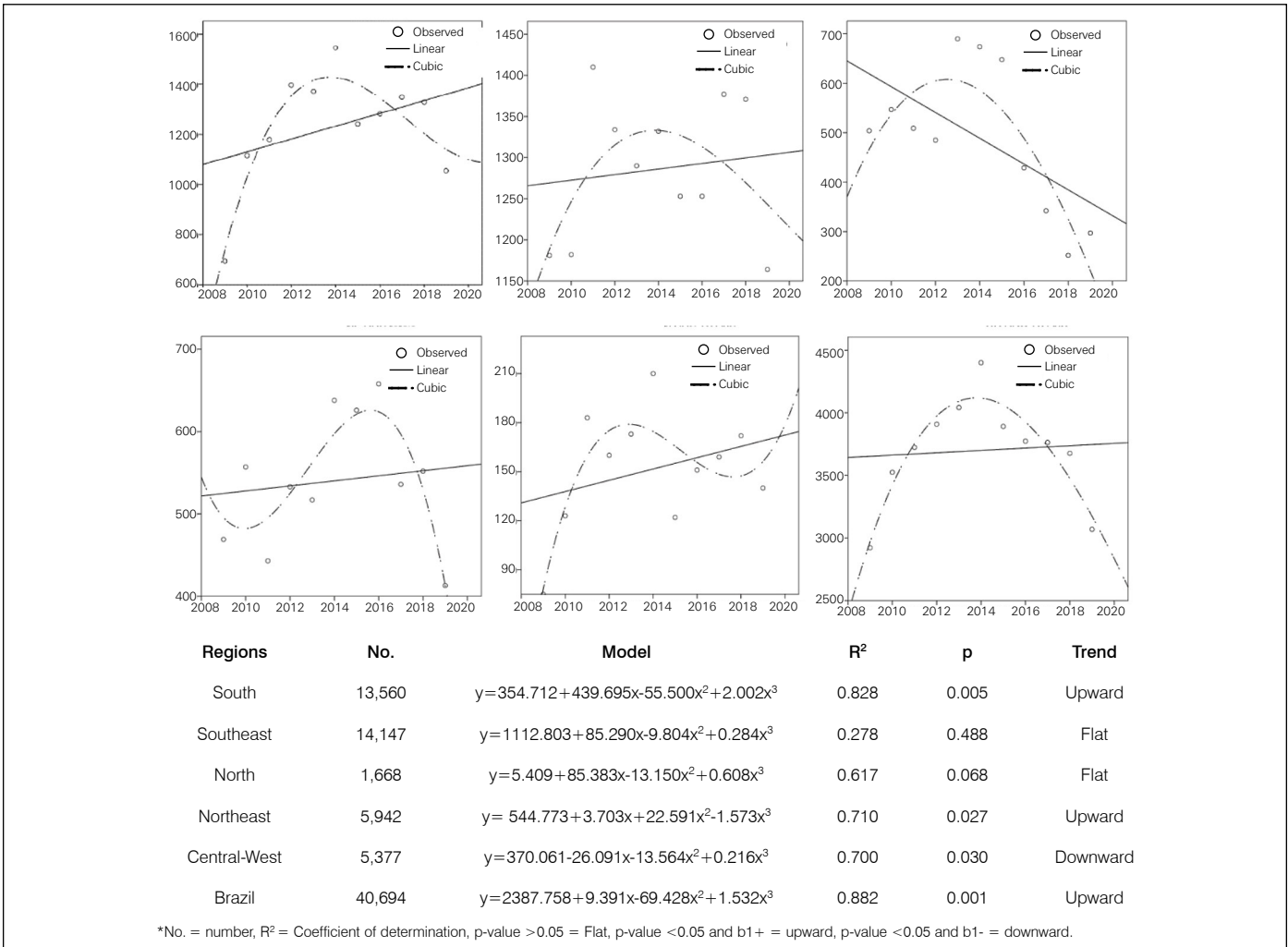


Figure 2. Temporal trends of emergency arthrodeses in Brazil > its regions from 2009 to 2019.

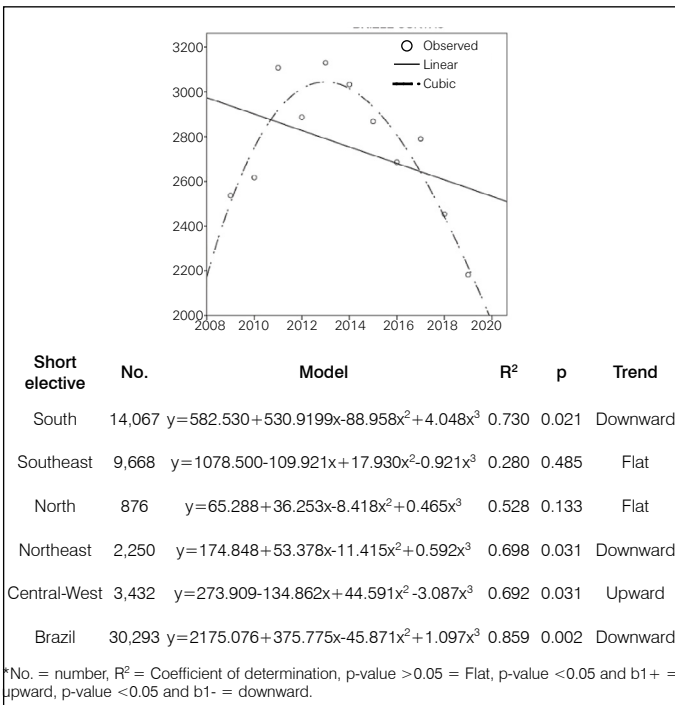


Figure 3. Temporal trends of short elective arthrodeses in Brazil and its regions from 2009 to 2019.

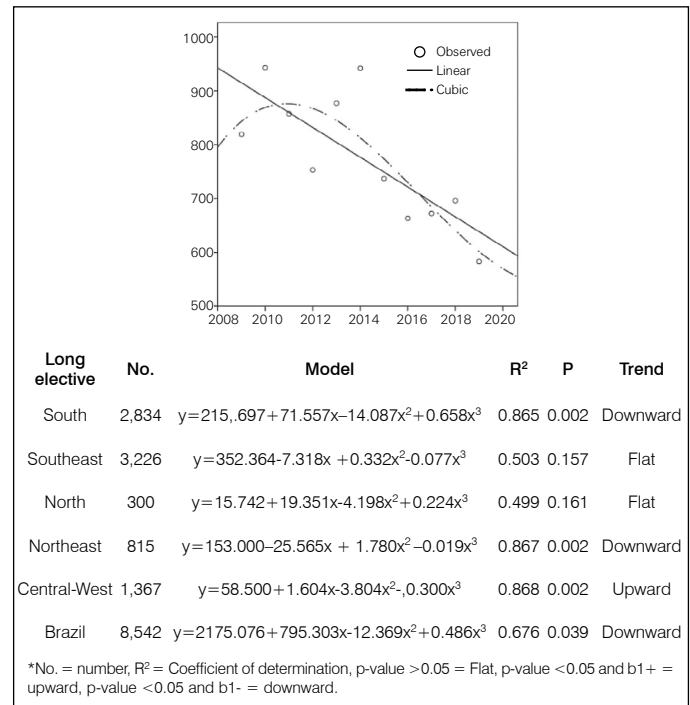


Figure 4. Temporal trends of long elective arthrodeses in Brazil and its regions from 2009 to 2019.

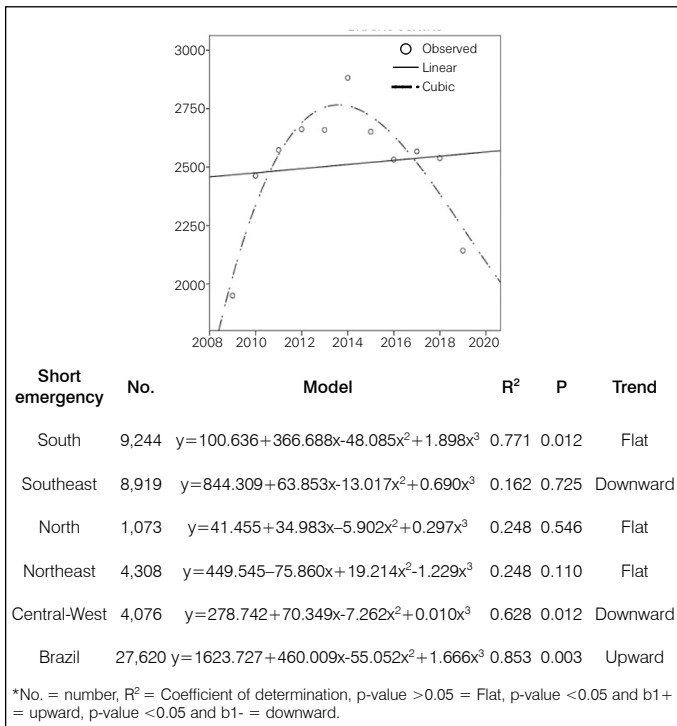


Figure 5. Temporal trends of short emergency arthrodeses in Brazil and its regions from 2009 to 2019.

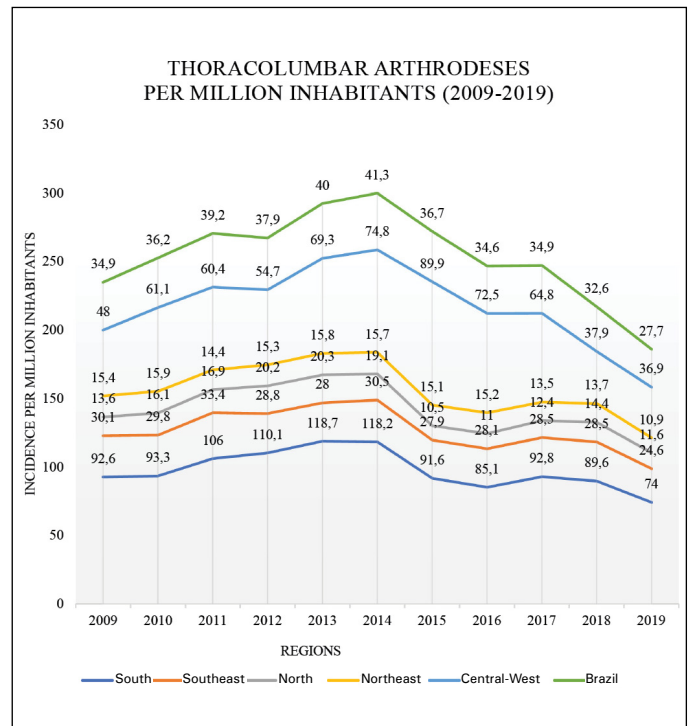


Figure 7. Incidence of Thoracolumbar Arthrodeses performed in Brazil by SUS per million inhabitants from 2009 to 2019.

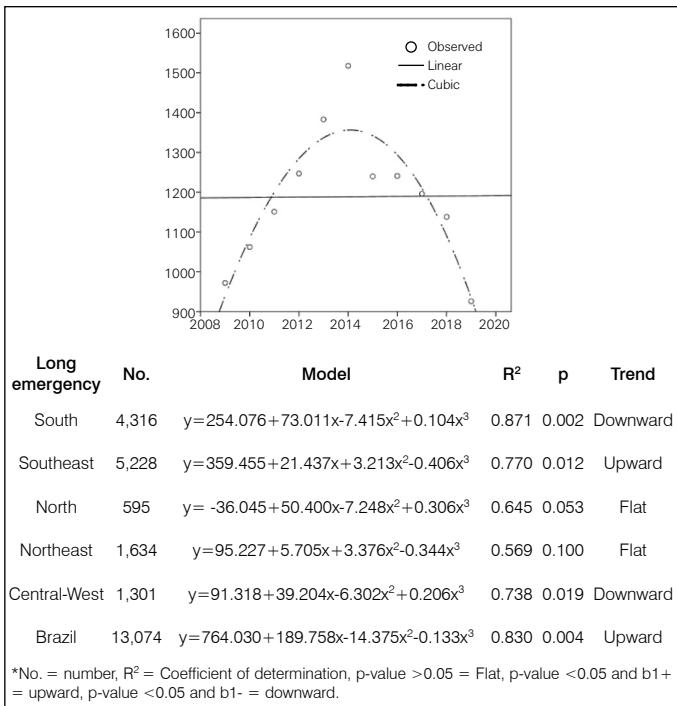


Figure 6. Temporal trends of long emergency arthrodeses in Brazil and its regions from 2009 to 2019.

thoracolumbar spinal fusions, such as patient characteristics, baseline diagnosis, personal experience, and the availability of special devices and imaging exams.⁵

The higher proportions of both emergency and elective short arthrodeses performed may be justified by epidemiological issues and some surgical implications. Regarding epidemiology, diseases affecting the spine that require long fusions, such as neoplasms, deformities, and infectious diseases, are less common.⁵ As for surgical implications, evidence suggests that in treating degenerative spinal diseases short arthrodesis, when indicated, has more benefits than long arthrodesis, due to lower costs, shorter intraoperative time, and a lower risk of complications, especially pulmonary ones.¹⁹

CONCLUSIONS

In Brazil, between 2009 and 2019, there was a downward temporal trend for both elective and emergency arthrodeses after 2015. Downward trends were also observed in all regions in the final years of the period evaluated for both the short and long categories of elective and emergency fusions. Finally, a decline in the incidence of thoracolumbar fusion per million inhabitants was observed in Brazil and in each of the five regions.

All authors declare no potential conflict of interest related to this article.

CONTRIBUTIONS OF THE AUTHORS: LDR: Writing, review, and intellectual concept; active participation in the discussion of the results; approval of the definitive version of the work. HB: Active participation in the discussion of the results; approval of the definitive version of the work. KSK: Writing, review, and intellectual concept; active participation in the discussion of the results; approval of the definitive version of the work. PSM: Active participation in the discussion of the results; approval of the definitive version of the work. ROM: Active participation in the discussion of the results; approval of the definitive version of the work. MBN: Writing, review, and intellectual concept; active participation in the discussion of the results; approval of the definitive version of the work.

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