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ORIGINAL PAPER

RISK FACTORS OF OCCUPATIONAL INJURIES AND PREVENTION STRATEGY AMONG CHINESE FRONTLINE FIREFIGHTERS

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Highlights

- Firefighters' occupational injuries are influenced by multiple factors.
- The injury rate among firefighters is very high.
- Occupational training is the most significant factor among frontline firefighters.

Abstract

Background: Occupational injuries among firefighters significantly impact their job performance. To reduce these injuries and enhance their professional capabilities, this study investigates and comprehensively evaluates the factors contributing to occupational injuries among frontline firefighters in China. It analyzes the underlying mechanisms of these injuries and proposes preventive strategies. **Material and Methods:** This study employed questionnaire surveys and factor analysis methods to conduct a comprehensive investigation and comprehensive assessment of occupational injuries and their influencing factors among 200 firefighters in China. The research subjects were randomly selected from the grassroots firefighters in cities of FuJian Province. Among them, 179 firefighters successfully completed the questionnaire survey. Through exploratory factor analysis, the key factors influencing firefighters' injuries were identified. **Results:** The injury rate among the participating firefighters in 2023 was 40.78%. The highest injury rate was observed during daily training (58.52%). Notably, the injury rate tends to decrease with increasing age. The most common types of injuries were sprains and strains (57.10%), with the knee joint exhibiting the highest incidence of injury among all body parts (47.00%). The primary factors influencing occupational injuries among firefighters include training factors, support factors, educational factors, and mental health factors, which collectively account for a variance contribution rate of 79.56%. **Conclusions:** Training, support, educational, and mental health factors are the 4 primary influences on firefighters' occupational injuries. The administrative department should strengthen the study and practice of physical fitness theory for firefighters, prioritize the prevention of occupational training injuries, enhance the scientific rigor of training programs, and promote the occupational health of firefighters. Med Pr Work Health Saf. 2026;77(1)

Key words: firefighters, occupational injury, prevention strategy, affecting factors, factors analysis, occupational training

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INTRODUCTION

Firefighting is a highly demanding, physically strenuous, and high-risk occupation. Due to the nature of this profession, firefighters face multiple hazards during firefighting operations, including exposure to toxic fumes, thick smoke, dangerous combustion products, high radiant heat loads, and chaotic work environments [1]. These environmental stressors can lead to cardiovascular strain and alterations in cardiac function among firefighters, potentially resulting in fatal outcomes [2]. The study has proved that in Poland 2015–2022, there were 12 588 individual and group accidents in various circumstances [3]. Most firefighter accidents occurred during rescue and firefighting operations, as well as during sports activities which dominate as the cause of injuries among firefighters in the observed period (37.8%), and injuries related to rescue and fire-fighting activities constitute 28.5%. Other work activities of firefighters cause 33.7% of injuries [3]. Complex architectural environments and spatial terrains can further increase physical exertion, thereby elevating the risk of injury.

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Additionally, traumatic experiences encountered during rescue operations can trigger post-traumatic stress responses and may lead to psychological disorders such as depression. A study has showed the stronger relationship and hierarchical system between post-traumatic stress disorder (PTSD) and depressive symptoms among firefighters [4]. Another study from South Korea on PTSD and post-traumatic growth (PTG) among 483 firefighters revealed the following results: "Low PTSD–low PTG (65.2%), moderate PTSD–moderate PTG (15.5%), low PTSD–high PTG (15.3%), and high PTSD–moderate PTG (3.9%)" [5]. Although a small proportion of firefighters suffer from high PTSD–moderate PTG following an injury, this demonstrates that firefighting significantly impacts their physical and mental health. Compared to other professions, firefighters experience significantly higher rates of occupational injuries. Multiple studies have confirmed high injury rates, and reported injury rates ranged 9–74% [6]. Some injuries can end a firefighter's career. One survey suggested that only about 18% of injured firefighters returned to their jobs, while 46% were unable to work due to their injuries [7]. Occupational injuries not only affect job performance but also increase medical costs. Physical rehabilitation accounts for 34% of these expenses [8].

To meet job demands, firefighters must engage in regular physical and drill training, encompassing aerobic and anaerobic endurance, strength, speed, agility, flexibility, and overall fitness training [9,10]. Most occupational injuries among firefighters are related to musculoskeletal issues. Studies indicate that 65% of musculoskeletal disorders occur during firefighting duties or physical training, while only 15% result from actions at the fire scene [11,12]. Intensive training often leads to musculoskeletal injuries due to the high physical fitness requirements of the profession. Thus, firefighter injuries are not just a fireground problem [11]. The occupational threats faced by firefighters are associated with rescue operations, firefighting, and occupation-related drills, training, and sports activities.

Since 2018, China's national firefighting administration has implemented a professionalization reform, leading to substantial transformations in recruitment, training, rescue missions, and support measures. To adapt to the demands of this professionalization reform, Chinese firefighters must undergo extensive physical fitness and skills training. However, due to the immaturity of the professional training system and sports health protection measures, preventing occupational injuries, proposing effective strategies, and improving occupational health have become critical research tasks. This study explores the characteristics and influencing factors of occupational injuries among Chinese firefighters, proposes a prevention mechanism, and provides suggestions for their professional development.

MATERIAL AND METHODS

Research subjects

This study focused on injuries related to firefighter occupational training. A total of 200 firefighters were selected from various regions in FuJian Province. Participants were asked to complete an online questionnaire within 1 day. This arrangement is conducive to timely collection of the questionnaires, so as to prevent firefighters from failing to complete or losing the questionnaires due to work-related issues. The research selected 8 fire stations in 4 cities: Fuzhou, XiaMen, Longyan and Zhangzhou. Each station had 25 frontline firefighters participating in the questionnaire survey. The respondents were informed of the purpose and content of the research and signed the consent forms.

Inclusion criteria: participants were primarily frontline firefighters (excluding managerial personnel), including both professional and volunteer firefighters who participated voluntarily.

Exclusion criteria: due to the specific nature of grassroots firefighting work, only male firefighters were included in the survey.

Questionnaire survey

The questionnaire was developed based on a comprehensive review of relevant literature concerning occupational health risk assessments for firefighters, incorporating findings from existing firefighter surveys and structured expert interviews. The framework and content of the questionnaire were formulated using a combination of investigative methods and expert scoring techniques. Key risk factors contributing to training-related injuries among firefighters were identified and integrated into a dedicated risk assessment form for occupational training injuries.

To ensure content validity, the research team engaged 6 experts specializing in fire protection, occupational health, and sports science to evaluate the questionnaire. These experts performed a 3-level rating assessment (categorized as "very relevant," "relevant" or "irrelevant") to judge the relevance of each item to the measurement objectives. After 2 rounds of expert review and subse-

quent revisions, the item-level content validity index reached 0.83, indicating strong content validity.

The reliability of the questionnaire was assessed through an analysis of internal consistency using SPSS statistical software package (v. 26.0 (IBM, Chicago, IL, United States) statistical software. The result yielded a Cronbach's α value of 0.76 (exceeded the threshold value of 0.7), demonstrating acceptable internal consistency reliability. Upon establishing satisfactory validity and reliability, the final testing index system was formally completed.

The questionnaire consisted of 2 parts:

- part 1 included: demographic information (age, height, weight, length of service), training details (average daily training duration, injury history, injuries sustained January–December 2023, types of injuries, and training status post-injury);
- part 2 included 24 potential items (X1–X24) contributing to occupational training injuries. Each factor was an ordinal variable rated on a 1–5 scale, with higher scores indicating a greater perceived impact.

Table 1. Demographic data of firefighters participating in the survey conducted in FuJian Province, China, 2023

Variable	Participants (N = 179)
Age [years]	
M±SD	27.10±5.10
min.–max	20–37
Height [cm]	
M±SD	174.18±2.50
min.–max	162–187
Weight [kg]	
M±SD	71.50±7.75
min.–max	61–93
BMI [kg/m^2]	
M±SD	23.61± 2.45
min.–max	17.10–28.60
Seniority [years]	
M±SD	9.60±3.74
min.–max	1–17

Data analysis

Descriptive statistics were calculated for demographic data like age, injury rate, type of injury, injury scene, and body mass index (BMI). The data analysis procedure consisted of 2 primary steps: data preprocessing and exploratory factor analysis (EFA).

Step 1: data preprocessing – positive treatment and standardization

Due to inconsistencies in the scoring ranges and directional interpretations of the 24 questionnaire items, the raw data required initial positive treatment to unify the scoring direction. Following this adjustment, the data were standardized using the default Z-score procedure in SPSS to eliminate scale differences and meet the assumptions of multivariate analysis.

Step 2: exploratory factor analysis

Exploratory factor analysis was conducted on the 24 influencing items. The suitability of the data for EFA was first assessed using the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test of sphericity. Upon confirming factorability, principal component analysis was employed to extract components. The criteria for retention included a minimum eigenvalue of 1.0 and communalities >0.7 for all indicators. Varimax rotation with Kaiser normalization was then applied to achieve a simplified factor structure through variance maximization. The rotated component matrix was examined, and the extracted factors were named based on the substantive characteristics of the variables loading highly on each factor.

RESULTS

Basic analysis of firefighters' demographic data

A total of 200 questionnaires were distributed and returned. After excluding 7 questionnaires from female firefighters and 14 invalid responses, 179 valid questionnaires were analyzed. Descriptive statistics are presented in Table 1. Among the 179 respondents, age was M±SD 27.10±5.10 years, height was M±SD 174.18±2.50 cm, weight was M±SD 71.50±7.75 kg, and BMI was M±SD 23.61±2.45 kg/m^2. The length of service was M±SD 9.60 ± 3.74 years, training experience was M±SD 10.20±2.14 years, and daily training time was M±SD 5.50±1.50 h. Analysis of demographic statistics revealed that the personnel are relatively young, which is related to China's professionalization reform. However, shorter working experience may increase injury risk due to insufficient rescue and firefighting experience. Obese individuals (BMI ≥ 28 kg/m^2) accounted for approx. 2.2%. Overweight individuals (BMI 24–27.9 kg/m^2) accounted for approx. 17.8%. Normal weight individuals (BMI 18.5–23.9 kg/m^2) accounted for approx. 78.3%. Underweight individuals (BMI < 18.4 kg/m^2) accounted for approx. 1.7%.

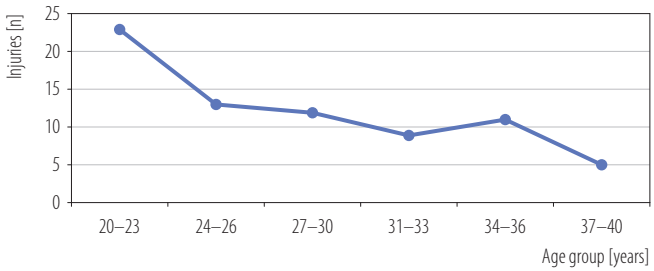
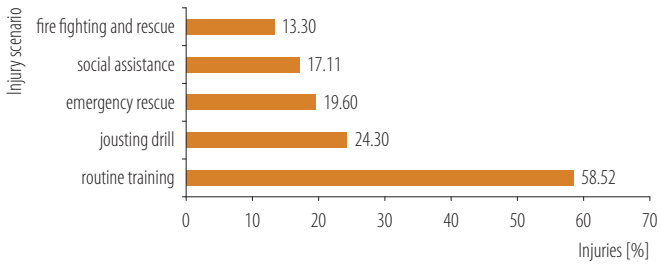


Figure 1. Relationship between age and injury frequency on 179 firefighters participating in the survey conducted in FuJian Province, China, 2023



Multiple-choice question.

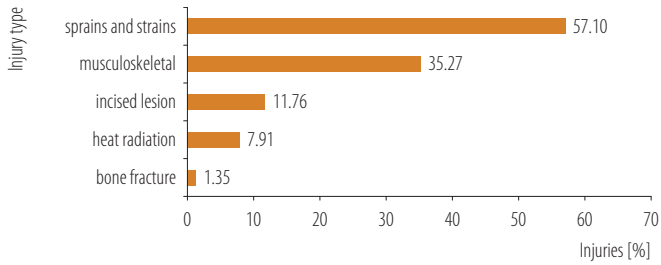
Figure 2. Distribution of injuries by scenario among 179 firefighters participating in the survey conducted in FuJian Province, China, 2023

Analysis of occupational injury characteristics by age among injured firefighters

All surveyed firefighters (100%) reported having suffered injuries since joining the service. In 2023 106 firefighters reported no injuries during training, while 73 experienced injuries, resulting in an annual injury rate of 40.78%. Among the injured, 58 continued training despite their injuries. Statistics on the number of injuries by age group are shown in Figure 1. The number of injuries generally decreased in 20–40-year-old age group, with a slight increase observed in the 34–36-year-old age range. The highest number of injuries occurred in the 20–23-year-old age group (21 instances), accounting for 28.8% of total injuries, identifying them as a high-risk group. This highlights the need for strengthened theoretical knowledge and physical training. The slight increase in the 34–36-year-old age group may be related to declining muscle mass and increased administrative duties reducing exercise time and intensity.

Analysis of the scenarios of firefighters' occupational injuries

The investigation into the scenarios of 179 firefighters' injuries was based on the analysis of data from injury incidents involving firefighters over the past year.



Multiple-choice question.

Figure 3. Injury types of 179 firefighters participating in the survey conducted in FuJian Province, China, 2023

The investigation of the scene of firefighters' injuries involves multiple-choice questions. Investigation into injury scenarios revealed that injuries during daily training accounted for the highest proportion (58.52%), followed by injuries during live-fire drills and exercises (24.3%) (Figure 2). This may be related to training intensity and fatigue accumulation. Injuries during rescue operations, social assistance, and firefighting accounted for 19.6%, 17.1%, and 13.3%, respectively. Usually, each injury suffered by firefighters corresponds to a specific scenario. Sometimes a firefighter may experience multiple occupational injuries within 1 year, and thus the types of corresponding scenarios may also vary. The research results further indicate that the occupational injuries of firefighters are closely related to the training scenarios. Therefore, firefighters should pay attention to the atmosphere of the training environment, the degree of concentration and psychological changes during their daily training.

Investigation and analysis of the types of injuries suffered by firefighters

The lifetime injury incidence rate among the 179 surveyed firefighters was 100%. Injury types and locations were assessed via multiple-choice questions. The main injury types were sprains and strains (57.1%) (Figure 3). The most common injury sites were the knees (47%), ankles (36%), and lower back (35%) (Figure 4). Long-term overtraining creates "weak links" making these areas prone to injury. New recruits are particularly susceptible due to lack of systematic training, weak core strength, and poor physical stability.

Extraction of occupational injury factors and principal factor analysis for firefighters

Analysis was conducted on the 24 indicators related to occupational training injuries in Table 2. Reverse score items were normalized, and Z-score standardiza-

tion was performed using SPSS. The KMO test value was 0.713, and Bartlett's test of sphericity was significant ($p < 0.01$), indicating the data were suitable for factor analysis. The communality of multiple factors >0.7, demonstrating strong correlations.

Principal component analysis with varimax rotation (Kaiser normalization) was applied to the 24 items. The rotation converged after 5 iterations. Based on the criterion of eigenvalues >1.0, 4 principal factors (F1, F2, F3, F4) were extracted, accounting for a cumulative variance of 79.56% (Table 3), effectively representing major data variations. The maximum variance method was applied to analyze the data of 24 items, and the rotated component matrix obtained was shown in Table 2. Multiple factors loading values of the relevant items >0.5, so these items were classified into the same factor category. Based on the meanings represented by the indicators with higher principal factor loadings, they are respectively named.

Training factor – F1

The following 9 indicators exhibited high loading values (≥0.7):

- the rationality of training content and scheduling (X3),
- the rationality of training intensity and rhythm (X4),
- the degree of warm-up before training (X5),
- the degree of relaxation after training (X6),
- the mastery level of sports techniques (X7),
- the level of concentration during training (X8),
- the frequency of weekly training (X12),
- the sports participation before employment (X13),
- the physical fitness level before employment (X14).

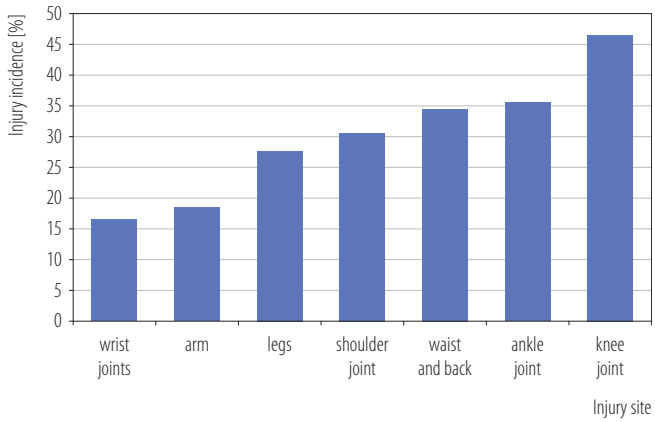
These indicators reflect the impact of firefighters' daily training, thus this factor is named the training factor.

Support factor – F2

The following 7 indicators demonstrated high loading values (≥0.7):

- the suitability of the training venue (X1),
- the adaptability of training equipment (X2),
- nutrition supplementation after training (X9),
- the daily sleep duration (X10),
- the appetite situation (X11),
- the use of protective equipment during training (X19),
- the allocation of coaches (X20).

These indicators represent the foundational support influencing firefighters' training, thus this factor is named the training support factor.



Multiple-choice question.

Figure 4. Injury site of 179 firefighters participating in the survey conducted in FuJian Province, China, 2023

Education factor – F3

The following 5 indicators exhibited high loading values (≥0.7):

- the awareness of the importance of physical training after employment (X15),
- the learning of injury prevention knowledge after employment (X16),
- training in injury prevention after employment (X17),
- the level of proficiency in applying injury prevention measures after employment (X18),
- the educational attainment level of team members (X22).

These indicators reflect firefighters' learning, mastery, and application of injury prevention knowledge, thus this factor is named the individual education factor.

Mental health factor – F4

The following 3 indicators exhibited high loading values (≥0.7):

- the level of friendliness in interpersonal relationships among team members (X21),
- members' satisfaction with their achievements (X23),
- members' level of psychological stress (X24).

As these indicators collectively represent the influence of psychological factors, this component was designated the mental health factor.

DISCUSSION

Occupational injury characteristics of Chinese frontline firefighters

The issues of obesity are of great concern to the fire management department. Obesity increases physical burden,

Table 2. Rotated component matrix of 24 main items affecting occupational injury of 179 firefighters participating in the survey conducted in FuJian Province, China, 2023

Item	F1	F2	F3	F4
X1. The suitability of the training venue	0.046	0.779	0.033	–0.032
X2. The adaptability of training equipment	0.023	0.703	0.009	–0.133
X3. The rationality of training content and scheduling	0.807	0.131	0.018	0.007
X4. The rationality of training intensity and rhythm	0.915	0.025	0.045	0.015
X5. The degree of warm-up before training	0.899	0.122	0.475	–0.074
X6. The degree of relaxation after training	0.875	–0.017	0.366	0.118
X7. The mastery level of sports techniques	0.812	0.025	0.101	0.026
X8. The level of concentration during training	0.837	0.066	0.121	0.170
X9. Nutrition supplement after training	0.067	0.738	0.050	0.019
X10. The daily sleep duration	0.278	0.964	0.039	0.065
X11. The appetite situation	0.079	0.878	0.064	0.138
X12. The frequency of weekly training	0.452	0.752	0.181	0.176
X13. The sports participation before employment	0.758	–0.053	0.322	0.114
X14. The physical fitness level before employment	0.788	0.019	–0.034	–0.020
X15. The awareness of the importance of physical training after employment	0.541	0.411	0.973	–0.053
X16. The learning of injury prevention knowledge after employment	0.165	0.042	0.875	–0.020
X17. Training in injury prevention after employment	0.276	0.066	0.830	0.051
X18. The level of proficiency in applying injury prevention measures after employment	–0.065	0.165	0.821	0.430
X19. The use of protective equipment during training	–0.079	0.842	0.064	–0.023
X20. The allocation of coaches	0.182	0.726	0.231	–0.077
X21. The level of friendliness in team members' interpersonal relationships	–0.230	0.037	0.155	0.786
X22. The educational attainment level of team members	0.074	–0.071	0.779	–0.170
X23. The satisfaction of team members with their achievements	0.231	0.573	–0.371	0.765
X24. The psychological stress level of team members	0.017	0.263	0.016	0.899

The extraction method is the principal component analysis method. If the extraction value of a relevant factor is >0.7, this factor is included in the relevant factors.
F1 – training factor, F2 – support factor, F3 – education factor, F4 – mental health factor.

impedes heat dissipation, negatively affects performance, and elevates injury risk [13]. According to the survey results of first-line firefighters in Table 1, the proportion of obese individuals is relatively low, accounting for only 2.2%. The main reason is that Chinese firefighters have numerous duty tasks and a high daily training load, resulting in significant energy consumption. Firefighting is inherently injury-prone. Threats arise from rescue operations, firefighting, drills, training, and sports activities [14]. According to the findings of this study, routine training is a significant scenario for occupational injuries among Chinese frontline firefighters. Therefore, it is necessary to make proper plans for training, update training equipment and provide protection, conduct stretching and relaxation before and after training, and avoid sports injuries. A strain involves injury to the muscle or musculotendinous junction, while a sprain is an injury to a ligament [15]. Previous studies report similar findings, with 64% of injuries classified as sprains/strains, and the back being the most common site (32%) [7]. Other studies indicate common injury sites are the knees, shoulders, and back, with back injuries often occurring during weightlifting, knee injuries during squatting, and shoulder injuries during pushing/pulling tasks [11]. The results of this study indicate that the first-line firefighters in China need to enhance protection for vulnerable parts that are prone to injury. From the perspective of injury sites and injured joints, the reason for the high injury rate in multiple areas is the high-load usage of various body parts, which leads to excessive fatigue and makes it easy for firefighters to suffer occupational injuries in various working environments. Therefore, en-

Table 3. Interpretation of variance of extracting the common factors based on data from 179 firefighters participating in the survey conducted in FuJian Province, China, 2023

Factor	Initial value eigenvalue			Sum of squares of rotational load		
	total	variance [%]	cumulative [%]	total	variance [%]	cumulative [%]
F1	7.877	36.196	36.196	7.359	34.453	36.949
F2	3.962	18.101	54.297	3.977	18.842	53.295
F3	3.345	15.128	69.425	3.198	15.023	68.318
F4	2.108	10.143	79.568	2.257	11.250	79.568

The extraction method was principal component analysis. This table presents only components with eigenvalues exceeding 1.0.
F1 – training factor, F2 – support factor, F3 – education factor, F4 – mental health factor.

hancing protection and functional training for these vulnerable areas is essential.

Factors affecting occupational injuries of Chinese frontline firefighters

This study aimed to investigate factors contributing to training injuries among firefighters. Principal component analysis identified 4 primary factors associated with injury risk, which can guide the development of preventive strategies.

Occupational training for firefighters, while distinct from athletic training, is a significant injury factor. Athletic training aims for peak performance, which may involve compromising physical well-being. In contrast, firefighter training is vocationally mandated to elevate overall health and physical capabilities, thereby ensuring operational competence in lifesaving tasks. The training factor (F1) had the highest eigenvalue (EV = 7.35) and variance contribution rate (%Var = 34.45%), identifying it as the primary contributor. It encompasses 8 training-related elements, showing a strong correlation with injuries. High-intensity training can lead to injuries and illnesses that impact health, performance, and team development [16]. Survey results indicated that 58.52% of injuries occurred during sports training. Key reasons include:

- a mismatch between physical fitness and job demands [8],
- lack of theoretical training guidance,
- high-intensity training leading to excessive fatigue and increased injury risk [17,18].

Therefore, firefighters should prioritize physical training, enhance understanding of training theory, improve program design, control intensity and rhythm, emphasize warm-up/cool-down and core strength training, integrate physical and technical training, and improve focus to reduce injuries. Training-related injuries are notably prevalent among Chinese firefighters. This issue is largely attributable to systemic changes following the professionalization reform of China's fire service, including shifts in recruitment practices, insufficient safeguards for ensuring systematic training, and outdated training methodologies. Consequently, it is crucial for management authorities to enhance the design and oversight of firefighters' professional training programs.

The support factor (F2) was the second major factor (EV= 3.97, %Var = 18.84%). It involves 2 aspects:

- training venues and apparatus – many grassroots facilities and equipment are substandard, leading to higher injury rates (e.g., inappropriate footwear causing heel, ankle, and knee injuries);
- nutrition and rest support – poor sleep quality increases psychological stress [19]. Adequate rest and proper nutrition are crucial for reducing cardiovascular disease and training fatigue [20].

The lack of qualified coaches also hinders scientific training development [21]. Weight management is vital, as weight gain increases muscle injury risk, while regular exercise improves weight health [22,23]. Compared with firefighters in Western countries, the proportion of overweight and obese people among Chinese firefighters is very low. This might be closely related to the dietary structure in China, such as the relatively low content of high-calorie and high-energy foods in the daily diet. Chinese firefighters face numerous and diverse daily tasks, which extend beyond routine duties to include responding to sudden and frequent emergency disasters and accidents. Consequently, it is imperative for them to obtain adequate sleep and rest to prevent excessive fatigue. Such fatigue can significantly compromise the quality of physical training and increase the risk of training injuries. Furthermore, it is essential to strengthen nutritional support and prioritize muscle recovery after professional training to ensure the effective development of combat readiness.

The education factor (F3) was the third major factor (EV = 3.19, %Var = 15.02%). The high loading for pre-employment physical fitness level (0.785) indicates that recruits often have poor baseline fitness, leading to poor adaptation to training intensity post-employment and increased injury risk. High loadings for factors like post-employment learning and application of injury prevention knowledge (~0.80) suggest insufficient training in exercise theory and injury prevention after recruitment. The survey indicates that Chinese firefighters generally lack knowledge and skills related to sports injuries prior to their formal occupational training, a gap which may be attributed to their educational backgrounds. To improve firefighters' health awareness, it is essential to strengthen education in sports rehabilitation knowledge and skills after they commence their duties. Furthermore, the surveyed firefighters unanimously acknowledged the importance of acquiring such injury management knowledge and skills, emphasizing that injury prevention education should be closely integrated with their daily tasks and professional characteristics.

The mental health factor (F4) was the fourth principal factor (EV= 2.25, %Var = 11.25%). Due to the work-related high stress, firefighters are at high risk of adverse mental health conditions. Previous studies link firefighter injuries to job satisfaction, interpersonal conflicts, and unsafe conditions. High job stress is associated with both the occurrence and frequency of injuries [24]. The 24-hour duty system and prolonged high-intensity training can lead to physical and psychological fatigue, causing recurrence of old injuries and psychological issues like stress, anxiety, and burnout. This manifests as distraction, slower reactions, increased errors, emotional instability, and training aversion. Overexertion, which causes attention decline, is a leading cause of non-fatal injuries across industries [15]. According to DeMoulin et al. "understanding the causal pathways to mental health risks among firefighters is the first step to developing prevention strategies and approaches for the best clinical practice" [25]. Therefore, it is essential for fire management departments and fire chiefs to enhance their awareness of strategies and intervention methodologies for addressing psychological health issues following traumatic incidents. This includes understanding and supporting firefighters in managing daily life challenges, as well as marital and emotional difficulties. Such support can not only foster harmonious interpersonal relationships among colleagues but also contribute to the healthy career development of firefighters.

For some firefighters, sustained high-intensity training rarely provides a sense of achievement. After experiencing repeated setbacks across various training modules, they gradually lose confidence and motivation. Furthermore, dissatisfaction with their physical fitness performance represents another source of occupational stress. Given that physical fitness scores are linked to annual evaluations – including bonuses and promotions – this can foster a psychologically negative attitude toward physical training [7]. High levels of interpersonal conflict are also associated with occupational injuries among firefighters [24]. It is important for firefighters to maintain positive relationships with colleagues, as supportive interpersonal dynamics can enhance on-duty performance. Therefore, management should prioritize mental health support for firefighters, which can effectively reduce the risk of occupational training injuries.

CONCLUSIONS

Factors related to training, support, education, and mental health have the greatest impact on occupational injuries among firefighters. Occupational injuries among frontline firefighters show a gradual decline with increasing years of service, though the lifetime injury incidence was 100% in this sample. In 2023, 40.70% of firefighters experienced injuries, with 58.52% attributed to sports training and 24.30% to live-fire drills and exercises. The most vulnerable areas are the knees and lower back. Fire departments should prioritize preventing these injuries to enhance professional performance and combat effectiveness.

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AUTHOR CONTRIBUTIONS

Research concept: Qiang Song
Research methodology: Qiang Song
Collecting material: Xinyu Gu
Statistical analysis: Xinyu Gu
Interpretation of results: Qiang Song
References: Qiang Song

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