Investigating Thoracic Vertebral Fractures in Residential Environments

Affiliations

(Residential Thoracic Spinal Fractures)

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Abstract

Introduction: Thoracic vertebral fractures within homes are pivotal public health concerns due to their associated morbidity and significant healthcare expenditures. This study aims to dissect the intricate epidemiology of these injuries, integrating comprehensive risk factors beyond conventional demographics and location analyses.

Methods: Utilizing a decade of data (2013-2022) from the National Electronic Injury Surveillance System (NEISS), this study examines thoracic vertebral fractures across age and gender in household settings. Inclusion criteria targeted specific thoracic spine-related terms, analyzing fractures by location (e.g., kitchen, stairs) and associated products. Data processing employed R programming, with statistical analysis focusing on descriptive statistics and multivariate logistic regression to identify fracture patterns and assess gender differences in fracture risks through Adjusted Odds Ratios (AORs).

Results: Analysis of 46,371 thoracic vertebral fractures identified stairs as the primary site (26.81%), with subsequent frequent locations being bedrooms (18.52%), living rooms (17.88%), and kitchens (16.29%). Gender-specific risk analysis revealed females had a higher likelihood of fractures on stairs (AOR = 1.24, 95% CI: 1.16-1.37, $p < .001$) and in bedrooms (AOR = 1.13, 95% CI: 1.09-1.54, $p < .001$). The most affected age group was 51-60, showcasing the multifaceted nature of risk factors beyondmere location.

Discussion: This study transcends prior insights by detailing the influence of various factors, including socioeconomic status and lifestyle, on fracture risk. It emphasizes the complexity of household fractures, highlighting gender and age as pivotal but not exclusive risk determinants.

Conclusion: By offering a comprehensive analysis that incorporates a wide array of risk factors, this study advances the understanding of thoracic vertebral fractures in residential environments. It underscores the necessity for targeted preventive measures that are cognizant of the multifactorial nature of these injuries, paving the way for improved safety interventions and public health policies.

Introduction

The investigation of vertebral fractures within residential environments has emerged as a pivotal public health endeavor, driven by the considerable morbidity associated with these injuries and the significant financial burden they impose. Reports suggest that the healthcare costs associated with such fractures can soar, in some instances, to over one million US dollars per patient, underscoring the economic impact alongside the human cost.[1,2] This stark reality propels the scientific community's growing interest in dissecting the epidemiology of thoracic vertebral fractures within household settings. The objective is twofold: to enhance public health prevention strategies and to formulate interventions that are both precise and impactful.[3,4]

A deeper understanding of the causative factors behind these injuries is crucial for developing effective prevention measures. Research led by Den Hauwe et al. has shed light on the commonality of incidents such as slipping, tripping, stumbling, and tumbling down from architectural elements like stairs, pinpointing these as predominant mechanisms behind spinal injuries in residential areas.[5] Their findings further accentuate the vulnerability of individuals over the age of 61 to such accidents, suggesting a demographic at particular risk and in need of targeted preventive strategies.[5-8]

Moreover, the role of household items in exacerbating the risk of falls leading to spinal injuries has been identified.[8,9] Utilization of objects such as step stools and ladders significantly elevates the likelihood of falls, necessitating a heightened focus on education and awareness at both the consumer and product development stages.[8-11] The susceptibility of the elderly to hazards like inadequate lighting and loose floor coverings further complicates the risk landscape within homes, reinforcing the need for comprehensive risk assessments tailored to this demographic.[8-13]

While thoracic vertebral fractures have been studied in various contexts , the unique challenges and considerations presented by the household environment demand a dedicated exploration. This study aims to pinpoint specific factors linked to these injuries in residential contexts, with a particular focus on the dynamics of domestic environments, including the use of consumer products and the execution of everyday activities. It posits that factors such as advanced age and the interaction with specific household items may significantly influence the incidence of thoracic vertebral fractures.[14,15]

The significance of this research extends beyond academic interest, aiming to inform the development of finely tuned prevention strategies, safety guidelines, and interventions. By elucidating the epidemiology of thoracic vertebral fractures within the context of the home, we strive to mitigate the burden these injuries place on individuals and the healthcare system alike, ultimately fostering safer living environments and enhancing the quality of life for those affected.

Methods

This study employs a cross-sectional design, drawing from the National Electronic Injury Surveillance System (NEISS) data from 2013 to 2022. NEISS, managed by the U.S. Consumer Product Safety Commission (CPSC), aggregates injury data from a strategic sample of 100 hospitals from a pool of 6,100. We focused on thoracic vertebral fractures, applying a targeted approach to data selection. Fractures were identified using terms directly related to the thoracic spine, such as "Thoracic," "T-spine," and "T1" through "T12." This specificity ensured the relevance of our dataset to the study objectives. Participant data were categorized by age, but to streamline our analysis and enhance its relevance, we condensed age categories into broader groups based on life stages: childhood (0-10), adolescence (11-20), early adulthood (21-30), middle age (31-60), and senior (61+). This approach aligns with physiological changes and risk exposure variations across different life stages.

Our analysis extended to the examination of household items categorized into general settings: kitchen, living room, bedroom, stairs, outdoor, and other. Rather than listing every possible item, we focused on those with a direct correlation to reported fractures, such as flooring types, furniture, and stairs-related equipment, providing a clearer link between household items and injury risk.

Data analysis was conducted using R programming language, emphasizing descriptive statistics and multivariate logistic regression to identify trends and associations. We clarified our use of Adjusted Odds Ratios (AOR) to highlight significant gender differences in fracture risk, ensuring our interpretations are grounded in the data. This analytical approach allowed us to distill meaningful insights from the NEISS dataset, contributing to a deeper understanding of sex-related thoracic vertebral fractures in residential settings.

Results

Our cross-sectional analysis of thoracic vertebral fractures, derived from a dataset spanning a decade, revealed a distribution pattern across various residential locations. The most frequent site of such fractures was the stairs, accounting for 12,432 cases or 26.81% of the total (Table 1). This was followed by the bedroom with 8,588 cases (18.52%), the living room with 8,291 cases (17.88%), and the kitchen with 7,554 cases (16.29%). Outdoor areas (yards or patios) and other unspecified locations accounted for 5,189 (11.19%) and 4,317 (9.31%) of the fractures, respectively, completing the profile of common sites for these injuries within the home. The differences in the number of thoracic vertebral fractures across various home locations were statistically significant ($p < 0.05$).

Table 1. Home Locations and Frequency of Thoracic Vertebral Fractures.

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Home Location	**Number of Fractures**	**% of Total Fractures**	
Stairs	12432	26.81%	
Bedroom	8588	18.52%	
Living Room	8291	17.88%	

Kitchen	7554	16.29%	
Outdoor (Yard/Patio)	5189	11.19%	
Other	4317	9.31%	
Total Thoracic vertebral fractures	46371	100%	**<.05**

Gender-specific analysis highlighted that females were more prone to fractures in certain domestic locations. The incidence of fractures on stairs was significantly higher for females, with an AOR of 1.24 (95% CI: 1.16-1.37, $p < .001$), indicating a 24% increased likelihood of sustaining such injuries compared to males. Females also experienced a higher rate of bedroom fractures with an AOR of 1.13 (95% CI: 1.09-1.54, $p < .001$). However, gender differences in fracture occurrences in the living room, kitchen, and outdoor areas were not statistically significant, with AORs of 1.18 (p=0.867), 0.93 (p=0.114), and 1.04 (p=0.645) respectively (Table 2).

Table 2. Distribution of Thoracic Vertebral Fractures by Gender and Home Locations.

Table 2: Distribution of Thoracic Vertebral Fractures by Sex and Home Locations				
Home Location	**Male (%)**	**Female (%)**	**AOR (95% CI)**	**P-value**
Stairs	5827 (46.87)	6605 (53.13)	**1.24 (1.16-1.37)**	**<.001**
Bedroom	4047 (47.12)	4541 (52.88)	**1.13 (1.09-1.54)**	**<.001**
Living Room	4043 (48.76)	4248 (51.24)	1.18 (.63-1.20)	0.867
Kitchen	3794 (50.22)	3760 (49.78)	.93 (.82-1.49)	0.114
Outdoor (Yard/Patio)	2526 (48.68)	2663 (51.32)	1.04 (.77-1.31)	0.645
Other	2044 (47.35)	2273 (52.65)	1.01(.86-1.52)	0.463
Total Thoracic vertebral fractures	21827 (47.07)	24544 (52.93)	**1.08 (1.04-1.85)**	**<.001**

The age group analysis provided further insights. Individuals aged 51-60 had the highest prevalence of fractures on stairs (21.36%) and in bedrooms (17.62%). This trend diminished in older age groups, with individuals aged 71-80 experiencing lower rates of stair-related fractures

(7.32%) and bedroom fractures (16.07%). Notably, the youngest age group (0-10) demonstrated the lowest incidence rates in all locations, particularly in the kitchen (4.39%) and outdoor areas (11.60%). This pattern suggests an age-related variance in the likelihood of fractures, with younger age groups benefiting from increased safety measures. The age groups 11-20 and 21-30 had a significantly lower percentage of stair-related fractures at 9.48% and 7.12%, respectively, while for older age groups, such as 61-70 and 81 and above, the percentages remained considerable at 20.01% and 8.28% (Table 3).

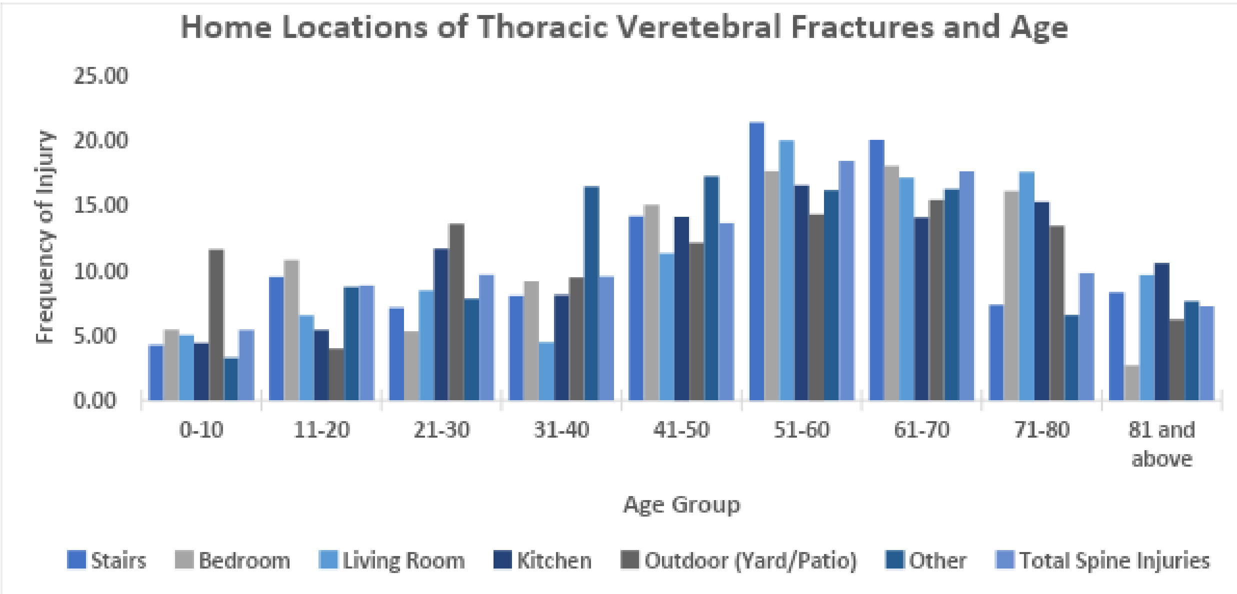
Table 3. Home Locations of Thoracic Vertebral Fractures and Age.

Table 3: Home Locations of Thoracic Vertebral Fractures and Age

Home Location	**0-10**	**11-20**	**21-30**	**31-40**	**41-50**	**51-60**	**61-70**	**71-80**	**81 and above**
Stairs	4.25	9.48	7.12	8.04	14.13	21.36	20.01	7.32	8.28
Bedroom	5.42	10.79	5.29	9.13	15.01	17.62	17.99	16.07	2.69
Living Room	5.03	6.53	8.44	4.45	11.28	19.97	17.10	17.57	9.64
Kitchen	4.39	5.40	11.66	8.10	14.09	16.53	14.04	15.24	10.55
Outdoor (Yard/Patio)	11.60	3.99	13.57	9.44	12.09	14.31	15.40	13.41	6.21
Other	3.28	8.72	7.82	16.43	17.22	16.14	16.23	6.55	7.62
Total Thoracic vertebral fractures	5.39	8.83	9.65	9.51	13.62	18.40	17.59	9.79	7.21

The bar graph in Figure 1 visualizes the frequency of fractures across different home locations segmented by age groups, illustrating a trend where certain locations appear to pose higher risks to specific age demographics. This visual representation emphasizes the stark differences in fracture prevalence corresponding to both the individual's age and their environment within the home.

Figure 1. Thoracic vertebral fractures by Home Locations and Age Groups, illustrating the percentage of total fractures in different home locations across various age groups.



Discussion

In analyzing the implications of our findings, we identify stairs as the most common location for thoracic vertebral fractures, comprising 26.81% of cases. This high incidence signals an urgent need for enhanced safety measures in architectural design, such as better lighting, installation of handrails, and non-slip treads to prevent falls. Rather than suggesting gender-specific structural flaws, our recommendations focus on mitigating the identified risks through improved home construction standards that benefit all occupants.[16]

The data also shows a higher fracture susceptibility in women, particularly those who are post-menopausal. Research has demonstrated that post-menopausal women are at increased risk due to the natural drop in estrogen, which affects bone density. These changes can begin to affect women as young as in their early 50s, a time in which many still live independently and thus their exposure to potential fracture events is higher.[17] This data points towards the necessity for further research into the role of bone density, hormonal changes, and lifestyle factors in fracture risk. To address this, we advocate for the integration of bone health screenings into regular health check-ups for women over 50, aiming to proactively manage and treat osteoporosis-related risks.[18]

Age-specific patterns emerge from our study, with individuals aged 51-60 experiencing the highest rates of fractures. This finding may be explained by several factors that have been suggested in prior studies. T, as this age group is known to face unique physiological changes that increase their fall risk, including but not limited to muscle loss, issues with balance, joint diseases, and vision loss. The high rate of fractures in the 51-60 age group may also be attributed to the transitory phase they are in, where the onset of age-related physical decline begins but is often not yet fully managed or mitigated through lifestyle changes or medical interventions.

Additionally, this age group is typically still very active, which could increase their exposure to household hazards compared to older age groups who may have more restricted mobility, and cautious attitudes towards their surrounding environment. In response, we recommend targeted preventive strategies for this age group, including balance training and strength exercises tailored to their needs to reduce fall risk. For the elderly, we propose in-depth home assessments to identify potential fall hazards, such as loose rugs or inadequate lighting, and the necessary modifications to create safer living environments.[19-21]

Children's lower rates of fractures emphasize the effectiveness of current protective measures, yet continuous education on child safety and the development of child-friendly spaces are essential to maintain this trend. Ensuring not only that children understand the ways to play safely, but also have safe environments to play in, can continue to spare them from higher rates of injury. For outdoor settings, regular maintenance and use of durable materials are key preventive measures.[22]

Our study calls for the implementation of specific, evidence-based interventions. Patient education programs, co-designed with healthcare professionals, should focus on fall-prevention techniques and healthy lifestyle practices. Furthermore, integrating physiotherapy and personalized exercise regimens into routine care for at-risk demographics can significantly contribute to minimizing fall risk across all age groups.[23-25]

Recognizing the NEISS database's limitation to emergency department data, we underscore the importance of more expansive research that captures unreported cases of thoracic vertebral fractures. Patients that fall outside of the purview of this database might offer additional insights into the frequency and circumstances of these injuries, and could importantly highlight additional risk factors or demographic characteristics that increase the risk of residential thoracic vertebral fractures. Future studies should investigate additional risk factors and alternative intervention methods to fully comprehend and tackle the underlying causes of these injuries.

This study thus serves as a catalyst for meaningful enhancements in home safety and public health initiatives. By providing a deeper understanding of the risk factors and effective preventive strategies for thoracic vertebral fractures, we lay the groundwork for policies aimed at fostering safer residential spaces and improving the overall well-being of individuals in their homes.

Conclusion

This study provides valuable insights into thoracic vertebral fractures in households, focusing on home locations, sex, and age groups. The stairs, bedroom, living room, and kitchen are common fracture sites, warranting targeted preventive measures. Females experience more fractures, particularly those related to stairs or in bedrooms. Age-specific vulnerability is evident, with the 51-60 age group at highest risk. In a contemporary context where homes serve as multifunctional spaces, comprehending the intricacies of thoracic vertebral fractures within these settings becomes imperative. Our study sets the stage for ongoing research, refinement of interventions, and policy formulation to enhance musculoskeletal health and overall well-being.

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Table 2: Distribution of Thoracic Vertebral Fractures by Sex and Home Locations				
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Living Room	5.03	6.53	8.44	4.45	11.28	19.97	17.10	17.57	9.64
Kitchen	4.39	5.40	11.66	8.10	14.09	16.53	14.04	15.24	10.55
Outdoor (Yard/Patio)	11.60	3.99	13.57	9.44	12.09	14.31	15.40	13.41	6.21
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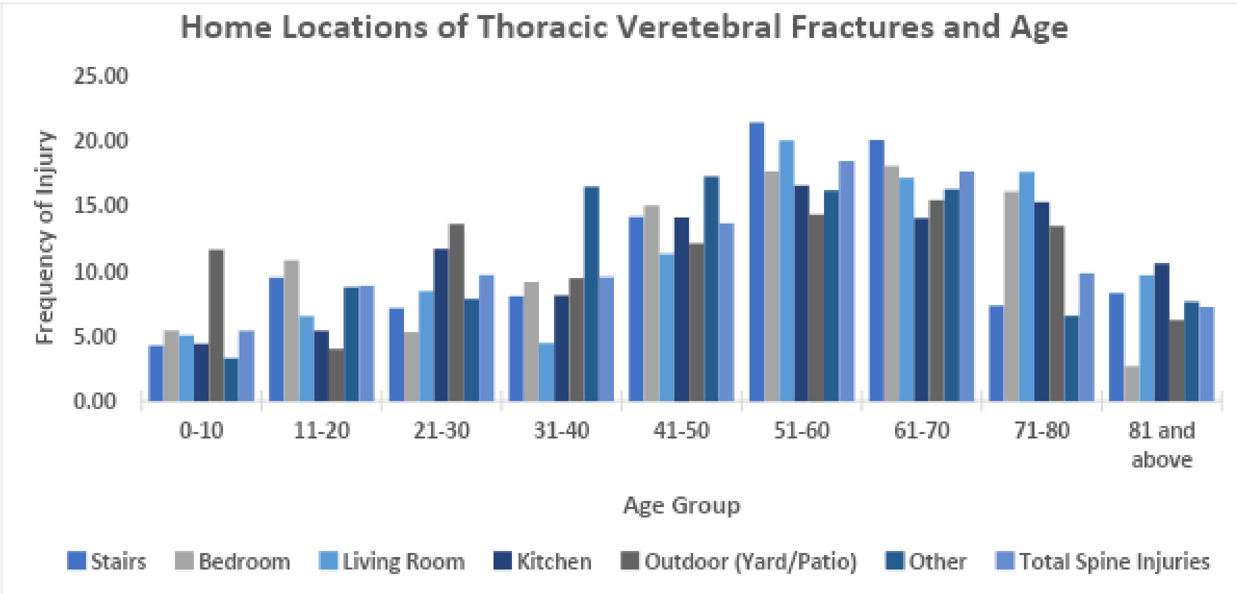
Figure 1. Thoracic vertebral fractures by Home Locations and Age Groups, illustrating the percentage of total fractures in different home locations across various age groups.



NEISS: National Electronic Injury Surveillance System
R: programming language
AOR: Adjusted Odds Ratios
US: United States
CPSC: Consumer Product Safety Commission
T-spine: Thoracic spine