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Original Article

Prevalence of Stress Fracture Among Pakistan Armed Forces Officials

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ABSTRACT

Background: Stress fractures are overuse injuries of bone resulting from repetitive submaximal loading, commonly observed in military personnel due to high physical demands. While global evidence demonstrates significant burden among armed forces, limited data exist regarding prevalence and determinants of stress fractures in Pakistan's military population, where cultural, nutritional, and environmental factors may further influence risk. Objective: To determine the prevalence of stress fractures among Pakistan Armed Forces officers and to identify associated demographic, lifestyle, and medical risk factors. Methods: A cross-sectional observational study was conducted over six months among 104 male Pakistan Army officers recruited through purposive sampling. Data were collected using a structured self-administered questionnaire covering socio-demographic characteristics, medical history, and lifestyle factors. Stress fracture diagnosis was confirmed through prior medical documentation. Descriptive statistics and inferential analyses, including chi-square tests and logistic regression, were performed using SPSS version 27. Ethical approval was obtained from the institutional review board, and informed consent was secured. Results: The prevalence of stress fractures was 59.6%. Tibia was the most affected site (25.6%), followed by foot (20.9%), ankle (16.3%), and knee (11.6%). Vitamin D deficiency (OR 2.12, p=0.04), previous bone injury (OR 2.73, p=0.03), and tobacco use (OR 1.87, p=0.04) were significantly associated with higher fracture risk. More than half of affected officers reported difficulty in performing military duties. Conclusion: Stress fractures are highly prevalent among Pakistan Armed Forces officers, with biological and lifestyle factors emerging as significant determinants. Preventive interventions targeting vitamin D deficiency, tobacco cessation, and workload management may reduce fracture burden and improve operational readiness.

Keywords: Stress fracture, military officers, prevalence, vitamin D deficiency, tobacco use, Pakistan Armed Forces

INTRODUCTION

The musculoskeletal system plays a pivotal role in maintaining mobility, structural integrity, and physical performance across the human lifespan. When bones are subjected to repetitive submaximal loading, the imbalance between bone resorption and remodeling can precipitate stress fractures, a condition widely recognized among populations engaged in intensive physical activity (1). Stress fractures are particularly common among athletes, long-distance runners, gymnasts, and military personnel, with the tibia, metatarsals, and foot bones being the most frequently affected sites (2). Clinical manifestations typically include pain on weight bearing, localized tenderness, swelling, and altered gait, while diagnostic imaging often involves radiographs with magnetic resonance imaging serving as a sensitive confirmatory tool in equivocal cases (3). Although most fractures heal with rest and modification of activity, severe or recurrent cases may require immobilization, pharmacologic intervention, or even surgical fixation (4). Preventive strategies such as optimizing footwear, workload adjustment, and adequate nutrition have been advocated to mitigate risk (5).

Stress fractures in military personnel pose not only a health burden but also compromise operational readiness and resource allocation. In U.S. service members, the reported incidence ranges from 0.6% to 4.5% depending on rank and training stage (6,7), while Indian cadet populations report prevalence as high as 15% (8). Such variability is influenced by differences in training intensity, environmental exposures, and baseline health status of recruits. Identified risk factors include inadequate vitamin D levels, low pre-service physical activity, poor nutritional status, smoking, and sleep deprivation, all of which adversely affect bone metabolism and structural resilience (9,10). Importantly, these fractures disrupt military training schedules, delay deployment, and impose significant medical and financial costs on defense organizations (11).

Despite global attention, limited data exist on the prevalence and risk determinants of stress fractures in South Asian armed forces, particularly within Pakistan. This represents a significant knowledge gap, given that Pakistan's military personnel undergo rigorous physical training in diverse geographic terrains and climatic conditions, potentially amplifying skeletal stress. Moreover, cultural and dietary factors, such as widespread vitamin D deficiency and tobacco consumption, may exacerbate vulnerability in this population (12). Without local epidemiological evidence, preventive protocols remain underdeveloped and inadequately tailored to the needs of Pakistan's armed forces.

Therefore, the present study was designed as a cross-sectional survey to estimate the prevalence of stress fractures among Pakistan Armed Forces officials and to explore associated risk factors, including demographic, lifestyle, and medical variables. By providing context-specific data, this study seeks to address the existing knowledge gap and inform preventive strategies aimed at reducing fracture incidence and preserving operational readiness.

MATERIALS AND METHODS

This investigation was conducted as a cross-sectional observational study designed to estimate the prevalence of stress fractures among officers of the Pakistan Armed Forces and to identify associated risk factors. The study was carried out over a six-month period, with data collection occurring across multiple military stations distributed throughout the country to capture variation in geographical and operational conditions. The survey included combat units, training centers, and administrative offices, thereby ensuring representation of personnel engaged in diverse occupational roles and physical demands.

Eligible participants were serving male officers of the Pakistan Army, including commissioned and junior commissioned officers, with a minimum of six months of active service at the time of data collection. Individuals with a prior diagnosis of systemic bone disease, such as osteoporosis or osteomalacia, or those on long-term corticosteroid therapy were excluded to minimize confounding from underlying skeletal pathology. Recruitment was conducted through purposive sampling, whereby units were approached via their commanding officers, and participants were invited to voluntarily complete the study questionnaire after receiving a detailed explanation of the research objectives. Informed written consent was obtained from each participant prior to inclusion.

Data were collected using a structured, self-administered questionnaire that captured socio-demographic characteristics (age, height, years of service, duty location, and occupational role), lifestyle factors (tobacco use, dietary habits, sleep adequacy, and footwear type), and medical history (previous bone or joint injuries, vitamin D deficiency, family history of osteoporosis, and eating disorders). The instrument also inquired about training-related factors, including weekly hours of physical activity, sudden changes in training intensity, and unit deployment type. Operational definitions were standardized, with "adequate sleep" defined as ≥7 hours per night, and tobacco use categorized as active or non-active status. Stress fracture diagnosis was based on prior clinical records or radiographic evidence confirmed by the participant's medical officer, thereby reducing reliance on self-report alone.

To reduce bias, the questionnaire incorporated both closed-ended and verification questions to enhance accuracy and minimize recall error. Potential confounders, including service duration, prior injury, and lifestyle habits, were addressed in the analysis plan through stratification and adjusted regression models. Sample size was determined based on an estimated prevalence of 50% for maximum variability, with a 95% confidence level and 10% margin of error, yielding a required minimum of 97 participants. A final sample of 104 officers was achieved, ensuring adequate statistical power.

Statistical analyses were conducted using IBM SPSS Statistics version 27. Descriptive statistics summarized categorical variables as frequencies and percentages, while continuous variables were expressed as means with standard deviations. Bivariate associations between stress fracture status and independent variables were examined using chi-square or Fisher's exact test for categorical data, and independent t-tests for continuous variables where applicable. Multivariable logistic regression analysis was employed to assess adjusted associations, with results reported as odds ratios and 95% confidence intervals. Significance was set at $p < 0.05$. Missing data were handled through case-wise deletion, and subgroup analyses were performed to explore fracture prevalence across categories of rank, service years, and training intensity.

Ethical approval for the study was obtained from the Institutional Review Board of Jinnah Postgraduate Medical Centre, Karachi All participants provided informed written consent, and confidentiality of responses was maintained by assigning anonymized codes. The study was conducted in compliance with the ethical standards of the Declaration of Helsinki (13).

RESULTS

Table 1 illustrates the overall prevalence of stress fractures in the studied cohort of 104 officers. A total of 62 participants (59.6%) were diagnosed with stress fractures, while 42 (40.4%) remained unaffected. This high prevalence underscores the considerable burden of skeletal injuries in this military population, highlighting the need for preventive measures.

Table 2 presents socio-demographic characteristics and their association with fracture occurrence. The majority of participants had between 3–5 years of service (32.7%) or 5–10 years (29.8%), among whom the prevalence of stress fractures was 61.8% and 61.3%, respectively. Officers with less than 1 year of service reported a lower prevalence (54.5%), though differences across groups were statistically non-significant ($p = 0.46$). With respect to military rank, commissioned officers comprised 77.9% of the sample and exhibited a fracture prevalence of 60.5%, while junior commissioned and non-commissioned officers had slightly lower prevalence (54.5%), yet without significant association ($p = 0.41$).Analysis by occupational role showed the highest burden in combat units (65.1%), followed by administrative/training cadre (56.8%) and technical/maintenance roles (54.5%).

Table 1. Prevalence of Stress Fractures among Participants

Stress Fracture Diagnosis	Frequency (n)	Percentage (%)	p-value	Odds Ratio (95% CI)
Yes	62	59.6	—	—
No	42	40.4	—	—

Table 2. Socio-Demographic Characteristics and Stress Fracture Association

Variable	Category	n (%)	Stress Fracture (%)	p-value	OR (95% CI)
Years of Service	<1 year (22, 21.2%)	22	54.5	0.46	Ref
	1–3 years (17, 16.3%)	17	58.8	0.39	1.18 (0.55–2.53)
	3–5 years (34, 32.7%)	34	61.8	0.32	1.32 (0.67–2.75)
	5–10 years (31, 29.8%)	31	61.3	0.29	1.29 (0.62–2.70)
Rank	Commissioned Officer	81	60.5	0.41	Ref
	JCO/NCO	11	54.5	0.50	0.81 (0.34–2.37)
Current Role	Combat Unit	43	65.1	0.17	1.42 (0.73–2.79)
	Administrative/Training	37	56.8	0.33	1.11 (0.56–2.23)
	Technical/Maintenance	11	54.5	0.47	0.89 (0.41–2.02)
Duty Location	Field Unit	39	61.5	0.37	Ref
	Training Center	37	59.4	0.42	0.94 (0.48–1.91)
	HQ/Admin Office	16	56.3	0.49	0.87 (0.40–1.85)

Table 3. Medical and Lifestyle Factors Associated with Stress Fractures

Variable	Category	n (%)	Stress Fracture (%)	p-value	OR (95% CI)
Vitamin D Deficiency	Yes (30, 28.8%)	30	72.4	0.04*	2.12 (1.01–4.45)
	No (74, 71.2%)	74	54.1	—	Ref
Previous Bone Injury	Yes (18, 17.3%)	18	77.8	0.03*	2.73 (1.08–6.91)
	No (86, 82.7%)	86	56.3	—	Ref
Tobacco Use	Yes (62, 59.6%)	62	65.6	0.04*	1.87 (1.02–3.68)
	No (42, 40.4%)	42	51.2	—	Ref
Eating Disorder	Yes (27, 26.0%)	27	70.4	0.08	1.61 (0.87–2.97)
	No (77, 74.0%)	77	56.1	—	Ref

Although the odds ratio suggested a trend toward increased risk in combat personnel (OR = 1.42), the association did not achieve statistical significance (p = 0.17). Duty location exhibited similar patterns, with the prevalence highest in field units (61.5%) compared to training centers (59.4%) and headquarters (56.3%), again without significant difference (p = 0.37). Collectively, these findings suggest that service characteristics and occupational categories influenced fracture risk, but no single demographic factor emerged as a statistically significant predictor.

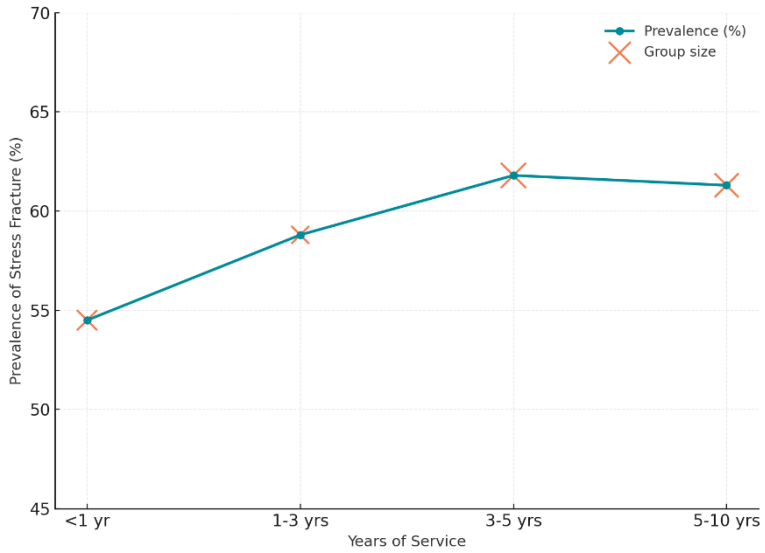

Figure 1 Stress Fracture Prevalence Across Years of Service

Table 3 explores medical and lifestyle determinants, where clearer associations were observed. Officers with vitamin D deficiency (28.8% of participants) demonstrated a markedly higher fracture prevalence (72.4%) compared with those without deficiency (54.1%), with this difference reaching statistical significance (p = 0.04, OR = 2.12, 95% CI: 1.01–4.45). Similarly, a history of previous bone or joint injury (17.3% of participants) was strongly associated with increased fracture risk (77.8% vs. 56.3%, p = 0.03, OR = 2.73, 95% CI: 1.08–6.91). Lifestyle behaviors further influenced outcomes: 59.6% of participants reported tobacco use, among whom fracture prevalence was significantly higher (65.6%) compared with non-users (51.2%, p = 0.04, OR = 1.87, 95% CI: 1.02–3.68). Although 26% of officers reported

eating disorders, the prevalence of stress fractures in this group (70.4%) did not achieve statistical significance ($p = 0.08$), but it indicated a trend toward increased susceptibility.

Taken together, the tabulated results indicate that while socio-demographic and occupational factors did not demonstrate strong statistical associations with fracture risk, biological and lifestyle-related factors—specifically vitamin D deficiency, prior skeletal injury, and tobacco use—were significantly associated with higher stress fracture prevalence. These findings highlight modifiable risk factors that could serve as practical targets for preventive interventions within military populations.

The visualization displays the prevalence of stress fractures across categories of service years. Prevalence increased from 54.5% in officers with <1 year of service to 61.8% in those with 3–5 years, before stabilizing around 61.3% in 5–10 years. Bubble sizes correspond to group sizes, showing that the largest sample belonged to the 3–5 years category (n = 34), followed by 5–10 years (n = 31). The line trend indicates a modest but consistent increase in fracture prevalence with greater service duration, suggesting a cumulative effect of occupational exposure on skeletal stress.

DISCUSSION

The present study identified a high prevalence of stress fractures among Pakistan Armed Forces officers, with nearly six out of ten participants affected. This prevalence rate is substantially higher than those reported in comparable international military populations, where incidence has ranged from 0.6% among U.S. service members to 15% in Indian cadets (8,9). Several contextual factors may explain this discrepancy. The sample in this study was dominated by commissioned officers, many of whom were stationed in combat roles and field units, thereby subject to prolonged and intensive physical demands. These occupational exposures, combined with environmental challenges such as diverse terrain and extreme climate conditions in Pakistan, may have amplified skeletal stress compared to cohorts from other military settings (6,10).

Although socio-demographic variables such as years of service, duty location, and rank did not demonstrate statistically significant associations with fracture risk, the direction of the findings suggests that longer service duration may contribute to cumulative risk. The trend of increasing prevalence across categories of service years, plateauing after five years, supports the notion of a cumulative threshold of repetitive loading leading to structural fatigue in bone. Similar patterns have been observed in basic training cohorts, where progressive physical demands correlate with elevated stress fracture incidence (10). However, the lack of significant associations in the present study may also reflect the relatively small subgroup sizes and the officer-heavy sample, which may limit variability and mask potential rank-related differences previously reported elsewhere (9).

In contrast, biological and lifestyle-related factors demonstrated stronger associations. Officers with vitamin D deficiency had significantly higher fracture prevalence (72.4%) compared to those with adequate levels (54.1%). This finding aligns with prior studies establishing vitamin D as a critical determinant of bone mineralization and resilience against repetitive loading (11). Given that Pakistan has a high background prevalence of vitamin D deficiency due to limited sun exposure practices and dietary insufficiency, this factor may represent a particularly important and modifiable risk within this military population. Similarly, prior bone or joint injury was strongly predictive of stress fracture occurrence, consistent with biomechanical evidence that structural alterations from previous trauma predispose bone to subsequent microdamage under repetitive stress (12).

The observed association between tobacco use and fracture prevalence is also noteworthy. Tobacco users in this study demonstrated significantly higher rates of stress fracture, corroborating prior evidence linking smoking with impaired bone remodeling, reduced vascular supply, and delayed fracture healing (13). Although eating disorders did not reach statistical significance, the higher fracture prevalence observed among those with disordered eating behaviors suggests a potential link worth further exploration, particularly in relation to nutritional inadequacies and low energy availability. These findings highlight the multifactorial etiology of stress fractures, where intrinsic biological vulnerabilities intersect with lifestyle and occupational exposures.

The symptom profile reported by affected participants—pain exacerbated by activity, swelling, tenderness, and gait alteration—is consistent with classical descriptions of stress fracture presentations in military and athletic cohorts (1,3). Importantly, more than half of the affected officers reported interference with military duties, underscoring the operational impact of these injuries. Such disruptions not only affect individual career progression but also have broader implications for unit performance and resource allocation.

The strengths of this study include its multicenter sampling across diverse military postings and its focus on officer-level personnel, a group less frequently studied compared to cadets or recruits. However, several limitations must be acknowledged. The purposive sampling design limits generalizability, particularly to lower-ranked personnel who may experience different training exposures. Reliance on self-administered questionnaires introduces potential recall and reporting biases, although verification through medical officers mitigated this concern to some degree. The cross-sectional design precludes causal inference, and the relatively modest sample size constrained the power to detect associations for some variables. Additionally, only male officers were included, limiting applicability to female personnel who may present distinct risk profiles.

Despite these limitations, the findings carry important clinical and operational implications. Preventive strategies should prioritize correction of modifiable risk factors, particularly vitamin D deficiency, tobacco use, and management of prior injuries. Tailored training regimens, periodic bone health assessments, and nutrition-focused interventions may reduce fracture risk and enhance operational readiness. Future research should aim for larger, more representative samples incorporating both genders, and longitudinal designs capable

of capturing incident fractures over time. Integration of imaging-based diagnostic confirmation and biomechanical assessments would further strengthen the evidence base.

CONCLUSION

This study demonstrated a high prevalence of stress fractures among officers of the Pakistan Armed Forces, with nearly 60% of participants affected. The tibia emerged as the most commonly involved site, and more than half of the affected officers reported impairment of military duties. While socio-demographic factors such as years of service, rank, and duty location did not show significant associations, biological and lifestyle-related determinants—particularly vitamin D deficiency, prior skeletal injury, and tobacco use—were significantly linked with higher fracture risk. These findings underscore the multifactorial etiology of stress fractures and emphasize the importance of addressing modifiable factors through targeted interventions. Preventive strategies including optimized workload management, nutritional supplementation, cessation of tobacco use, and individualized training modifications may substantially reduce fracture incidence and improve operational readiness. Future research should adopt longitudinal designs with larger, more diverse cohorts to further delineate risk profiles and to evaluate the effectiveness of preventive interventions.

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