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Vertebral fractures caused by speed humps on the road: a cross-sectional study

Fracturas vertebrales causadas por reductores de velocidad en la carretera: un estudio transversal

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ABSTRACT. Introduction: traumatic spinal injuries account for nearly 700,000 new cases annually worldwide and are most commonly associated with high-energy trauma. An uncommon mechanism was reported as thoracolumbar fractures in bus passengers after vehicles crossed speed humps. Subsequent reports have documented similar injuries, typically affecting the thoracolumbar spine and passengers seated in the rear rows. Despite the widespread use of speed humps as traffic-calming devices, their potential role in vertebral fractures remains poorly explored and may represent an underrecognized mechanism of spinal injury. **Objective:** to evaluate the experience of Latin American spine surgeons with thoracolumbar fractures in bus passengers caused by road speed humps. **Material and methods:** a cross-sectional survey was conducted among spine surgeons in Latin America between February and March 2025. Participants were recruited through a non-probabilistic snowball sampling method

RESUMEN. Introducción: las lesiones traumáticas de la columna vertebral representan cerca de 700,000 casos nuevos al año en todo el mundo y se asocian con mayor frecuencia a traumatismos de alta energía. Se ha descrito un mecanismo poco común consistente en fracturas toracolumbares en pasajeros de autobús después de que los vehículos atraviesan reductores de velocidad. Reportes posteriores han documentado lesiones similares, que típicamente afectan la columna toracolumbar y a pasajeros sentados en las filas posteriores. A pesar del uso generalizado de los reductores de velocidad como medidas de control del tráfico, su posible papel en causar fracturas vertebrales permanece poco explorado y podría representar un mecanismo subreconocido de lesión espinal. **Objetivo:** evaluar la experiencia de cirujanos de columna de América Latina con fracturas toracolumbares en pasajeros de autobús causadas por reductores de velocidad en la vía. **Material y métodos:** Se realizó una encuesta transversal entre cirujanos de columna de América

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using the AOSpine database. An online questionnaire explored: 1) demographic and professional background; 2) experience with thoracolumbar trauma; and 3) cases attributed specifically to speed humps. **Results:** of 224 responses received, 165 complete surveys were analyzed. Respondents were predominantly male (94.5%), orthopedic surgeons (67.9%), and had over five years of spinal surgery experience (73.9%). The highest response rates came from Chile (30.9%), Mexico (18.2%), Brazil (15.8%), and Argentina (13.3%). Most surgeons acknowledged speed humps as common urban traffic measures and had encountered thoracolumbar fractures resulting from them. Only 9.7% had never treated such cases. The typical patient was female (67.9%), older than 45 years (72.7%), with isolated thoracolumbar fractures (84.2%) located between T10 and L2, without neurological injury (87.8%), and most commonly classified as type A fractures (93.3%). The most frequently reported vehicle position at the time of injury was the last row of bus seats (53.9%). **Conclusion:** spine surgeons in several Latin American countries report clinical experience with thoracolumbar fractures related to speed humps, a mechanism of injury underrepresented in current literature. These findings highlight the need for increased awareness and preventive measures in public transportation safety.

Keywords: speed humps, spine, vertebral fractures, bus, spine surgeons, trauma.

Latina entre Febrero y Marzo de 2025. Los participantes fueron reclutados mediante un muestreo no probabilístico en cadena (bola de nieve) utilizando la base de datos de AOSpine. Un cuestionario en línea exploró: 1) antecedentes demográficos y profesionales; 2) experiencia con trauma toracolumbar; y 3) casos atribuidos específicamente a reductores de velocidad. **Resultados:** de 224 respuestas recibidas, se analizaron 165 encuestas completas. Los encuestados fueron predominantemente hombres (94.5%), cirujanos ortopédicos (67.9%) y con más de cinco años de experiencia en cirugía de columna (73.9%). Las tasas de respuesta más altas provinieron de Chile (30.9%), México (18.2%), Brasil (15.8%) y Argentina (13.3%). La mayoría de los cirujanos reconoció los reductores de velocidad como medidas de tránsito urbano comunes y había encontrado fracturas toracolumbares resultantes de éstos; sólo el 9.7% nunca había tratado casos así. El paciente típico era mujer (67.9%), mayor de 45 años (72.7%), con fracturas toracolumbares aisladas (84.2%) localizadas entre T10 y L2, sin lesión neurológica (87.8%) y más comúnmente clasificadas como fracturas tipo A (93.3%). La posición del vehículo más frecuentemente reportada al momento de la lesión fue la última fila de asientos del autobús (53.9%). **Conclusión:** los cirujanos de columna en varios países de América Latina reportan experiencia clínica con fracturas toracolumbares relacionadas con reductores de velocidad, un mecanismo de lesión poco representado en la literatura actual. Estos hallazgos resaltan la necesidad de mayor concientización y medidas preventivas en la seguridad del transporte público.

Palabras clave: reductores de velocidad, columna vertebral, fracturas vertebrales, autobús, cirujanos de columna, trauma.

Introduction

The estimated incidence of traumatic spinal injuries worldwide is approximately 700,000 new cases per year, with a wide geographical variability. High-energy trauma, such as traffic accidents and falls, are the primary causes.[1] In 1996, Bowery et al. reported the first two cases of thoracolumbar spine fractures that occurred in passengers seated on public transport buses after the vehicles had traversed speed humps on the road.[2] Speed humps are one of the most common physical traffic calming interventions used in urban areas. The pavement surface features a gradual raised area to reduce vehicle speeds and collisions.[3]

This specific blunt trauma injury mechanism to the spine has been reported from Latin American authors in the literature after Bowery's original publication.[4,5,6] Munjin et al. reported the largest cohort of patients with this injury documented to date. They described 52 fractures in 46 bus passengers after indirect trauma crossing speed humps in Chile.[5] Most of the injuries occur in the thoracolumbar spine and affect passengers seated in the last row of seats.[2,4,5,6] A similar mechanism has been described in speedboat passengers.[7]

While speed humps are widely used as traffic-calming measures, their potential role as a cause of vertebral fractures remains underexplored. Understanding the epidemiological burden and clinical implications of these injuries is crucial for developing preventive strategies and improving patient outcomes.

It remains unclear whether this injury mechanism is truly limited to certain countries due to cultural factors, traffic law enforcement, and infrastructure design, or if it is an underrecognized phenomenon in other regions where it has not yet been reported.

The objective of this study is to evaluate the experience of Latin American spine surgeons with thoracolumbar fractures caused by speed humps. This will help establish the importance of future research aimed at preventing these traumatic spine injuries.

Material and methods

This is a cross-sectional study on thoracolumbar fractures among bus passengers caused by speed humps. An online survey was conducted among spine surgeons actively working in Latin American centers between

Table 1: Questionnaire.

Section, question	Answer options
Demographic and professional data	
1. Age	
2. Gender	Male Female Other
3. Country/City	
4. Type of healthcare institution	Public Private Both
Spinal trauma experience	
5. Spine surgery experience (years)	Resident < 5 5-10 > 10
6. Do you perform spinal trauma surgery? (%)	No < 25 25-50 51-75 > 75
Experience with thoracolumbar fractures caused by speed humps	
7. Have you treated thoracolumbar fractures caused by speed humps?	Never Rarely Sometimes Frequently Very frequently
8. Age group most commonly affected (years)	0-18 18-65 > 65
9. Predominant gender among affected patients	Male Female No gender difference
10. Most commonly affected spinal region	C0-C7 T1-T9 T10-L2 L3-L5 S1-Coccyx
11. Most frequent seat position of the injured passenger	Not recorded Front row Middle rows Last row
12. Have you documented similar injuries in other vehicles?	No Cars Trucks Motorcycles Bicycles Other (specify)
13. Have you managed these fractures non-surgically?	Rarely Sometimes Frequently Very frequently
14. Have you identified osteoporosis or high fragility fracture risk in these cases?	Never Rarely Sometimes Frequently Very frequently
15. Most common fracture type according to AOSpine classification	A0 A1 A2 A3-A4 B C I don't use this classification
16. How important is it to improve prevention strategies in your city/country?	Very important Important Moderately important Slightly important Not important

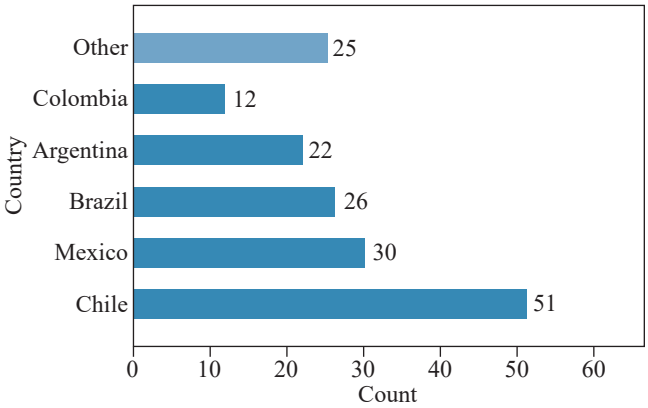

Figure 1: Respondent's country distribution.
Countries with a low response rate were included in the category «other» (Venezuela n = 5, Paraguay n = 5, Bolivia n = 4, Peru n = 4, Cuba n = 2, Dominican Republic n = 2, Ecuador n = 1, Uruguay n = 1).

Table 2: Demographic and professional data.

Variables	Results n (%)
Age (years), mean ± SD [range]	46.6 ± 10.6 [44.9-48.2]
Gender	
Male	156 (94.5)
Female	9 (5.5)
Medical specialty	
Orthopedic surgeon	112 (67.9)
Neurosurgeon	53 (32.1)
Type of health institution	
Public	24 (14.5)
Private	51 (30.9)
Both	90 (54.5)
Spine surgery experience (years)	
Resident	9 (5.5)
Spine surgeon (< 5)	34 (20.6)
Spine surgeon (5-10)	26 (15.8)
Spine surgeon (> 10)	96 (58.2)
Percentage of spine trauma surgeries per year	
0	2 (1.2)
< 25	79 (47.9)
25-50	47 (28.5)
50-75	25 (15.2)
> 75	12 (7.3)

February and March 2025, using a non-probabilistic «snowball» sampling method. An online questionnaire was sent via email and other messaging applications to spinal surgeons, including both male and female neurosurgeons and orthopedic surgeons, registered in the AOSpine database from Latin American centers who have agreed to receive surveys. Incomplete questionnaires (i.e. those with less than 50% of answers) were excluded. An online self-administered questionnaire was designed using the SurveyMonkey Inc (San Mateo, CA) application, following an interactive consensus among the members of the AOSpine Latin America Trauma Study Group *(Table 1)*.

The survey included three sections: 1) demographic and professional data; 2) experience with thoracolumbar trauma cases; and 3) experience with thoracolumbar fractures caused by speed humps.

The survey was conducted in accordance with the Declaration of Helsinki. Institutional review board approval (2017-97) was obtained to ensure the anonymity of subjects and healthcare centers participating in the study. All participants consented to their participation by answering the form.

Statistical analysis

Qualitative variables were expressed as counts and percentages. The quantitative variables were described with the mean and median, according to their distribution and their dispersion measures, standard deviation (SD) and range. For the description, analysis, tables and graphics design SPSS Statistics 25 software was used. IP addresses were recorded as metadata with each survey response, allowing assessment for duplication and preventing multiple entries from the same individual.

Results

During the study period, 224 responses were received. We excluded 59 incomplete questionnaires

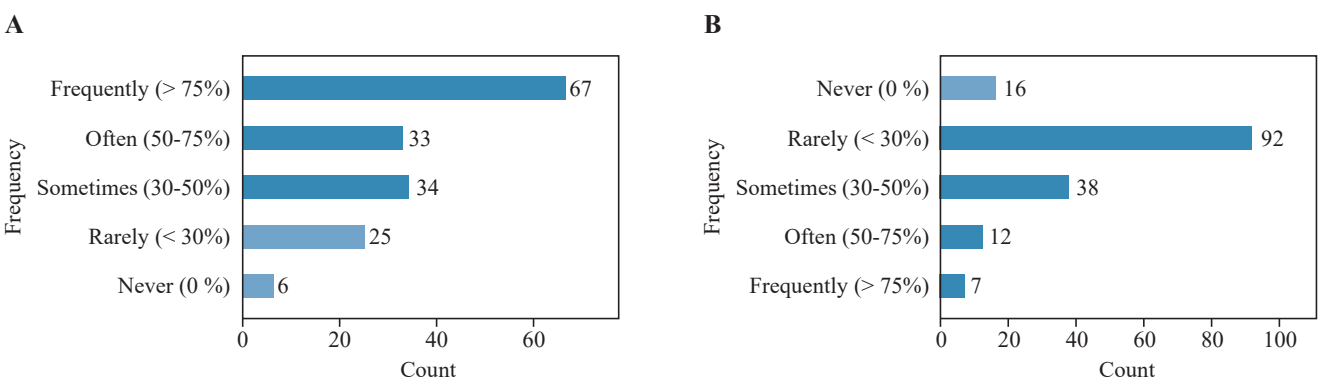

Figure 2: A) Local use of speed humps. **B)** Treatment of vertebral injuries caused by speed humps.

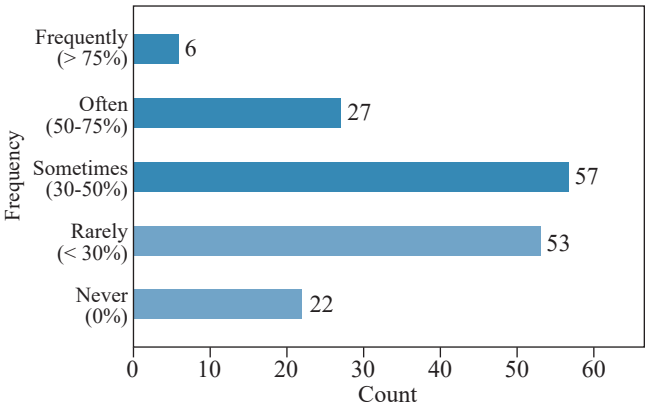

Figure 3: Misdiagnoses frequency distribution.

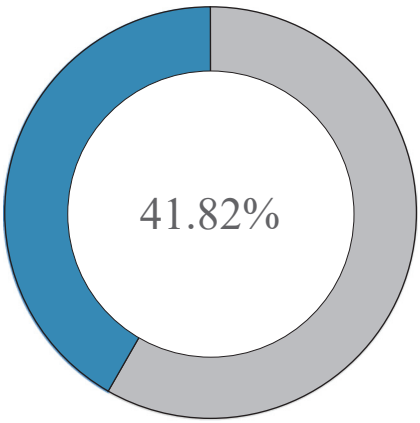

Figure 4: Circular chart: percentage of patients with initial assessment after 24 hours from trauma.

(completion rate = 73.6%). Finally, 165 responses were analyzed, from mostly male spinal surgeons (n = 156; 94.5%), 112 orthopedic surgeons (67.9%) and 53 (32.1%) neurosurgeons, with more than five years of experience in spinal surgery (n = 122; 73.9%). The largest proportion of respondents worked in Chile (n = 51; 30.9%), followed by Mexico (n = 30; 18.2%), Brazil (n = 26; 15.8%) and Argentina (n = 22; 13.3%) *(Figure 1)*. Demographic and professional data of respondents are presented in *Table 2*.

Experience with thoracolumbar fractures caused by speed humps

The majority of participants recognized the use of speed humps as a local speed reduction measure in their cities, although with varying frequency (81.2% answered at least «sometimes» or more) *(Figure 2)*. They also reported at least one previous case of thoracolumbar fracture caused by speed humps *(Figure 2)*. However, most of them described those cases as rare in their daily practice («rarely» n = 92; 55.8%). It is important to highlight that only 16 (9.7%) spinal surgeons have never treated a patient with this specific injury.

Initial assessment

Among surveyed spinal surgeons more than 50% responded that these injuries are misdiagnosed at least «sometimes» («sometimes/often/frequently» n = 90; 54.5%) *(Figure 3)*. Additionally, more than 40% (n = 69; 41.8%) described that these injuries are assessed after initial 24 hours from trauma during its daily practice *(Figure 4)*.

Demographic and clinical features

Respondents described more frequently female patients (n = 112; 67.9%), older than 45 years old (n = 120; 72.7%) with isolated (associated injuries n = 43; 26.1%) thoracolumbar fractures (T10-L2 n = 139; 84.2%), without neurological injury (neurological injury «never/rarely» n = 145; 87.8%) and type A (from A1 to A4) fracture from AOSpine Classificacion system (n = 154; 93.3%) *(Table 3)*. Most of them described the presence of documented or at least suspected osteoporosis («often/frequently» n = 93; 56.3%).

Injury mechanism

In relation with the injury mechanism, bus passengers seated in the last row of seats was the main documented vehicle position (n = 89; 53.9%) *(Figure 4)*, 32.1% do not document this information during the initial assessment after spinal injuries related to speed humps. Other vehicles, different from buses, were less frequently reported like cars (n = 38; 23%), trucks/vans (n = 17; 10.3%), and motorcycles (n = 6; 3.6%).

Imaging

For imaging these vertebral injuries, spinal surgeons rely mainly on computerized tomography (CT) (n = 133; 80.6%), followed by MRI (n = 121; 73.3%) and X-Ray (n = 85; 51.5%) *(Figures 5 and 6)*. Only 30.3% (n = 50) of

Table 3: Fracture type distribution.

AOSpine classification type	Fracture n (%)
A1	76 (46.1)
A2	21 (12.7)
A3/A4	57 (34.5)
B1	2 (1.2)
B2	2 (1.2)
C	7 (4.2)

spinal surgeons support the use of densitometry, and other studies, such as dynamic X-Rays (n = 15; 9.1%), CT-based Hounsfield unit assessment (< 1%), or vitamin D dosage (< 1%) were rarely suggested.

Treatment

More than 60% of spinal surgeons answered to indicate surgery in less than 50% of the cases (n = 102; 61.8%) and almost one third of the sample «never» or «rarely» (n = 52; 31.5%). Treatment decisions did not significantly differ according to the specialty of the spinal surgeon.

Topic relevance

More than 70% (n = 125; 75.7%) of surveyed spinal surgeons considered «important/very important» work for prevention for spinal injuries caused by speed humps.

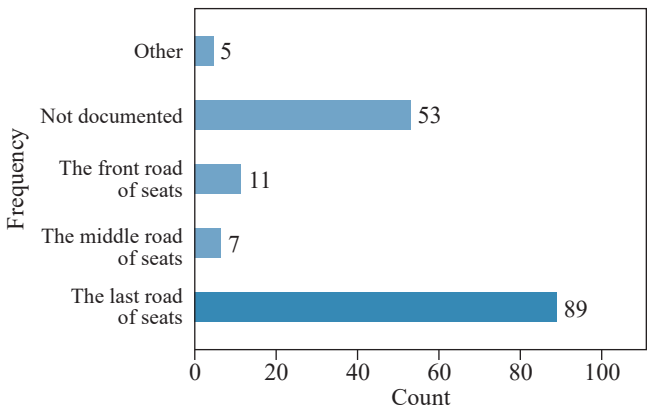

Figure 5: Vehicle position distribution.

Discussion

The survey results indicate that spinal injuries caused by speed humps are a matter of daily practice for spinal surgeons in several Latin American countries. Although rare in previous publications, our survey found that surgeons from Chile, Mexico, Brazil, and Argentina have experience in diagnosing and treating this type of injury. Surgeons from other Latin American countries, with a low response rate in our survey, also recognized this mechanism of injury.

According to the injury mechanism, most of the surveyed spinal surgeons reported that their patients were frequently bus passengers seated in the last row of seats. Previous literature has identified this location as the primary site for patients who have suffered injuries caused by road speed humps.[4,5,6] Munjin et al. published a detailed description of the injury mechanism, which implies a torque generated as the motor vehicle rises while it passes over the speed hump, consequently it generates a catapult effect on the vehicle's suspension system. The passenger elevates suddenly from their seat, falling back abruptly and hitting the seat shortly because of gravity.[5] It should be noted that, in addition to buses, other vehicles were mentioned in our survey.

Females over the age of 45 with bone fragility may be at a higher risk of this type of injury. However, these are purely hypothetical predictive factors derived from limited prior descriptions and also supported by the spinal surgeon's experience documented in our survey. Longitudinal cohorts are necessary to identify specific risk factors for these injuries.[2,4,5,6] Munjin et al. reported a heterogeneous group of 46 patients with a broad age range, from young healthy patients to adults over 65 years old. They documented bone metabolism disorders in 23.9% of their patients.[5]

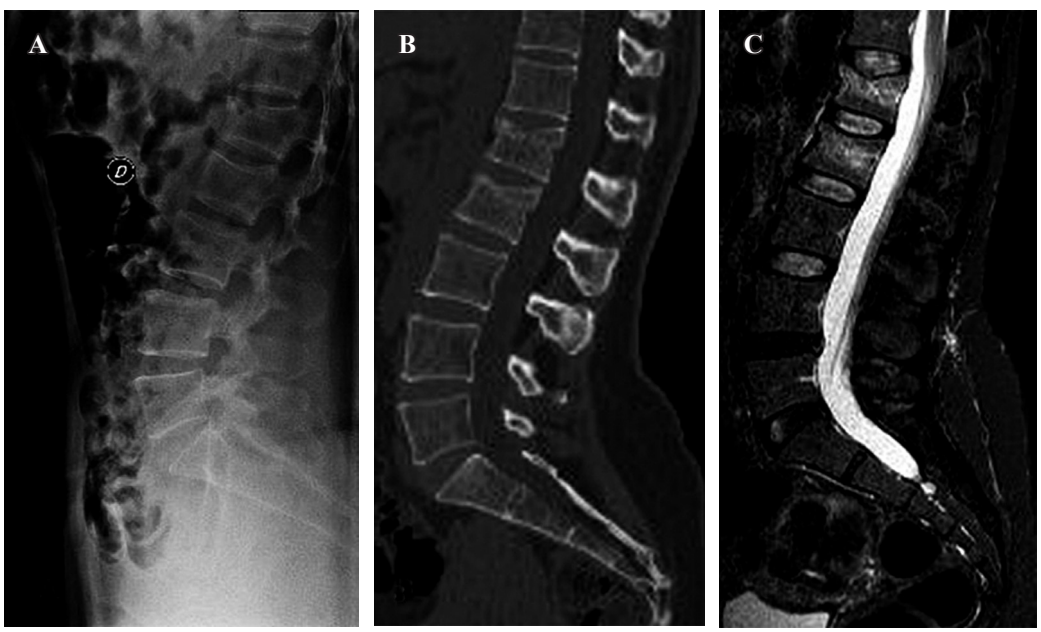

Figure 6:

Representative case example of a stable thoracolumbar fracture. A 45-year-old female patient with no relevant comorbidities, who was traveling as a passenger in the last row of seats on a bus. She sustained compression fractures at L1 and L2 after the vehicle passed over a speed bump. The injury was managed conservatively.

Formaggin et al. reported a demographically similar case series of 23 patients and excluded patients with documented severe osteoporosis.[6] Both series suggest that this type of injury mechanism could be interpreted as at least moderate energy trauma carrying a risk of traumatic vertebral fractures.[5,6] Females were the predominant gender in both publications, accounting for more than 50% of the patients.[5,6]

In our survey, the respondents primarily evaluated and classified spinal injuries caused by road humps as traumatic compression fractures. However, 30% of surveyed surgeons suggested the need for densitometry to assess bone mineral density. It is debatable how we judge the energy of this injury mechanism, and this could have an impact on our daily practice, for example when we have to decide whether spinal fractures are purely traumatic compression fractures or a particular type of spinal fragility fracture. This may be important in the assessment of occupational accidents.[6]

Previous publications have shown that spinal injuries caused by speed humps mainly affect the thoracolumbar spine.[2,4,5,6] In fact, over 80% of the respondents reported predominantly treating thoracolumbar injuries. The thoracolumbar junction is a transition zone between the rigid thoracic spine and the mobile lumbar spine, which justifies its vulnerability and high frequency of traumatic compression fractures.[5]

According to the fracture classification, type A fractures were mostly reported in the literature in accordance with the spinal surgeon's experience documented in our survey. Neurological injury is a rare complication. None of the patients reported by Munjin et al had neurological impairment and only one of those documented by Formaggin et al.[5,6]

The survey has limitations. Several Latin American countries are underrepresented. Additionally, the survey relied on a clinician's recollection of practice, which makes it vulnerable to recall bias. To generalize our results in the region, a larger sample size is needed. The primary future task is to conduct large multicenter patient cohorts to determine the clinical profile of patients with spinal injuries caused by speed humps, as well as biomechanical studies that may support the described mechanism of injury. The combination of this key information could support future guidelines to evaluate future policy decisions to prevent traumatic spinal injuries caused by speed humps.

Conclusion

Our survey revealed that spine surgeons in Chile, Mexico, Brazil, and Argentina have encountered vertebral fractures in bus passengers related to the sudden impact over speed humps, an injury mechanism scarcely reported in the literature. This suggests a potentially underestimated public health issue. Whether this pattern is truly limited to certain countries due to differences in road design, transportation safety regulations, and law enforcement, or whether it is simply underrecognized elsewhere, remains unclear. To address this gap, we propose the development of prospective multicenter studies across diverse regions to determine the true incidence and contributing factors. In parallel, public policy initiatives should consider reviewing the design standards and placement of speed control devices, particularly in areas where high-risk public transportation practices are prevalent. Strengthening data collection systems and including spine trauma mechanisms in traffic safety evaluations may also help guide more effective preventive strategies.

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