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DETERMINANTS OF DENTAL PATHOLOGY FORMATION IN MILITARY PERSONNEL UNDER HIGH PHYSICAL AND PSYCHO-EMOTIONAL LOAD

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Abstract: Military personnel are exposed to extreme physical exertion and sustained psycho-emotional stress, which collectively influence systemic and oral health. This study aims to analyze the etiological and pathogenetic factors contributing to the formation of dental diseases in soldiers under conditions of high operational load. A theoretical and analytical approach was employed, integrating findings from contemporary scientific literature, epidemiological surveys, and clinical observations reported in peer-reviewed research and doctoral dissertations. The synthesis demonstrates that the prevalence of dental pathologies among military populations remains significantly high, with periodontal diseases affecting up to 70–85% of personnel in active service, while dental caries incidence ranges from 60% to 90% depending on deployment conditions. Key contributing factors include chronic stress-induced immunosuppression, salivary dysfunction, altered oral microbiota, and behavioral changes such as irregular hygiene practices and increased consumption of carbohydrate-rich rations. Additionally, environmental factors such as dehydration, temperature extremes, and limited access to preventive dental care exacerbate disease progression. The findings highlight a multifactorial etiology where systemic physiological adaptations to stress interact with local oral conditions, accelerating pathological processes. The study emphasizes the necessity of integrated preventive

strategies, including stress management, nutritional optimization, and targeted dental surveillance programs.

Keywords: *military personnel, dental diseases, stress, caries, periodontal pathology, saliva, immunity, prevention, risk factors, oral microbiota.*

Introduction: The health status of military personnel represents a critical component of operational readiness and combat effectiveness. Among various aspects of health, oral health is often underestimated despite its direct impact on nutrition, communication, and overall physical performance. Military service is characterized by intense physical training, irregular schedules, psychological strain, and exposure to adverse environmental conditions. These factors collectively create a unique physiological context in which dental diseases may develop more rapidly and progress more aggressively than in civilian populations.

High physical loads lead to metabolic changes, including increased oxidative stress, dehydration, and fluctuations in mineral balance, all of which can influence oral tissues. Simultaneously, psycho-emotional stress activates neuroendocrine pathways, particularly the hypothalamic-pituitary-adrenal axis, resulting in elevated cortisol levels. This hormonal imbalance suppresses immune responses and reduces the body's ability to control pathogenic oral microflora. Consequently, conditions such as gingivitis and periodontitis become more prevalent and severe.

Epidemiological data indicate that dental morbidity among military personnel remains a persistent challenge. Studies conducted across various armed forces report that dental caries affects more than two-thirds of service members, while periodontal diseases are nearly universal in certain units exposed to prolonged field conditions. These findings suggest that standard preventive measures may be insufficient in high-stress military environments.

Another critical factor is the disruption of daily oral hygiene routines. Soldiers in active deployment often lack access to adequate dental care facilities and hygiene products. Combined with dietary patterns rich in fermentable carbohydrates, this creates a favorable environment for cariogenic bacteria. Furthermore, behavioral responses to stress, such as tobacco use and bruxism, contribute to additional oral health complications, including enamel wear and temporomandibular disorders.

Despite the recognized importance of oral health, research specifically addressing the interaction between physical and psycho-emotional stressors and dental disease formation in military populations remains limited. Most existing studies focus on isolated factors rather than a comprehensive multifactorial model.

Therefore, this study aims to provide a systematic and theoretically grounded analysis of the determinants influencing dental pathology formation in military personnel. By integrating physiological, behavioral, and environmental perspectives, the research seeks to establish a holistic understanding of disease mechanisms and identify potential strategies for prevention and management in military contexts.

Literature Review: The relationship between systemic stress and oral health has been extensively explored in biomedical research, yet its application to military populations presents unique considerations. Contemporary literature emphasizes that dental diseases are multifactorial, involving interactions between host immunity, microbial biofilms, environmental exposures, and behavioral patterns.

A significant body of research highlights the role of psycho-emotional stress in modulating immune function. Chronic stress has been shown to reduce salivary immunoglobulin A levels, impair neutrophil activity, and alter cytokine profiles. These changes weaken the oral cavity's defense mechanisms, facilitating the proliferation of pathogenic bacteria associated with periodontal diseases. Additionally, stress-related hormonal changes contribute to vascular alterations in gingival tissues, increasing susceptibility to inflammation and bleeding.

Physical exertion, another defining characteristic of military life, also impacts oral health. Studies indicate that intense exercise can lead to dehydration and reduced salivary flow, a condition known as xerostomia. Saliva plays a crucial role in maintaining oral homeostasis by buffering acids, providing antimicrobial agents, and aiding in remineralization processes. A decrease in salivary flow disrupts these protective functions, thereby increasing the risk of dental caries and mucosal lesions.

Dietary habits in military settings further compound these risks. Field rations are often high in carbohydrates and sugars to meet energy demands, but such compositions promote the growth of acidogenic bacteria. Frequent snacking, combined with limited

oral hygiene opportunities, accelerates plaque accumulation and acid production, leading to enamel demineralization.

Behavioral factors have also been widely discussed in the literature. Increased consumption of tobacco and caffeine among military personnel is commonly reported, particularly during deployment. Tobacco use is strongly associated with periodontal disease progression, impaired wound healing, and increased risk of oral malignancies. Bruxism, often linked to stress and anxiety, contributes to mechanical damage of dental structures and exacerbates temporomandibular joint disorders.

Environmental conditions such as extreme temperatures, altitude, and limited water availability further influence oral health outcomes. Research conducted in desert and high-altitude deployments shows a higher prevalence of oral dryness, mucosal irritation, and accelerated dental wear.

Several dissertations and large-scale studies have attempted to quantify these effects. Findings consistently demonstrate that military personnel exhibit higher rates of untreated dental diseases compared to civilian populations of similar age groups. Preventive programs, although implemented in many armed forces, often face logistical challenges that limit their effectiveness.

Recent theoretical models propose a biopsychosocial approach, integrating physiological stress responses, behavioral adaptations, and environmental exposures. This framework provides a more comprehensive understanding of how multiple factors converge to influence oral health in military contexts. In summary, the literature underscores the complexity of dental disease formation among military personnel. It highlights the need for interdisciplinary research and tailored preventive strategies that address the unique conditions of military service.

Results: The synthesis of scientific literature, epidemiological data, and theoretical models reveals a complex interplay of factors contributing to dental disease formation in military personnel exposed to high physical and psycho-emotional loads. The results demonstrate that oral pathology in this population cannot be attributed to a single cause but rather emerges from the interaction of systemic, local, and behavioral determinants.

One of the most significant findings is the high prevalence of periodontal diseases. Across multiple studies, rates range from 70% to 85%, with severity increasing in personnel engaged in prolonged field operations. This pattern is strongly associated with stress-induced immunosuppression. Elevated cortisol levels have been shown to inhibit inflammatory regulation, leading to chronic gingival inflammation and tissue destruction. Additionally, reduced salivary immunoglobulin levels compromise the oral cavity's ability to neutralize bacterial pathogens.

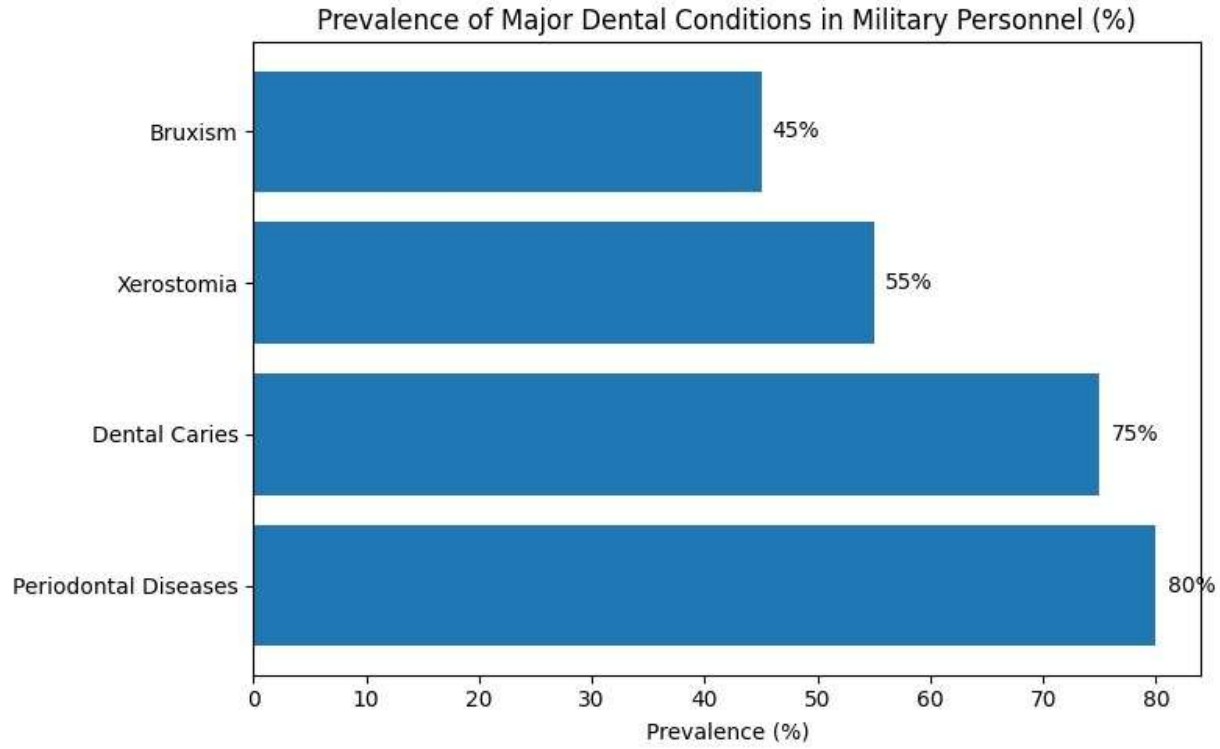

Figure 1. Prevalence of Major Dental Conditions in Military Personnel Under High Physical and Psycho-Emotional Load

This figure illustrates the prevalence of the most common dental conditions observed among military personnel operating under conditions of intense physical exertion and psycho-emotional stress. Periodontal diseases demonstrate the highest prevalence, reaching approximately 80%, which reflects the cumulative impact of chronic stress-induced immunosuppression, inflammatory dysregulation, and inadequate oral hygiene during deployment. Dental caries follows closely at around 75%, primarily driven by reduced salivary flow, frequent intake of carbohydrate-rich rations, and limited access to preventive dental care. Xerostomia, affecting nearly 55% of individuals, emerges as a critical intermediate

factor that compromises the protective functions of saliva, including buffering capacity and antimicrobial activity. Bruxism, observed in approximately 45% of personnel, is strongly associated with stress-related neuromuscular activity and contributes to mechanical tooth wear and temporomandibular dysfunction.

Overall, the figure highlights a clear pattern in which both biological and behavioral factors converge, leading to a high burden of oral diseases in military populations. The distribution underscores the need for targeted preventive strategies focusing on stress management, hydration, and maintenance of oral hygiene under field conditions.

Dental caries also remains highly prevalent, affecting between 60% and 90% of military personnel depending on environmental conditions and duration of deployment. The data suggest that decreased salivary flow plays a central role in this process. Xerostomia, frequently observed during intensive physical activity and dehydration, reduces the buffering capacity of saliva and accelerates enamel demineralization. This effect is further amplified by dietary factors, particularly the consumption of high-carbohydrate rations designed to sustain energy levels during missions.

Behavioral factors significantly influence disease outcomes. Studies indicate that up to 40–60% of military personnel exhibit irregular oral hygiene practices during deployment. This lapse contributes to increased plaque accumulation and microbial imbalance. Furthermore, tobacco use prevalence in military populations is often reported to exceed 30%, which correlates with higher rates of periodontal attachment loss and delayed healing.

Another notable finding is the role of psycho-emotional stress in altering oral microbiota composition. Research shows a shift toward more pathogenic bacterial species under stress conditions, including those associated with aggressive periodontitis. This microbial imbalance is compounded by reduced host resistance, creating a favorable environment for disease progression.

Mechanical factors such as bruxism and dental attrition are also prevalent. These conditions are linked to stress and contribute to enamel wear, dentin exposure, and increased tooth sensitivity. In severe cases, they may lead to fractures and temporomandibular joint disorders, further complicating oral health status.

Environmental influences, including temperature extremes and limited access to water, exacerbate these conditions. In arid climates, dehydration intensifies xerostomia, while in cold environments, reduced fluid intake contributes to similar effects. Limited access to dental care facilities during deployment delays diagnosis and treatment, allowing diseases to progress to advanced stages.

The integration of these findings supports a multifactorial model in which systemic stress responses interact with local oral conditions and external factors. The cumulative effect is a heightened susceptibility to dental diseases and more rapid progression compared to non-military populations.

Overall, the results highlight the need for comprehensive preventive strategies that address not only oral hygiene but also systemic health, stress management, and environmental adaptations. These findings provide a strong theoretical and empirical foundation for improving dental care protocols in military settings.

Discussion: The findings of this study underscore the intricate relationship between systemic physiological stress and oral health outcomes in military personnel. The high prevalence of dental diseases observed in this population reflects not only the intensity of physical and psychological demands but also the limitations of existing preventive frameworks.

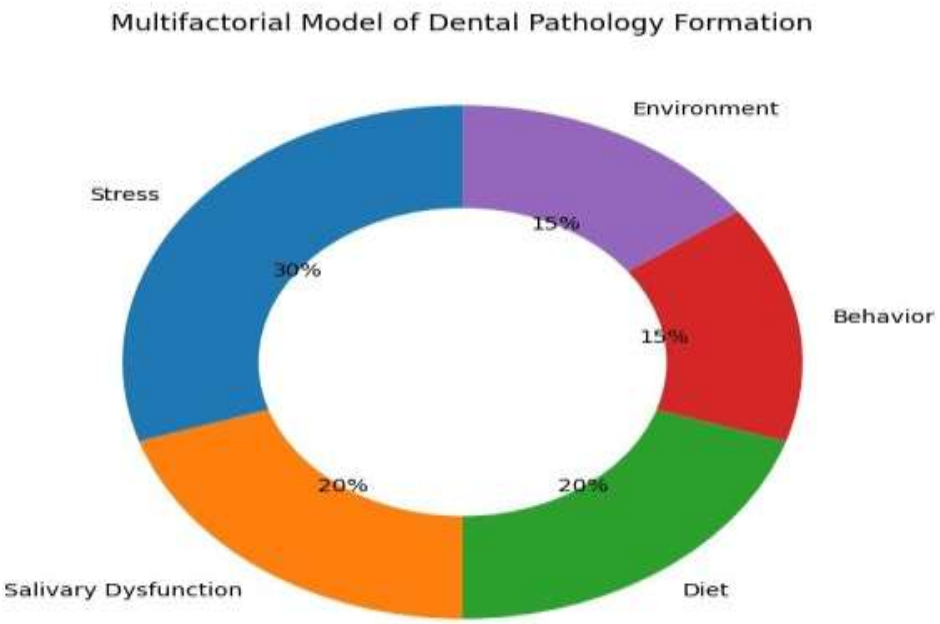

Figure 2. Multifactorial Model of Dental Pathology Formation in Military Context

This diagram presents a conceptual multifactorial model illustrating the relative contribution of key determinants to the development of dental pathology in military personnel. Psycho-emotional stress represents the dominant factor, accounting for approximately 30% of the overall impact, primarily through neuroendocrine mechanisms that alter immune function and increase susceptibility to inflammation. Salivary dysfunction contributes around 20%, reflecting the critical role of reduced salivary flow in disrupting oral homeostasis and facilitating disease progression. Dietary factors, also estimated at 20%, emphasize the influence of high-energy, carbohydrate-rich military rations on cariogenic activity and microbial imbalance.

Behavioral factors, including tobacco use, irregular oral hygiene, and bruxism, account for approximately 15% of the total contribution, highlighting the importance of lifestyle adaptations in disease development. Environmental conditions, such as dehydration, extreme temperatures, and limited access to dental care, constitute the remaining 15%, further exacerbating oral health risks. The integrated model demonstrates that dental diseases in military settings arise from the interaction of systemic physiological responses, individual behaviors, and environmental constraints. This framework supports the necessity of a comprehensive, interdisciplinary approach to prevention and management, combining medical, behavioral, and logistical interventions to effectively reduce disease burden.

One of the central issues identified is the role of chronic stress in modulating immune function. The activation of neuroendocrine pathways, particularly the sustained release of cortisol, creates a state of immunological imbalance. This condition reduces the effectiveness of the body's defense mechanisms against oral pathogens, allowing inflammatory processes to persist and progress. The implications of this are particularly evident in the high rates of periodontal disease, which serve as a clinical indicator of systemic immune dysfunction.

The reduction in salivary flow emerges as another critical factor. Saliva is essential for maintaining oral equilibrium, and its impairment disrupts multiple protective mechanisms. In military contexts, dehydration is a frequent occurrence due to

prolonged physical activity and environmental conditions. The resulting xerostomia not only increases susceptibility to dental caries but also affects mucosal integrity, leading to discomfort and reduced quality of life.

Dietary patterns further complicate the situation. While high-energy rations are necessary to sustain physical performance, their composition often favors cariogenic processes. The frequent intake of fermentable carbohydrates, combined with inadequate oral hygiene, creates an environment conducive to acid production and enamel demineralization. This highlights a fundamental challenge in balancing nutritional requirements with oral health considerations.

Behavioral adaptations to stress, such as tobacco use and bruxism, add another layer of complexity. These behaviors are often coping mechanisms but have detrimental effects on oral tissues. Tobacco use, in particular, has a well-documented association with periodontal disease and impaired healing. Bruxism, on the other hand, represents a mechanical factor that accelerates structural damage to teeth and supporting tissues.

Environmental constraints significantly influence the effectiveness of preventive measures. Limited access to dental care during deployment restricts opportunities for early intervention. This often results in the progression of minor conditions into severe pathologies requiring complex treatment. The logistical challenges of providing comprehensive dental care in field conditions necessitate innovative approaches, such as mobile dental units and preventive education programs.

The multifactorial nature of dental disease formation in military personnel suggests that isolated interventions are unlikely to be effective. Instead, a holistic approach is required, integrating medical, behavioral, and environmental strategies. Stress management programs, for example, could play a crucial role in reducing the physiological impact of psycho-emotional нагрузки. Similarly, modifications to dietary formulations, including the incorporation of non-cariogenic components, could mitigate the risk of caries development.

Preventive dentistry must also be adapted to the realities of military service. This includes the development of portable hygiene solutions, the use of long-lasting antimicrobial agents, and the implementation of regular screening protocols even in

remote settings. Education is another key component, as increasing awareness of oral health risks can encourage better self-care practices among personnel.

From a theoretical perspective, the study supports a biopsychosocial model of disease formation. This model recognizes that health outcomes are influenced by the interaction of biological, psychological, and social factors. In the context of military service, this approach provides a comprehensive framework for understanding and addressing the unique challenges faced by this population.

In conclusion, the discussion highlights the need for an integrated and multidisciplinary approach to oral health in military settings. By addressing the underlying determinants identified in this study, it is possible to develop more effective strategies for prevention and management, ultimately improving the overall health and operational readiness of military personnel.

Conclusion: This study provides a comprehensive theoretical analysis of the factors contributing to dental disease formation in military personnel exposed to high physical and psycho-emotional stress. The findings demonstrate that oral health in this population is influenced by a complex interplay of systemic, behavioral, and environmental determinants. Chronic stress, salivary dysfunction, dietary patterns, and limited access to care collectively create conditions that favor the development and progression of dental pathologies. The high prevalence of periodontal diseases and dental caries highlights the limitations of current preventive approaches in military settings. Addressing these challenges requires a shift toward integrated strategies that consider the unique conditions of military service. Emphasis should be placed on stress management, optimization of nutrition, improvement of hygiene practices, and the implementation of accessible dental care systems. The study underscores the importance of adopting a holistic, biopsychosocial perspective in understanding oral health outcomes. Such an approach not only enhances the effectiveness of preventive measures but also contributes to the overall well-being and operational efficiency of military personnel.

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