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A systematic review of musculoskeletal disorders among dental professionals

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This review of current literature is aimed at examining the prevalence of musculoskeletal disorders in dental professionals and possible aetiological factors.

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Abstract: Musculoskeletal problems have become a significant issue for the profession of dentistry and dental hygiene. This review provides a detailed examination and discussion regarding the prevalence of musculoskeletal disorders (MSD) in dental personnel and possible causative factors. All research studies or literature reviews, which have reported on the prevalence of musculoskeletal symptoms and/or potential risk factors for this problem in dentists, dental hygienists and dental students, were selected for inclusion. Our literature suggests that the prevalence of general musculoskeletal pain ranges between 64% and 93%. The most prevalent regions for pain in dentists have been shown to be the back (36.3–60.1%) and neck (19.8–85%), while the hand and wrist regions were the most prevalent regions for dental hygienists (60–69.5%). Interestingly, we found that studies on MSDs among dental and dental hygiene students are quite limited. Many risk factors have been identified, including static and awkward posture and work practices. Overall, the review suggests that musculoskeletal problems represent a significant burden for the dental profession. More research in the form of larger studies is urgently required, to help more clearly elucidate the development of this important issue for dental hygienists and dental hygiene students.

Key words: dental hygienist; dental student; musculoskeletal disorders; dentist; occupational health

Introduction

Musculoskeletal disorders (MSD) are one of the most important occupational health issues in healthcare workers. The 12-month period prevalence for nurses was recently reported at 85.5% (1). MSD are identified as injuries to the human support system of

muscles, ligaments, tendons, nerves, blood vessels, bones and joints, and can occur from a single event or cumulative trauma (2). MSD can cause pain in the neck, shoulder, arm, wrist, hands, upper and lower back, hips, knees and feet (2). Musculoskeletal pain can be an occupational health problem for dental professionals, particularly dentists and dental hygienists, who sit in static postures using precision hand and wrist movements (2–5). In two recent literature reviews of the general health of dentists and occupational health in dentistry, MSD were identified as a significant issue for the profession (6, 7). Research has recognized that MSD in dentistry contribute considerably to sick leave, reduced productivity and leaving the profession (6, 8). The magnitude of this problem warrants a literature review, specifically aimed at examining the evidence gathered on the prevalence on MSD in dental personnel. Studies have indicated a wide variety of causative factors associated with musculoskeletal pain in dentists and dental hygienists. The physical burden of clinical work has been established as having a strong association with MSD in dental health workers (5, 8); however, evidence is mounting which suggests that psychosocial factors may also be associated with the prevalence of MSD (5, 9). Little research has investigated the prevalence of MSD in dental and dental hygiene students. Given the pressures of tertiary education and the physical burden of clinical training, it seems an area that is lacking; it may be that musculoskeletal problems begin during dental education and training.

The aim of this review therefore, is to analyse critically the literature and report on the prevalence of musculoskeletal pain and possible aetiology of this problem in dental professionals, including dentists, dental hygienists and dental students.

Methods

Criteria for inclusion of manuscripts

Empirical and case studies and literature reviews published in English in peer reviewed journals were considered. Letters to the Editor, conference proceedings and policy statements were not considered for this review. Participants in the studies were to be dentists, dental hygienists or dental students; no restrictions were placed on age, gender, race or socioeconomic status. Papers that researched the prevalence of MSD and risk factors for MSD were considered.

Search methods

The review began with a search of a range of relevant databases from February to April 2008. The following Medical subject headings were used in the search strategy for MEDLINE via OVID:

1 Musculoskeletal diseases
2 Dental hygienists
3 Dentists

The search of Scopus and The Cochrane Library was based on the search strategy used for MEDLINE, with the medical subject headings being used as keywords. The search strategy for CINAHL used the same search strategy for Scopus and the Cochrane Library, and also included the keywords 'occupational health'. An online search of the Education Research Theses Index was also included, using the medical subject headings as keywords. The reference lists of potentially relevant manuscripts were hand searched to uncover further papers.

Study selection

For all of the papers identified by the search strategy, the title and keywords (and where available the abstract) were considered for possible relevance to this literature review. For all manuscripts that appeared to meet the inclusion criteria, a full text copy was obtained, and these papers were subject to critical analysis and data extraction.

Search results

The search strategy uncovered a total of 95 titles. A number of the titles were duplicated in the database searches. After examining the titles, keywords and abstracts (where available) for relevance, and excluding any duplicates, the complete manuscript of 44 potentially relevant papers was acquired. From these papers, 21 were considered irrelevant for this literature review. Papers were chiefly excluded on the basis that the study did not measure the prevalence of MSD or possible risk factors, that the manuscript was not a research study or literature review or that no references were cited in the paper. Twenty-three manuscripts were considered suitable to be included in this review.

Results

Prevalence of musculoskeletal disorders

The high prevalence of musculoskeletal pain among dentists and dental hygienists is well documented, as indicated in Table 1. Several of the articles reviewed reported a high prevalence of musculoskeletal pain generally. A study of dentists

Table 1. **Musculoskeletal disorder (MSD) prevalence rates by body site, country and year of publication**

Body site	MSD prevalence (%)	Participants	Country	Year	Author	Reference
Any	64	Dentists	Australia	1997	Marshall *et al.*	10
	78	Dentists	Thailand	2000	Chowanadisai *et al.*	11
	78	Female dental personnel	Sweden	1999	Akesson *et al.*	12
	93	Dental hygienists	United States	2002	Anton *et al.*	13
Back	67 (upper back)	Dental hygienists	United States	2003	Anton *et al.*	13
	81 (upper extremity)	Female dental health workers	Sweden	2006	Lindfors *et al.*	5
	57 (lower back)	Dental hygienists	United States	2004	Anton *et al.*	13
	60 (lower back)	Dentists	Denmark	1998	Finsen *et al.*	3
	54 (lower back)	Dentists	Australia	2006	Leggat and Smith	18
	60	Dentists	Poland	2002	Szymanska	17
	24	Dental hygienists	United States	2001	Lalumandier *et al.*	19
	45	Dentists	Netherlands	2005	Droeze and Jonsson	20
	36	Dentists	Saudi Arabia	2001	AlWazzan *et al.*	21
	39	Dental hygienists	Sweden	1993	Oberg and Oberg	22
	21	Dental hygienists	Saudi Arabia	2002	AlWazzan *et al.*	21
Hand/wrist	44	Dentists	Poland	2003	Szymanska	17
	34	Dentists	Australia	2007	Leggat and Smith	18
	21 (hand only)	Dentists	Netherlands	2006	Droeze and Jonsson	20
	14 (wrist only)	Dentists	Netherlands	2007	Droeze and Jonsson	20
	64	Dental hygienists	Sweden	1999	Akesson *et al.*	12
	54	Dentists	Sweden	2000	Akesson *et al.*	12
	69	Dental hygienists	United States	2003	Anton *et al.*	13
	60	Dental hygiene students	United States	2003	Morse *et al.*	15
Neck/shoulder	60	Dentists	Denmark	1998	Finsen *et al.*	3
	64	Dental hygienists	Sweden	1999	Ylipaa *et al.*	23
	85	Dentists	Sweden	1999	Akesson *et al.*	12
Neck only	57	Dentists	Australia	2006	Leggat and Smith	18
	56	Dentists	Poland	2002	Szymanska	17
	51	Dentists	Netherlands	2005	Droeze *et al.*	20
	28	Dentists and dental hygienists	United States	2001	Lalumandier *et al.*	19
	28	Dental hygienists	Saudi Arabia	2002	AlWazzan *et al.*	21
	20	Dentists	Saudi Arabia	2003	AlWazzan *et al.*	21
	62	Dental hygienists	Sweden	1993	Oberg and Oberg	22
	68	Dental hygienists	United States	2002	Anton *et al.*	13
Shoulder only	21	Dentists	United States	2001	Lalumandier *et al.*	19
	26	Dental hygienists	United States	2002	Lalumandier *et al.*	19
	52	Dentists	Netherlands	2005	Droeze and Jonsson	20
	53	Dentists	Australia	2006	Leggat and Smith	18
	60	Dental hygienists	United States	2002	Anton *et al.*	13
	81	Dental hygienists	Sweden	1993	Oberg and Oberg	22
Lower extremities	48	Dentists	Poland	2002	Szymanska	17
	12	Dentists	Netherlands	2005	Droeze and Jonsson	20
	6 (leg)	Dentists	United States	2001	Lalumandier *et al.*	19
	8 (leg)	Dental hygienists	United States	2002	Lalumandier *et al.*	19
	23 (hip)	Female dental personnel	Sweden	1999	Akesson *et al.*	12
	19 (hips/thighs)	Dental hygienists	United States	2003	Anton *et al.*	13
	13 (hip)	Dentists	Australia	2006	Leggat and Smith	18
	14 (knee)	Dental hygienists	United States	2004	Anton *et al.*	13
	19 (knee)	Dentists	Australia	2006	Leggat and Smith	18
	16 (ankles/feet)	Dental hygienists	United States	2005	Anton *et al.*	13
	12 (ankles/feet)	Dentists	Australia	2006	Leggat and Smith	18

in New South Wales, Australia found that 64% had experienced some type of pain in the past month (10). A total of 78% of dentists in southern Thailand reported musculoskeletal pain in the previous 12-month period in a study of the occupational health problems (11), and a study of female dental personnel also found that 78% experienced musculoskeletal pain (12). A more recent study of female dental health workers reported similar results that upper extremity musculoskeletal

pain (neck, shoulders, arms, wrists, hands) was experienced by 81% of participants (5). In this Swedish study, only 12% of participants were hygienists (5). A study of United States dental hygienists reported that approximately 93% experienced musculoskeletal symptoms within the previous 12 months (13).

Research into the prevalence of musculoskeletal pain in dental and dental hygiene students is limited and contradictory. A study of Michigan students revealed that they experienced very few upper extremity musculoskeletal symptoms during their education (14), while a pilot study of Connecticut dental hygiene students revealed that musculoskeletal symptoms of the hand and arm do appear as early as during their training (15). A paper assessing the ergonomic curriculum of dental hygiene programmes in the United States found that over half of all hygiene education programmes participating in the study reported that they presently had students suffering from musculoskeletal symptoms (16).

Many of the studies examined prevalence in selected musculoskeletal regions, so these results will be examined separately.

Back pain

In a recent review, lower back pain was determined to be the most prevalent musculoskeletal problem amongst dentists (7). Supporting this, a Polish study found that the most reported musculoskeletal problem was in the thoracic lumbar region at 60.1% (17). Similarly, less than 60% of Danish dentists (3) and 53.7% of Queensland dentists have reported lower back pain (18). A study of United States army dental personnel found that back pain was the most prevalent musculoskeletal complaint amongst dentists and dental specialists (19), although in other studies, only 45% of Dutch dentists (20) and 36.3% of Saudi Arabian dentists reported regular back pain (21). It has also been documented that dental hygienists experience musculoskeletal pain in the back region. In a study of the United States Army staff, 23.5% of hygienists reported back pain (19). Similarly, 20.7% of Saudi Arabian dental hygienists experienced regular back pain (21), and 39% of dental hygienists in Sweden complained of back problems (22). Another United States study found a higher prevalence again with 56.8% of dental hygienists experience lower back pain, and 67.4% experience upper back discomfort (13).

Hand and wrist pain

Wrist and hand pain was reported as a symptom by 44% of Polish dentists (17) and 33.7% of dentists in Queensland, Australia (18). Conversely, only 14% and 21% of Dutch dentists experienced wrist and hand pain respectively (20). A recent literature review regarding the general health of dentists stated that dental hygienists in particular experience a high prevalence of hand or wrist pain (7). In a study of a Swedish female dental workforce, 64% of dental hygienists experienced wrist or hand pain in the previous 12 months compared with 54% of dentists and 27% of dental assistants (12). Pain in the wrist and hand region was also the most prevalent symptom (69.5%) in a study of MSDs of United States dental hygienists (13). A pilot study of dental hygiene students found that 60% experienced some pain in the hand and arm region (15). While this study was small, the results indicate that the onset of musculoskeletal symptoms may begin during dental training and education. Carpal tunnel syndrome is a specific musculoskeletal problem, which has also been investigated in dental professionals. A study of United States dental hygienists reported that 44.2% had symptoms of carpal tunnel syndrome (13), and a study of Swedish dental hygienists indicated that it was the most common diagnosis in the wrist and hand region (12).

Neck pain and/or shoulder pain

Many of the studies have measured neck and shoulder pain differently. Some have reported on neck and shoulder pain combined, while others reported these separately as neck pain or shoulder pain, and some studies have only reported one or the other. This has made comparing the prevalence of these disorders more difficult.

In a Danish study of MSDs, 60% of dentists surveyed reported neck and/or shoulder pain (3). Comparable are the results of a study of Swedish dental hygienists, which reported that 63.8% experience musculoskeletal pain in the upper body region (23). A separate Swedish study reported a higher prevalence again with 85% of female dentists experiencing shoulder and neck pain (12). A study of dentists in Queensland, Australia reported that neck pain was the most prevalent musculoskeletal complaint at 57.5% (18). Parallels can be drawn to other studies where 56.3% of Polish dentists (17) and 51% of Dutch dentists experienced neck pain (20). In contrast, a study of US army general dentists and hygienists reported neck pain at 28.1% and 28.5% respectively (19). Similar results were reported for Saudi Arabian dental hygienists, where 27.6% experienced regular neck pain, however the results for the dentists in this study do not compare at 19.8% prevalence (21). Also, in other studies, 62% of Swedish dental hygienists (22) and 68.5% of United States dental hygienists reported that they experienced symptoms in the neck region (13). These

reported results vary greatly between the studies. In the United States Army, 21.3% of general dentists and 26.1% of dental hygienists reported shoulder pain as a musculoskeletal complaint (19). In other studies, 52% of dentists in the Netherlands (20), 53.3% of Queensland dentists (18) and 60% of United States dental hygienists reported shoulder pain (13), while an even higher prevalence was found in a study of Swedish dental hygienists, where 81% complained of shoulder pain (22).

Lower extremities

Several studies looked briefly at musculoskeletal pain in the lower extremities such as hips, legs and feet. No studies examined or discussed these results in any great detail.

Musculoskeletal pain in the lower extremities occurred in 47.8% of Polish dentists; however, a large percentage of these dentists work in a standing position (17). In another study, the leg region was reported by only 6.3% of United States Army general dentists (19), which is a much smaller prevalence. The leg region was reported as experiencing pain by 8.3% of United States Army dental hygienists (19); 23% of female Swedish dentists and dental hygienists reported hip pain (12); a study of United States dental hygienists details that 19% experienced pain in the hips or thighs, 13.7% in the knee region and 15.8% in the feet (13). Pain in the lower extremities was experienced by 12.6% of Queensland dentists in the hips, 18.9% in the knees and 11.6% for the ankles and feet (18). A study of Dutch dentists reported that less than 12% experienced pain in the numerous lower extremity regions (20). Overall, the prevalence of lower extremity musculoskeletal pain is often less than 20%, which is considerably lower than the prevalence of upper extremity pain.

Identifying risk factors

It appears that the prevalence of musculoskeletal complaints is negatively associated with years of practicing dentistry. Thai dentists were found to have a lesser chance of experiencing musculoskeletal pain in the previous 12 months if they had more years of clinical experience (11). This is supported by a study of Danish dentists who found that older dentists had the least neck pain (3), and also a study of Queensland dentists who found that younger dentists had a higher prevalence of musculoskeletal pain (18). In contrast, a Polish study who found that those who did not report any symptoms had been practicing dentistry for the shortest length of time, mostly less than 5 years (17).

Length of appointment time appeared to influence neck pain in a study of Danish dentists, with those dentists providing longer appointments experiencing more neck pain (3). Patient treatment time was also positively associated with musculoskeletal pain in a study of Swedish dental hygienists (24). Female gender appears to be positively correlated with severity of musculoskeletal pain. A study of Thai dentists found that female dentists experienced on average a higher pain severity in the shoulder region than their male counterparts (11). This is supported by the findings in a study of dentists from New South Wales, Australia where dentists who rated their pain severity at the highest ranking were more likely to be female (10). These results are concerning for the profession of dental hygiene, which is predominantly female (14, 15, 24).

A number of other possible risk factors for musculoskeletal pain have been identified in the literature, without being correlated with any findings of prevalence. It has been stated that the clinical work of dentists and dental hygienists is visually demanding (12), with a high work zone and unsupported forearms (3, 4), using repetitive motions (4, 5, 13, 15, 24, 25) with fine tuned actions (5) and using vibrating instruments (4, 15). These characteristics of clinical work are the basis for static neck position (4, 12, 26) and extended neck flexion (3, 13) and poor posture (3, 4, 6, 21) that are also associated with musculoskeletal complaints. A study of the working postures of dentists and dental hygienists found that both professions spent 86% of their working time with a neck flexion of at least 30°, and 53% and 50% of their work time respectively with a trunk flexion of at least 30° (26). Psychosocial factors (4, 5, 23, 24) have also been mentioned as possible aetiological factor for this burden. Three of the studies examining psychosocial factors looked at Swedish dental hygienists (5, 23, 24), which may make it difficult to generalize the results to the global profession. It appears to be very difficult to separate the various possible risk factors to gain any definitive causative factor for MSD.

Discussion

There was extensive evidence that musculoskeletal pain is a significant burden in dentistry. The findings from this literature review were sourced from 23 papers, which each measured differing regions of musculoskeletal symptoms using different measurement tools. A number of studies utilized a modification of the standardized Nordic Questionnaire as part of their surveys (3, 12, 13, 22). This appears to be an accepted method of measuring the prevalence of musculoskeletal complaints. Other methods included pilot tested surveys and

questionnaires (10, 18, 21, 23). While self-report methods can introduce some recall bias, this is an inexpensive and convenient technique. Perhaps more accurate results would be obtained by performing physical examinations and assessments (12), but these methods are time-consuming and expensive.

Many studies identified possible selection bias influenced by non-responders or drop-outs (11, 12). It may be that those persons who chose to participate did so because they had experienced musculoskeletal pain, which would strengthen the results. A number of trials selected practicing dentists from dental association membership registers (3, 10, 11, 18, 23, 24). This again may introduce bias into the results, as those dental personnel who experienced severe musculoskeletal pain may have left the profession, which may dilute the results.

The most prevalent regions that dentists experienced musculoskeletal symptoms were the back, neck and shoulder regions (3, 7, 12, 17–20); however, the reported prevalence for these regions varied greatly between studies, with a noteworthy difference in the range of results. Musculoskeletal pain in dentists was negatively correlated with years of work experience (3, 11, 18). It has been hypothesized that more experienced dentists learn to adjust their work posture to avoid such problems, or that those dentists with musculoskeletal problems have left the profession (6). It seems important to include dentists not currently practicing in future research to explain this finding.

A number of studies examined the prevalence of musculoskeletal problems in dental hygienists. Those that did reported that dental hygienists are more likely to experience neck, shoulder and hand/wrist pain than other dental professionals (12, 19). The manuscripts that included data on dental hygienists often had a small sample size, or a low percentage of the total respondents fall into this profession. In a study of Swedish female dental personnel, only one third (n = 30) of all participants were dental hygienists (12). In this particular follow-up study, a large number of participants who left the study during the 5-year period had a high prevalence of musculoskeletal pain, many of whom were dental hygienists (12). A separate Swedish study of female dental health workers only acquired dental hygienists as 12% of all respondents (5). Small sample size (n = 82) was identified as a limitation of the study of dental hygiene students in Connecticut (15). The study of dental hygienists in Iowa, USA also had small sample size (n = 109), and selection bias was introduced to the study as participants were recruited from a continuing education conference on ergonomics (13). The problem with small samples means it is difficult to generalize the results to the broader dental hygiene profession. Further studies are required into the prevalence of musculoskeletal symptoms in dental hygiene and dental hygiene students, using a larger sample size to be able to reach valid conclusions and be able to generalize results. Nevertheless, all studies included in this review had excellent response rates. This review did not include papers that were unpublished, or written in a language other than English. While this may be considered a limitation of the review, the search strategy for relevant literature involved a comprehensive search on Medline and other databases, which uncovered substantial recent data.

Conclusion

Overall, this review clearly demonstrates that MSD represent a significant burden for the dental profession. The high prevalence of musculoskeletal pain in the upper extremities is a concern for the occupational health of dentists and dental hygienists. More research should now be undertaken on musculoskeletal problems in dental hygienists, with an emphasis on larger sample sizes and response rate to be able to generalize the results and conclusions. Given the limited number of studies specifically focusing on students going into the dental hygiene profession, which has a high prevalence of musculoskeletal problems, and the opposing findings of the current research, it suggests that it is important to research this further to obtain more concrete results.

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