https://doi.org/10.52889/1684-9280-2025-76-1-56-62

Original article

The financial burden of traumatic spinal cord injuries in the Republic of Kazakhstan

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Abstract

Objective of the study: The aim was to identify the amount of expenditure the Republic of Kazakhstan incurs to maintain and improve the health and physical well–being of individuals with spinal cord injuries.

Methods. The evaluation was conducted based on three indicators: the amount of funds saved for reduced hospitalization, disability, and mortality. The analyzed period: 2018–2022.

Results. Over the analyzed period, the economic loss from the hospitalization of patients with traumatic spinal cord injuries amounted to approximately 800 million tenge. Taking into account secondary health conditions, the government spends an additional average of 13.6±0.4%. The total economic loss to the state amounted to 10 598 376 937 tenge, and from mortality, 1 111 907 729,3 tenge. Overall, over the past 5 years, considering hospitalization, disability, and mortality from spinal cord injuries, the economic loss to the state reached 12 620 410 304,6 tenge.

Conclusions. Spinal cord injuries impose significant financial burdens, which are not solely due to increased healthcare system expenditures but also affect the patients themselves. Moreover, they reduce the quality of life of the patients (disability, reduced working capacity, etc.).

Keywords: financial burden, economic loss, spinal cord injuries.

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J Trauma Ortho Kaz 76 (1) 2025: 56-62
Recieved: 25-01-2025
Accepted: 27-02-2025

Introduction

Over the past decade, there has been an increase in the incidence and mortality from spinal cord injuries and their consequences, which impose a social and economic burden on healthcare systems worldwide, affecting patients' quality of life and their life expectancy [1]. Despite advancements in medicine, the treatment and care of individuals with spinal cord injuries remain a significant challenge for society.

According to global estimates, in 2021, approximately 15,4 million people were living with spinal cord injuries, resulting in over 4,5 million years of life lived with disability [2].

Based on «The Global Burden of Diseases, Injuries, and Risk Factors» study, between 1990 and 2019, the global prevalence of spinal cord injuries increased by 81,5% (from 74,2 to 87,1), incidence rose by 52,7% (from 30,3 to 69,8), and YLDs increased by 65,4% (from 56,3 to 76,0) [3,4,5].

In 2019, there were 20,6 million people worldwide living with spinal cord injuries (of which 175,000 were in Central Asia), with an incidence of 0,9 million new cases (600,000 in Central Asia) [3].

The financial burden of traumatic spinal cord injuries worldwide amounts to significant sums, which not only include the costs of providing qualified medical care but also the costs borne by society due to disability and mortality among individuals with spinal cord injuries. The financial damage from spinal cord injuries is often much higher than from any other injury [6].

In 2023, the global spinal cord injury treatment market was valued at $7,49 billion, and it is projected to reach $11,15 billion by 2031. This growth is attributed not only to the increasing incidence of cases but also to costs associated with advancements in regenerative medicine and new therapeutic strategies [7].

According to a systematic review by Hamid Malekzadeh et al. (2021), the average direct costs for inpatient care of patients with spinal cord injuries in Canada range from $39,330 for incomplete paraplegia to $138,620 for complete paraplegia. In Australia, the costs range from $42,600 for patients with paraplegia to $63,134 for patients with quadriplegia. In the United States, regardless of neurological status, the costs range from $92,220 to $337,400 [8].

Regarding healthcare expenditure as a percentage of GDP per capita, in Australia, it ranges from 68% to 110%, in Canada, from 47% to 73%, in the United States, from 281% to 590%, and in low - and middle-income countries from 12% to 123%.

A study conducted by Brian Chun-Fai Chan et al. (2019) on the lifetime cost of spinal cord injury treatment funded by public sources (direct costs) in Canada revealed that the net lifetime cost for spinal cord injury of 1,716 patients was $336,000 per person [9].

Additionally, significant costs are associated with indirect expenses. According to Yue Cao & James S. Krause (2020), the average annual indirect costs related to changes in employment and income before and after the injury amounted to $29,354 in 2019 [10].

Spinal cord injuries represent a substantial burden on healthcare systems. Both direct and indirect costs for individuals with spinal cord injuries are significant and accumulate throughout their lifetime [11]. Assessing the financial burden of spinal cord injuries is crucial for developing effective national healthcare policies and establishing prevention strategies.

The study aimed to identify the total amount of expenditures incurred by the Republic of Kazakhstan for maintaining and enhancing the health and physical well–being of individuals with spinal cord injuries.

Materials and Methods

The financial burden (both direct and indirect) was assessed based on three indicators: (1) hospitalization rates, (2) disability rates, and (3) mortality rates of patients with spinal cord injuries. The analyzed period was from 2018 to 2022. The evaluation was based on accumulated data from patients in Almaty who received specialized neurosurgical services.

For the assessment of economic damage related to hospitalization, the following parameters were defined: the number of spinal cord injuries and their consequences with ICD–10 codes (S12.0, S12.1, S12.2, S12.7, S13.0, S13.1, S14.0, S22.0, S22.1, S23.0, S23.1, S24.0, S24.1, S32.0, S33.0, S33.1, T91.1, T91.3); and the average cost of hospitalization in tenge.

The average cost of hospitalization was calculated as the sum of the tariff for inpatient care based on clinical cost groups (S12.0-S14.0; S22.0-S24.1, S32.0-S33.1) with consideration of the regression coefficient. The average cost of hospitalization in round-the-clock inpatient care for the analyzed ICD-10 conditions has been increasing annually: in 2018 - 211,594 tenge, in 2019 - 217,941.8 tenge, in 2020 - 279,684 tenge, in 2021 - 288,074.5 tenge, and in 2022 - 296,716.7 tenge [12].

Direct costs during hospitalization were calculated using the formula:

$$DC=nSCI*AH \quad (1)$$

Where, DC - direct costs; nSCI - number of spinal cord injuries; AH - average cost of hospitalization.

To calculate the indirect financial burden of spinal cord injuries, an assessment of economic damage due to disability and mortality was conducted.

The assessment of the economic damage from disability aimed to estimate the economic losses associated with payments for temporary disability benefits, disability pensions, the number of lost productive years of life (in monetary terms), the reduction in GDP production, and other related factors.

This indicator was calculated using the formula:

$$ED=VP*WD+(DP+SL+MC)*CD \quad (2)$$

Where, ED - economic damage; VP - value of the production lost due to disability (per working day); WD - number of working days lost due to disability; DP - daily disability pension; SL - daily social benefits; MC - daily medical care costs for the disabled person; CD - number of calendar days spent in disability.

The indicator of the value of production lost due to disability (per working day) corresponds to the monthly calculation indicator (MCI) for the reporting period (2018 - 2405 tenge; 2019 - 2525 tenge; 2020 - 2778 tenge; 2021 - 2917 tenge; 2022 - 3063 tenge).

The number of working days lost due to disability was calculated as the difference between the average pension age and the average age of a patient with a disability after a spinal cord injury, multiplied by the average number of working days over 11 months and the number of patients assigned disability of groups I and II. The calculations for

the number of lost working days were as follows: 2018 – 266,247 days; 2019 - 337,278 days; 2020 - 59,244 days; 2021 - 123,318 days; and 2022 - 303,480 days.

The cost of one calendar day spent on disability was determined as the sum of the disability pension, social benefits, and medical care costs for the disabled and amounted to the following for the government: 2018 - 3962 tenge; 2019 - 4325 tenge; 2020 - 4583 tenge; 2021 - 4868 tenge; and 2022 - 5761 tenge.

Another indirect indicator - the economic damage from mortality due to spinal cord injury, was calculated using the formula:

$$Ppvt(year)=NMC*CAL*(LE–AI)=209,378,795.3 \text{ tenge} \quad (3)$$

Where, NMC - number of mortality cases; LE - life expectancy; CAL - cost of 1 year of average life in tenge; AI - average indicator of the age range in Almaty.

The life expectancy in Almaty was as follows: 2018 - 75,54 years; 2019 - 75,45 years; 2020 - 74,02 years; 2021 - 71,97 years; and 2022 - 77,32 years [13].

The cost of 1 year of average life is typically taken as the average annual wage or per capita GDP, calculated based on the population employed in the economy during the financial year in Almaty. The cost for each year was: 2018 – 120,684 tenge; 2019 - 141,954 tenge; 2020 - 161,234 tenge; 2021 - 179,554 tenge; and 2022 - 214,122 tenge.

The age interval value was taken as the average indicator of the age range in Almaty, which was: 2018 - 37,77 years, 2019 - 37,22 years, 2020 - 37,01 years, 2021 - 35,98 years; and 2022 - 38,66 years. This approach is justified as it takes into account the average statistical value.

Results

Indicator: «Hospitalization». There was an increase in hospitalization from 799 to 971 cases (an 18,8% increase) during the period from 2018 to 2022. In 2020–2021, a decline in hospitalization rates was observed due to quarantine measures (COVID–19) implemented in the country.

Considering that only average standardized values (tariffs) were used in calculating the above indicators, the actual costs of providing care to individuals with spinal cord injuries are higher.

In 2018, the healthcare system spent 169,063,606.0 tenge on the primary hospitalization of individuals with spinal cord injuries, not accounting for the financial expenses borne by the patients themselves (on average, their share is up to 28,5%). The hypothetical total cost of hospitalization, considering all funding sources, could amount to 217,246,733.7 tenge.

In 2019, due to a slight increase in hospitalization cases (0,5%), the cost increased by 27,737,839.4 tenge (Table 1). In 2020, the hospitalization rate decreased due to the introduction of restrictive measures related to COVID-19, allowing the government to reduce its expenses to 174,802,500.0 tenge.

In 2022, the government spent up to 288,111,915.7 tenge on hospitalization. Considering all financial sources (with the patient's contribution at 17,9%), this amount rises to 339,683,948.6 tenge.

Table 1 - Costs of Primary Hospitalization for Individuals with Spinal Cord Injuries, 2018 – 2022, in Tenge

Period	Costs According to Clinical Cost Groups Tariff	Hypothetical Total Cost Indicator
2018	169 063 606,0	217 246 733,0
2019	196 801 445,4	245 411 402,4
2020	49 783 752,0	62 478 608,8
2021	101 690 298,5	127 621 324,6
2022	288 111 915,7	339 683 948,6
Total	805 451 017,6	992 442 017,2

Considering the costs associated with the treatment of Secondary health conditions, the costs for the «recovery» of individuals with spinal cord injuries increase.

Since 37.3±1.7% of all hospitalized patients experience secondary health conditions (and in some cases, two or more), an assessment of the burden was carried out using the average values based on the tariffs for each year.

The average cost in a 24–hour hospital for secondary health conditions according to ICD-10 was, on average, 85,695.7 tenge in 2018, 88,987.2 tenge in 2019, 97,548.6 tenge in 2020, 98,564.5 tenge in 2021, and 104,217.7 tenge in 2022 [12].

The state spends, on average, an additional 13.6±0.4% on medical services for secondary health conditions. Consequently, in 2018, the costs for the hospitalization of individuals with spinal cord injuries and secondary health conditions increased by 15,6% (26,308,578.9 tenge), in 2019 by 14,4% (28,386,916.8 tenge), in 2020 by 14.5% (7,218,596.4 tenge), in 2021 by 13.6% (13,799,030.0 tenge), and in 2022 by 10.05% (28,972,520.6 tenge) (Figure 1).

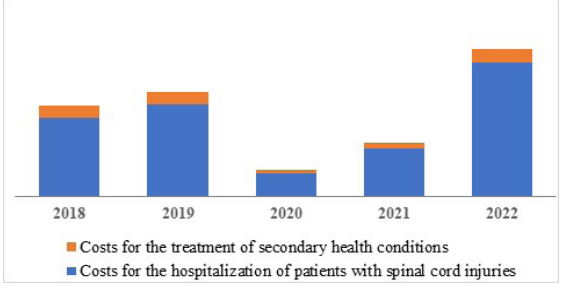

Figure 1 - Costs for the treatment of Secondary health conditions in patients with spinal cord injury

Considering that more than two–thirds of secondary health conditions can be preventable at the level of safe healthcare organization and timely response of specialists to the symptoms of Secondary health conditions, the financial burden could be reduced.

Indicator «Disability». The economic damage from the disability of individuals with spinal cord injuries (indirect costs), according to the calculations (Table 2), amounted to 3,532,379,040 tenge in 2022. Over the past 5 years, the total economic damage from disability due to spinal cord injuries for the state amounted to 10,598,376,937 tenge.

Table 2 - Economic Damage from Disability of Patients with Spinal Cord Injuries

Year	Cost of Undeveloped Product Due to Disability	Number of Work-days Lost Due to Disability	Disability Pension Amount per Day	Social Benefits per Day	Medical Care Costs per Day	Number of Calendar Days Spent on Disability	Economic Damage (Column. 2*3+ (4+5+6)*7)
1	2	3	4	5	6	7	8
2018	2405	4 671,0*57= 266 247.0	2 333	942	487	6 954,0*57= 396 378.0	2 210 773 671
2019	2 525	5 034,0*67= 337 278.0	2406	1 417	502	7 494,0*67= 502 098.0	3 026 200 800
2020	2 778	4 937,0*12= 59 244.0	2 619	1 417	547	7 350,0*12= 88 200.0	568 822 432
2021	2 917	4 743,0*26= 123 318.0	2 855	1 417	596	7 062,0*26= 183 612.0	1 260 200 994
2022	3 063	5 058,0*60= 303 480.0	3 111	2 000	650	7 530,0*60= 451 800.0	3 532 379 040

Indicator «Fatality». In 2018, the economic damage from fatality due to spinal cord injury amounted to 209,378,795.3 tenge.

*Ppv(t) (2018) = 46 * 120,684 * (75.54 – 37.77) = 209,378,795.3 tenge*

In 2019, the economic damage from fatality due to spinal cord injuries amounted to 238,783,622.5 tenge.

*Ppv(t) (2019) = 44 * 141,954 * (75.45 – 37.22) = 238,783,622.5 tenge*

In 2020, the economic damage from fatality due to spinal cord injury amounted to 65,639,973.7 tenge.

*Ppv(t) (2020) = 11 * 161,234 * (74.02 – 37.01) = 65,639,973.7 tenge*

In 2021, the economic damage from fatality due to spinal cord injury amounted to 151,095,385.7 tenge. During this period, quarantine measures due to COVID–19 were also observed, affecting the fatality rate.

*Ppv(t) (2021) = 23 * 179,554 * (71.97 – 35.98) = 151,095,385.7 tenge*

In 2022, the economic damage from fatality due to spinal cord injury amounted to 447,009,652.08 tenge.

*Ppv(t) (2022) = 54 * 214,122 * (77.32 – 38.66) = 447,009,652.1 tenge*

Thus, over the studied period, the total economic damage from fatality amounted to 1,111,907,729.3 tenge.

The financial burden of traumatic spinal cord injuries. The total economic damage to the state over the past 5 years, considering hospitalization, disability, and mortality from spinal cord injuries, amounted to 12,620,410,304.6 tenge (Figure 2).

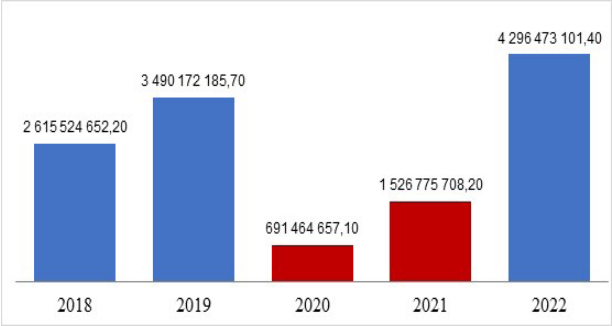

Figure 2 - Financial burden of spinal cord injury trauma

Discussion

Spinal cord injuries not only impose a significant social burden but also place a financial strain on the healthcare system, and the state as a whole. Despite the relatively low incidence of spinal cord injuries compared to other diseases, the consequences are disproportionately high. International studies indicate significant costs associated with spinal cord injuries, but estimates vary widely, and interpretation is complicated due to differences in healthcare systems and levels of social support [14, 15].

Over the past 5 years, Kazakhstan has spent approximately 1 billion tenge (around 2 billion USD) on the hospitalization of victims with spinal cord injuries, with the cost of a single episode being 1,000 USD or more. Malekzadeh H. et al. (2021), who combined 21 studies in their work, highlight lower costs for Nigeria, Tanzania, China, and Taiwan (from $290 to $4,860), while figures for Australia ($29,500), Canada ($9,980), and the United States ($92,220) are several times higher [8, 16]. Although Kazakhstan's figures are low compared to developed countries, the costs related to providing care for individuals with spinal cord injuries are substantial for the economy.

The main causes of spinal cord injuries are trauma resulting from falls, and road traffic accidents, followed by violence (including self–harm and suicide

attempts), and occupational or sports injuries. During the COVID–19 period, which affected causal factors due to implemented quarantine measures, there was a reduction in the hospitalization of patients with spinal cord injuries in healthcare organizations, as well as a general decline in the level of trauma. This suggests that reducing hospitalization rates through expanded preventive initiatives among the population could help decrease costs.

Delayed identification and treatment of secondary health conditions in patients with spinal cord injuries contribute additional financial burden on the healthcare system (covering costs of diagnostics and treatment, prolonged hospitalization, etc.). Secondary health conditions increase the treatment costs for spinal cord injuries by an average of 13.6±0.4%. The results of this analysis are supported by literature findings. In the study by Yue Cao & James S. Krause, it was noted that secondary health conditions increase annual healthcare costs for spinal cord injury patients by 1.5–2 times [10]. The authors found that gastrointestinal disorders contributed to an increase in costs up to 38,608 USD (compared to 22,968 USD in their absence), pressure sores increased costs up to 45,457 USD (from 27,724 USD), and urinary tract infections up to 38,417 USD (from 24,953 USD). In the Canadian study by Chan BC et al. (2019), additional costs for secondary health conditions ranged from 0,14 to 0,28 million pounds, depending on rehabilitation and the presence of pressure sores [14].

As survival rates after spinal cord injuries increase, the number of people with disabilities is also growing. This fact is linked not only to complications resulting from the injury itself (anatomical and physiological features) but also to systemic deficiencies (issues with the referral system for care, low accessibility of rehabilitation services, etc.). Research by Wei–Chih Lien et al. (2021), Diana Pacheco Barzallo et al. (2021), and Amy Richardson et al. (2019) showed that disability decreases the health potential of the population and impacts the loss of productive life years, social, and economic development of society [17–21]. Over the past 5 years, the economic loss from disability due to spinal cord injuries in Kazakhstan amounted to around 10 billion tenge.

Implementing cross-sector initiatives to reduce risk factors (road and pedestrian path safety, raising public awareness, etc.) will help decrease the number of deaths from spinal cord injuries and significantly reduce the economic damage that the state bears. The economic cost of fatalities from spinal cord injuries in Kazakhstan amounted to up to 1 billion tenge over the past 5 years.

Conclusion

Spinal cord injuries present significant financial challenges, not only due to the increased healthcare system costs but also the burden on the patients themselves. These injuries also reduce the quality of life for patients (disability, reduced working capacity, etc.). Over the past 5 years, considering hospitalization, disability, and mortality from spinal cord injuries, the economic damage to the state has amounted to 12 billion tenge.

Conflict of Interest: None.

Funding: None.

Author Contributions: Conceptualization – A.M., K.M.; Methodology – A.M., K.A.; Validation – A.M.; Formal analysis – A.M., Al.M; Writing (original draft preparation) – M., K.A.; Writing (review and editing) – A.M., K.M., Al.M.

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Қазақстан Республикасындағы жұлын жарақаттарының қаржылық ауыртпалығы

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Түйіндеме

Зерттеудің мақсаты: жұлын жарақатынан зардап шеккендердің денсаулығы мен физикалық әл–ауқатын сақтау және нығайту үшін Қазақстан Республикасы көтеретін шығындар сомасын анықтау болып табылады.

Әдістері. Бағалау үш көрсеткіш бойынша жүргізілді: емдеуге жатқызу, мүгедектік және өлім–жітім азайған жағдайда үнемделген қаражат сомасы. Талданатын кезең: 2018–2022 жылдар аралығы.

Нәтижелер. Талданып отырған кезеңде жұлынның жарақаттық зақымдануы бар пациенттерді емдеуге жатқызудан келтірілген экономикалық залал шамамен 800 млн. теңгені құрады. Ілеспе ауруларды ескере отырып, мемлекет орташа есеппен қосымша 13,6 ± 0,4% шығын жұмсады. Мемлекет үшін экономикалық залал сомасы 10 598 376 937 теңгені, ал өлім–жітімнен – 1 111 907 729,3 теңгені құрады. Өткен 5 жыл ішінде емдеуге жатқызуды, мүгедектікті және жұлын жарақатынан өлім–жітімді ескергенде мемлекеттің экономикалық шығыны 12 620 410 304,6 теңгені құрады.

Қорытындылар. Жұлын жарақаттары едәуір қаржылық қиындықтарға алып келеді, олар денсаулық сақтау жүйесіне, сондай–ақ пациенттің өзіне арналған шығыстардың ұлғаюының нәтижесі болып табылады. Сонымен қатар пациенттердің өмір сүру сапасын төмендетеді (мүгедектік, еңбек ету қабілетінің төмендеуі және т.б.).

Түйін сөздер: қаржылық ауыртпалық, экономикалық залал, жұлын жарақаттары.

Финансовое бремя травматических повреждений спинного мозга в Республике Казахстан

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Резюме

Цель исследования: являлось выявление суммы затрат, которое несет Республика Казахстан для сохранения и укрепления здоровья и физического благополучия пострадавших со спинномозговыми травмами.

Методы. Оценка проводилась по трем показателям: сумма средств, сэкономленная в случае снижения госпитализации, инвалидности и летальности. Анализируемый период: 2018–2022 годы.

Результаты. За анализируемый период экономический ущерб от госпитализации пациентов с травматическими повреждениями спинного мозга поставил около 800 млн. тенге, с учетом сопутствующих заболеваний в среднем государство тратит дополнительно 13,6±0,4%. Сумма экономического ущерба для государства составил 10 598 376 937 тенге, а от летальности – 1 111 907 729,3 тенге. Суммарно, за прошедшие 5 лет с учетом госпитализации, инвалидности и летальности от спинномозговых травм экономический ущерб государства составил 12 620 410 304,6 тенге

Выводы. Спинномозговые травмы несут значительные финансовые трудности, которые не только являются результатом увеличения расходов на систему здравоохранение, но и самого пациента; а также снижает качество жизни пациентов (инвалидизация, снижение трудоспособности и др.).

Ключевые слова: финансовое бремя, экономический ущерб, спинномозговые травмы.