

EPIDEMIOLOGICAL PROFILE OF PATIENTS WITH TRAUMATIC SPINAL FRACTURE

PERFIL EPIDEMIOLÓGICO DOS PACIENTES COM FRATURA TRAUMÁTICA DE COLUNA VERTEBRAL

PERFIL EPIDEMIOLÓGICO DE LOS PACIENTES CON FRACTURA TRAUMÁTICA DE LA COLUMNA VERTEBRAL

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ABSTRACT

Objective: To analyze the epidemiological profile of patients with spinal fractures and the characteristics of the population at risk attended at a university hospital. **Methods:** The study population is composed of 202 patients diagnosed and treated for vertebral fracture due to trauma. The variables were correlated with each other and the correlations with $p < 0.05$ were considered statistically significant. **Results:** The ratio of incidence of trauma between the sexes was 3:1 for males. The mean age was 37 years and the age group with the highest incidence was between 20 and 39 years. Traffic accidents were the most frequent mechanism (51.2%) and secondly, falls (33.2%). There was a statistical correlation between trauma mechanisms to age group and region of the spine. The first lumbar vertebra (L1) fracture alone accounted for 21.5% of all cases studied associated with the fall mechanism. Spinal cord injury was recorded in 33.7% of the individuals in the sample. A total of 57.3% of the patients were submitted to surgical treatment and 41.7% to the conservative treatment. The mean hospitalization time was 15 days. **Conclusions:** Spinal fractures are important determinants of morbidity and mortality in the population with a major impact on economically active individuals, especially males. They are directly associated to traffic accidents in the young population and to falls in the higher age brackets. Primary prevention of trauma is the main mechanism for change in this scenario.

Keywords: Spinal injuries; Epidemiology; Spinal fractures; Spine; Accident prevention.

RESUMO

Objetivo: Analisar o perfil epidemiológico dos pacientes com fratura da coluna vertebral e as características da população de risco atendida em um hospital universitário. **Métodos:** A população do estudo é composta de 202 pacientes diagnosticados e tratados por fratura de vértebras devido a trauma. As variáveis foram correlacionadas entre si e consideradas estatisticamente significantes as correlações com $p < 0,05$. **Resultados:** A relação da incidência do trauma entre os sexos foi 3:1 para o sexo masculino. A média de idade foi 37 anos e a faixa etária de maior incidência entre 20 e 39 anos. Os acidentes de trânsito foram o mecanismo de mais frequente (51,2%) e em segundo lugar, as quedas (33,2%). Houve correlação estatística dos mecanismos de trauma conforme faixa etária e região da coluna vertebral. A fratura de primeira vértebra lombar (L1) representou sozinha 21,5% de todos os casos estudados associados ao mecanismo queda. A lesão raquimedular foi registrada em 33,7% dos indivíduos da amostra. Um total de 57,3% dos pacientes foi submetido a tratamento cirúrgico e 41,7% ao conservador. O tempo de internação médio foi de 15 dias. **Conclusões:** As fraturas de coluna são importantes determinantes de morbidade e mortalidade da população, com impacto principal nos indivíduos economicamente ativos, sobretudo do sexo masculino. Estão diretamente associadas a acidentes de trânsito na população jovem e a quedas nas faixas etárias maiores. A prevenção primária do trauma é o principal mecanismo para mudança desse cenário.

Descritores: Traumatismos da coluna vertebral; Epidemiologia; Fraturas da coluna vertebral; Coluna vertebral; Prevenção de acidentes.

RESUMEN

Objetivo: Analizar el perfil epidemiológico de los pacientes con fractura de la columna vertebral y las características de la población de riesgo tratada en un hospital universitario. **Métodos:** La población del estudio está compuesta de 202 pacientes diagnosticados y tratados por fractura de vértebras debido a trauma. Las variables se correlacionaron entre sí y se consideraron estadísticamente significativas las correlaciones con $p < 0,05$. **Resultados:** La proporción de incidencia del trauma entre los sexos fue 3:1 para el sexo masculino. La edad media fue de 37 años y el rango de edad de mayor incidencia fue entre 20 y 39 años. Los accidentes de tránsito fueron el mecanismo más frecuente (51,2%) y en segundo lugar, las caídas (33,2%). Se observó correlación estadística entre los mecanismos de trauma según el grupo de edad y la región de la columna vertebral. La fractura de la primera vértebra lumbar (L1) sola representó el 21,5% de todos los casos estudiados asociados al mecanismo de caída. La lesión de la médula espinal se registró en el 33,7% de los individuos de la muestra. Un total de 57,3% de los pacientes fueron sometidos a tratamiento quirúrgico y el 41,7% al conservador. La duración promedio de la estancia hospitalaria fue de 15 días. **Conclusiones:** Las fracturas de columna son determinantes importantes de morbilidad y mortalidad con impacto principal en los individuos económicamente activos, sobre todo del sexo masculino. Se asocian directamente con los accidentes de tránsito en la población joven y a las caídas en los rangos de edad mayores. La prevención primaria del trauma es el principal mecanismo para cambiar este escenario.

Descritores: Traumatismos vertebrales; Epidemiología; Fracturas de la columna vertebral; Columna vertebral; Prevención de accidente.

Study conducted in the Spine Surgery Unit, Orthopedics and Traumatology Service, Hospital de Clínicas, Universidade Federal de Uberlândia (HC-UFU), Uberlândia, Minas Gerais, Brazil.
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INTRODUCTION

Although spinal fractures account for only a small percentage of all fractures,¹ their occurrence has significant socioeconomic impacts, even more serious in patients who are victims of radiculomedullary trauma (RMT). The functional independence, family dynamics, and quality of life of these patients are compromised.^{2,3}

Studies in different countries show that there is a higher incidence of spinal fractures in the young male population. In addition, they are mainly associated with traffic accidents and falls from heights.^{4,5} The same epidemiological pattern is maintained in patients with spinal cord injuries, with an annual incidence of approximately 19.4 patients per million inhabitants in France, 10.7 in Germany, 38.4 in the USA, and 21.0 in Brazil.⁶⁻⁸ There is dearth of epidemiological studies about spinal fractures in Brazil.

Patients with spinal fractures have prolonged hospitalizations and high immediate treatment and long-term follow-up costs.⁹ As a consequence, great expenses are generated for national health and social security systems.

The estimated cost for an individual with spinal injury ranges from \$1.5 million for incomplete paraplegia to \$3 million for complete quadriplegia.¹⁰ A spinal fracture is also a well-established predictor of subsequent new fractures of the spine in the same individual,^{11,12} with medical costs for patients with a new fracture during the first year of follow-up of \$5906 and €3670 in the USA and in Sweden, respectively.¹³

Because there is a higher incidence in the economically active population, the economic impacts increase. There are reductions in functional capacity, rehabilitation challenges, difficulties in reentering the work force, and a reduced life expectancy, especially from respiratory complications.¹⁴

The objective of this study was to analyze the epidemiological profiles of patients with spinal fractures and the characteristics of the population at risk in a Brazilian high-complexity university hospital (UH) that is a regional reference for trauma located in the city of Uberlândia, MG. Included in the objective was a comparison of the study results with those of other studies conducted in other regions of Brazil and of the world.

METHODS

The study population was made up of 202 patients diagnosed with and treated for spinal fracture from trauma during the period from 2008 to 2014 at the Hospital Universitário da Universidade Federal de Uberlândia.

The data were obtained from medical records. Therefore, it was a retrospective, cross-sectional study. Even though it did not involve direct interaction with the patients or disclosure of personal information, the study was submitted to and approved by the Institutional Review Board under registration CAAE 15047713.0.0000.5152.

Variables such as sex, age, trauma mechanism, affected region and vertebra, association with RMT, treatment of choice (surgery X conservative), and hospitalization time were correlated with each other. Correlations with $p < 0.05$ were considered to be statistically significant. The statistical analyses were conducted using IBM SPSS 22 software. The principal analyses were of the Chi-square type.

RESULTS

The trauma incidence ratio between the sexes was 3:1, with 75.2% of the subjects being male and 24.8% female. The average age was 37 years, the median age was 35 years, and the minimum and maximum ages were 9 and 77 years, respectively. The highest incidence was in the 20 to 39 years of age range with 48% of the cases. Traffic accidents were the trauma mechanism with the highest frequency at 51.2% and, in second place, falls at 33.2% (Table 1).

In relation to the region of the fracture, the distribution was similar for cervical (32.3%), thoracic (30.4%), and lumbar (32.8%) regions. Fractures of the first lumbar vertebra (L1) alone accounted for 21.5% of the total cases studied.

A total of 57.3% underwent surgical treatment and 41.7% were submitted to conservative treatment. The average hospitalization time was 15 days, with a minimum of 1 and a maximum of 180 days. Of the 202 patients, 33.7% presented radiculomedullary trauma (RMT)

associated with the spinal fracture (Table 1). RMT was diagnosed in 26.2% of the cervical, 40.3% of the thoracic, and 38.5% of the lumbar spinal fractures. There was no statistical difference between the regions and the occurrence of RMT ($p > 0.05$) (Table 2).

When we analyzed the relationship between the occurrence of RMT and the trauma mechanisms, we observed that 31.6% of automobile accidents, 31.9% of motorcycle accidents, and 38.5% of falls involved neurological deficit. (Table 2) However, it was not possible to infer that a particular mechanism favors the occurrence of RMT ($p > 0.05$).

Regarding the association between RMT and sex, it was found that 33.9% of the men had RMT, while 36% of the women presented neurological deficit. There was no statistical difference between the groups ($p > 0.05$).

In relation to age, the peak of RMT was in the 20 to 39 years of age group with 42.6% of the total cases of RMT, followed by the 40-59 years of age group with 41.1% of the total, with $p > 0.05$ between the groups. There was also no statistical difference in the occurrence of RMT between the groups when separated using the median age (35 years) as the cutoff.

The most common trauma mechanisms were falls (33.2%), car accidents (28.2%), motorcycle accidents (23.3%), and others (15.3%). These four large groups were created for statistical purposes.

More specifically, in the "falls" group, 4.5% were falls from a standing position, while the rest were "from other heights". Diving in shallow water, gunshot wounds, and being run over were included within the "other traumas" group, with 3.9%, 4.4%, and 3.9% of the cases, respectively.

We observed changes in the distribution of the most frequent trauma mechanisms by age group. For example, the 20-39 years of age group, which had the peak incidence of fractures in the population, had traffic accidents as the principal protagonist, made up of automobile (36.1% in the group and 17.6% of the total) and motorcycle (30.9% in the group and 13.5% of the total) accidents. In the 40-59 years of age group, falls played the major role among trauma mechanisms with 54.7% in the group and 17.1% of total fractures (Figure 1). All these differences were statistically significant ($p < 0.05$).

Table 1. Characteristics of the population, trauma mechanisms, spine region of the fracture, and hospitalization time.

Variable	Male	Female	Both
Sex	75.2%	24.8%	100%
Age (years)			
Mean	38	35	37
Minimum	12	9	9
Maximum	76	77	77
Age range			
0-19	6.6%	14%	8.4%
20-39	47.4%	52%	48.5%
40-59	34.2%	20%	30.7%
> 60	11.8%	14%	12.4%
Trauma mechanism			
Automobile accident	23.3%	44.9%	28.5%
Motorcycle accident	23.8%	22.4%	23.5%
Fall	35.8%	22.4%	32.5%
Other traumas	17.2%	10.2%	15.5%
Region			
Cervical	34.2%	31.3%	33.5%
Thoracic	30.8%	35.4%	32%
Lumbar	34.9%	33.3%	34.5%
Hospitalization time			
Overall average	17	11	15
Surgical	19	11	18
Conservative	11	10	11

Table 2. Distribution of RMT by vertebral spine region and trauma mechanism.

RMT/Region ($p = 0.225$)	Cervical	Thoracic	Lumbar
Yes	26.2%	40.3%	35.8%
No	73.8%	59.7%	64.2%
RMT/Mechanism ($p = 0.767$)	Automobile accident	Motorcycle accident	Fall
Yes	31.6%	31.9%	38.5%
No	68.4%	68.1%	61.5%

Among males, falls were the most frequent (36.6%), followed by motorcycle accidents (23.5%), and car accidents (22.9%). Among females, 47.1% of the traumas resulted from car accidents, while motorcycle accidents and falls had similar frequencies at 21.6% each (Figure 2). We observed a statistically significant difference between the sexes and the trauma mechanisms ($p < 0.05$).

There was no statistically significant difference found between the sexes when analyzing the mechanisms and age groups. For further analysis, we divided the population into two groups using the median age (35 years) as the cutoff. The mechanisms were divided into two groups (traffic accidents and falls) and we analyzed them in relation to differences between the sexes.

Among men younger than the median age, 56.8% had fractures due to traffic accidents (car and motorcycle). After this age, fractures of this type decreased to 36.7%, while falls prevailed at 51.9%. All these differences were statistically significant.

Among the women younger than 35 years of age, traffic accidents predominated (81.5%). In the group above 35, traffic accidents continued to predominate (51.4%), but there was a significant increase in falls (33.3%). The statistical significance was considered to be borderline ($p = 0.077$).

A statistically significant correlation was found between the trauma mechanism and the region of the spinal fracture. For example, 60% of the fractures of the lumbar spine resulted from falls. On the other hand, traffic accidents were responsible for most of the cervical (80.4%) and thoracic (63.5%) spinal fractures. This association continued to be significant even when the traffic accidents were analyzed in two groups separately by automobile and motorcycle accidents (Figure 3).

The most frequently fractured vertebrae in the cervical, thoracic, and lumbar regions were C5, T12, and L1, respectively. Considering the three regions, the first lumbar vertebra accounted for 21.5% of all fractures, followed by T12 (12.5%) and C5 (12%) (Figure 4).

In relation to the distribution of fractured vertebrae and trauma mechanisms, the importance of "falls" in lumbar vertebral fractures

stands out, especially in the thoracolumbar transition (T12, L1, and L2). More precisely, falls were responsible for 56% of the fractures of T12, 58.1% of those of L1, and 69.2% of those of L2 (Figure 5).

Automobile and motorcycle accidents stand out as the principal trauma mechanisms of the cervical spine above the fifth vertebra (C5), especially in the upper cervical spine (C1-C3), where traffic accidents are the cause of 66.7% of C1 fractures, 80% of C2 fractures, and 83.3% of C3 fractures and falls were not responsible for any injuries at this level (Figure 5).

There was no statistical correlation between the number of vertebral fractures and the existence of RMT, the mechanism, the age range, or sex ($p > 0.05$).

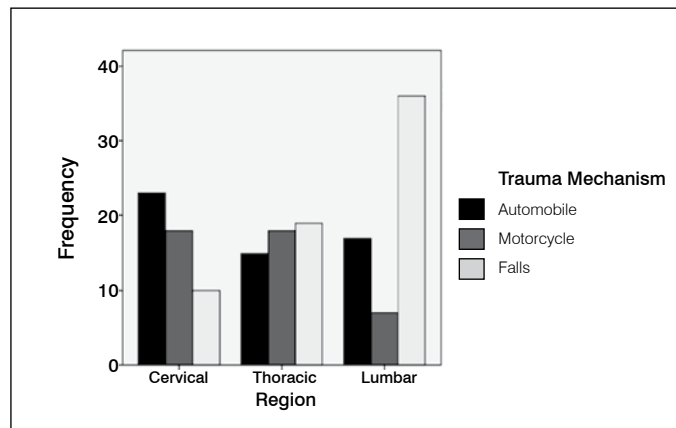


Figure 3. Trauma Mechanism and Spinal Region.

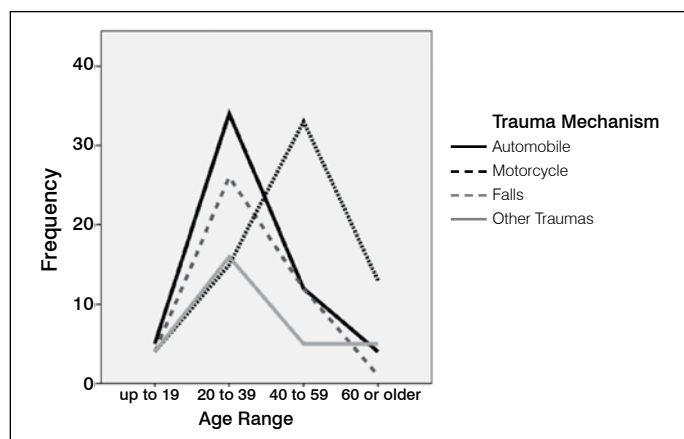


Figure 1. Distribution of Trauma Mechanisms by Age Range.

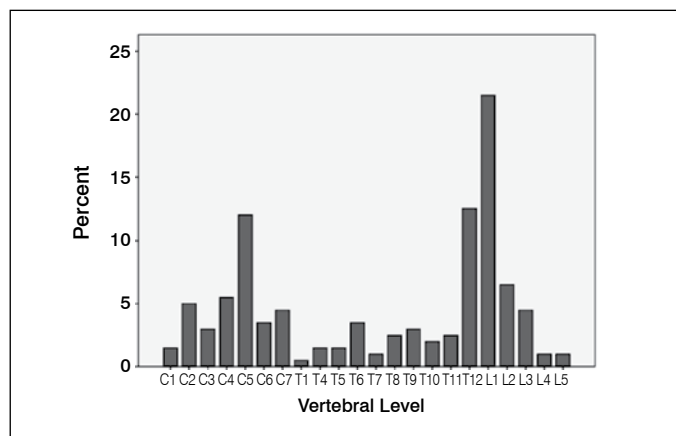


Figure 4. Distribution by Frequency of Fractured Vertebrae.

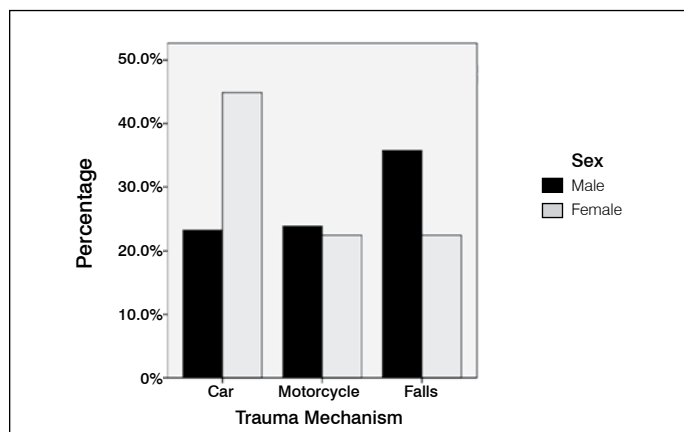


Figure 2. Trauma Mechanisms by Sex.

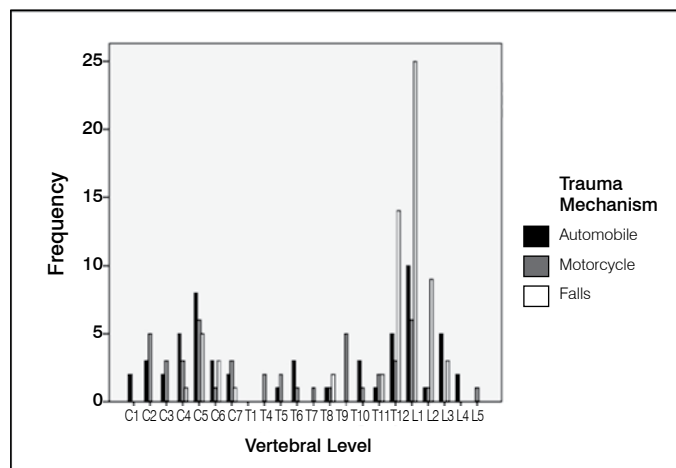


Figure 5. Vertebrae and Trauma Mechanisms.

DISCUSSION

Spinal fractures predominated in the 20 to 39 years of age range, with a peak incidence at 37 years (Table 1) in concordance with already published epidemiological studies.^{4,5,7} This range practically coincides with the peak of the economically active population (EAP) in Brazil, which is from 25 to 49 years of age (60.9% of the EAP in 2015).¹⁵ Thus, spinal fractures have a great economic impact, since the group with the highest incidence is exactly that of young economically active individuals.

Distribution by sex in this age group also agrees with the 2015 EAP, with 53.2% men and 46.8% women. Although men and women have similar proportions of involvement in the labor market, the risk of death at work is a possible way to understand the occupational differences between the sexes. Although it is not possible to define the factors that lead to the occupational differences by sex, it is possible to estimate the impact of the effect: the difference in physical risk among the occupations accounts for around a quarter of this segregation.¹⁶

Thus, the 3:1 ratio of fractures in men in relation to women found in this (Table 1) and in other studies,^{4,5,17,18} is probably more related to the type of work performed according to sex than to the relative quantity of men versus women. To date, there are no published scientific studies that test this hypothesis in spinal fractures and new studies are necessary for statistical confirmation.

The incidence of spinal cord injury in spinal fractures observed in different studies ranges from 5.4 to 27.6%.^{19,20} Chu et al.¹⁹ conducted a study involving 51,641 patients with spinal lesions between 2000 and 2003 in which they found an incidence of neurological deficit in 27.6% of the patients. This value was close to, although less than, the 33.7% observed in this study (Table 1). The authors believe that the high incidence of RMT is due to the fact that this work was conducted in a hospital that is a regional reference for high-complexity traumas.

The frequency of RMT was higher in fractures of the thoracic spine and also when the mechanisms were "falls" (Table 2). However, there was no statistical correlation between these variables. Thus, it could not be confirmed that there was a higher risk of RMT from thoracic spinal fractures or when the trauma resulted from a fall. RMT also had no significant correlation with sex, age range, or the median age of the population.

The main mechanisms for spinal fractures were falls, car accidents, motorcycle accidents, falls from a standing position, diving in shallow

water, gunshot wounds, and being run over (Table 1). Violent causes continued to be more accentuated in developing countries than in developed countries.^{8,21}

There was a statistical correlation between the different trauma mechanisms and the three spinal regions analyzed (Figure 5). The predominance of fractures of the first lumbar vertebra in association with "falls", as well as that of fractures of the upper cervical spine with traffic accidents, was clear.

In the group between 20 and 39 years of age, that with the peak incidence of fractures in the population, the main protagonist was traffic accidents, specifically automobile accidents. In the group between 40 and 59 years of age, falls assume the main role among trauma mechanisms (Figure 1) in agreement with other epidemiological studies.⁵ Thus, with advancing age and the biomechanical changes in the spine, there is a concomitant increase in fractures from falls and a decrease in fractures from traffic accidents as compared to the younger populations.²² The statistical difference between the age groups is a solid piece of data for driving awareness and prevention campaigns.

We found a statistical difference between sex and trauma mechanism (Figure 2). When sex was analyzed using median age as the cutoff point, men and women up to 35 years of age had a higher probability of suffering spinal fractures due to traffic accidents. In women older than 35, this tendency was maintained, while in men, spinal injuries resulted mainly from falls. Future studies are necessary to clarify the relationship between sex, age, and trauma mechanism.

CONCLUSION

Spinal fractures are important determinants of morbidity and mortality in the population and, considering that the peak incidence occurs in economically active persons, direct and indirect costs are higher. The main measure of impact in this scenario is prevention, given that external causes (trauma) are the most important mechanisms. For this reason, new epidemiological studies are needed to better define the regional prevention priorities.

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REFERENCES

- van Staa TP, Dennison EM, Leufkens HG, Cooper C. Epidemiology of fractures in England and Wales. *Bone*. 2001;29(6):517-22.
- Migliorini CE, New PW, Tonge BJ. Quality of life in adults with spinal cord injury living in the community. *Spinal Cord*. 2011;49(3):365-70.
- Blanes L, Carmagnani MI, Ferreira LM. Quality of life and self-esteem of persons with paraplegia living in São Paulo; Brazil. *Qual Life Res*. 2009;18(1):15-21.
- Wang H, Zhang Y, Xiang Q, Wang X, Li C, Xiong H, et al. Epidemiology of traumatic spinal fractures: experience from medical university-affiliated hospitals in Chongqing; China; 2001-2010. *J Neurosurg Spine*. 2012;17(5):459-68.
- Leucht P, Fischer K, Muhr G, Mueller EJ. Epidemiology of traumatic spine fractures. *Injury*. 2009;40(2):166-72.
- Rahimi-Movaghar V, Sayyah MK, Akbari H, Khorramirouz R, Rasouli MR, Moradi-Lakeh M, et al. Epidemiology of traumatic spinal cord injury in developing countries: a systematic review. *Neuroepidemiology*. 2013;41(2):65-85.
- Botelho RV, Albuquerque LDG, Bastianello Junior R, Arantes Junior AA. Epidemiology of traumatic spinal injuries in Brazil: systematic review. *Arq Bras Neuroci*. 2014;33(2):100-6.
- Lee BB, Cripps RA, Fitzharris M, Wing PC. The global map for traumatic spinal cord injury epidemiology: update 2011; global incidence rate. *Spinal Cord*. 2014;52(2):110-6.
- French DD, Campbell RR, Sabharwal S, Nelson AL, Palacios PA, Gavin-Dreschnack D. Health care costs for patients with chronic spinal cord injury in the Veterans Health Administration. *J Spinal Cord Med*. 2007;30(5):477-81.
- Krueger H, Noonan VK, Trenaman LM, Joshi P, Rivers CS. The economic burden of traumatic spinal cord injury in Canada. *Chronic Dis Inj Can*. 2013;33(3):113-22.
- Ross PD, Davis JW, Epstein RS, Wasnich RD. Pre-existing fractures and bone mass predict vertebral fracture incidence in women. *Ann Intern Med*. 1991;114(11):919-23.
- Black DM, Arden NK, Palermo L, Pearson J, Cummings SR. Prevalent vertebral deformities predict hip fractures and new vertebral deformities but not wrist fractures. Study of Osteoporotic Fractures Research Group. *J Bone Miner Res*. 1999;14(5):821-8.
- Lindsay R, Burge RT, Strauss DM. One year outcomes and costs following a vertebral fracture. *Osteoporos Int*. 2005;16(1):78-85.
- Schilero GJ, Radulovic M, Wecht JM, Spungen AM, Bauman WA, Lesser M. A center's experience: pulmonary function in spinal cord injury. *Lung*. 2014;192(3):339-46.
- Instituto Brasileiro de Geografia e Estatística (IBGE). Indicadores IBGE: pesquisa mensal de emprego; Abril 2015. Rio de Janeiro: IBGE; 2015. p. 1-29.
- DeLeire T, Levy H. Worker Sorting and the Risk of Death on the Job. *Journal of Labor Economics*. 2004;22(4):925-53.
- Chamberlain JD, Deriaz O, Hund-Georgiadis M, Meier S, Scheel-Sailer A, Schubert M, et al. Epidemiology and contemporary risk profile of traumatic spinal cord injury in Switzerland. *Inj Epidemiol*. 2015;2(1):28.
- Kristinsdottir EA, Knutsdottir S, Sigvaldason K, Jonsson H Jr, Ingvarsson PE. Epidemiology of Spinal Cord Injury in Iceland from 1975 to 2014. *Laeknabladid*. 2016;102(11):491-6.
- Chu D, Lee YH, Lin CH, Chou P, Yang NP. Prevalence of associated injuries of spinal trauma and their effect on medical utilization among hospitalized adult subjects—a nationwide data-based study. *BMC Health Serv Res*. 2009;9:137.
- El-Faramawy A, El-Menyar A, Zarour A, Maull K, Riebe J, Kumar K, et al. Presentation and outcome of traumatic spinal fractures. *J Emerg Trauma Shock*. 2012;5(4):316-20.
- Ovalle FAT, Rios EC, Balbuena FR. Incidence and functional evolution of traumatic injuries of the spine. *Coluna/Columna*. 2014;13(3):223-7.
- Wang H, Xiang L, Liu J, Zhou Y, Ou L. Gender differences in the clinical characteristics of traumatic spinal fractures among the elderly. *Arch Gerontol Geriatr*. 2014;59(3):657-64.