European Journal of Oral Sciences

Eur J Oral Sci 2015; 123: 356–361
DOI: 10.1111/eos.12210

European Journal of Oral Sciences

Occupation as a potential contributing factor for temporomandibular disorders, bruxism, and cervical muscle pain: a controlled comparative study

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Emodi Perelman A, Eli I, Rubin PF, Greenbaum T, Heiliczer S, Winocur E. Occupation as a potential contributing factor for temporomandibular disorders, bruxism, and cervical muscle pain: a controlled comparative study. Eur J Oral Sci 2015; 123: 356–361. © 2015 Eur J Oral Sci

The aim of the study was to compare the prevalence of cervical muscle pain (CMP) and myogenic temporomandibular disorders (MFP) among female dentists, high-tech workers, and a group of subjects employed in other occupations; to investigate the associations among CMP, MFP, and bruxism in those groups; and to evaluate the influence of work-related stress on MFP and CMP. Evaluation was based on clinical examinations of MFP and CMP and self-reported questionnaires concerning pain and stress. The diagnosis of sleep bruxism was adapted using the validated diagnostic criteria of the American Academy of Sleep Medicine (International Classification of Sleep Disorders (ICSD-2), 2005, Westchester, IL), whilst the diagnosis of awake bruxism was made on the basis of a questionnaire. The odds of a subject with MFP experiencing concurrent CMP or bruxism (sleep and/or awake) ranged from 2.603 to 3.077. These results suggest that high-tech workers and dentists are at greater risk for developing temporomandibular disorders (TMDs) and CMP when compared with general occupation workers, as defined in this study. Furthermore, the associations shown here between TMDs and CMP highlight the importance of palpating neck musculature as part of any routine examination of TMD.

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Key words: bruxism; cervical pain; myogenic pain; occupation; stress

Accepted for publication July 2015

Many occupations require an individual to maintain a specific posture for a prolonged period of time, especially professions such as dentistry (in which the caregiver has to sit in a specific position) or the high-tech industry (wherein a prolonged amount of time is spent sitting in front of a computer).

It is currently well accepted that the etiology of temporomandibular disorders (TMDs), bruxism, and cervical muscle pain (CMP) is multifactorial, involving central factors as well as predisposing, initiating, and perpetuating factors (1). Although the actual causal relationship between TMDs and bruxism is still controversial (2), evidence exists showing that emotional stress plays a role in both syndromes (3, 4).

Cervical muscle pain is often the main symptom in acute or chronic cervical spine disorders, which affect 30% of the population per year (5). The cervical spine can be a source of pain and dysfunction in the orofacial region (6). The atlas vertebra is the foundation of the cranium; during mastication, the head tends to move on the upper neck in the sagittal plane. The upper neck segments are a very common source of orofacial pain as a result of the convergence of nociceptive information with the trigeminal nerve (7).

Various occupations have been associated with cervical pain (8). Researchers have found that neck pain is associated with exposure to sustained abnormal posture, repetitive and/or force-requiring tasks, poor emotional support from supervisors or colleagues at work, high demands made of an employee, and poor control over working patterns (9).

As a result of the nature of the working posture required in dentistry and/or the high-tech industry, it was our hypothesis that female subjects working in these areas are more prone to develop TMDs, bruxism, and CMP symptoms compared with female subjects working in other professions. Accordingly, the aim of the study was three-fold: (i) to compare the prevalence of CMP and TMDs among female dentists, high-tech workers, and a group of subjects employed in other occupations; (ii) to investigate the associations among CMP, myogenic temporomandibular disorders (MFPs), and bruxism in those groups; and (iii) to evaluate the influence of stress on MFPs and CMP.

Material and methods

The Ethical Committee for Conducting Research on Human Subjects of Tel Aviv University approved this study. All participants received detailed explanations regarding the study objectives and its manner of implementation and signed detailed consent forms. All participants were adults (over 18 yr of age) who were legally and cognitively capable of understanding the information supplied.

Study sample population

The majority of patients treated for TMDs (10) and CMP (11) are women; accordingly, only women were recruited for this study. To qualify for the study, participants were required to have no history of general neurological disturbances or any pain syndrome (including migraine, fibromyalgia, common back pain, etc.), hormonal diseases, neoplasm, or psychiatric diseases, and could not have a prior history of a recent accident involving the head or the cervical spine. Additionally, the women chosen for the study had a minimum of 3 yr of professional experience in their field and they worked for five or more hours per day, for five or more days per week. Women who did not fulfill these requirements were not included in the study.

High-tech employees

Two out of three high-tech companies in the greater Tel Aviv area gave permission for their employees to take part in the study. All female employees at these two companies were sent written requests asking them to participate and this request was followed by an in-person visit on a predetermined day, during which 89 women were present. The response rate was 60.67% ($n = 54$) and, of the women who responded, only 10 did not meet the criteria specified above and thus were excluded from the study. The final high-tech group included 44 women (mean age ± SD: 39.9 ± 7.7 yr; range: 27–56 yr). The mean ± SD duration of professional experience was 12.7 ± 7.9 yr.

Dentists

Participants were recruited during a scientific meeting that took place in Tel Aviv in 2007. A total of 70 female dentists were approached regarding participation in the study and a response rate of 78.6% ($n = 55$) was achieved. Considering the same inclusion criteria from above, seven women were excluded for recent accidents involving the cervical spine. The final group included 48 female dentists (mean age ± SD: 39.2 ± 9.4 yr; range: 28–62 yr) with a mean ± SD duration of professional experience of 12.8 ± 9.7 yr.

General occupation group

Participants were recruited from female patients who arrived for treatment at the dental clinics of The Maurice and Gabriela Goldschleger School of Dental Medicine at Tel Aviv University. None of the women came with a specific complaint of pain. Eighty-two women were approached, with a response rate of 63.4% ($n = 52$). Specific inclusion criteria were a minimum of 3 yr of experience in an occupation requiring 1 h or less of computer-based work during a 5-h work day. The group consisted of 14 teachers, nine saleswomen, five dental assistants, five secretaries (not working with computers), three social workers, three managers of various lines of business, two physiotherapists, two X-ray technicians, two nurses, one librarian, one architect, one gynecologist, one sports instructor, one photographer, one biologist, and one educational adviser. Two women were excluded because of an accident involving the cervical spine and two women were excluded for not completing all the requested questionnaires. The final number of subjects in this group was 48 (mean age ± SD: 40.5 ± 8.6 yr, age-range: 27–65 yr) with a mean ± SD duration of work experience of 13.3 ± 8.6 yr.

Research tools

Questionnaires were designed to diagnose both sleep bruxism and awake bruxism and self-reported cervical pain in all study participants. Bruxism has two distinct circadian manifestations: it can occur during sleep (sleep bruxism) or during wakefulness (awake bruxism) (12). The diagnosis of sleep bruxism was based on a modification of the validated diagnostic criteria of the American Academy of Sleep Medicine (13). The diagnosis was based on a self-report questionnaire that referred to events during the past 6 months, as follows (yes/no response): are you aware of grinding your teeth frequently during sleep, or have you been told by your room-mate, parent, or sibling that you make grinding noises during sleep; do you have any of the following symptoms upon awakening: sensation of fatigue, tightness or soreness of your jaw upon awakening, a feeling that your teeth are clenched or that your mouth is sore upon awakening, aching of your temples upon awakening, difficulty in opening your mouth wide upon awakening, feeling of tension in your jaw joint upon awakening and feeling as if you have to move your lower jaw to release it; hearing or feeling a 'click' in your jaw joint upon awakening that disappears afterwards?

Excluding previous diagnosis of a sleep or medical/neurological disorder, or medication/substance use that could explain the jaw-muscle activity, respondents were defined to have active sleep bruxism if they were aware of frequently grinding their teeth during sleep, and/or presented with hypertrophy of the masseter muscles on voluntary forceful clenching, and/or provided at least one positive answer to a symptom listed on the questionnaire (14). Subjects were defined as exhibiting awake bruxism if they provided an affirmative response to the question (14): are you aware of frequently clenching, tightening or grinding your teeth during wakefulness, for example when you are concentrated or anxious?

The questionnaire on self-reported cervical pain was composed of five comprehensive (yes/no) questions (do you wake up in the morning with neck pain; do you feel neck pain during your working day or by the end of it; do you feel numbness or needles in your hands; is your neck tight; have you been diagnosed with a cervical spine disorder, such as cervical disc hernia). An affirmative response to at least two of the five questions was defined as positive self-reported cervical pain. To obtain a diagnosis of self-reported stress at work, participants were also asked whether they considered their work to be stressful (yes/no).

Clinical examinations

Clinical examinations were confined to a cervical muscle examination and a TMD examination. The examination of

cervical muscle sensitivity to palpation included application of pressure of approximately 2 kg in the areas of the trapezius muscles, splenius capitis muscle, stermo cleido mastoid muscle, and the levatus scapula muscle. Pain at each location was graded on a scale of 0–3. Following palpation, the arithmetic mean of all scores was calculated and used for further analysis of CMP.

Clinical TMD examination included a full Axis I examination and diagnosis according to the Research Diagnostic Criteria for Temporomandibular Disorders (15). These criteria were developed to research TMD-related conditions and have been widely accepted as a research tool for studying such disorders. The dual-axis system provides standardized diagnostic criteria for physical (Axis I) and psychological (Axis II) findings in patients reporting TMDs. The following categories comprise the full diagnostic Axis I: Myofascial Pain Disorder (with and without limited opening); Disc Condyle Relation Derangement Disc Displacement; and Arthralgia, Osteoarthrosis, and Osteoarthritis. In this study, only myofascial pain disorder was analyzed. To shorten the examination process and encourage higher response rates from participants, who were either already occupied in the midst of a workday (the high-tech group) or attending a coffee break during the dental congress (dentists), we did not perform a full Axis II study.

Calibration

One clinician (H.S.) performed all clinical examinations. Quantification of pressure on palpation was determined according to the training practice session of the International Consortium for Temporomandibular Disorders (16). Before the start of the study, the clinical examinations were practiced on 10 women who were not part of the study group. Each of these 10 women was examined twice, with an interval of 30 min between examinations. The results of the first examination were not given to the examiner. A certificated physiotherapist instructed and trained the examiner who performed the cervical examination. The intrarater reliability of these examinations (KAPPA) was as follows: cervical muscle sensitivity = 0.73; masticatory muscle sensitivity = 0.65.

In all study groups, the occurrence of MFP, sleep bruxism, awake bruxism, self-reported cervical pain, and self-reported stress at work was defined using a chi-square test. ANOVA was used to compare CMP on palpation among groups. Post-hoc analyses on 2 × 2 tables, or a Tukey test, were performed to determine whether any associations were related to specific groups. To establish the associations of the different variables with MFP, regardless of group, a multivariate analysis (logistic regression) was performed.

Results

The results of self-reported cervical pain, stress at work, sleep bruxism, awake bruxism, CMP, and MFP are listed in Table 1. When age was used as the sole comparison criterion across groups, no significant differences were found ($P = 0.76$). Additionally, no significant differences among groups could be observed when taking into account self-reported cervical pain, awake bruxism, or sleep bruxism.

Significantly higher stress at work was reported for the high-tech and dentist groups than for the general occupation group ($P < 0.05$), and the high-tech and dentist groups also had a significantly higher occurrence of MFP than the general occupation group ($P = 0.02$). Notably, the high-tech group also exhibited a significantly higher occurrence of CMP than the other two groups ($P < 0.001$).

To find out whether the associations were related to a specific group, a post-hoc analysis was performed on 2 × 2 tables. No significant differences were found between the high-tech workers and dentists regarding stress at work or MFP. The high-tech workers did exhibit significantly higher MFP scores compared with the general occupation group, but did not exhibit significantly higher stress levels. The dentists exhibited much higher levels of both stress and MFP compared with the general occupation group. Finally, a post-hoc Tukey test showed that CMP was highest within the high-tech group, next highest in the dentist group, and lowest in the general occupation group.

Regardless of group, subjects who were diagnosed with MFP ($N = 42$) were found to experience self-reported cervical pain ($P < 0.05$) and CMP ($P < 0.001$) more frequently than subjects who were not diagnosed with MFP ($N = 97$). Furthermore, regardless of group, a significant association was found between CMP and

Table 1

Results of self-reported cervical pain (CP), self-reported stress at work (Stress), cervical muscular pain (CMP), myofascial pain (MFP), awake bruxism (AB), and sleep bruxism (SB) among dentists, high-tech workers, and the general occupation group

	Dentists ($n = 44$)	High-tech worders ($n = 48$)	General group ($n = 48$)	Significance (P)	Test
CP*	23 (47.9)†	22 (60)	24 (50)	Not significant	$\chi^2 = 0.055$
Stress	31 (65)	27 (61)	19 (40)	0.03	$\chi^2 = 7.11$
CMP	0.75	1.26	0.66	<0.001	$F_{(2,136)} = 8.875$‡
MFP	18 (37)	17 (38.6)	7 (15)	0.02	$\chi^2 = 8.281$
AB	21 (43.8)	13 (29.5)	17 (35.4)	Not significant	$\chi^2 = 2.032$
SB	11 (22.9)	6 (13.6)	10 (20.8)	Not significant	$\chi^2 = 1.383$

*Arithmetic mean on a scale of 0–3.
†Percentage of participants.
‡ANOVA.

MFP ($P < 0.001$) and between CMP and awake bruxism ($P = 0.022$). A positive statistical association was also found between MFP and both types of bruxism ($P < 0.005$ and $P < 0.001$, sleep and awake, respectively). Logistic regression showed that the odds of a subject with MFP also presenting CMP or bruxism (sleep and/or awake) ranged from 2.603 to 3.077 (Table 2). However, no significant associations were found between either MFP or CMP and self-reported stress at work.

Discussion

The results of our study show that certain occupations, such as working in the high-tech industry and in dentistry, can act as triggers for myofascial and cervical muscular pain among women. Israeli law stipulates a 43-h work week with a full work day constituting 8–9 h. Furthermore, a minimum break of 45 min during a work day of 6 h is mandatory. Although many academic institutions have tried to implement ergonomics in their curricula, these principles are often disregarded in practice and there is no information available about the average time a person actually spends working in non-functional positions.

The increased occurrence of MFPs and CMP within the high-tech and dentist groups may be a result of the fact that these occupations require a sitting posture that is not beneficial to the subject's musculature over prolonged periods of time. These findings are in accordance with other studies (17) postulating that a forward-leaning head position implies that the occlusal contacts between maxillary and mandibular teeth are posterior to the intercuspal position. This change in occlusion can interfere with the equilibrium of the stomatognathic system and cause undue stress on the masticatory muscles. Moreover, a forward gliding of the skull can also cause overloading on the posterior cervical neck muscles, resulting in limited neck movement and in pain (17). Some studies have also demonstrated an association between TMDs and stress (e.g. 18). Thus, the high occurrence of MFP among women working in the high-tech industry and in dentistry may also be correlated with the high stress load at work reported by these individuals.

There are numerous reports of risk factors for CMP among office workers (19–22). Factors such as a static position of the neck and arms, duration of sitting, sitting posture, and limited pauses during work, are implicit in such disorders. The Washington State Department of Labor and Industries (23) published a paper with detailed instructions concerning safe work environments, positions, and ergonomics, in order to prevent musculoskeletal disorders. The relatively high occurrence of CMP among professional workers, found in the present study, agrees with a recently published review (20) reporting that office workers using computers are the most likely group to develop neck pain compared with other professions. The same review also found that women are twice as likely as men to experience CMP.

Another study, associating dentistry and cervical pain (24), reported an even higher percentage of female dentists who experienced neck and shoulder pain (65%) compared with that found here (48%). This difference may be a result of the evaluation methods used (clinical palpation in the present study compared with solely a questionnaire in the former). Leggat *et al.* (25) reported that female dentists with fewer years of experience reported more neck pain and upper back and shoulder pain than their colleagues with more years of experience, possibly because the more senior dentists developed coping strategies, or even ceased working in the face of severe musculoskeletal pain.

Our results are also in agreement with those of de Wijer & Steenks (26), who demonstrated that patients with TMDs often show signs and symptoms correlated with the CMP. de Wijer *et al.* (27, 28) reported a considerable overlap between signs and symptoms of TMDs and cervical spine disorders, and recommended that the functioning of the masticatory system be evaluated in patients with cervical complaints so that any disorder of the masticatory system and its possible role in cervical muscular pain could be ruled out.

Yilinen *et al.* (29) showed that intensive training of the neck muscles on a regular basis can improve cervical symptoms. Thus, in view of our findings that occupation may act as a predisposition for both MFP and CMP, it would be wise to advise women in the dental profession and those working for prolonged periods of time in front of a computer to incorporate appropriate physiotherapy exercises.

In the present study, significant associations were also found between MFP and both sleep bruxism and awake bruxism. A systematic review performed by Lobbezoo & Manfredini (3) showed that awake bruxism (clenching), but not sleep bruxism, seems to be associated with psychosocial factors and psychopathological symptoms. One of the review conclusions was that because most of the data were drawn from studies based on a clinical and/or self-reported diagnosis of bruxism, there is a need for future research directed toward achieving a better distinction between the two forms of bruxism.

We note finally several limitations inherent in the foregoing study. The clinicians performing examinations were informed of participant occupations, which could have introduced reporting bias. Reported stress

Table 2

Logistic regression: associations of the cervical muscular pain (CMP), awake bruxism (AB), and sleep bruxism (SB) with myofascial pain

			95% CI for odds	
	Significance (P)	Odds	Lower	Upper
CMP	<0.001	3.077	1.736	5.454
AB	0.034	2.603	1.076	6.297
SB	0.039	3.005	1.057	8.546

in the workplace was evaluated using only a few key questions, to reduce the burden of a lengthy questionnaire on the participants who were examined in their workplace or during a professional congress. However, it is possible that a more thorough evaluation of work stress may have yielded more complete insights. In the evaluation of cervical pain, we were limited to available instruments that measure only cervical motion range, as opposed to pain, in response to palpation, similarly to the well-validated and documented diagnostic criteria for TMDs.

Bruxism was diagnosed by self-report questionnaires and did not include clinical examination. The diagnosis was based on a report from a panel of international bruxism experts (12), which suggested that 'possible' sleep bruxism or awake bruxism should be based on self-report (questionnaires and/or the anamnestic part of a clinical examination); 'probable' sleep bruxism or awake bruxism should be based on self-report plus the inspection part of a clinical examination; and 'definite' sleep bruxism should be based on self-report, a clinical examination, and a polysomnographic recording (12). Accordingly, the diagnosis of bruxism in this study should be defined only as probable. We did, however, seek to improve the reliability of the sleep bruxism diagnosis by adopting a modification to the criteria of the American Academy of Sleep Medicine (13) (see Research tools under Material and methods). Although dental wear was not measured, we examined participants for hypertrophy of the masseter muscles on voluntary forceful clenching and for symptoms on awakening that would suggest strong sleep masticatory activity.

Epidemiological studies have shown that the most suitable approach for investigating awake bruxism is via a self-report questionnaire. For a grading of 'definite' awake bruxism, self-report, clinical examination, and an electromyographic recording are needed, preferably combined with the Ecological Momentary Assessment Methodology, which enables a true estimate of the frequency of tooth contacts during wakefulness. Electromyographic recording is applicable in moderately sized populations, but is of limited availability (12), and Ecological Momentary Assessment, which requires participants to maintain a moment-by-moment diary, is challenging to implement in large studies. Although we believe that such an assessment is probably the best strategy, in its absence, self-report of wake-time activities via a questionnaire is likely to be a good compromise. Finally, the diagnosis of sleep bruxism was in accordance with the American Academy of Sleep Medicine (aasm) (13). It is noteworthy that one of the questions (Do you feel an aching of your temples upon awakening?) may have been associated also with the diagnosis of MFP, in which self-reported pain (upon awakening or at another time) is also a criterion for diagnosis.

It may thus be concluded that working in dentistry and in the high-tech industry may present a risk factor for MFP and CMP. Additionally, associations found in this study between MFP and CMP highlight the importance of palpating the neck musculature as part of any routine TMD examination. Additional studies with larger groups of individuals pursuing various professions may yield more information about this important issue.

Acknowledgements – The study was self-funded by the authors.

Conflicts of interest – None of the authors had any financial support or relationships posing conflict of interest.

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