



ORIGINAL ARTICLE

Direct healthcare costs of spinal disorders in Brazil

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Abstract

Objectives To estimate the direct healthcare costs of spinal disorders in Brazil over 2016.

Methods This is a prevalence-based cost-of-illness study with a top-down approach from the perspective of the public healthcare system. All international Classification of Diseases codes related to spinal disorders were included. The following costs were obtained: (1) hospitalization; medical professional service costs; intensive care unit costs; companion daily stay; (2) outpatient (services/procedures). Data were analyzed descriptively and costs presented in US\$.

Results The healthcare system spent US\$ 71.4 million, and inpatient care represented 58%. The number of inpatient days was 250,426, and there were 36,654 hospital admissions (dorsalgia and disk disorders representing 70% of the costs). More than 114,000 magnetic resonance scans and 107,000 computerized tomography scans were adopted. Men had more inpatient days (138,215) than women (112,211). Overall, the inpatient/outpatient cost ratio was twice as high for men.

Conclusions We demonstrated that the direct costs of spinal disorders in Brazil in 2016 were considerable. We also found a substantial amount of financial resources spent on diagnostic imaging. This is relevant as the routine use of diagnostic imaging for back pain is discouraged in international guidelines.

Keywords Cost of illness · Back pain · Costs and cost analysis · Hospital costs · Ambulatory care

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Introduction

The functional and social impact of spinal disorders on occupational and daily living activities has long been recognized (Gore et al. 2012). Chronic spinal disorders are one of the leading health problems worldwide, sustaining the highest rates of years lived with disability (GBD 2017) and having a global prevalence of 13% to 40% (Dean et al. 2014; Hoy et al. 2012). In Brazil, the annual prevalence of spinal disorders in Brazil was estimated between 22% and 50% (Depintor et al. 2016; Nascimento and Costa 2015; Zanuto et al. 2015); however, there is a high heterogeneity between studies owing to the type of population studied (e.g., workers, elderly), geographic location and associated clinical conditions (e.g., obesity). Spinal disorders can affect both men and women within different age-groups (Longworth et al. 2014; Muraki et al. 2014). The consequences of these conditions can also affect activities of daily living, work ability, and quality of life (Weigl et al. 2008). Hence, poorer health conditions due to spinal disorders remain a concern for all members of society, such as workers and their families, employers, and the government (de Vroome et al. 2015). In this context, it is important to emphasize the increasing need for clinical decision making

based on scientific evidence that supports the allocation of financial resources based on rational criteria (Ferraz 2015).

Cost-of-illness studies are useful and might help to determine the costs of the diagnosis and treatment of a specific illness and to broaden the understanding of public health problems (Larg and Moss 2011). Evidence regarding the costs and economic burden of spinal disorders has been established in several countries since the 1990s (Asklof et al. 2014; Lambeek et al. 2011; Maniadakis and Gray 2000; van Tulder et al. 1995; Wenig et al. 2009). In Brazil, economic evaluations focusing on spinal disorders are still in their early stages, and the evidence on the use of financial resources directed to these diseases is scarce (Teles et al. 2016).

One study showed that the costs of ankylosing spondylitis in Brazil are substantial, though this was based on a cost analysis of a single outpatient clinic in 2005 (Torres et al. 2010). The country's National Social Security Institute granted more than 1 million disability benefits to private sector workers in 2008, mostly due to spinal disorders (Vieira et al. 2011). Likewise, pension benefits due to spinal disorders covered approximately 12 million work days lost in 2007 (Meziat and Silva 2011). Moreover, it was estimated that costs of spinal surgeries had increased by 540%, in Brazil, in the past 20 years (Teles et al. 2016). It is well known that the Brazilian society is affected by the high prevalence of spinal disorders (Nascimento and Costa 2015; Zanuto et al. 2015). These findings were also corroborated by the Global Burden of Diseases Study, with recent data demonstrating that spinal disorders were one of the major components of worldwide disability, including Brazil (GBD 2017).

Nonetheless, gaps remain in our understanding of the healthcare expenses related to spinal disorders within the Brazilian public healthcare system, which warrants further cost-of-illness studies with representative data. Therefore, the aim of the present study is to estimate the direct healthcare costs of spinal disorders in Brazil over 2016.

Method

Study design

This is a prevalence-based cost-of-illness study with a top-down approach from the perspective of the public healthcare system (Ministry of Health). The study was approved by the Institutional Research Ethics Committee (Protocol n. 1.969.372; 16/03/2017).

We included all codes related to spinal disorders (International Classification of Diseases 10th revision—ICD-10), as follows: M40 (kyphosis and lordosis); M41 (scoliosis); M42 (spinal osteochondrosis); M43 (other

deforming dorsopathies); M45 (ankylosing spondylitis); M46 (other inflammatory spondylopathies); M47 (spondylosis); M48 (other spondylopathies); M49 (spondylopathies in diseases classified elsewhere); M50 (cervical disk disorders); M51 (other intervertebral disk disorders); M53 (other dorsopathies); M54 (dorsalgia); M96 (postprocedural musculoskeletal disorders, not elsewhere classified); M99 (biomechanical lesions, not elsewhere classified).

Data sources

Health expenses related to hospital (inpatient) and ambulatory (outpatient) care were obtained (in Brazilian Reais – R\$) from the Brazilian Health Ministry's Hospital Information System (SIH) and Outpatient Information System (SIA), respectively. The Hospital Information System contains all records of inpatient care, which are processed and sent to the Ministry of Health and included in a National Database. The Outpatient Information System includes all outpatient care by public and private providers contracted by the Brazilian Public Health System (SUS). Individual patient data were not available, and the expenses are aggregated and associated with the inpatient/outpatient admission documents. Thus, per capita analyses were not possible considering that there may be situations in which there is more than one procedure recorded in the same admission document, and there may be more than one hospitalization document for the same person (in cases of return for consultations or new hospitalization within a short period of time).

The expenses are based on prices, represented by the Brazilian Ministry of Health's reimbursements to all health providers who delivered care in a public health system setting. For that purpose, the Brazilian Healthcare System adopts a reference registered in the Table Management System of Procedures, Medical Drugs, Orthotics, Prosthetics, and Special Materials of the Brazilian Health System (SIGTAP). Both systems are intended for the registration, control, and processing of all health care provided, with an accounting and payment purpose (BRASIL 2017).

These systems present all procedures performed in the Brazilian Public Health System (SUS), which is financed by the Ministry of Health and covers approximately 75% of hospital and outpatient care in Brazil (Sussenbach et al. 2014). The systems use the ICD-10, which allows epidemiological analysis. The total number of hospital admissions in 2016 was 11,522,919 within a network of approximately 6712 registered hospitals. Additionally, the total amount for healthcare expenses in Brazil in 2016 was US\$ 5.228 million and US\$ 5.631 million for inpatient and outpatient care, respectively (BRASIL 2017).

Inpatient care expenses

The following direct medical costs were obtained: hospitalization (i.e., daily rate; room fees; food; personal hygiene; bed support; hospital supplies; allied healthcare professional service costs; medications and diagnostic and therapeutic auxiliary services); medical professional service costs; intensive care unit (ICU) costs (including the use of all equipment for intensive care, technical teams, and 24-h patient monitoring); companion daily stay (the Brazilian regulations allow, for each patient, one companion during the hospital stay, and the amount includes adequate accommodation and provision of the main meals).

Outpatient care expenses

The Brazilian Outpatient Information System (SIA) accounts for all ambulatory services and procedures, such as medical and allied healthcare consultations, examinations, diagnostic imaging, clinical and surgical procedures, physiotherapy, acupuncture, rehabilitation, and other procedures registered in the SIGTAP.

Data analysis

The inpatient and outpatient costs and procedures data are presented descriptively with tables and figures. The TABWIN software version 1.4.1 was used for extracting and processing data from the public health system. The outpatient costs were discriminated and reported separately for the following categories: clinical, surgical, diagnosis, orthosis and prosthetics, and complementary actions. For the inpatient care, expenses were presented separately for hospital and professional services, ICU, and companion stay. As all expenses are aggregated within the hospital system, the discrimination of each category was not possible. Resource use (quantity) was presented for the following components: clinical, surgical, and diagnosis.

Age-groups were established according to the Brazilian Ministry of Health's policies, i.e., the childhood until 12 years old, adolescence from 12 to 18 years old, and subsequently adults from 19 years old and up (BRASIL 2016). Therefore, the age-groups were applied as follows: < 1 year; 1–4 years; 5–11 years; 12–18 years; 19–28 years; 29–38 years; 39–48 years; 49–58 years; 59–68 years; 69–78 years and more than 79 years. The population of each age-group was based on the available information of the Brazilian population census of 2010 (IBGE 2017), in which the estimated population was 193,976,530 inhabitants. These data were used to calculate the ratio between the male population divided by the female population (ratio M/F). Additionally, the inpatient-

to-outpatient costs ratio (I/O ratio) and the average cost per hospital admission (in US\$; currency—December 07, 2017: US\$ 1 = R\$ 3.2348) were calculated for each age-group.

The total cost ratio (TCR) considered the total direct costs (in US\$) spent per 1000 people, according to the following equation:

$$\text{TCR} : \frac{\text{Inpatient} + \text{Outpatient Costs (US\$)}}{\text{Population (age groups)}} \times 10^3$$

Results

In 2016, the Brazilian public healthcare system spent US\$ 71.4 million on spinal disorders, and the inpatient costs represented 58% of these costs (Table 1). The geographic distribution of these costs in Brazilian states is given in Online Resource Figure 1. Both inpatient and outpatient costs were more concentrated in the southeast and south regions. The total amount of inpatient days due to spinal disorders in 2016 was 250,426 days, and the number of hospital admissions was 36,654. Dorsalgia and intervertebral disk disorders represented approximately 70% of these hospital admissions in 2016 (Table 1). The total expense of spinal disorders in Brazil represented around 0.7% of all healthcare expenses within the inpatient and outpatient care in 2016 (additional data are given in Online Resource Table 1).

Arthrodesis surgeries (115,148 procedures), treatment with multiple surgeries (106,997 procedures), and treatment of complications (97,042 procedures) represented, respectively, 10.5%, 9.7%, and 8.8% of the total amount of procedures reported as the main reason for hospital admissions (additional data are given in Online Resource Table 2). Approximately, more than US\$ 13 million (18% of the total expenses) were spent on diagnostic imaging during outpatient (Table 2) and inpatient care (Online Resource Table 3), mostly due to magnetic resonance (MRI) and computed tomography (CT). In addition, a large amount of MRI and CT was adopted only for intervertebral disk disorders and dorsalgia (additional data are given in Online Resource Table 4). It is worth noting that around 42,000 MRI and 36,000 CT scans were used for low back pain with or without sciatica alone. Physiotherapy interventions were predominantly reported in the outpatient context, which represented approximately US\$ 15 million and 49% of the outpatient costs (Table 2) and 20% of the total healthcare expense with spinal disorders in 2016.

The number of hospital admissions in 2016 due to spinal disorders for men and women was similar, except between the ages of 29–38 years, in which a slightly higher percentage (less than 2%) of admissions was found for men

Table 1 Healthcare expenses of inpatient and outpatient care for spinal disorders in 2016

		Inpatient						Outpatient costs	Total costs	C%
		Adm	Hc	Pc	ICUc	CSc	Inpatient costs			
M40	Kyphosis and lordosis	52	120,226	15,575	17,552	512	153,864	231,400	385,265	0.5
M41	Scoliosis	842	3,381,911	293,811	196,923	7637	3,880,282	821,996	4,702,278	6.6
M42	Spinal osteochondrosis	51	30,823	7367	1970	406	40,565	19,567	60,132	0.1
M43	Other deforming dorsopathies	539	1,048,273	127,881	46,230	3507	1,225,891	232,275	1,458,166	2.0
M45	Ankylosing spondylitis	294	134,997	17,845	8651	1311	162,804	140,731	303,535	0.4
M46	Other inflammatory spondylopathies	766	871,141	146,084	84,697	9210	1,111,132	100,336	1,211,468	1.7
M47	Spondylosis	1060	605,648	108,023	49,137	10,667	773,476	444,367	121,7843	1.7
M48	Other spondylopathies	527	672,858	113,071	62,543	3455	851,926	188,985	104,0911	1.5
M49	Spondylopathies classified elsewhere	97	100,727	15,233	2775	1395	120,129	511,099	631,228	0.9
M50	Cervical disk disorders	2202	2,624,601	439,776	279,981	12,348	335,6705	928,829	4,285,535	6.0
M51	Other intervertebral disk disorders	12,201	19,205,533	3,208,300	796,688	63,111	23,273,632	4,149,866	27,423,498	38.4
M53	Other dorsopathies	156	191,246	32,275	28,581	952	253,054	329,572	582,626	0.8
M54	Dorsalgia	13,143	1,771,210	276,106	57,943	50,380	2,155,638	18,472,097	20,627,735	28.9
M96	Postprocedural musculoskeletal disorders	4075	2,662,950	391,280	219,632	32,383	330,6245	1,160,103	4,466,348	6.3
M99	Biomechanical lesions	649	504,441	96,921	24,835	2720	62,8918	2,388,433	3,017,351	4.2
Total		36,654	33,926,584	5,289,547	1,878,138	199,993	41,294,262	30,119,657	71,413,919	100.0

Values are presented in US\$ dollars (currency: US\$ 1 = R\$ 3.2348). Brazil, 2016

Adm admissions, *Hc* hospital costs, *Pc* professional costs; *ICUc* intensive care unit costs, *CSc* companion stay costs; *C%* percentage relative to the direct costs of spinal disorders (inpatient + outpatient)

Bold markings represent the total sum for each row

(Fig. 1). Additionally, men's admissions to hospital accounted for a higher cost between the ages of 19 and 48 years compared to women. In contrast, the costs of outpatient care were higher for women, with a higher amount between the ages of 39 and 68 years compared to men (Fig. 2).

Table 3 presents the inpatient days and costs ratios among men and women during inpatient and outpatient care. Overall, men had more days of hospitalization compared to women between the ages of 19 and 68 years. The ratio between inpatient and outpatient costs was twice as high for men compared to women between the ages of 19 and 68. Likewise, the average cost per hospital admission tended to be higher for men.

Discussion

The aim of our study was to estimate the healthcare spending with spinal disorders in Brazil, from the perspective of the public healthcare system, over 2016. This is the first study to investigate the costs related to spinal

disorders using national data covering all of Brazil. We demonstrated that dorsalgia and intervertebral disk disorders accounted for the highest percentage of the direct costs. Moreover, approximately 14% of the direct costs were attributed to the routine use of diagnostic imaging. Men in the economically active age-group (19–68 years of age) had slightly higher inpatient costs, while women had higher outpatient costs. Physiotherapy covered the largest part of outpatient care, accounting for around 20% of the total direct costs.

We showed that, in 2016, the Brazilian public healthcare system spent US\$ 71.4 million on spinal disorders, 58% of which were attributed to inpatient care. This finding is of utmost importance and might help to improve our understanding of the burden to the Brazilian society, considering that there is a high prevalence and well-known impacts of these conditions in different populational groups (Depintor et al. 2016; Nascimento and Costa 2015). Even though comparisons with international studies are difficult, this might improve our understanding of the Brazilian scenario since spinal disorders are a worldwide health problem. We found similar cost components to those of other countries

Table 2 Most common procedures and services adopted during outpatient spinal disorders care in 2016

Nature of procedure	Quantity	Costs (US\$)	Most used	Quantity	Q%	Costs (US\$)	C%
Diagnostic	270,418	13,415,541	Magnetic resonance imaging	118,080	1.1	9,865,837	32.8
			Computed tomography scans	105,326	1.0	3,223,210	10.7
			X-ray imaging	8479	0.1	24,692	0.1
			Assessment of respiratory function	7212	0.1	22,295	0.1
			Ultrasound	6966	0.1	61,848	0.2
			<i>Total diagnostic</i>	<i>246,063</i>	<i>2.4</i>	<i>13,197,882</i>	<i>43.8</i>
Clinical	10,087,558	16,136,955	Physiotherapy: motor changes	8,687,766	67.4	12,619,325	42.1
			Physiotherapy: pre- and post-surgery in musculoskeletal dysfunctions	1,047,136	8.1	2,061,215	6.9
			Multiprofessional team: rehabilitation of physical dysfunctions	191,308	1.5	1,162,537	3.9
			Physiotherapy: neuromusculoskeletal disorders without complications	45,066	0.4	65,061	0.2
			<i>Total clinical</i>	<i>9,971,276</i>	<i>96.0</i>	<i>15,908,138</i>	<i>52.8</i>
Surgery	2296	18,796	Curative (with or without debridement)	734	0.01	7352	0.02
			Joint manipulation (osteomuscular surgery)	665	0.01	5842	0.02
			Wound suture	321	< 0.01	2298	0.01
			Local anesthesia	320	< 0.01	2203	0.01
			<i>Total Surgery</i>	<i>2040</i>	<i>0.02</i>	<i>17,695</i>	<i>0.1</i>
Orthoses and prostheses	3854	416,865	Brace—Putti (high)	1159	0.01	57,183	0.2
			Brace—Putti (low)	986	0.01	59,438	0.2
			Brace—Milwaukee	573	< 0.01	161,194	0.5
			Brace—Boston	311	< 0.01	57,541	0.2
			<i>Total orthoses and prostheses</i>	<i>3029</i>	<i>0.03</i>	<i>335,356</i>	<i>1.1</i>
Complementary actions	17,586	131,499	Aid for food	2800	0.03	15,211	0.1
			Aid for transportation	14,786	0.14	116,288	0.4
			<i>Total complementary actions</i>	<i>17,586</i>	<i>0.17</i>	<i>131,499</i>	<i>0.4</i>
Total (in 2016)	10,381,712	30,119,656	Total (most used)	10,189,658	98.2	27,947,202	92.8

Costs are presented in US dollars (currency 1 US\$: R\$ 3.2348). Brazil, 2016

Q% percentage relative to the total number of procedures reported during outpatient care in 2016, C% percentage relative to the total outpatient costs in 2016

Italic markings represent the partial sum for each category, and the bold markings represent the total sum

(Lambeek et al. 2011; Maniadakis and Gray 2000; Walker et al. 2003; Wenig et al. 2009); however, caution is recommended since Brazilian expenses were lower than that in developed countries. For instance, similar cost-of-illness studies reported direct healthcare costs of approximately €400 million in the Netherlands (Lambeek et al. 2011) and £1600 million in the UK (Maniadakis and Gray 2000). Likewise, Torres et al. (2010) demonstrated a lower cost for the treatment of ankylosing spondylitis in Brazil compared to other countries. The authors (Torres et al. 2010) highlighted methodological differences and a low *per capita* spending on health care in Brazil. The low share (0.66%) attributed to the costs of spinal disorders compared to all healthcare expenses in Brazil in 2016 could also be explained by operational differences in the healthcare systems (Ferraz 2015), discrepancies between perspectives,

and different cost components being included in other countries (Lambeek et al. 2011; Larg and Moss 2011). In addition, the economic burden related to smoking-related diseases, cardiac diseases, and obesity are higher in Brazil, and previous studies reported higher costs (de Oliveira et al. 2015; Pinto et al. 2015) compared to our findings. Nonetheless, we were not able to include the productivity losses due to spinal disorders in 2016, as the information was not available in the Brazilian Social Security System during the writing of this paper. We verified that, in 2016, the Social Security System granted approximately 205,000 benefits due to spinal disorders, considering the same ICD-10 classifications adopted in this study. Therefore, including the productivity losses would lead to a much higher expenditure and show a higher burden of spinal disorders to Brazilian society.

Fig. 1 Inpatient admissions among men and women, stratified by age-groups (values are presented in % of the total number of admissions) (Brazil, 2016)

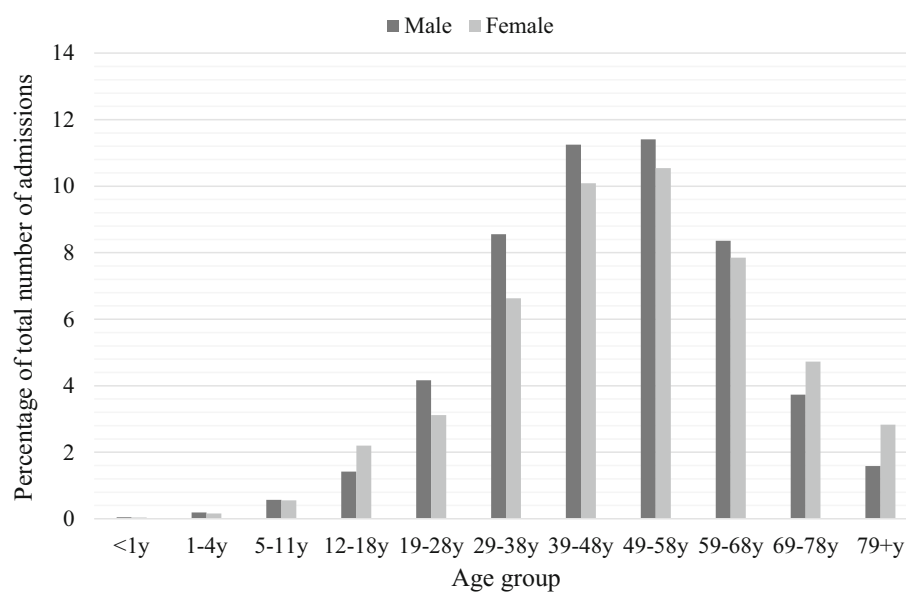


Fig. 2 Distribution of **a** inpatient (hospital) and **b** outpatient (ambulatory) direct costs among men and women, stratified by age groups (Values are presented in % of the direct cost)

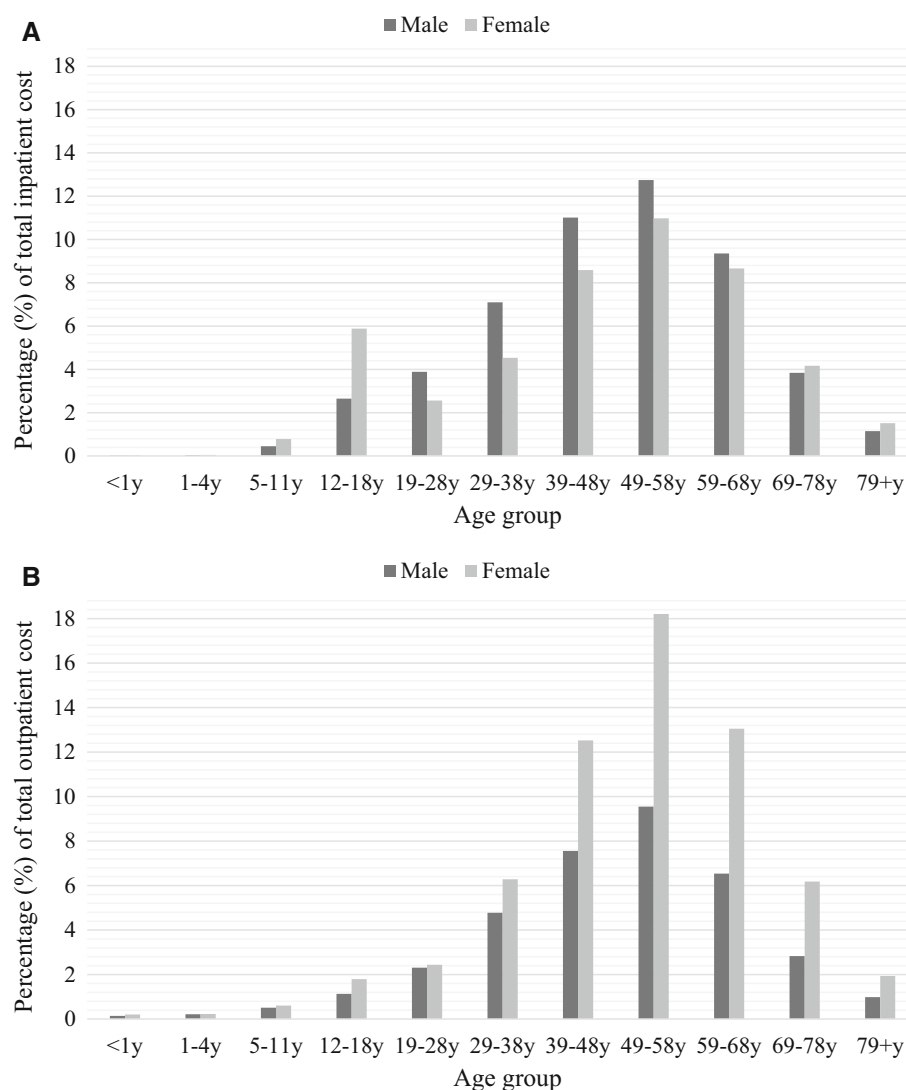


Table 3 Data of inpatient period (in days), and cost ratios among men and women with spinal disorders, stratified by age-groups. Brazil, 2016

	Age-groups (years)										
	< 1	1–4	5–11	12–18	19–28	29–38	39–48	49–58	59–68	69–78	> 79
M/F (number of men for 100 women)	103	104	104	102	99	96	94	90	87	78	63
Inpatient period (in days):											
Men	171	401	1196	4113	11,083	19,954	27,193	31,107	26,679	11,648	4670
Women	105	349	1418	5462	7078	13,169	20,056	23,491	19,667	13,204	8212
TCR (US\$/1000 people):											
Men	35.4	14.1	29.4	111.9	116.2	286.9	540.8	888.3	1056.6	845.1	651.6
Women	52.7	16.1	45.3	236.1	90.3	238.5	548.1	997.0	1187.8	972.4	645.5
I/O costs (ratio):											
Men	0.2	0.2	1.2	3.0	2.2	1.9	1.9	1.7	1.9	1.8	1.5
Women	0.2	0.3	1.7	4.3	1.4	0.9	0.9	0.8	0.9	0.9	1.0
Cost per hospital admission (in US\$):											
Men	503	211	842	2002	1001	890	1050	1198	1200	1105	780
Women	834	340	1515	2870	882	734	913	1117	1183	945	575

TCR total cost ratio in US\$ (inpatient + outpatient costs, per 1000 people), *I/O costs* inpatient-to-outpatient costs (ratio between inpatient (*I*) and outpatient (*O*) costs), *M/F* ratio between the male population divided by the female population (values presented as number of men for 100 women)

We found an overall inpatient-to-outpatient cost ratio of 1.4, which could be interpreted as a relative equilibrium between inpatient and outpatient care and a fair amount of investment in outpatient facilities (Adam and Evans 2006). Data from previous studies are heterogeneous, with inpatient-to-outpatient ratios ranging from approximately 2 to 19 (Adam and Evans 2006; Lambeek et al. 2011; Maniadakis and Gray 2000), which could be attributable to differences in gross domestic product per capita, type of insurance (public or private), occupancy rate, and hospital sizes within countries (Adam and Evans 2006). Nevertheless, it is recognized that outpatient care has advantages, such as saving hospital capacity for more complex patients and reducing costs (Vitikainen et al. 2010). Outpatient services could help avoid hospitalization-related costs, shorten operation times, and lower complication rates of spinal surgery (Ahn et al. 2016) due to time-saving and more effective preoperative procedures (Trentman et al. 2010). Additionally, the outpatient setting led to fewer complications after lumbar discectomy, in which patients were more likely to have a decreased rate of urinary catheterization and shorter exposure to pathogens (Pugely et al. 2013). Therefore, the inpatient-to-outpatient cost ratio in Brazil in 2016 was compelling and warrants further investigation to elucidate the trend pattern over a wider period of time. We recommend that future studies investigate the impact of outpatient services on the efficiency and costs (Vitikainen et al. 2010) of inpatient spinal care in Brazil.

We found that dorsalgia and intervertebral disk disorders represented approximately 70% of hospital admissions and 65% of direct costs. This was expected, as previous Brazilian studies demonstrated a sustained and high prevalence of spinal disorders throughout the years (Depintor et al. 2016; Fernandes and Carvalho 2000; Zanuto et al. 2015). Moreover, our findings are similar to other countries and support the worldwide health burden due to spinal disorders (Asklof et al. 2014; Lambeek et al. 2011; Wenig et al. 2009). It is worth noting that inpatient and outpatient costs were higher in the south and southeast regions, which are more developed, industrialized, and densely populated. Therefore, given that the most affected age-group was in the economically active range, the impacts of inherent risk factors, such as increased occupational physical demand (Bevan 2015), might explain our findings. Men aged between 19 and 68 years had slightly more inpatient days and more hospital admissions compared to women. There were fewer men than women in these age-groups (ratio M/F), indicating that the relative expense for men was higher. This finding may be explained by epidemiological and socioeconomic aspects. For instance, the number of disability benefit claims and the amount of days off work due to back pain are higher for men in Brazil (Meziat and Silva 2011; Vieira et al. 2011). Also, it is usually assumed that men seek health assistance later and with a worsened clinical condition (Galdas et al. 2005). Thus, it might be speculated that men needed more complex and costly actions during inpatient care. However, we found that the expenses with women were higher during

the outpatient care compared to men. Previous studies reported that women tend to use outpatient services more frequently than men (Frayne et al. 2007; Luo et al. 2004). It is possible to assume that associated conditions that are intrinsic to women (e.g., pregnancy) and others frequently attributed to women (e.g., child care) could have influenced these different patterns of healthcare use (Mustard et al. 1998). This is an interesting finding that requires further investigation to elucidate whether women are treated differently than men despite presenting with the same health problem.

Procedures adopted as the main reason for hospital admissions were mostly the treatment of complications after surgical or clinical procedures, surgery (e.g., arthrodesis/vertebral fusion and discectomy), and drug treatment for severe pain. The use of more complex interventions, such as vertebral fusion, is increasing with the associated rise in costs and surgical complications (Balagué et al. 2012). There is a current debate regarding the efficacy of operative procedures in back pain (Koes et al. 2006), and the results from systematic reviews show limited or insufficient evidence that spinal surgery has a positive effect on clinical outcomes for lumbar spinal stenosis (Zaina et al. 2016) and lumbar spondylosis (Gibson and Waddell 2005). Furthermore, a recent systematic review did not identify any evidence comparing surgical to non-surgical interventions for scoliosis with severe curvature (Bettany-Saltikov et al. 2015). In the context of conservative treatments, physical therapy interventions were widely employed, but mainly in the outpatient setting, totaling approximately 10 million sessions in 2016. Physical therapy had a substantial share of the direct costs (20%). Our findings are similar to a systematic review that demonstrated that physical therapy is responsible for the highest share of direct costs, with an average of 17% (Dagenais et al. 2008). This is an interesting finding because physical therapy interventions focused on spinal disorders are widely recommended by international clinical guidelines (NICE 2016, 2017; Stochkendahl et al. 2018). Interventions such as exercise therapies are considered beneficial, and there is low (Stochkendahl et al. 2018), moderate (NICE 2016), and strong (Delitto et al. 2012) evidence that they improve outcomes related to quality of life, pain, and disability. They have also been deemed useful for improving fatigue, stiffness, and joint mobility, although the quality of the evidence for spondyloarthritis was low (NICE 2017). Nonetheless, future studies are warranted to evaluate whether conservative interventions are being implemented or whether implementation could be improved. It would also be important to determine whether these interventions reduce costs and the number of spinal surgeries.

An interesting result was the high amount of routine diagnostic imaging adopted in 2016, which represented roughly 18% of the total healthcare expenditure. It is worth mentioning that the costs are an underestimation of the real costs, as diagnostic imaging is also included in the costs of inpatient care. Nevertheless, our findings were higher compared to those reported by other studies, ranging from approximately 1 to 7% of the direct costs (Dagenais et al. 2008; Lambeek et al. 2011; Wieser et al. 2011). This is relevant and comprises decision-making implications, as international clinical guidelines rather discourage the frequent use of diagnostic imaging (NICE 2016). A considerable amount of MRI and CT scans were used for low back pain or sciatica. It is important to note that the information included in our study does not allow inferences on the exact decision-making flow and patient context that determined the use of diagnostic imaging. Notwithstanding, the National Institute for Health and Care Excellence (NICE) guideline (NICE 2016) reported that there is no clear benefit for imaging all individuals with low back pain or sciatica. As a recommendation, the NICE guideline suggests alternative diagnoses, particularly in light of new or altered symptoms. Additionally, imaging should only be carried out in the presence of red flags and/or if the procedure will considerably change the management (e.g., if epidural or spinal surgery is being considered) and not in response to a diagnostic uncertainty (Balagué et al. 2012; Koes et al. 2006; NICE 2016). Therefore, it is suggested that specific actions might be adopted to assess the decision-making process for using diagnostic imaging in back pain patients in Brazil in light of up-to-date international guidelines.

Our study has some limitations. First, we might have underestimated the direct costs related to spinal disorders, as the Brazilian Hospital and Outpatient System covers approximately 75% of all healthcare services, though this is a representative sample. Second, inherent limitations to cost-of-illness studies should also be considered. For instance, the poor reliability of specific diagnostics (ICD-10 categories) and problems related to the diagnosis during hospital admission due to the lack of information in the patient's medical records (Bittencourt et al. 2006) may have influenced our findings. Third, as private care and health insurance companies were not included in the present study, the direct costs of spinal disorders in Brazil could be higher.

Conclusion

Our study demonstrated that the direct healthcare costs of spinal disorders in the Brazilian public healthcare system in 2016 were considerable. Dorsalgia and intervertebral disk disorders accounted for approximately 70% of these costs.

A significant amount of financial resources was spent on diagnostic imaging, during both inpatient and outpatient care. This is a compelling finding given that international clinical guidelines recommend that the routine use of diagnostic imaging for back pain should be limited.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval The Institutional Research Ethics Committee granted approval for the present study (Protocol No. 1.969.372; 16/03/2017).

Informed consent Informed consent was not needed, as public secondary data were used for the analysis.

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