ORIGINAL ARTICLE

Factors of dental morbidity in military personnel under high physical and psycho-emotional load

Islomjon R. Sattarov[1*], Mavlonjon Z. Nasirdinov[2]

[1]*Central Asian Medical University, Fergana, Republic of Uzbekistan*

[2]*Andijan Branch of Kokand University, Andijan, Republic of Uzbekistan*

*Corresponding author: Islomjon R. Sattarov; e-mail: nagaeva.gulnora@mail.ru

Abstract

Background. Dental diseases are a frequent cause of temporary loss of fitness for duty in military personnel, but the contribution of psycho-emotional strain, sleep and saliva properties remains insufficiently studied.

Aim. To identify factors associated with clinically significant dental pathology in military personnel and to develop an integral point-based dental risk model.

Methods. This cross-sectional comparative study (January 2022 – March 2025) included 511 male servicemen (age 26.40 ± 4.08 years). Based on an integral assessment of adaptive strain, groups I (n = 137), II (n = 168) and III (n = 206) were formed. DMFT, OHI-S, PMA, bleeding and CPI indices, the PSS-10, STAI-S, MFI-20 and PSQI scales, salivary flow rate, pH, buffer capacity and salivary α-amylase activity were assessed. Spearman correlation, multivariable logistic regression and ROC analysis were used.

Results. From group I to group III, the prevalence of active caries increased from 49.6% to 84.5%, of inflammatory periodontal disease from 38.0% to 77.2%, DMFT from 5.04 ± 1.91 to 8.94 ± 2.20 and PMA from 16.94 ± 6.20% to 38.60 ± 7.79% ($p < 0.001$). Unstimulated salivary flow decreased from 0.45 ± 0.07 to 0.23 ± 0.09 mL/min and pH from 6.77 ± 0.22 to 6.26 ± 0.24, while α-amylase increased from 125.74 ± 32.34 to 225.83 ± 45.40 U/L. Perceived stress correlated with unstimulated salivary flow ($rS = -0.705$) and PMA ($rS = 0.678$). Independent predictors of clinically significant pathology were high perceived stress (odds ratio (OR) 8.00; 95% confidence interval (CI) 4.53–14.15), sleep under 6 h (OR 7.93; 95% CI 4.21–14.95), unstimulated salivary flow below 0.30 mL/min (OR 6.62; 95% CI 3.10–14.12), irregular oral hygiene (OR 3.18; 95% CI 1.77–5.73) and daily smoking (OR 2.25; 95% CI 1.23–4.10). The area under the ROC curve of the integral model (0–16 points) was 0.929 (95% CI 0.89–0.96); the frequency of pathology in the low-, intermediate- and high-risk categories was 14.5%, 62.0% and 97.5%.

Conclusion. Dental morbidity in military personnel is closely associated with psycho-emotional strain, sleep deficiency and reduced salivary flow. The five-component point-based model may support risk-oriented prevention after external validation.

Keywords: *military personnel; dental morbidity; psychological stress; sleep quality; salivary flow; periodontal diseases; risk assessment.*

MAIN TEXT

Introduction

Dental diseases remain a frequent cause of temporary loss of fitness for duty in military personnel: acute toothache, exacerbations of periodontal disease and oral mucosal injuries require unscheduled visits and remove personnel from their duties [1]. Similar patterns have been described in elite athletes, in whom poor oral health is associated with reduced self-reported performance [2, 3].

Untreated caries and severe periodontitis are among the most prevalent diseases worldwide [4, 5]. Dental morbidity in servicemen has traditionally been considered in terms of the prevalence of caries and periodontal disease and treatment needs. However, psycho-emotional stress and maladaptive coping strategies are associated with the severity of inflammatory periodontal disease [6, 7], and occupational stress with poorer oral health in working populations [8]. Academic stress increases gingival inflammation and impairs oral hygiene [9, 10], and occupational stress in army personnel is also associated with periodontal status [11].

Possible mediators of these associations include short sleep [12], reduced salivary flow and buffer capacity [13, 14], sympathetic activation indirectly reflected by salivary α-amylase activity [15, 16], and masticatory muscle parafunctions, including bruxism [17]. Existing dental risk assessment models [18] are based mainly on clinical and behavioural features and do not take into account psychometric indicators, sleep or saliva properties typical of military service.

The aim of the study was to identify psychometric, behavioural, service-related and biological factors associated with clinically significant dental pathology in military personnel and to develop an integral point-based dental risk model on this basis.

Material and Methods

Study design and setting

A cross-sectional comparative clinical and psychometric study with retrospective registration of acute dental conditions over the preceding 12 months and subsequent prognostic modelling was performed. The study was carried out at the dental department of a multidisciplinary military clinical hospital and two dental offices of training and combat units from January 2022 to March 2025 according to a uniform protocol. Acute dental conditions, self-treatment of toothache and dental visits were verified using a structured questionnaire, unit dental records and hospital outpatient records.

Participants

A total of 546 male servicemen were examined; after checking inclusion and exclusion criteria and data completeness, 511 (93.6%) were included in the final analysis. The mean age was 26.40 ± 4.08 years (19–45 years) and the mean length of service 4.79 ± 2.35 years. Inclusion criteria were active military service, consent to dental and psychometric examination, a fully completed questionnaire and the possibility of obtaining a standard morning saliva sample. Exclusion criteria were acute somatic and infectious diseases, decompensated endocrine disorders, systemic connective tissue diseases, severe mental disorders, antibiotic therapy or drugs substantially affecting salivation, severe maxillofacial trauma within 6 months, marked orthodontic load and dental interventions less than 14 days before the examination.

Stratification

Study groups were formed according to the authors' integral assessment of adaptive strain (Table 1), which included only features recorded at the initial examination without additional equipment. Score thresholds were set on the basis of the pilot distribution of features in the cohort and expert clinical judgement. Military specialty, position and unit were not included in the stratification scheme.

Table 1. Criteria of the integral assessment of adaptive strain

Criterion	Points	Scoring
Type of service load	0–3	0, routine duty; 1, support; 2, training and combat tasks; 3, predominantly field and combat load
Frequency of field deployments	0–3	0, rarely or never; 1, ≤1 per month; 2, 2–3 per month; 3, weekly or more often
Sleep duration	0–2	0, ≥7 h; 1, 6.0–6.9 h; 2, <6 h
Perceived stress (PSS-10)	0–2	0, <20 points; 1, 20–23 points; 2, ≥24 points
Daily smoking	0–1	0, no; 1, yes
Oral hygiene	0–1	0, toothbrushing twice daily; 1, once daily or irregular
Eating pattern	0–1	0, regular; 1, irregular
Limited self-care	0–1	0, no; 1, yes
Total score	0–14	0–3, group I; 4–8, group II; ≥9, group III

PSS-10 thresholds (<20, 20–23, ≥24 points) were used only for stratification in this study and do not replace standard interpretation of the scale.

Group I included 137 (26.8%) servicemen, group II 168 (32.9%) and group III 206 (40.3%). Mean age in the groups was 24.95 ± 3.50, 26.68 ± 3.93 and 27.13 ± 4.33 years, length of service 3.40 ± 1.72, 5.09 ± 2.09 and 5.48 ± 2.51 years, and mean sleep duration 7.16 ± 0.67, 6.24 ± 0.67 and 5.58 ± 0.68 h, respectively.

Dental examination

Examinations were performed by two calibrated dentists using a dental mirror, explorer and WHO periodontal probe. Inter-examiner agreement on repeated assessment of 32 servicemen was $\kappa = 0.82$. The DMFT index, the simplified oral hygiene index (OHI-S) [19], the papillary-marginal-attached (PMA) index, the bleeding index and the Community Periodontal Index (CPI, categories 0–4) were determined. Dentine hypersensitivity, oral mucosal changes, complaints of dry mouth, gingival bleeding and halitosis, and signs of nocturnal jaw clenching and temporomandibular joint (TMJ) dysfunction were recorded. Two or more acute dental conditions per year were considered clinically significant.

Psychometric assessment and questionnaire

The Perceived Stress Scale (PSS-10) [20], the State-Trait Anxiety Inventory state subscale (STAI-S), the Multidimensional Fatigue Inventory (MFI-20) [21] and the Pittsburgh Sleep Quality Index (PSQI) [22] were used. A 27-item questionnaire covered the type of service, frequency of field deployments, night duties, sleep duration, eating pattern, consumption of sugary snacks and energy drinks, smoking, toothbrushing frequency, access to oral hygiene products during service, self-treatment of toothache and dental attendance.

Saliva analysis

Saliva was collected in the morning, at least 90 min after eating, smoking, chewing gum, energy drinks and intensive physical exercise, after a 10-min rest. Unstimulated and stimulated salivary flow rates (mL/min), pH, buffer capacity (semi-quantitative test, points) and α-amylase activity (colorimetric method, U/L) were determined. If preparation conditions were violated, sampling was postponed.

Endpoint and statistical analysis

The endpoint was clinically significant dental pathology, defined as a combination of carious, inflammatory and functional-biological changes requiring active preventive and therapeutic management. Analysis was performed with STATISTICA 23.0. Normality was tested with the Shapiro–Wilk test. Three groups were compared with one-way analysis of variance or the Kruskal–Wallis test, pairwise comparisons were made with Student’s t-test or the Mann–Whitney U test with correction for multiple comparisons, and categorical variables with Pearson’s χ^2 test. Associations were assessed with Spearman’s rank correlation coefficient (rS). Independent predictors were identified by multivariable logistic regression with stepwise selection; β coefficients, odds ratios (OR) and 95% confidence intervals (CI) were calculated. Diagnostic accuracy was assessed by the area under the ROC curve (AUC), sensitivity, specificity and positive and negative predictive values. The critical level of significance was 0.05.

Results

Dental status

The frequency of all main forms of dental pathology and index values increased consistently from group I to group III (Table 2). Active caries was found in 49.6%, 70.2% and 84.5% of servicemen and inflammatory periodontal disease in 38.0%, 64.3% and 77.2%, respectively. DMFT increased from 5.04 ± 1.91 to 8.94 ± 2.20 and PMA from 16.94 ± 6.20% to 38.60 ± 7.79%.

Table 2. Dental status of servicemen by study group

Parameter	Group I (n = 137)	Group II (n = 168)	Group III (n = 206)	p
Active caries, n (%)	68 (49.6)	118 (70.2)	174 (84.5)	<0.001
Inflammatory periodontal disease, n (%)	52 (38.0)	108 (64.3)	159 (77.2)	<0.001
Dentine hypersensitivity, n (%)	25 (18.2)	39 (23.2)	107 (51.9)	<0.001
Oral mucosal changes, n (%)	21 (15.3)	44 (26.2)	83 (40.3)	<0.001
≥2 acute dental conditions in 12 months, n (%)	7 (5.1)	27 (16.1)	72 (35.0)	<0.001
Dry mouth, n (%)	18 (13.1)	58 (34.5)	123 (59.7)	<0.001
Signs of nocturnal jaw clenching, n (%)	20 (14.6)	46 (27.4)	91 (44.2)	<0.001
Signs of TMJ dysfunction, n (%)	7 (5.1)	30 (17.9)	76 (36.9)	<0.001
DMFT, points, M ± SD	5.04 ± 1.91	6.96 ± 2.02	8.94 ± 2.20	<0.001
OHI-S, points, M ± SD	1.04 ± 0.28	1.37 ± 0.29	1.82 ± 0.29	<0.001
PMA, %, M ± SD	16.94 ± 6.20	25.13 ± 8.56	38.60 ± 7.79	<0.001
Bleeding index, points, M ± SD	0.73 ± 0.26	1.13 ± 0.36	1.58 ± 0.40	<0.001

Categorical variables were compared with Pearson's χ^2 test and continuous variables with the Kruskal–Wallis test. TMJ, temporomandibular joint.

The distribution of CPI categories shifted towards more severe periodontal changes (Figure 1): CPI 3–4 accounted for 21.8% in group I, 33.3% in group II and 56.8% in group III ($p < 0.001$).

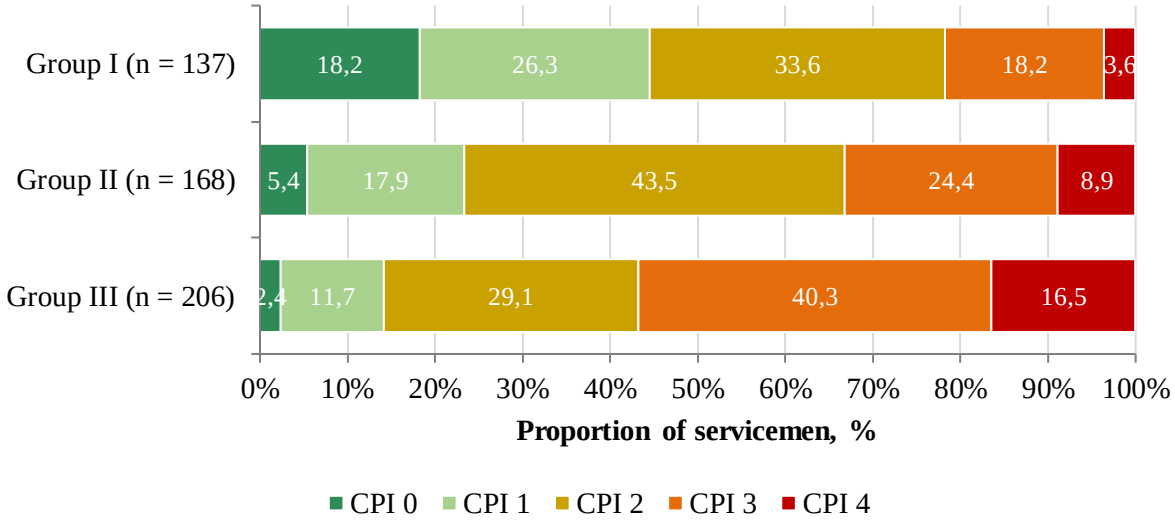


Figure 1. Distribution of Community Periodontal Index (CPI) categories by study group, %.

Psycho-emotional status, sleep and behavioural factors

Scores on all psychometric scales and the frequency of unfavourable behavioural factors increased consistently from group I to group III (Table 3). Sleep under 6 h was reported by 3.6%, 35.7% and 76.2% of servicemen, and limited access to oral hygiene products during service by 14.6%, 30.4% and 59.2%, respectively. PSQI values above 10 points were recorded in 2.2%, 15.5% and 58.7%.

Table 3. Psychometric indicators and behavioural risk factors by study group

Parameter	Group I (n = 137)	Group II (n = 168)	Group III (n = 206)	p
PSS-10, points, M ± SD	15.73 ± 2.89	23.36 ± 3.50	32.26 ± 3.18	<0.001
STAI-S, points, M ± SD	34.57 ± 5.34	43.61 ± 6.56	54.81 ± 6.78	<0.001
MFI-20, points, M ± SD	38.88 ± 7.43	50.70 ± 9.53	62.45 ± 8.55	<0.001
PSQI, points, M ± SD	5.09 ± 1.84	8.01 ± 1.89	10.93 ± 2.04	<0.001
Sleep <6 h, n (%)	5 (3.6)	60 (35.7)	157 (76.2)	<0.001
Daily smoking, n (%)	29 (21.2)	49 (29.2)	98 (47.6)	<0.001
Irregular oral hygiene, n (%)	24 (17.5)	62 (36.9)	118 (57.3)	<0.001
Irregular eating, n (%)	26 (19.0)	68 (40.5)	140 (68.0)	<0.001
Frequent sugary snacks and energy drinks, n (%)	33 (24.1)	71 (42.3)	138 (67.0)	<0.001
Limited access to oral hygiene products, n (%)	20 (14.6)	51 (30.4)	122 (59.2)	<0.001
Infrequent preventive dental visits, n (%)	30 (21.9)	71 (42.3)	126 (61.2)	<0.001

Continuous variables were compared with the Kruskal–Wallis test and categorical variables with Pearson's χ^2 test; all pairwise differences were significant.

Saliva parameters

As adaptive strain increased, salivary flow rate, pH and buffer capacity decreased and α-amylase activity increased (Table 4). Unstimulated salivary flow decreased from 0.45 ± 0.07 mL/min in group I to 0.23 ± 0.09 mL/min in group III. The difference between groups I and II for this parameter was p = 0.004, and all other pairwise differences were p < 0.001.

Table 4. Saliva parameters by study group (M ± SD)

Parameter	Group I (n = 137)	Group II (n = 168)	Group III (n = 206)	p
Unstimulated salivary flow, mL/min	0.45 ± 0.07	0.37 ± 0.09	0.23 ± 0.09	<0.001
Stimulated salivary flow, mL/min	1.48 ± 0.21	1.27 ± 0.22	0.92 ± 0.23	<0.001
Saliva pH	6.77 ± 0.22	6.55 ± 0.23	6.26 ± 0.24	<0.001
Buffer capacity, points	8.71 ± 1.35	6.84 ± 1.45	5.33 ± 1.33	<0.001
α-Amylase, U/L	125.74 ± 32.34	164.02 ± 39.02	225.83 ± 45.40	<0.001

Associations of psychometric, behavioural and biological parameters with dental status

The strongest correlations were found between perceived stress and unstimulated salivary flow (rS = −0.705), PMA (rS = 0.678), OHI-S (rS = 0.672) and DMFT (rS = 0.551). PSQI correlated negatively with unstimulated salivary flow (rS = −0.604) and saliva pH (rS = −0.523); sleep duration correlated negatively with PMA (rS = −0.482) and positively with buffer capacity (rS = 0.497). α-Amylase activity correlated with PSS-10 (rS = 0.656), PMA (rS = 0.567) and OHI-S (rS = 0.555). The associations of daily smoking with DMFT (rS = 0.171) and of irregular hygiene with OHI-S (rS = 0.288) were weak; p < 0.001 for all coefficients given.

Clinically significant dental pathology was found in 13.1% of group I, 57.1% of group II and 95.1% of group III (p < 0.001). Across PSS-10 quartiles it increased from 16.8% to 96.1%, while unstimulated salivary flow decreased from 0.44 ± 0.07 to 0.22 ± 0.09 mL/min; the steepest increase occurred between the second and third quartiles (Figure 2). With 0–1, 2–3 and ≥4 unfavourable behavioural factors, clinically significant pathology was found in 19.0%, 55.1% and 92.8% of servicemen.

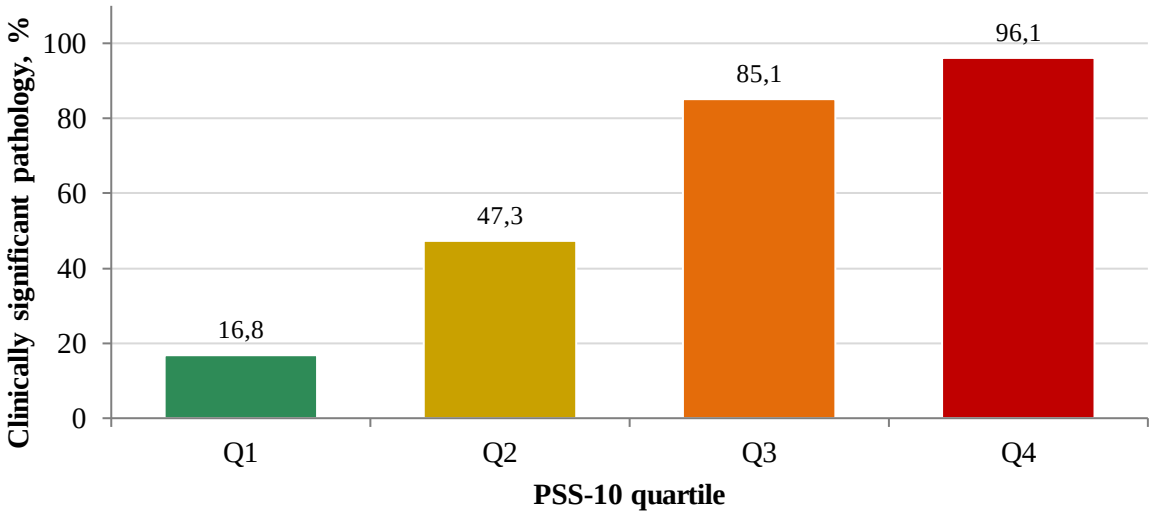


Figure 2. Frequency of clinically significant dental pathology across quartiles of the Perceived Stress Scale (PSS-10) (n = 511). Unstimulated salivary flow in Q1–Q4: 0.44 ± 0.07, 0.38 ± 0.09, 0.28 ± 0.11 and 0.22 ± 0.09 mL/min.

Independent predictors and integral risk model

After stepwise selection, five features remained significant in the multivariable model (Table 5). The highest odds ratios were obtained for high perceived stress (PSS-10 ≥ 24), sleep under 6 h and unstimulated salivary flow below 0.30 mL/min. Based on β coefficients, features with β of about 2.0 were assigned 4 points and features with β below 1.2 were assigned 2 points (maximum score, 16 points).

Table 5. Independent predictors of clinically significant dental pathology and points of the integral model

Predictor	β	OR	95% CI	p	Points
Sleep <6 h	2.071	7.93	4.21–14.95	<0.001	4
High stress (PSS-10 ≥ 24)	2.080	8.00	4.53–14.15	<0.001	4
Unstimulated salivary flow <0.30 mL/min	1.890	6.62	3.10–14.12	<0.001	4
Irregular oral hygiene	1.157	3.18	1.77–5.73	<0.001	2
Daily smoking	0.809	2.25	1.23–4.10	0.008	2

Multivariable logistic regression with stepwise selection. Risk categories: 0–3 points, low; 4–8, intermediate; 9–16, high.

Sequential addition of features increased the AUC from 0.741 (sleep under 6 h alone) to 0.929 (95% CI 0.89–0.96) for the full model; the largest increment (+0.101) came from adding high stress (Figure 3). At a cut-off of 0.62, sensitivity was 85.5%, specificity 87.6%, positive and negative predictive values 91.4% and 79.6%, and overall accuracy 86.3%.

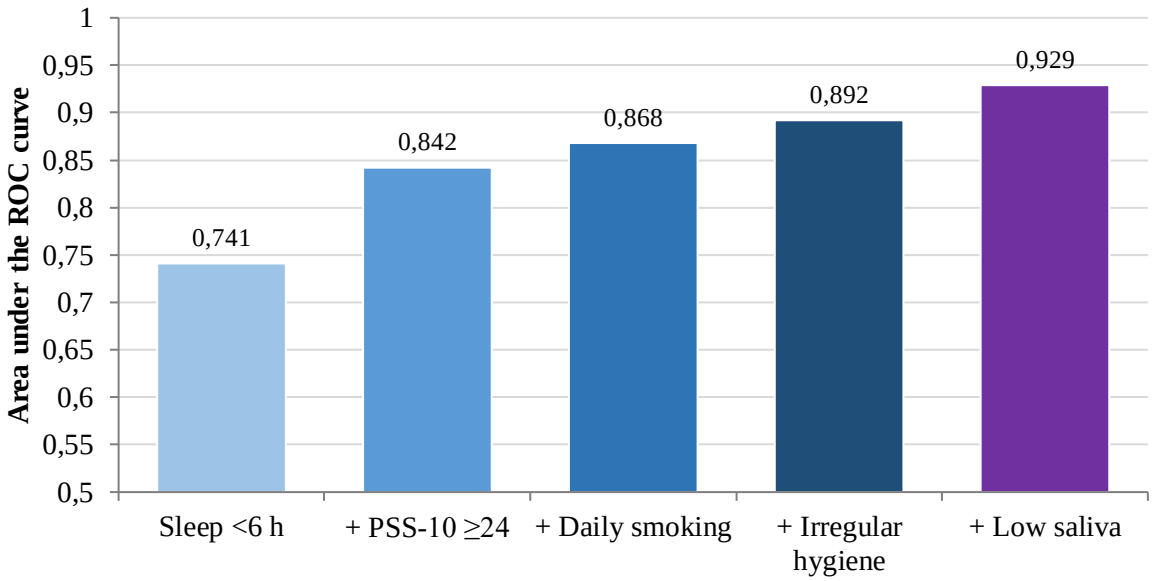


Figure 3. Stepwise contribution of model components to the area under the ROC curve (AUC). 95% CI: 0.69–0.79, 0.79–0.88, 0.82–0.91, 0.85–0.93, 0.89–0.96.

According to the total score, 166 (32.5%) servicemen were classified as low risk, 142 (27.8%) as intermediate and 203 (39.7%) as high risk; the frequency of clinically significant pathology in these categories was 14.5%, 62.0% and 97.5%, and the frequency of acute dental conditions per year 12.7%, 34.5% and 61.6%, respectively. Within narrower score intervals, the frequency of pathology accelerated after 4–5 points (Figure 4).

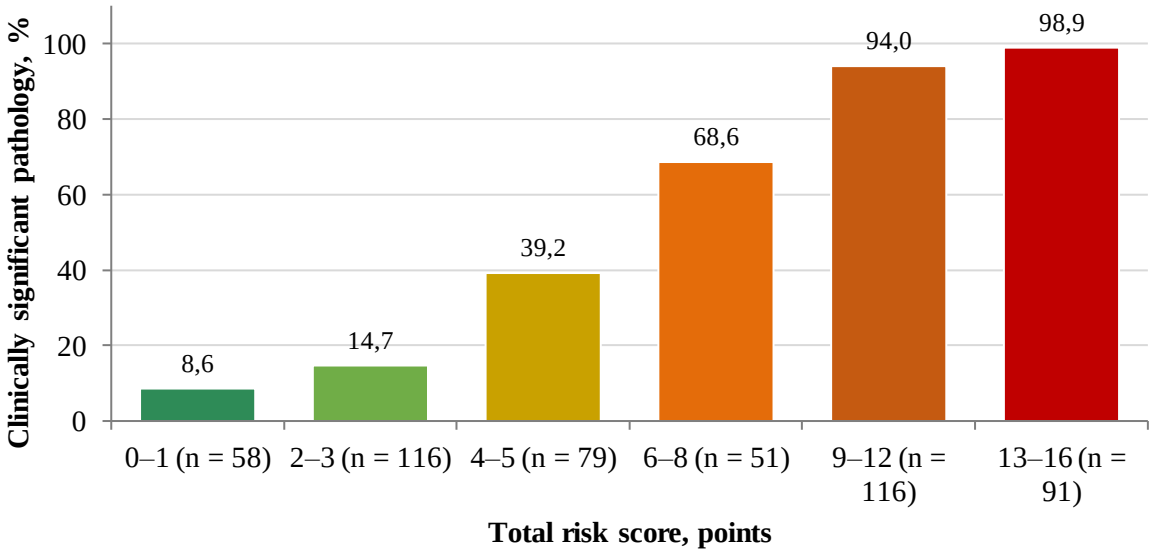


Figure 4. Frequency of clinically significant dental pathology according to the total score of the integral risk model (n = 511).

Discussion

The study shows that in servicemen with increasing adaptive strain, dental pathology develops not in isolation but as a coordinated shift in clinical, psychometric and biological

parameters: from group I to group III, DMFT, OHI-S and PMA, the proportion of severe CPI categories and the frequency of acute dental conditions and functional disorders increased, whereas salivary flow, pH and buffer capacity decreased. This is consistent with current views on the joint influence of lifestyle and behavioural factors on caries and periodontal disease [23, 24].

The association of perceived stress with oral hygiene and periodontal status is consistent with systematic reviews that consider psychological stress and ineffective coping as risk factors for periodontal disease [6, 7] and occupational stress as a factor of poorer oral health in workers [8]. Studies of academic stress have shown that its effect on the periodontium is partly mediated by deterioration of oral hygiene [9, 10]; in our study, irregular hygiene also retained independent significance (OR 3.18), in line with meta-analytic evidence on oral hygiene and periodontitis [25]. The significance of daily smoking (OR 2.25) agrees with meta-regression data on the effect of smoking on periodontitis [26], and the high consumption of sugary snacks and energy drinks in group III with the role of sugars in caries [27]. Stress also reduces the effectiveness of non-surgical periodontal therapy [28], which is important for treatment planning in group III.

Short sleep was one of the strongest predictors. According to a meta-analysis, sleep of 5 h or less is associated with a higher prevalence of periodontitis [12]. Reduced unstimulated salivary flow and buffer capacity are a biologically plausible link, because saliva provides clearance, buffering and remineralisation [13, 14]. The increase in α-amylase activity in group III is consistent with its role as a marker of sympathetic activation [15], but this parameter depends on time of day, collection method and salivary flow [16, 29] and should be interpreted with caution. The high frequency of nocturnal jaw clenching and TMJ dysfunction signs in group III corresponds to the role of psychosocial factors in bruxism [17].

The practical value of the study is that the model includes five features that can be recorded during a routine examination in a unit dental office and makes it possible to identify servicemen who need enhanced prevention and priority treatment. Unlike known periodontal risk assessment models [18], it takes into account sleep, perceived stress and salivary flow.

Limitations

The study is cross-sectional and does not allow causal inference. Acute dental conditions were registered retrospectively. Some features (sleep, PSS-10, smoking and hygiene) were included both in the stratification scheme and in the prognostic model, which may have inflated between-group differences. The model was developed and evaluated in the same sample without internal (bootstrap) or external validation, so its accuracy estimates are probably optimistic. Buffer capacity was assessed semi-quantitatively. Only men from one region were examined. The model requires prospective validation before practical implementation.

Conclusion

Servicemen with high adaptive strain had a higher frequency of caries, inflammatory periodontal disease and functional disorders, associated with poorer sleep, psycho-emotional status and saliva properties. Sleep under 6 h, high perceived stress, reduced unstimulated salivary flow, irregular oral hygiene and daily smoking were independently associated with clinically significant dental pathology. The five-component point-based model divides servicemen into groups with a frequency of pathology from 14.5% to 97.5% and, after external validation, may be used for risk-oriented prevention in military dental care.

Additional information

Author contributions. All authors contributed to the compilation and layout of this material.

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Generative artificial intelligence. The dissertation material was translated from Uzbek, and the manuscript was structured and edited, and the abstract translated into English, using Claude (Anthropic, https://claude.ai). The authors verified all numerical data against the primary material and take full responsibility for the content.

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Information about the authors

Islomjon R. Sattarov — Assistant, Department of Periodontology and Orthodontics, Central Asian Medical University, Fergana, Republic of Uzbekistan; e-mail: isasattarov1995@gmail.com; ORCID: https://orcid.org/0009-0001-3965-332X

Mavlonjon Z. Nasirdinov — PhD, Associate Professor, Department of Normal and Pathological Physiology, Andijan Branch of Kokand University, Andijan, Republic of Uzbekistan; e-mail: profnasirdinov@gmail.com; ORCID: https://orcid.org/0009-0007-5957-9861