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ORIGINAL RESEARCH

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Trauma occurrence and outcomes in young adult males: a five-year analysis from a level I trauma center in Northwest China

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Abstract

Background: Globally, the occurrence and trauma-related mortality rate among young adult males are both high, resulting in significant societal loss. Despite this, there is limited research focusing specifically on trauma in young adult males, making it essential to conduct a comprehensive investigation. This study aims to explore the epidemiological characteristics of trauma in young adult males, providing a reference for preventive and therapeutic strategies. **Methods**: We retrospectively analyzed 7251 cases of young adult males (aged 20–39) treated at the Trauma Center of Lanzhou University First Hospital from 01 January 2020 to 31 December 2024. Descriptive statistics were used to examine the time and monthly distribution, trauma site, causes, and length of stay (LOS) in the emergency department (ED). **Results**: A total of 7251 young adult male patients were included. Trauma cases were more frequent in the summer and autumn months (May to October) compared to the winter months (January to February). The peak times for trauma occurrences were between 12:00–16:00 and 20:00–22:00. The leading causes of trauma were falls (40.10%), road traffic accidents (16.67%), other trauma (15.32%), cuts/stabs (12.84%), violence (12.04%), mechanical injuries (2.10%), winter sports injuries (0.57%), animal bites (0.17%), burns (0.12%), and electrical injuries (0.07%). Extremity and skin trauma were the most common, with significant differences in trauma site distribution based on the causes ($p < 0.001$). The average LOS in the ED was 68.26 $\pm$ 45.70 minutes. **Conclusions**: It is essential to implement specific preventive measures targeted at reducing trauma in young adult males. Furthermore, advancements in information technology within the trauma care system can help enhance the quality of care and optimize patient management.

Keywords

Trauma; Disease analysis; Epidemiology; Injury; Trauma center

1. Introduction

Trauma is a global public health issue and one of the leading causes of death and disability among the working-age population worldwide [1–3]. Each year, millions of productive life-years are lost, resulting in significant economic and social burdens on societies globally [3]. A consistent observation across various geographical and economic contexts is that young adult males are disproportionately affected by traumatic injuries [4, 5]. This demographic group tends to engage in higher-risk behaviors and occupations, which makes them particularly vulnerable to incidents such as road traffic accidents, falls, and interpersonal violence [6].

The epidemiology of trauma, however, may not be uniform. It can potentially vary significantly based on factors such as regional socioeconomic development, infrastructure, cultural norms, and public health policies. While robust trauma registries in high-income countries have provided a wealth of data to guide prevention and treatment strategies, there is a comparative scarcity of comprehensive, registry-based research from low- and middle-income countries, where over 90% of global trauma fatalities occur [7].

Northwest China is an economically less developed region with relatively low health insurance and educational coverage, yet undergoing rapid development [8]. This rapid growth is accompanied by expanding infrastructure, increasing motorization, and significant population migration. These changes likely influence the patterns and mechanisms of traumatic injury. Previous regional studies, such as an analysis of maxillofacial trauma in Xinjiang, have highlighted the prominence of traffic accidents and the vulnerability of the young adult population [9]. Similar findings have been reported in other developing nations, where road traffic accidents are a primary cause of injury among young adults [10]. In accordance with definitions reported in multiple previous studies and consider-

ing the distribution of our dataset, young adults were defined as individuals aged 20~39 years [11–13]. Compared to older adults, young adults are often the core of the family and the main workforce of society [14]. They make significant contributions to economic growth and play a vital role in their families, often acting as primary breadwinners. They also play a key part in addressing challenges such as aging populations and promoting social stability. In this context, it becomes increasingly important to protect the health of young adult males, focusing on trauma prevention and improving the quality of trauma care for this demographic.

Understanding the specific local patterns of trauma is critical for the effective allocation of healthcare resources and the development of targeted prevention programs. For instance, identifying the predominant mechanisms of injury can inform public safety campaigns, while characterizing the most common and lethal injury patterns can guide the training and resource allocation within trauma centers [15, 16]. Furthermore, surviving a severe traumatic injury especially traumatic brain injury is not merely a physical event, it is often a profound psychological stressor with long-term consequences, including post-traumatic stress disorder (PTSD), depression, and anxiety [17–21]. This suggests that a holistic approach to trauma care must extend beyond the acute hospital stay.

This study, therefore, was designed to address the existing knowledge gap by providing a detailed, registry-based analysis of trauma in young adult males in Northwest China. The primary objectives were to comprehensive analysis of trauma, examining various factors such as the time, causes, and trauma sites, as well as the duration of stay in the emergency department (ED). By providing this foundational data, we aim to inform evidence-based strategies for trauma prevention and trauma system enhancement in this rapidly developing region.

2. Methods

2.1 Data sources

The data used in this study were obtained from the trauma database of Lanzhou University First Hospital, a Level I trauma center in Gansu Province. Strict quality control measures were implemented to ensure the integrity and accuracy of the dataset. The data includes all trauma patients treated at our hospital from 01 January 2020 to 31 December 2024. This comprehensive trauma registry encompasses all patients seeking treatment at our institution, with no exclusions based on the severity of their injuries. The exported dataset primarily includes key demographic factors such as age, gender, cause, and location of injury, along with the length of stay (LOS) in the ED. The dataset was carefully filtered by age group, focusing on male patients aged 20 to 39. After the data cleaning process, a total of 7251 cases with complete and valid data were included in the analysis.

2.2 Study methods

In this study, the cause of trauma was classified according to the system defined by the Medical Priority Dispatch System. Concurrently, trauma site categorization followed the methodology outlined in the Trauma Index [22]. A key aspect of the classification involved grouping trauma cases with unspecified causes or sites under the category of “other trauma”. This inclusive category encompasses a range of trauma types where specific details regarding either the cause or the site were unavailable.

2.3 Statistical methods

Statistical analysis in this study was performed using Excel 16.0 (Microsoft Corporation, Redmond, WA, USA) and SPSS 21.0 (IBM Corporation, Armonk, NY, USA) for descriptive statistics, while graphs were created using R 4.2.1 (R Foundation for Statistical Computing, Vienna, Austria). Key parameters, including the month of trauma occurrence, temporal distribution, causes of trauma, trauma site distribution, patient age, and the duration of stay in the ED, were systematically analyzed. For intergroup comparisons, chi-square tests were employed, with statistical significance set at $p < 0.05$.

3. Results

3.1 Basic information

From 01 January 2020 to 31 December 2024, a total of 7251 male trauma patients aged 20–39 with complete data were admitted to our trauma center. The average age of the patients was 29.66 ± 5.45 years.

3.2 Time distribution of trauma

Throughout the day, we observed that the number of young adult male trauma patients presenting to the trauma center varied over time. As shown in Table 1 and Fig. 1, the patient count was relatively low between 24:00 and 12:00, while it increased between 12:00 and 24:00. The data revealed that the peak times for young adult trauma patients occurred between 12:00–16:00 and 20:00–22:00. In contrast, the early morning hours, particularly between 8:00–10:00, saw the fewest visits, with numbers approximately one-eighth of those during peak hours. Further analysis of the trends indicates that while the number of trauma cases fluctuates from 12:00 to 24:00, it remains significantly higher than during the early morning and dawn hours. In terms of monthly distribution, trauma events in young adults predominantly occur between May and October, corresponding to the summer and autumn seasons, with the highest occurrence observed in July and August. In contrast, trauma cases in January and February are notably lower, reflecting the winter season. By dividing the day into four-time intervals for analysis, we found that trauma cases occurred most frequently between June and August, regardless of the time period, and least frequently between January and February.

3.3 Distribution of causes of trauma

Refer to the details shown in Table 2 and Fig. 2. The causes of trauma, ranked by occurrence from highest to lowest, include falls, road traffic accidents, other trauma, cuts/stabs, violence, mechanical injuries, winter sports injuries, animal bites, burns, and electrical injuries. The distribution across different age groups shows that 1876 cases occurred in the 20–24 age group,

TABLE 1. Temporal distribution of trauma.

Months/hours	0–2	2–4	4–6	6–8	8–10	10–12	12–14	14–16	16–18	18–20	20–22	22–24	Total
January	20	21	23	21	5	19	44	38	48	37	58	30	364
February	21	35	12	3	15	36	44	60	29	18	44	26	343
March	24	25	23	14	31	43	50	65	48	38	62	33	456
April	47	40	24	36	5	43	58	78	45	62	77	52	567
May	55	48	33	27	17	56	75	90	59	63	82	77	682
June	59	58	50	29	8	36	100	92	58	66	97	81	734
July	56	50	59	47	12	46	81	98	76	71	112	92	800
August	46	67	50	28	9	87	90	116	76	89	74	84	816
September	56	54	38	34	7	58	85	96	94	65	84	74	745
October	39	57	20	19	6	69	71	79	92	67	85	62	666
November	28	28	19	31	3	55	63	88	40	72	61	77	565
December	31	31	24	31	5	22	69	58	76	43	52	71	513
Total	482	514	375	320	123	570	830	958	741	691	888	759	7251

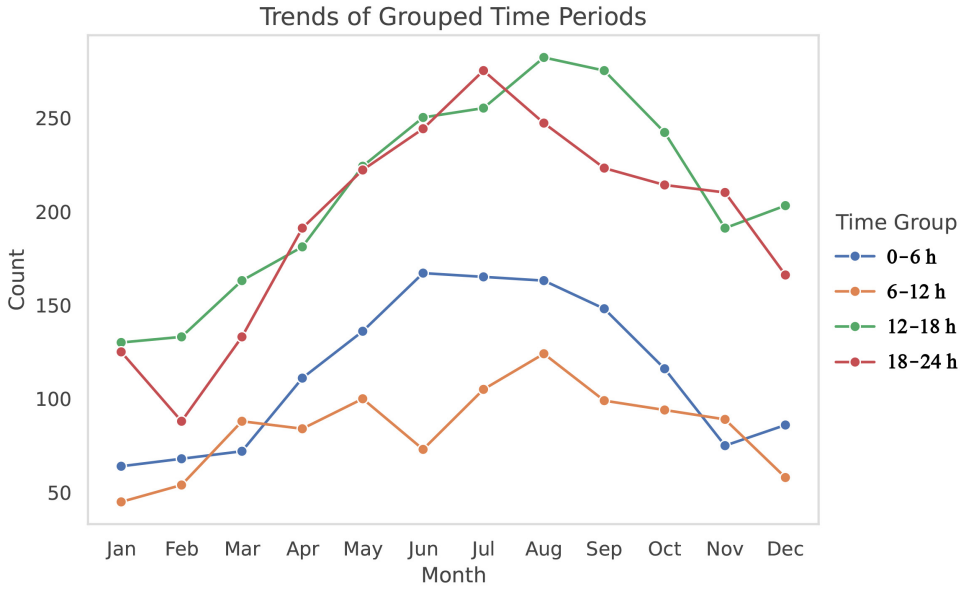

FIGURE 1. Temporal distribution of trauma.

TABLE 2. Distribution of causes of trauma.

Cause of trauma	20–24 (age)	25–29 (age)	30–34 (age)	35–39 (age)	Total	Component ratio (%)	Rank
Falls	749	749	887	523	2908	40.10	1
Road traffic accidents	294	334	367	214	1209	16.67	2
Other trauma	270	299	343	199	1111	15.32	3
Cuts/stabs	300	245	236	150	931	12.84	4
Violence	202	221	277	173	873	12.04	5
Mechanical injuries	37	44	39	32	152	2.10	6
Winter sports injuries	18	11	8	4	41	0.57	7
Animal bites	4	4	3	1	12	0.17	8
Burns	1	2	2	4	9	0.12	9
Electrical injuries	1	1	3	0	5	0.07	10
Total	1876	1910	2165	1300	7251	100.00	-

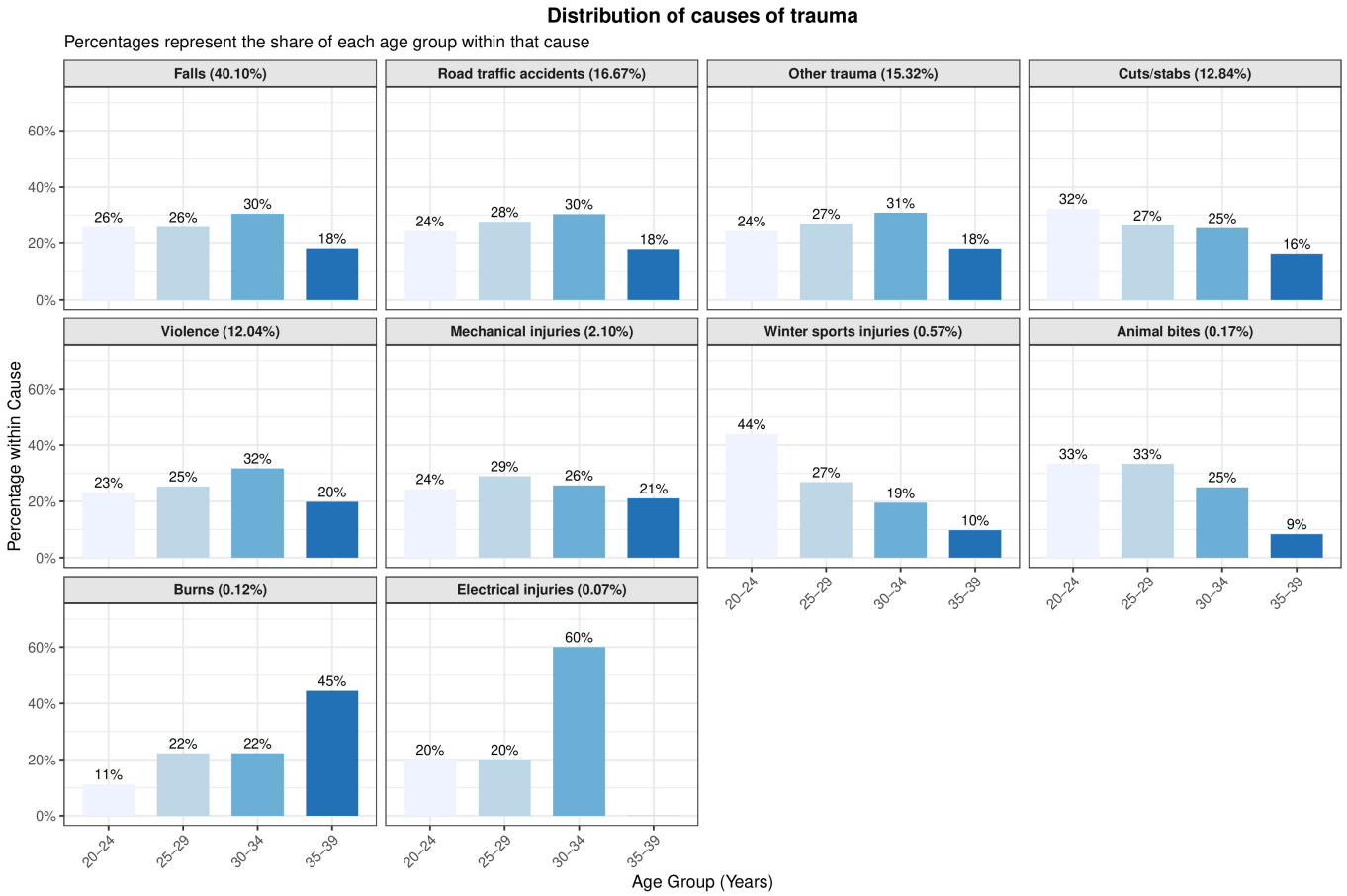

FIGURE 2. Distribution of causes of trauma.

1910 cases in the 25–29 age group, and 2165 cases in the 30–34 age group, while 1300 cases occurred in the 35–39 age group. Among these, the highest number of cases occurred in the 30–34 age group.

3.4 Distribution of trauma sites

In terms of overall occurrence, extremity/skin trauma occurred at a significantly higher rate than injuries to other body parts, followed by head/neck trauma and chest/abdomen trauma, with the fewest cases occurring in the back. The number of trauma cases was ranked as extremity/skin > head/neck > chest/abdomen > back. Statistical analysis revealed a significant difference in the distribution of trauma locations ($p < 0.001$), highlighting the notable variation in injury sites caused by different types of traumas. For a more detailed classification of trauma locations corresponding to each cause, please refer to the details listed in Table 3 and Fig. 3.

3.5 Length of stay at the emergency department

As shown in Fig. 4, the LOS for patients in the ED ranged from 16 minutes to 396 minutes. The majority of patients stayed for less than 60 minutes, and as the LOS exceeded 60 minutes, the number of patients gradually decreased with longer stays. Most patients had a LOS of no more than 90 minutes, with an average stay of 68.26 ± 45.70 minutes.

4. Discussion

This 5-year retrospective study, conducted at a level I trauma center in Northwest China, provides a comprehensive overview of the epidemiology and outcomes of trauma in young adult males. Our findings confirm that this demographic constitutes a major portion of the trauma burden, highlighting a distinct pattern of trauma driven by the region's unique socioeconomic context. The primary mechanism of trauma was predominantly falls, with the average age of patients being 29.66 ± 5.45 years. Among trauma patients, the highest number of cases occurred in the 30–34 year age group. Trauma incidents were most frequent during two peak periods: from 12:00 to 16:00 and from 20:00 to 22:00. Additionally, the occurrence of trauma was higher from May to October, while fewer cases were observed between January and February. Extremities and skin were the most common sites of injury. The average time spent in the emergency department was 68.26 ± 45.70 minutes. These findings have significant implications for public health policy, trauma prevention, and the organization of trauma care in the region.

4.1 Age characteristics of young adult male trauma patients

In this study, a total of 7251 young adult males with a mean age of 29.66 years were analyzed. The age group with the highest number of trauma cases was 30–34 years, which can be

TABLE 3. Distribution of trauma sites in patients with different causes of trauma (%).

Cause of trauma/injury location	Back	Chest/abdomen	Head/neck	Extremity/skin	Total
Falls	76	229	469	2134	2908
Road traffic accidents	38	145	241	785	1209
Other trauma	29	78	174	830	1111
Cuts/stabs	7	25	56	843	931
Violence	9	78	524	262	873
Mechanical injuries	1	11	33	107	152
Winter sports injuries	2	4	3	32	41
Animal bites	0	1	0	11	12
Burns	0	1	3	5	9
Electrical injuries	0	0	0	5	5
Total	162	572	1503	5014	7251

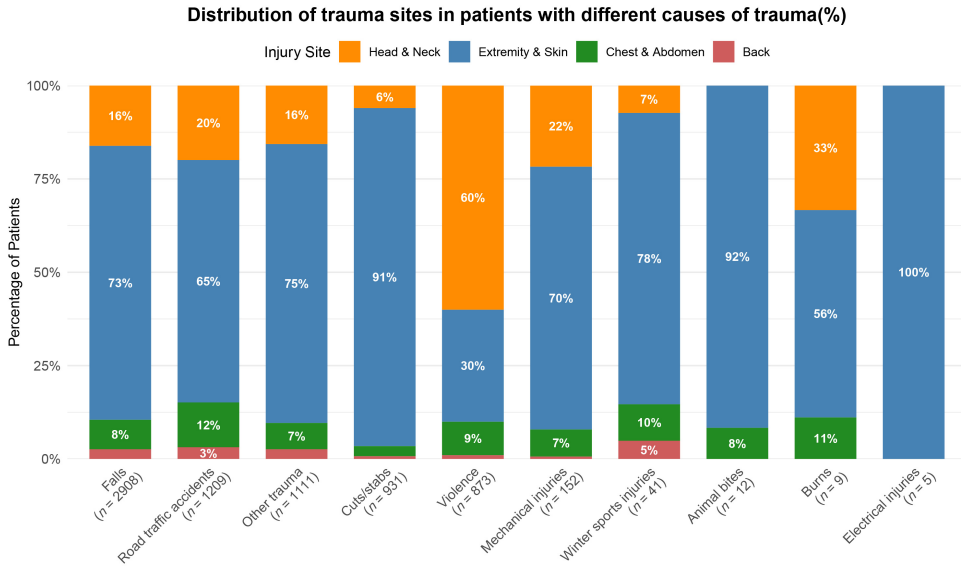

FIGURE 3. Distribution of trauma sites in patients with different causes of trauma.

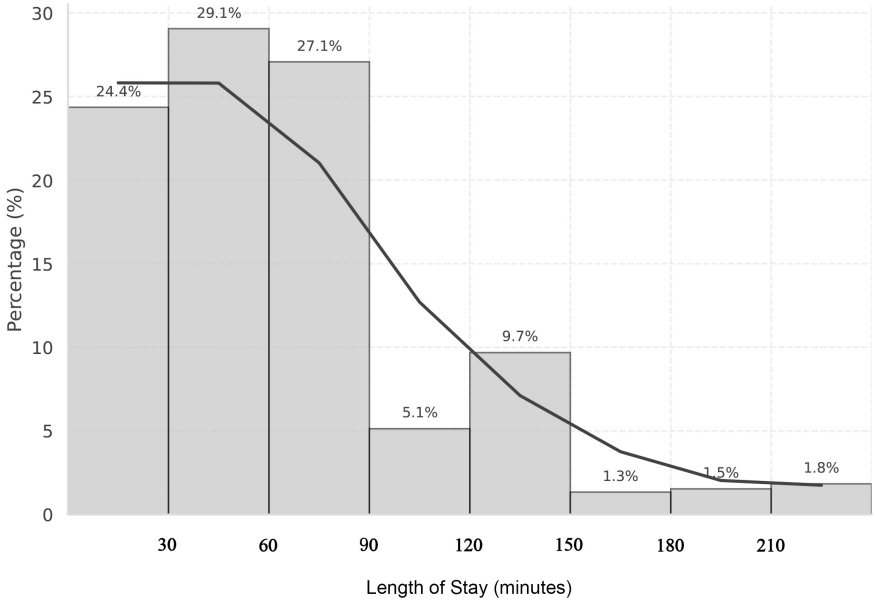

FIGURE 4. Length of stay in the emergency department.

attributed to several factors. During growth and development, male bone mineral density reaches its peak between the ages of 20 and 23 and subsequently declines with age [23]. Additionally, other physiological functions also experience gradual decline with aging [24]. Consequently, compared to the 20–29 age group, individuals in the 30–34 age group have relatively more fragile bone structures, and experience a decline in their reflexes, leading to a higher likelihood of trauma. Furthermore, compared to the 35–39 age group, the 30–34 age group may be in a period of career advancement, often engaging in more physically demanding or high-risk occupations, which further contributes to a higher trauma occurrence.

4.2 Time distribution and monthly patterns of trauma incidents

The number of trauma admissions exhibits distinct temporal patterns, with the lowest frequency observed in the early morning hours (8:00–10:00), followed by a marked increase from 10:00 to 24:00, particularly peaking in the afternoon between 12:00 and 16:00. The secondary peak occurs between 20:00 and 22:00. This pattern can be attributed to several factors, with a primary focus on the daily activity patterns of young adult males. Between 8:00 and 10:00, young adult males typically follow stable routines, such as work, school, or daily chores, during which the likelihood of trauma is comparatively low. After 10:00, as daily activities accumulate, the risk of accidents rises, particularly during the afternoon hours of 12:00 to 16:00, when outdoor activities or leisure pursuits increase the likelihood of injury.

Furthermore, from the perspective of work and social activities, young adult males are more likely to experience trauma between 12:00 and 16:00, as many engage in social gatherings beyond work or academic commitments. Post-lunch, especially in recreational venues, parties, or sports activities, trauma incidents are notably frequent. Additionally, the period from 20:00 to 22:00 is marked by an uptick in entertainment activities, such as social gatherings, dinners, and outings. At this time, the more relaxed social atmosphere, coupled with alcohol consumption and fatigue, contributes to an increased occurrence of trauma, including fights, falls, and traffic accidents.

Moreover, these patterns may be influenced by circadian rhythms, as research has shown that human alertness is closely related to internal homeostasis and circadian processes [25]. During the night, homeostatic processes accumulate sleep pressure, which decreases alertness upon waking. However, sleep pressure gradually increases with wakefulness, thereby affecting cognitive and physical vigilance throughout the day [26]. In the morning, reduced sleep pressure corresponds with higher alertness and lower trauma rates in young workers. Specifically, in Lanzhou, these patterns align with the local climate and the typical daily schedules of young adult males. Lanzhou, characterized by a temperate continental climate with significant diurnal temperature variation, experiences lower temperatures in the early morning hours [27]. This colder temperature limits outdoor activity, resulting in a lower occurrence of trauma. As temperatures rise after 10:00, young adult males begin engaging in more physically demanding tasks, thereby increasing the likelihood of injury.

Notably, the trauma occurrence peaks between 14:00 and 16:00, which may be associated with the “afternoon slump” effect. This phenomenon, linked to the interaction between homeostatic processes and circadian rhythms, contributes to decreased alertness as sleep pressure accumulates after midday [28]. During this period, many industries, such as construction and transportation, resume high-intensity operations, which increases the risk of accidents and workplace injuries, such as falls.

These findings highlight the need for targeted trauma prevention and emergency resource planning, particularly for young adult males. The monthly distribution demonstrated a higher prevalence of trauma between May and October, corresponding to Lanzhou’s warmer seasons. Conversely, rates decreased significantly in the colder months of January and February. This pattern suggests that warmer weather may promote increased outdoor or occupational activity [29], potentially elevating the risk of injury. Seasonal variation should thus be considered in the development of dynamic prevention strategies.

4.3 Causes and site distribution characteristics of trauma

Falls are the leading cause of trauma, aligning with established trauma patterns observed in demographic studies [30]. Large-scale trauma studies from the Netherlands, Spain, and the United States have reported similar findings, identifying falls as the primary cause of trauma, with road traffic accidents also being a significant contributor [31–33]. However, a study on major trauma conducted in Switzerland found that road traffic accidents were the leading cause of trauma, followed by falls [34]. Similarly, research from Nigeria yielded comparable results [35]. These findings suggest that the primary causes of trauma may vary depending on regional economic development and traffic conditions. Nevertheless, falls and road traffic accidents consistently emerge as major causes of trauma across different regions. Despite the variations in regional studies, the overall trend indicates that young males, due to their engagement in risk behaviors, face a higher risk of falls and traffic accidents, drawing attention from public health experts. This highlights the urgent need for preventive measures to reduce trauma risk in young adults and raise safety awareness.

Although much of the published research focuses on falls in the elderly, falls remain a significant trauma pattern in young adults as well. A study conducted in the United States identified slipping and tripping as the primary causes of falls in this population [36]. Due to the higher physical activity levels in this population, the mechanical instability of bipedal motion is greater, and multitasking behaviors (*e.g.*, walking while chatting) often lead to high falls or other types of accidents [36, 37]. Additionally, alcohol or drug use are major contributing factors to the increased fall rate among young adults [38].

In the context of Lanzhou, a city situated in the Yellow River Basin with complex topography and steep slopes in certain areas, the occurrence of high falls and falls is particularly high. Furthermore, the growth of manufacturing and construc-

tion industries in Lanzhou has increased the participation of young adult males in high-risk labor, thus further raising the likelihood of fall-related trauma. Road traffic accidents are the second most common cause of trauma among young adult males in Lanzhou. With economic development, the surge in motor vehicle numbers, coupled with the narrow roads in some valley regions, has heightened the probability of traffic-related injuries.

It is noteworthy that the primary injury sites among young adult males in Lanzhou are the extremities and skin. Additionally, significant differences are observed in the distribution of trauma sites depending on the trauma's cause ($p < 0.001$). This suggests that the nature of the trauma—whether it is associated with falls, road traffic accidents, or other causes—tends to affect specific areas of the body. Understanding these differences is crucial for developing targeted prevention and treatment strategies that address the unique risks associated with each type of trauma.

4.4 Length of stay of young adult male trauma patients

Severe trauma often results in injuries to multiple anatomical sites and organs, significantly affecting the overall physiological status of the body. These cases are prone to misdiagnosis and are challenging to treat. If the injured individual does not receive timely and effective treatment, it may lead to death [39]. Prolonged pre-hospital care, rescue, and treatment times lower survival rates and negatively impact prognosis [40, 41]. Therefore, providing "rapid, accurate, correct, and effective" emergency treatment is crucial, and minimizing the LOS in the ED is essential. For example, the National Health Management Targets of New Zealand recommend controlling LOS to within 6 hours for 95% of patients, while in the UK, a LOS exceeding 4 hours is considered associated with poor prognosis [42–44]. As the world's second most populous country, China faces the challenge of balancing a large population with limited healthcare resources. The prolonged stay of critically ill patients in the ED severely affects the quality of care and increases waiting times for new patients [45], which may correlate with higher mortality and poorer outcomes. Given these realities, there is an urgent need to optimize trauma center processes and improve treatment quality. Currently, the average length of stay in our hospital's ED is 68.26 ± 45.70 minutes, and the occurrence of patients staying in the ED for more than 4 hours has significantly decreased. Information technology is also playing an increasingly important role in improving trauma systems [39]. In today's era of rapid technological advancement, we firmly believe that the informatization of the healthcare system will significantly shorten LOS, greatly enhance the quality of trauma care, and make substantial contributions to improving healthcare services and advancing medical health development.

Interestingly, findings from a pediatric trauma study in Saudi Arabia highlight that the mechanism of injury can significantly influence LOS [46]. In that study, patients with motor vehicle injuries were nearly five times more likely to experience extended hospital stays ($\geq$21 days) compared to patients with fall injuries, and those with prolonged LOSs had more severe injuries as indicated by higher Injury Severity Scores and lower Glasgow Coma Scale scores [46]. While the population and healthcare context differ from China, this research underscores the importance of targeted preventive measures and resource allocation. For adult and mixed trauma populations, such insights suggest that specific injury types—particularly high-energy traumas—may disproportionately contribute to ED and hospital stay lengths. Integrating mechanism-specific management strategies and early triage protocols could therefore be an effective way to further optimize LOS and improve outcomes.

4.5 Recommendations for the prevention and treatment of trauma in young adult males

To address the epidemiological characteristics of young adult males, the following preventive measures can be implemented:

1. Enhance safety awareness education for young adult males, focusing on practices such as moderate alcohol consumption, proper medication use, maintaining focus, and avoiding rugged terrain to prevent accidents such as falls or high-impact injuries.
2. Improve road traffic design and urban traffic conditions, further promoting traffic safety knowledge and legal regulations. Strict enforcement of laws against drunk driving, speeding, and other violations will help effectively prevent traffic accidents.
3. Ensure comprehensive workplace and labor protection by improving safety measures in the work environment, providing safety training for workers, ensuring compliance with standard operating procedures, and equipping protective measures.
4. Promote mental health education across society, disseminate legal knowledge, implement anti-violence laws, enforce strict control over weapons, and impose severe penalties for violent actions to maintain a harmonious and safe social environment.

In terms of treating young adult male patients, the trauma registry system can be further improved by establishing a dedicated trauma database for this group. Statistical analysis of the data in this database can reveal the unique characteristics and patterns of trauma in this age group. Based on these findings, targeted research on trauma treatment for young adult males can be conducted, and corresponding treatment strategies can be developed to improve the quality of trauma care for this population, thereby reducing mortality and adverse outcomes.

4.6 Limitations

The limitations of this study include the fact that our data were exclusively sourced from the Trauma Center at the First Hospital of Lanzhou University, a level I trauma center. Due to the siphoning effect in healthcare, some patients may preferentially seek treatment at higher-level trauma centers, which could introduce a potential selection bias in our findings. As a result, the trauma patterns and outcomes observed in our study may not fully represent those encountered in lower-level trauma centers, potentially limiting the generalizability of our conclusions.

Additionally, the study period encompassed the COVID-19 pandemic, during which the number of patients visiting the

hospital was reduced due to various restrictions and concerns regarding virus transmission. This decrease in patient volume may have affected the trauma case distribution and could have led to an underrepresentation of certain trauma types.

Furthermore, this study did not specifically examine whether the injuries were work-related. This could be an important factor for prevention planning, and its absence may limit the comprehensiveness of the findings. Future research should consider including data on the occupational nature of injuries to better inform prevention strategies in this demographic.

These factors may have influenced the results of our research, and future studies should consider a more diverse data pool from multiple trauma centers and longer follow-up periods to confirm the findings and better understand the broader impact of the pandemic on trauma care.

5. Conclusions

The occurrence of trauma among young adult males is high, and the timing, causes, and sites of their trauma show distinct characteristics. Overall, falls are the leading cause of trauma in this group. Traumas occur more frequently during favorable weather conditions, when social interactions and work activities are more prevalent. Implementing targeted preventive measures is crucial for improving the outcomes of such injuries. Additionally, optimizing the trauma care system and promoting its informatization will further enhance the quality of trauma treatment.

ABBREVIATIONS

PTSD, Post-Traumatic Stress Disorder; ED, Emergency Department; LOS, length of stay.

AVAILABILITY OF DATA AND MATERIALS

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request. The data are derived from the institutional trauma registry of The First Hospital of Lanzhou University. Restrictions apply to the availability of these data, which were used under license for the present study and are therefore not publicly available.

AUTHOR CONTRIBUTIONS

LYZ, KYL, LH, ZYS, YTL—Conceptualization; Writing–review & editing. LYZ, KYL, JXC, YRH—Data curation; Visualization (Figure preparation). LH, YRH, YL—Formal analysis; Software (Statistical computing). ZYS, KYL, XYL—Methodology; Validation. YTL, NM—Supervision; Validation (Results verification); Writing–review & editing. LSD—Project administration; Funding acquisition. All authors contributed to writing the original draft, read and approved the final manuscript, and agreed to be accountable for all aspects of the work.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was approved by the Ethics Committee of The First Hospital of Lanzhou University (Approval No. LDYYLL2024-428). Given that this study involved a retrospective analysis of routinely collected clinical data, the requirement for informed consent was waived by the Ethics Committee.

The waiver was granted based on the following conditions: (1) All patients were informed at the time of admission that their anonymized medical data might be used for future scientific research; (2) All data were de-identified and anonymized prior to analysis to ensure patient confidentiality; and (3) The research posed minimal risk to participants. The study was conducted in strict accordance with the principles of the Declaration of Helsinki and the ethical guidelines set forth by our institution.

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CONFLICT OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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