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Overweight and Obesity as Predictors of Work-Related Upper Extremity Disability among Dentists in Arak, Iran: A Cross-Sectional Study

Yashar Mansouri Rad
Arak University of Medical Sciences
Mojtaba Bayani
Arak University of Medical Sciences
Milad Gholami
Arak University of Medical Sciences
Farhad Ghamari
f.ghamari@yahoo.com

Arak University of Medical Sciences

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Abstract

Background

Musculoskeletal disorders (MSDs) pose a significant occupational health challenge for dental professionals due to prolonged static postures and repetitive movements. While obesity is a known risk factor for MSDs, its specific association with upper extremity disability among dentists remains underexplored.To investigate the association between body mass index (BMI) and work-related upper extremity disability among dentists in Arak, Iran.

Methods

A cross-sectional study was conducted among 276 dentists recruited from dental offices and clinics in Arak using convenience sampling. Data were collected using a demographic and occupational questionnaire, the Nordic Musculoskeletal Questionnaire (NMQ), and the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire. BMI was categorized according to World Health Organization criteria. Binary logistic regression and chi-square (χ^2) tests were employed to determine factors associated with upper extremity disability. Statistical significance was defined as a p-value < 0.05.

Results

The prevalence of overweight and obesity was 36.6% and 19.2%, respectively. The shoulder was the most frequently affected site (58.7%), followed by the wrist/hand (53.6%) and neck (47.8%). After adjusting for gender, age, and work experience, overweight (adjusted OR = 1.84, 95% CI: 1.02–3.32, p = 0.04) and obesity (adjusted OR = 2.98, 95% CI: 1.42–6.25, p = 0.004) were significantly associated with higher odds of upper extremity disability compared to normal-weight dentists. No significant associations were observed for gender, age, or work experience.

Conclusion

Elevated BMI is independently associated with upper extremity disability among dentists in a dose-response manner. These findings highlight the need for integrated weight management and ergonomic interventions in occupational health strategies for dental professionals to reduce MSD burden.

Introduction

Musculoskeletal disorders (MSDs) constitute a pervasive occupational health challenge, with dental professionals facing a notably high risk due to the inherent physical demands of their practice(1). The nature of dental work frequently entails prolonged static postures, repetitive fine motor movements, the use of vibrating instruments, and the application of precise forces, all of which predispose dentists to

MSDs, particularly in the upper extremities, including the arms, shoulders, and hands(2). Epidemiological data underscore the substantial burden of these conditions. While prevalence estimates vary, studies from Iran report overall MSD rates between 50% and 70% among dentists, and international research indicates that at least 77% of dental professionals experience MSDs, with approximately one-third citing these disorders as a factor in early career departure(3–10).

The pathogenesis of MSDs in this profession is multifactorial, involving rapid repetitive motions, awkward joint positioning, extreme flexion and extension of the wrists and fingers, tendon pressure, and static muscle and joint loading(11). These occupational stressors often manifest as pain, numbness, weakness, reduced range of motion, and functional limitations that impair both daily activities and clinical performance(1). Beyond personal health consequences, these disorders diminish work productivity, increase absenteeism, and compromise the quality of patient care. The consequences extend to psychological, social, and economic domains, potentially leading to reduced job satisfaction, increased fatigue, and early retirement(5).

Regional studies consistently identify the neck, shoulders, and upper limbs as the most affected areas among dental practitioners. For instance, Malaysian dentists reported the highest MSD prevalence in the neck (82%) and lower back (64%), with female practitioners being more susceptible(12). Similarly, a study from Queensland, Australia, found self-reported neck, lower back, and shoulder issues in 24.6%, 22.1%, and 21.8% of dentists, respectively(13). In Iran, comparable figures- 43.4% for neck pain, 35.8% for back/shoulder pain, and 25% for wrist pain- confirm a significant burden(9). Multiple factors contribute to this high prevalence, including work-related elements such as extended working hours, insufficient rest, poor ergonomic practices, and inadequate equipment; individual characteristics like age, gender, years of experience, smoking, and physical activity; and overall health status(3–5). The repetitive and continuous nature of dental procedures particularly taxes the upper extremities, often resulting in more pronounced symptoms in these regions. Research indicates that 47% of these disorders manifest after 10–19 years of practice, with the 30–49 age group most affected, and symptom severity correlated with clinical experience(14).

In recent years, the role of overweight and obesity, as measured by Body Mass Index (BMI), has garnered increasing attention as a potential independent and modifiable risk factor for MSDs(15). While much of the existing research has focused on the association between high BMI and low back pain, growing evidence suggests that elevated BMI also contributes to symptoms in other regions, including the neck, shoulders, and upper and lower extremities. Several hypotheses explain this link. Increased mechanical load on weight-bearing joints, such as the spine and lower limbs, is a primary factor. Metabolic changes associated with obesity, including systemic inflammation, also play a role(16). Furthermore, in the case of carpal tunnel syndrome, adipose tissue accumulation within the carpal tunnel can lead to median nerve compression. These potentially differing mechanisms underscore the importance of distinguishing between body regions when evaluating MSD risk factors(17, 18).

Longitudinal data reinforce this association, revealing that obese employees have a higher risk of developing musculoskeletal symptoms and lower chances of recovery from existing symptoms compared to their normal-weight peers(19). Interestingly, physical workload modifies this association; the link between BMI and symptoms is stronger among those with low physical workload, suggesting that greater muscle mass around joints may offer a protective effect in physically active, high-BMI individuals(16). Therefore, weight reduction is hypothesized to alleviate musculoskeletal pain, positioning BMI-targeted interventions as potential primary and secondary prevention strategies.

Overweight and obese dentists exhibit notably higher disability scores than their normal-weight counterparts. Biomechanically, increased joint forces are more relevant for weight-bearing regions, whereas metabolic factors may better explain symptoms in non-weight-bearing areas such as the shoulders and upper extremities(20). Additionally, the observation that many obese individuals use their upper extremities to support body weight when rising from seated positions may contribute to upper limb symptoms. The association between high BMI and non-weight-bearing joint osteoarthritis (e.g., in the hands) and conditions like fibromyalgia further supports the existence of non-mechanical pathways(21). Weight-loss studies among obese workers have shown reductions in upper extremity symptoms, reinforcing the role of BMI in upper limb morbidity(22).

The sedentary work habits common among dentists—with nearly 93% primarily working in a seated position and over half adopting a bent-back posture—may compound the effects of elevated BMI on musculoskeletal health(23). Prolonged spinal flexion, torso extension toward patients, and repetitive fine-motor tasks in confined spaces overburden muscles, ligaments, joints, and tendons, particularly in the lumbar and cervical regions(23). Despite the clear relevance of this topic, few studies have concurrently examined BMI and MSDs in dentists. Most domestic Iranian research has focused solely on prevalence rather than modifiable risk factors, leaving a significant gap in the literature. Documentation of MSDs and their associated risk factors remains sparse in many regions, and limited efforts have explored the interplay between MSD prevalence and risk determinants, particularly BMI. Given the repeated stress on the hand and wrist from dental procedures, which can cause tendon inflammation and median nerve compression, targeted research is urgently needed.

In light of this, the present study aims to investigate the association between BMI categories and work-related upper extremity disability among dentists practicing in Arak, Iran. The objectives are to determine the prevalence of upper extremity functional limitations, examine its relationship with BMI categories, and identify occupational and demographic factors that may modify this association. By pinpointing modifiable risk factors such as BMI, this research aspires to inform preventive strategies and occupational health interventions aimed at reducing the MSD burden in the dental workforce. The findings are expected to contribute to ergonomic guidelines, workplace health promotion programs, and individual-level interventions addressing weight management and proper posture. Ultimately, this study seeks to raise awareness among Iranian dentists about the importance of maintaining a healthy weight and adopting sound ergonomic practices to prevent the development and progression of work-related upper extremity disabilities.

Methods

1. Study Design and Setting

This descriptive-analytical cross-sectional study was conducted in dental offices and clinics located in Arak city, Iran. The overall project timeline spanned approximately 12 months (2025–2026), encompassing the stages of obtaining ethical and administrative approvals, data collection, data analysis, and final report preparation. The exposure variables of interest comprised demographic and occupational characteristics of dentists, along with their obesity and overweight status as determined by body mass index, all of which were measured concurrently with the primary outcome variable—namely, upper limb disability. Given the cross-sectional design, no follow-up period was implemented, and all data were collected at a single time point using a structured questionnaire.

2. Ethical Considerations

The study protocol was reviewed and approved by the relevant ethics committee of Arak University of Medical Sciences, Arak, Iran (IR.ARAKMU.REC.1404.128). All participants provided written informed consent prior to enrollment, and the confidentiality of their personal information was strictly maintained throughout the research process.

3. Study Participants

Participants were recruited from among dentists actively practicing in dental offices and clinics across Arak city using a convenience sampling method. Following the acquisition of necessary administrative approvals from the university and coordination with the management of each participating center, the researcher visited the facilities and, after elucidating the research objectives, extended invitations to eligible dentists.

The inclusion criteria were: (a) possession of a Doctorate in Dentistry degree and a valid professional license, (b) active dental practice in Arak during the year 2025, (c) willingness to participate in the study, and (d) provision of signed informed consent. Exclusion criteria comprised: (a) a history of recent trauma or surgical intervention (within the preceding 6 months) affecting the arm, shoulder, or hand region unrelated to dental practice, and (b) known systemic rheumatic or inflammatory diseases (e.g., rheumatoid arthritis) that could independently influence upper limb function.

4. Sample Size Calculation

The required sample size was determined based on the cross-sectional nature of the study and its primary objectives of estimating prevalence and examining associations between variables. Taking into

account the anticipated prevalence of moderate to severe upper limb disability among the target population, the sample size was calculated as 276 dentists employed in Arak city.

5. Data Collection Instruments

5.1. Demographic and Occupational Information Questionnaire

A researcher-developed questionnaire was formulated following a comprehensive review of the literature pertaining to demographic and occupational factors affecting dentists' health. This instrument encompassed items addressing age, gender, marital status, years of clinical experience, daily and weekly working hours, number of working days per week, type and frequency of physical exercise, smoking status, dominant hand, as well as self-reported height and weight for BMI calculation.

5.2. Body Mass Index (BMI) Assessment

Anthropometric measurements, specifically weight and height, were obtained from all participants during the face-to-face interviews. Body mass index (BMI) was subsequently computed by dividing each participant's body weight in kilograms by the square of their height in meters (kg/m^2). Based on the calculated BMI values, participants were stratified into four distinct categories in accordance with the World Health Organization (WHO) classification system: Lightweight (< 18.5), normal weight (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2), and obese (≥ 30.0 kg/m^2).

5.3. Nordic Musculoskeletal Questionnaire (NMQ)

To assess work-related musculoskeletal symptoms, the Extended Nordic Musculoskeletal Questionnaire (NMQ-E) was employed. This instrument was designed to standardize the measurement of musculoskeletal complaints across various occupational populations. The Persian version of the NMQ-E has demonstrated strong psychometric properties, with excellent internal consistency reported in validation studies (Cronbach's alpha = 0.87), confirming its reliability for use in Iranian populations(24).

The NMQ-E comprises a posterior-view human figure divided into nine anatomical regions: the neck, shoulders, upper back, lower back, elbows, wrists/hands, hips/thighs, knees, and ankles/feet. For each region, the questionnaire includes items addressing the presence of musculoskeletal pain, the inability to perform normal activities, and the necessity of consulting a healthcare professional. Responses are recorded dichotomously (yes/no), with respondents indicating the presence or absence of each symptom. In the present study, the NMQ-E was utilized to estimate the prevalence of musculoskeletal pain and associated work disturbance among dentists, assessed over both the preceding 12 months and the recent week, as well as to evaluate work-related functional limitations.

5.4. Disability of the Arm, Shoulder, and Hand (DASH) Questionnaire

The DASH (Disability of the Arm, Shoulder and Hand) questionnaire is a standardized, self-administered instrument designed to evaluate physical function and symptomatology in individuals with musculoskeletal disorders affecting the upper extremities. Originally developed through a collaborative effort involving the American Academy of Orthopaedic Surgeons, the Council of Musculoskeletal Specialty Societies, and the Institute for Work and Health, this tool has gained widespread acceptance as a reliable outcome measure in both clinical practice and research contexts.

The core section of the questionnaire comprises 30 items that assess the participant's functional status over the preceding week, encompassing difficulties encountered in performing daily activities (e.g., turning keys, washing hair, carrying heavy objects, and participating in recreational pursuits), as well as symptoms such as pain during sleep or activity, weakness, and joint stiffness. Furthermore, the instrument evaluates the impact of physical limitations on social and occupational functioning. Two optional modules, each containing four items, are also available to assess the effect of upper limb problems on work performance and on sports or musical activities. All items are rated on a 5-point Likert scale, with scores ranging from 1 (no disability) to 5 (severe disability).

The Persian adaptation of the DASH questionnaire has been rigorously validated in Iranian populations, demonstrating excellent psychometric properties. The most comprehensive validation studies, conducted by Mousavi et al. (2008) and Zakerjafari et al. (2018), reported a Cronbach's alpha coefficient of 0.96 for the Persian DASH(25, 26). This exceptionally high value indicates outstanding internal consistency, confirming that the questionnaire items reliably measure the same underlying construct of upper limb disability and supporting the instrument's suitability for use in Iranian clinical and research settings.

6. Statistical Analysis

All statistical analyses were conducted using SPSS software (version 26.0). Descriptive statistics were generated for all demographic, occupational, and clinical variables. Continuous data were expressed as means with standard deviations (SD), whereas categorical variables were summarized as frequencies and percentages.

The association between categorical variables (including gender, dominant hand, and BMI categories) and upper limb disability severity (categorized as mild, moderate, or severe based on DASH score classifications) was evaluated using the chi-square test, with Fisher's exact test applied when expected cell frequencies were insufficient. Comparisons of mean DASH scores between two independent groups were performed using the independent samples t-test following verification of normality assumptions; when normality was violated, the non-parametric Mann–Whitney U test was employed. For comparisons involving more than two groups, one-way analysis of variance (ANOVA) was utilized for normally

distributed data, with the Kruskal–Wallis test applied as a non-parametric alternative when distributional assumptions were not met.

Correlations between continuous variables- including age, years of clinical experience, weekly working hours, and BMI- and the continuous DASH score were assessed using Pearson's correlation coefficient for normally distributed data or Spearman's rank correlation coefficient for non-normally distributed data. To evaluate the independent effects of multiple variables on DASH scores, multiple linear regression analysis was performed. When the DASH score was dichotomized as a categorical outcome, binary logistic regression was employed to identify factors associated with the presence of upper extremity disability. For all statistical tests, a two-sided p-value of less than 0.05 was considered statistically significant.

Results

A total of 276 dentists took part in this study. Table 1 details the demographic characteristics and job-related factors stratified by BMI category. The gender distribution was nearly balanced, comprising 142 males (51.4%) and 134 females (48.6%). The predominant age group was 30–39 years, with 112 participants (40.6%), followed by those aged 40–49 years (76, 27.5%), under 30 years (48, 17.4%), and 50 years or older (40, 14.5%). Regarding professional experience, the majority had practiced for 5–15 years (116, 42.0%), followed by 16–25 years (72, 26.1%), fewer than 5 years (52, 18.8%), and 25 years or more (36, 13.0%).

The BMI distribution revealed that 104 participants (37.7%) were of normal weight, 101 (36.6%) were overweight, 53 (19.2%) were obese, and 18 (6.5%) were classified as underweight.

Table 1
Demographic information and job characteristics of theparticipants across BMI categories

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	142	51.4
	Female	134	48.6
Age group (years)	< 30	48	17.4
	30–39	112	40.6
	40–49	76	27.5
	≥ 50	40	14.5
Work experience (years)	< 5	52	18.8
	5–15	116	42.0
	16–25	72	26.1
	≥ 25	36	13.0
BMI(Kg/ m^2)	Lightweight(< 18.5)	18	6.5
	Normal(18.5–24.9)	104	37.7
	Overweight(25-29.9)	101	36.6
	Obese(> 30)	53	19.2
Total		276	100

Table 2 summarizes the 12-month prevalence of work-related musculoskeletal symptoms (WMSs) and associated functional limitations. The shoulder was the most frequently affected site, with 162 participants (58.7%) reporting symptoms, followed by the wrist and hand (148, 53.6%), the neck (132, 47.8%), and the arm and elbow (104, 37.7%). A similar pattern was observed for symptoms in the preceding 7 days, with shoulder symptoms remaining the most prevalent (145, 52.5%), followed by wrist and hand (132, 47.8%), neck (110, 39.8%), and arm and elbow (87, 31.5%).

Functional limitations attributed to work were most commonly associated with neck complaints, affecting 62 participants (22.4%), followed by shoulder (45, 16.3%), wrist and hand (28, 10.1%), and arm and elbow (23, 8.3%).

Table 2
Frequency of Musculoskeletal Complaints and Associated Work-Related Functional Limitations in the Study Population

Body region	WMSs during the previous 12 months [n (%)]	WMSs during the previous 7 days [n (%)]	Work-related limitation [n (%)]
Neck	132 (47.8)	110 (39.8)	62 (22.4)
Shoulder	162 (58.7)	145 (52.5)	45 (16.3)
Arm and elbow	104 (37.7)	87 (31.5)	23 (8.3)
Wrist and hand	148(53.6)	132 (47.8)	28(10.1)

WMSs: Work-related Musculoskeletal Symptom

The distribution of upper limb disability severity, as assessed by DASH scores, is presented in Table 3. Among all participants, 124 (44.9%) exhibited moderate disability (DASH score 21–40), 96 (34.8%) had mild disability (score 0–20), and 56 (20.3%) showed severe disability (score > 40).

Table 3
Distribution of Upper Limb Disability Severity Based on DASH Score Among Participants (N = 276)

Disability Level	DASH Score Range	Frequency (n)	Percentage (%)
Mild	**0–20**	**96**	**34.8**
Moderate	**21–40**	**124**	**44.9**
Severe	**> 40**	**56**	**20.3**
Total	**-**	**276**	**100**

Figure 1 depicts the mean DASH scores across BMI categories, revealing a progressive increase in upper extremity disability severity with rising BMI. Overweight dentists demonstrated higher mean DASH scores than their normal-weight counterparts, while obese dentists recorded the highest mean scores, indicating the most pronounced upper extremity disability. This graphical trend corroborates the logistic regression findings presented in Table 5, supporting a dose-response relationship between increasing BMI and greater severity of upper extremity disability among dentists. These findings suggest that higher BMI is associated with an escalating burden of work-related upper extremity musculoskeletal impairment.

Table 4 examines the associations between demographic and occupational variables and mean DASH scores. The mean DASH score for males (26.1 ± 7.9) was comparable to that for females (25.6 ± 8.2),

with no statistically significant difference (p = 0.34). Although mean DASH scores tended to increase with age—from 24.8 ± 7.5 in the under-30 group to 27.5 ± 8.1 in those aged 50 and above—this trend was not statistically significant (p = 0.12). Similarly, scores rose with longer work experience, ranging from 25.2 ± 7.6 for those with fewer than 5 years to 27.2 ± 8.0 for those with 25 or more years, yet this association also failed to reach significance (p = 0.08).

Table 4
Relationship Between Demographic Variables and Upper Extremity DASH Score

Independent variable	Group / Category	Mean ± standard deviation DASH	Statistical test	P-value
Gender	Woman	25.6 ± 8.2	Independent t-test	0.34
	Man	26.1 ± 7.9		
Age group (years)	< 30	24.8 ± 7.5	One-way ANOVA	0.12
	30–39	26.3 ± 8.0		
	40–49	26.9 ± 8.4		
	≥ 50	27.5 ± 8.1		
Work experience (years)	< 5	25.2 ± 7.6	One-way ANOVA	0.08
	5–15	26.5 ± 8.0		
	16–25	26.8 ± 8.3		
	≥ 25	27.2 ± 8.0		

Binary logistic regression analysis was conducted to identify factors associated with upper extremity disability, defined as a DASH score greater than 20 (Table 5). After adjusting for gender, age group, and work experience, both overweight and obesity were significantly associated with higher odds of disability relative to normal-weight dentists. Overweight dentists had 1.84 times higher odds of disability (adjusted OR = 1.84, 95% CI: 1.02–3.32, p = 0.04), while obese dentists exhibited nearly threefold higher odds (adjusted OR = 2.98, 95% CI: 1.42–6.25, p = 0.004). No significant associations were observed for gender, age group, or work experience (all p > 0.05).

Table 5
Binary Logistic Regression for Factors Associated with Upper Extremity Disability (DASH > 20)

Variable	Category	Crude OR (95% CI)	Adjusted OR (95% CI)	p-value*
Gender	Male	1.00 (Ref)	1.00 (Ref)	—
	Female	0.92 (0.56–1.51)	0.88 (0.52–1.49)	0.63
Age group (years)	< 30	1.00 (Ref)	1.00 (Ref)	—
	30–39	1.30 (0.66–2.56)	1.25 (0.62–2.52)	0.53
	40–49	1.48 (0.72–3.04)	1.42 (0.68–2.96)	0.35
	≥ 50	1.62 (0.74–3.55)	1.56 (0.70–3.48)	0.28
Work experience (years)	< 5	1.00 (Ref)	1.00 (Ref)	—
	5–15	1.22 (0.61–2.44)	1.18 (0.58–2.40)	0.65
	16–25	1.35 (0.64–2.85)	1.30 (0.61–2.77)	0.50
	≥ 25	1.42 (0.63–3.20)	1.38 (0.60–3.18)	0.45
BMI(Kg/ m2)	Normal weight	1.00 (Ref)	1.00 (Ref)	—
	Overweight	1.91 (1.09–3.35)	1.84 (1.02–3.32)	0.04
	Obese	3.11 (1.56–6.20)	2.98 (1.42–6.25)	0.004

Conversely, no significant associations were observed for gender, age group, or work experience in the adjusted model. Females showed slightly lower odds of disability than males (adjusted OR = 0.88, 95% CI: 0.52–1.49, p = 0.63), though this difference was not statistically significant. Advancing age and greater work experience displayed trends toward increased odds of disability, with adjusted odds ratios ranging from 1.25 to 1.56; however, none of these estimates reached statistical significance (all p > 0.05).

Discussion

The present study aimed to investigate the association between body mass index (BMI) and upper extremity musculoskeletal disability, as measured by the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire, among a sample of 276 practicing dentists. Our findings demonstrate a significant, positive, and dose-dependent relationship between increasing BMI and greater upper extremity disability, with overweight and obese dentists exhibiting substantially higher odds of functional impairment compared to their normal-weight counterparts. This association remained robust after adjustment for potential confounders, including gender, age, and years of professional experience,

underscoring the independent contribution of elevated BMI to musculoskeletal morbidity in this occupational group.

The most salient observation from our study was the graded increase in DASH scores across ascending BMI categories, with obese dentists recording the highest mean scores and the greatest severity of disability. Binary logistic regression further substantiated this pattern, revealing that overweight dentists had 1.84 times higher odds of disability (adjusted OR = 1.84, 95% CI: 1.02–3.32, p = 0.04), while obese dentists faced nearly threefold increased odds (adjusted OR = 2.98, 95% CI: 1.42–6.25, p = 0.004). These findings are consistent with a substantial body of domestic and international literature(16, 20, 23). For instance, Salemi et al. (2020) and Faghri et al. (2015) reported that overweight healthcare workers experienced significantly higher prevalence of shoulder and upper extremity pain(27, 28), while Aytutuldu et al. (2022), in a study of office workers, identified high BMI as a significant predictor of upper limb disability(29). Similarly, Nakhostin et al. (2016), in an Iranian dental cohort, observed elevated rates of musculoskeletal problems among dentists with higher BMI(30). Our results also align with the work of Alexopoulos et al. (2004) and Hayes et al. (2009), both of whom identified overweight and obesity as independent risk factors for work-related musculoskeletal disorders (MSDs) across various occupational settings(2, 31). Collectively, these concordant findings suggest that the deleterious effects of excess body weight on the musculoskeletal system extend beyond the lower extremities to encompass the upper limbs, likely through shared biomechanical and metabolic pathways.

Several plausible mechanisms may underpin the observed BMI–disability relationship. First, increased body mass imposes greater mechanical loading on joints, tendons, and muscles, altering movement patterns and exacerbating the effects of prolonged static postures that are inherently required in dental practice. Second, excess adipose tissue is associated with a chronic low-grade inflammatory state, characterized by elevated pro-inflammatory cytokines such as interleukin-6 and tumor necrosis factor-alpha, which may impair tissue repair and heighten pain sensitivity following repetitive strain (Calder et al., 2011)(19). Third, obesity may limit range of motion and reduce physical fitness, thereby diminishing the capacity to adopt ergonomically optimal working postures and increasing compensatory movements that strain the upper extremities. In the dental context, where clinicians frequently sustain static neck and shoulder flexion combined with fine motor precision tasks, these biomechanical and physiological factors are likely compounded, resulting in accelerated musculoskeletal deterioration.

In addition to the primary BMI findings, our study examined the prevalence and distribution of specific musculoskeletal symptoms. Over the 12-month recall period, the shoulder was the most commonly affected site (58.7%), followed by the wrist and hand (53.6%), the neck (47.8%), and the arm and elbow (37.7%). A similar pattern was observed over the preceding 7 days. Notably, although shoulder symptoms were most prevalent, functional limitations were most frequently attributed to neck complaints (22.4%), followed by shoulder (16.3%). This discordance suggests that while shoulder pain is highly prevalent, neck-related dysfunction may impose a greater burden on daily occupational performance, possibly due to the sustained cervical flexion inherent in dental procedures. This observation is consistent with the work of Åkesson et al. (2012), who found that neck disorders in

dentists are often associated with more pronounced perceived disability due to the postural demands of clinical work(32).

Regarding demographic and occupational variables, our analysis revealed no statistically significant associations between gender, age, or work experience and DASH scores, although trends toward increased disability with advancing age and longer experience were noted. These findings are in agreement with previous studies that have reported limited independent effects of these factors on upper extremity disability severity (Hadid et al., 2017)(33). The lack of statistical significance may be attributed to several factors, including insufficient sample size within certain subgroups, the possibility that these variables exert indirect effects mediated through BMI, or the presence of protective workplace adaptations that mitigate age- or experience-related declines. For instance, more experienced dentists may have developed compensatory ergonomic strategies over time, or they may self-select into less physically demanding roles. Alternatively, the cumulative effect of age and experience on disability may be largely accounted for by their association with gradual weight gain across the career lifespan, a hypothesis supported by the attenuation of these effects upon inclusion of BMI in the regression model. These findings underscore the importance of considering lifestyle factors—particularly BMI—and physical work conditions as primary targets for intervention, rather than relying solely on demographic characteristics for risk stratification.

It is important to acknowledge that some studies have reported mixed or attenuated associations between BMI and upper extremity disability. For example, Mamani et al. (2025), in a cross-sectional investigation, found that the relationship between BMI and upper limb impairment was substantially weakened after adjustment for occupational factors and physical activity history(34). Such discrepancies may arise from differences in study design, sample characteristics, outcome measurement tools (e.g., DASH versus clinical examinations), or the occupational diversity of study populations. In physically active or ergonomically optimized work environments, the detrimental effects of elevated BMI may be partially offset, whereas in high-risk professions such as dentistry—characterized by prolonged static postures and repetitive fine motor tasks—the impact of excess weight is likely more pronounced. This distinction reinforces the context-specific nature of musculoskeletal risk and highlights the need for tailored preventive strategies.

The strengths of our study include the use of a validated and standardized instrument (the DASH questionnaire) to quantify disability, the inclusion of both symptom prevalence and functional limitation data, and the rigorous adjustment for multiple confounders through logistic regression. Furthermore, the demonstration of a dose-response relationship between BMI and disability severity strengthens the plausibility of a causal interpretation, even within a cross-sectional framework.

However, several limitations must be acknowledged. First, the cross-sectional design precludes the establishment of temporal causality; reverse causality remains plausible, as pre-existing disability could lead to reduced physical activity and subsequent weight gain. Second, reliance on self-reported symptoms and anthropometric data may introduce recall and social desirability biases, although the use

of standardized questionnaires likely mitigated this concern. Third, our sample was drawn from a single geographic region, which may limit the generalizability of findings to dentists in other cultural or healthcare settings. Fourth, we did not assess potentially confounding variables such as leisure-time physical activity, dietary habits, smoking status, or specific ergonomic practices, all of which could interact with BMI to influence disability outcomes. Fifth, the relatively small number of participants in the underweight and severe obesity categories reduced statistical power for subgroup analyses, and the absence of objective biomechanical or inflammatory markers limited our ability to explore mechanistic pathways.

Despite these limitations, our findings carry important practical implications for occupational health policy and dental practice. The high prevalence of overweight (36.6%) and obesity (19.2%) observed in our sample, coupled with the strong association between elevated BMI and upper extremity disability, underscores the urgent need for integrated weight management and ergonomic intervention programs. Dental training curricula and continuing professional development should incorporate education on the musculoskeletal risks associated with excess body weight and emphasize the importance of maintaining a healthy BMI through lifestyle modifications. Workplace wellness initiatives that promote physical activity, healthy nutrition, and stress reduction could serve as effective primary prevention measures. Moreover, routine occupational health evaluations for dentists should include BMI screening, and overweight or obese practitioners should receive personalized ergonomic assessments, including recommendations for supportive equipment (e.g., saddle chairs, loupes, and counterbalanced handpieces) to reduce mechanical strain on the upper extremities.

Future research should adopt longitudinal designs to elucidate the temporal dynamics between BMI changes and the progression of musculoskeletal disability, as well as to determine whether weight loss interventions can reverse or mitigate disability severity. Studies incorporating objective biomechanical measurements—such as electromyography, motion capture, or force plate analysis—would provide deeper insights into the pathophysiological mechanisms linking obesity to upper extremity impairment. Additionally, interventional trials evaluating the combined efficacy of weight reduction and ergonomic training programs in reducing DASH scores and symptom prevalence would be invaluable for informing evidence-based guidelines. Multicenter collaborations involving diverse populations and healthcare settings would further enhance the external validity and generalizability of findings.

Conclusion

This cross-sectional study of 276 dentists in Arak, Iran, demonstrated a significant, dose-dependent association between elevated body mass index (BMI) and upper extremity disability. Overweight dentists had 1.84 times higher odds of disability, while obese dentists faced nearly threefold increased odds compared to normal-weight counterparts, after adjusting for confounders. The prevalence of musculoskeletal symptoms was notably high, with the shoulder (58.7%), wrist/hand (53.6%), and neck (47.8%) being the most commonly affected sites.

Given that BMI is a modifiable risk factor, these findings underscore the urgent need for integrated weight management and ergonomic intervention programs in dental practice. Routine occupational health evaluations should include BMI screening, with overweight or obese practitioners receiving personalized ergonomic assessments and lifestyle recommendations. Dental training curricula should incorporate education on musculoskeletal risks associated with excess body weight.

Future longitudinal and interventional studies are warranted to elucidate causal mechanisms and evaluate the efficacy of weight reduction programs in mitigating disability. In conclusion, overweight and obesity represent significant, independent risk factors for upper extremity disability among dentists, highlighting the importance of addressing modifiable lifestyle factors in occupational health strategies to promote long-term musculoskeletal health in the dental workforce.

Abbreviations

BMI Body Mass Index

MSDs Musculoskeletal disorders

DASH Disabilities of the Arm, Shoulder and Hand

NMQ Nordic Musculoskeletal Questionnaire

Declarations

Ethics approval and consent to participate

The study protocol was approved by the university ethics committee (IR.ARAKMU.REC.1404.128). All participants gave informed consent after being briefed on confidentiality and voluntary participation. The study adhered to the Declaration of Helsinki. Consent to publish was not applicable.

Consent for publication

All authors have read and approved the final version of the manuscript and agree to its submission for publication. Informed consent was obtained from all participants involved in the study.

Availability of data and materials

The datasets generated and/or analyzed during this study are available from the corresponding author upon reasonable request.

Competing interests

None declared

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Authors' contributions

YMR: Methodology, Data curation, Drafting the original manuscript**. MB:** Data analysis, Validation, Writing – review & editing. **MG**: Conceptualization, Methodology, Investigation, Validation, Writing – review & editing. **FG**: Conceptualization, Methodology, Investigation, Validation, Writing – review & editing. All authors have reviewed and endorsed the final manuscript and accept full responsibility for all aspects of this work, guaranteeing that any queries concerning the accuracy or integrity of any component will be properly examined and resolved.

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Figures

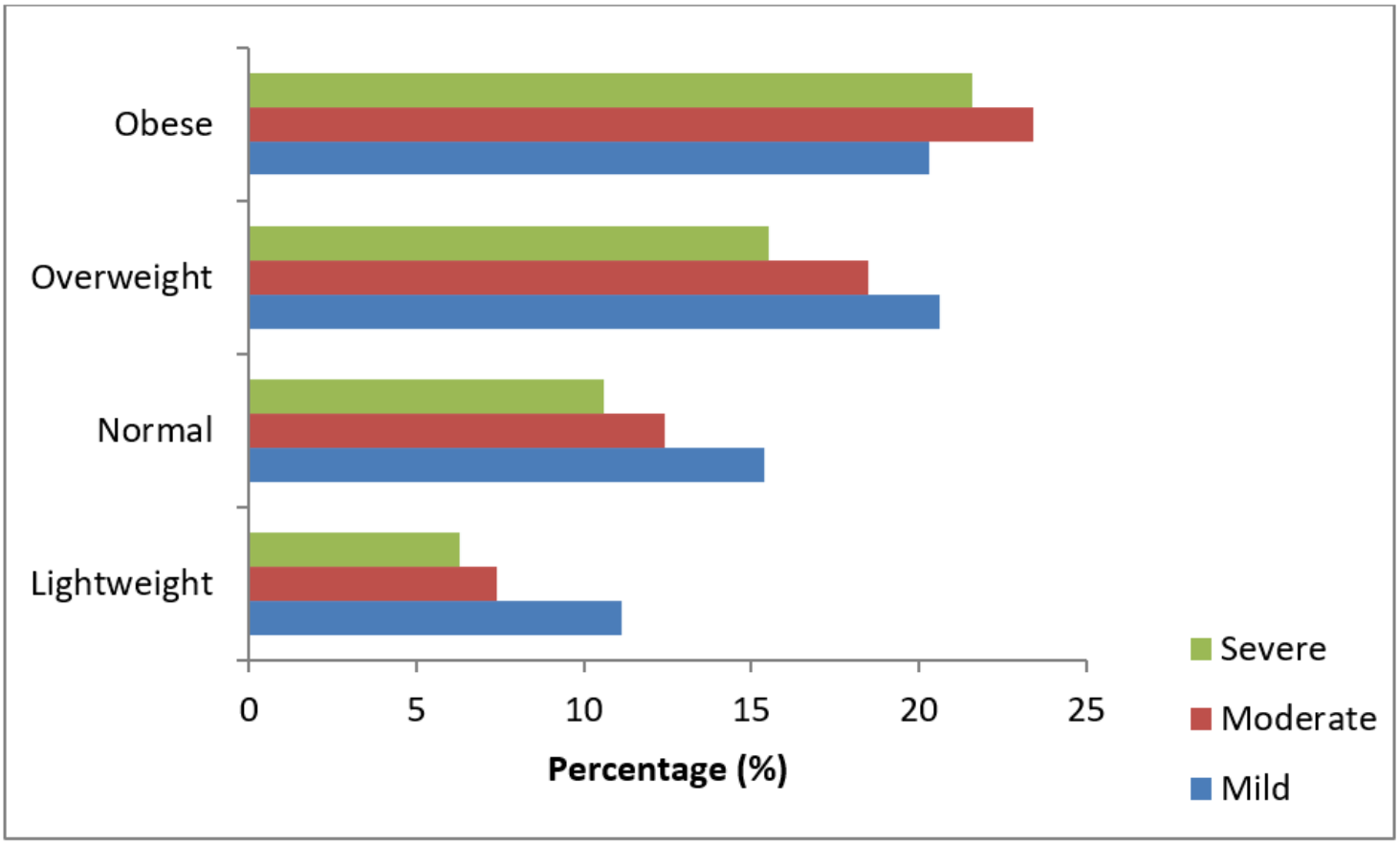


Figure 1

Upper Extremity Disability Severity Based on Mean DASH Scores Across BMI Categories