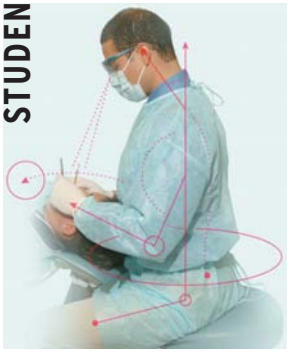
STUDENTS



Prevalence of Upper Extremity Symptoms and Disorders among Dental and Dental Hygiene Students

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ABSTRACT

CONTEXT: Upper extremity musculoskeletal disorders are common among dental professionals. The natural history of these disorders is not well-understood. These disorders are more common in older workers, but the prevalence among younger workers has not been well-studied.

OBJECTIVE: The objective of this study was to determine if dental/dental hygiene students had a similar prevalence of upper extremity musculoskeletal disorders compared to age-matched clerical workers. We hypothesize students will have a lower prevalence of upper extremity musculoskeletal disorders compared to clerical workers.

DESIGN: This was a cross-sectional design.

SETTING: Dental and dental hygiene students from three schools were compared to clerical workers from three locations (an insurance company and two data processing plants).

SUBJECTS: There were 343 dental and dental hygiene students and 164 age-matched clerical workers.

MAIN OUTCOME MEASURES: Regional discomfort was the primary outcome. The secondary health outcomes were diagnoses of carpal tunnel syndrome and upper extremity tendinitis.

RESULTS: Clerical workers had a higher prevalence of hand symptoms (62 percent vs. 20 percent), elbow symptoms (34 percent vs. 6 percent) and shoulder/neck symptoms (48 percent vs. 16 percent) and a higher prevalence of carpal tunnel syndrome (2.5 percent vs. .6 percent) and upper extremity tendinitis (12 percent vs. 5 percent). The clerical workers were more obese, smoked more, exercised less frequently, and had lower educational levels and less control of their work environment.

CONCLUSIONS: Dental and dental hygiene students have a very low prevalence of upper extremity musculoskeletal disorders. A longitudinal study is necessary to evaluate ergonomic and personal risk factors.

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Upper extremity musculoskeletal disorders are well-known problems among industrial workers but have also had an impact upon clerical and white collar workers, especially among dental professionals. These upper extremity musculoskeletal disorders cost employers billions of dollars each year in medical costs, lost wage replacement, and reduced productivity. Among dentists and dental hygienists, several studies have demonstrated a high prevalence of upper extremity symptoms and the American Dental Association and American Dental Hygienists' Association have reported that these musculoskeletal disorders have impacted their professions dramatically with more than 20 percent reporting a leave of absence due to these disorders.[1-8]

According to a survey of practicing dentists performed by the American Dental Association, more than 50 percent of female dentists shortened their work hours due to repetitive motion disorders.[1] Although this statistic may reflect a sample bias, it still demonstrates that upper extremity musculoskeletal disorders have a significant impact of the professionalís ability to work. It has been reported that 7 percent to 12 percent of dental hygienists have been diagnosed with carpal tunnel syndrome in cross-sectional studies.[3,4] Prior cross-sectional studies of active dentists and dental hygienists have demonstrated a high prevalence of symptoms in the upper extremities although the prevalence of carpal tunnel syndrome was only slightly higher than the general population.[9,10] Hygienists have a higher prevalence of upper extremity tendinitis compared to the general population and it is similar to the rate among industrial workers.[10] It is clear that repetitive motion disorders exist among white-collar workers and the dental professionals appear to be at relatively high risk.

Recent cross-sectional studies of dentists and dental hygienists have demonstrated upper extremity musculoskeletal disorder problems among practicing dental professionals, the onset of these problems and causally related factors can only be determined by a prospective, longitudinal study. In an effort to assess workers at the beginning of their careers, the authors recruited dental and dental hygiene students to participate in a baseline study of their musculoskeletal conditions and assessment of their median and ulnar nerve function. Access to a similar dataset that reflects a large population of active clerical workers was available. The authors compared the characteristics of the cohort of dental and dental hygiene students to age-matched clerical workers to determine if their symptom and electrophysiologic profiles were similar.

According to a survey of practicing dentists performed by the American Dental Association, more than 50 percent of female dentists shortened their work hours due to repetitive motion disorders.

Clerical workers are known to have a low rate of carpal tunnel syndrome compared to industrial workers, but it is not known if they are representative of the general population or have increased risk of other upper extremity musculoskeletal disorders due to the repetitive hand activity.

The authors hypothesized that dental and dental hygiene students would have low prevalence of symptoms and musculoskeletal disorders due to their age and relatively low exposure to repetitive stress during their training years. The authors hypothesized that the age-matched clerical workers would also have low levels of symptoms and musculoskeletal disorders that were similar to the dental and dental hygiene students.

Methods

Dental and dental hygiene students were recruited from three training programs: the University of Michigan (dental and dental hygiene programs), Forsyth Institute (dental hygiene) and the University of Illinois-Chicago (dental and dental hygiene). All students, regardless of their class standing in the respective programs, were invited to participate. All subjects signed a written consent approved by the University of Michigan and the respective local Institutional Review Boards. Students over the age of 29 were excluded from the analyses to avoid potential confounding of prior ergonomic stress and aging. The clerical workers were selected from an earlier study and clerical workers under the age of 30 were used as a comparison group.[11] These subjects had completed the same medical screening the dental and dental hygiene students underwent. All clerical subjects had worked on their job for at least six months prior to the study.

The medical screening included the following procedures: completion of a self-administered symptom questionnaire (all subjects); a limited physical

examination of the upper extremities and neck (symptomatic subjects only); and limited electrodiagnostic testing of both hands (all subjects). The standardized physical examination included tests for range of motion, strength, muscle stretch reflexes, and provocative maneuvers to identify possible tendinitis and nerve entrapment.[12] The physical examinations were conducted by the lead authors (Werner and Franzblau) who were blinded to the results of the other measures. The nerve conduction testing, the physical examination, and the symptom surveys were conducted independently of each other.

Subjects completed a self-administered symptom questionnaire. The questionnaire focused on demographic information, prior medical conditions, occupational history, current health status, and symptoms which may be related to upper extremity cumulative trauma disorders. These questionnaires have been previously investigated and demonstrated to have good reliability.[13] Subjects were instructed to report a regional symptom if it had been present on at least three separate episodes, or one episode that had lasted more than one week, in the 12 months preceding the survey. The survey queried subjects about nine symptoms (burning, stiffness, pain, cramping, tightness, aching, soreness, tingling, and numbness) in each of 15 body locations (neck, right or left shoulder, right or left upper arm, right or left elbow, right or left forearm, right or left wrist, right or left hand and right or left fingers). For the purpose of analysis these were combined to create three regions: neck/shoulder/upper arm, elbow/forearm, and wrist/hand/finger.

Subjects were asked to rate each regional discomfort by defining "current discomfort" and "worst discomfort in the past 30 days" on a visual analog scale of 0 to 10. Subjects who reported

numbness, tingling, burning, or pain in the hand and/or fingers were asked to shade in a hand diagram to determine if the symptoms matched the distribution of the median nerve in the hand.[14,15] Psychosocial variables were assessed using a questionnaire based on the one developed by Karasek.[16] The areas assessed included estimates of skill discretion, job insecurity, perceived stress and job satisfaction based on the decision latitude of the worker and the psychological demands placed upon the worker. Each worker was weighed and measured for height to calculate the body mass index (BMI, kg/m^2).

Electrodiagnostic studies of the median and sensory nerves were conducted bilaterally with the techniques described by Kimura.[17] These techniques have been investigated previously and shown to have high reliability with the median-ulnar peak latency difference being a particularly stable measure.[18] The tests were performed with antidromic, supramaximal stimulation, a distance of 14 cm, and ring-recording electrodes placed around digits two and five. A standard distance of 3 cm between electrodes was used. Hand temperature was recorded and the hand was warmed if the mid-palmar temperature was below 32 degrees Celsius. All studies were performed or supervised on-site by a certified electromyographer and/or a certified electrodiagnostic technician. There were three physicians and three technicians collecting data during the study. The peak latency, sensory amplitude, and takeoff latency were recorded for each sensory nerve. A difference of 0.5 msec or greater between the median and ulnar peak latencies was considered as the definition for a median mononeuropathy.

The hand diagrams were scored according to the methods described by Franzblau et al.[15] Scores ranged from 0 to 3 (unlikely, possible, probable and definite) with respect to the likelihood of establishing a diagnosis of carpal tunnel syndrome. Carpal tunnel syndrome was defined as numbness, tingling, burning, or pain in the distribution of the median nerve (based on a hand diagram score of "probable" or "definite") with ipsilateral median ulnar nerve conduction difference of ≥0.5 msec. These criteria for defining carpal tunnel syndrome are consistent with those recommendations by expert consensus.[19]

Clerical workers had a significantly lower level of job satisfaction, job security, skill discretion, and social support on the job compared to the student population.

Consistent with expert consensus criteria for tendinitis, a diagnosis of tendinitis was established if the subject reported symptoms in a specific area and the physical examination demonstrated focal tenderness to palpation and/or reproduced symptoms with specific provocative tests in the same area.[20]

Results

A total of 429 dental and dental hygiene students were recruited into the study, but excluded students over the age of 29 and thus, analyzed data from 343 students. This included 232 dental students and 111 dental hygiene students from the three sites. Among the dental students, freshmen represented 26 percent of the sample; sophomores, 18 percent; juniors, 26 percent; and seniors, 29 percent. The dental hygiene students were equally divided between first and second year. The demographics, symptom and electrophysiologic data of the dental and dental hygiene students are presented in **Table 1**. The total number of students eligible for the study was 1005, with a 43 percent participation rate. The dental and dental hygiene students were similar in most respects except for gender (dental students 51 percent female vs. dental hygiene students 93 percent female); smoking (dental students 11 percent vs. dental hygiene students 23 percent); wrist/hand/finger discomfort rating (dental students .5 vs. dental hygiene students 0.9), and elbow discomfort rating (dental students .03 vs. dental hygiene students .2). Electrophysiologic features were also similar in terms of the relative latency of the median and ulnar sensory latencies but the absolute latencies were shorter in the dental hygiene students. This difference most likely represents the gender differential.[11]

The dental and dental hygiene student data was grouped for the remaining analyses. The comparison of the students versus the young clerical workers is presented in **Table 2**. There are many differences noted between the two groups. The clerical workers have the same mean age and gender distribution, but the clerical workers have many more complaints of upper extremity symptoms and a history of more tendinitis. The clerical workers had three times as many complaints of hand/wrist/finger symptoms (62 percent vs. 20 percent, $p<.01$) and elbow/forearm complaints (48 percent vs. 16 percent, $p<.01$) and five times as

Table 1

COMPARISON BETWEEN DENTAL AND DENTAL HYGIENE STUDENTS

	Dental students (age<29) n=232	Dental hygienist (age < 29) n=111	P
Demographic variables			
BMI	23.8	22.8	0.03
Age	25	24	<0.01
Gender (% female)	51.3%	93.7%	<0.01
Hand dominance (right hand)	93.1%	94.55%	0.61
Diabetes	0.86%	0%	1
Rheumatoid arthritis	0.86%	0%	1
Exercise	90.9%	90.7%	0.94
Smoking	11.3%	23.4%	<0.01
Regional discomfort variables Worst discomfort rating in last 30 days			
Wrist/hand/finger	0.23	0.37	0.21
Wrist/hand/finger	0.47	0.94	0.01
Neck/shoulder	0.32	0.56	0.09
Neck/shoulder	0.59	0.99	0.08
Elbow/forearm	0.034	0.22	0.03
Elbow/forearm	0.15	0.38	0.08
Carpal tunnel syndrome variables			
CTS based on abnormal hand diagram & prolonged median lat. (>=0.5msec)	0.43%	0.9%	0.62
Median sensory peak lat. (dominant side)	3.1	3.02	0.01
Ulnar sensory peak lat. (dominant side)	3.095	2.99	<0.01
Median peak lat.-ulnar peak lat., dominant side	0.005	0.028	0.33
Regional tendinitis variables			
Shoulder tendinitis (our diagnosis)	1.72%	3.6%	0.28
Elbow tendinitis (our diagnosis)	0.43%	0%	1
Wrist/hand/finger tendinitis (our diagnosis)	1.29%	1.8%	0.66
Any upper extremity tendon (overall tendinitis based on self-report)	5.6%	2.7%	0.28

Table 2

DENTAL AND DENTAL HYGIENE STUDENTS COMPARISON WITH YOUNG CLERICAL WORKERS (AGE <29)

	All students (age<29) n=343	Young clerical workers (age < 29) n=164	P<0.01
Demographic variables			
Age	24.7	24.8	0.53
Body mass index (BMI)	23.6	26.5	<0.01
Gender (% female)	65%	73.2%	0.07
Hand dominance (right hand)	93.6%	86%	<0.01
Diabetes	0.58%	0%	1
Rheumatoid arthritis	0.58%	0.61%	1
Regular exercise	90.9%	80%	<0.01
Smoking	15.3%	31.7%	<0.01
Regional discomfort variables Worst discomfort rating in last 30 days			
Wrist/hand/finger	1.42	2.09	0.04
Wrist/hand/finger	3.2	5.45	<0.01
Neck/shoulder	2.55	2.67	0.76
Neck/shoulder	4.62	5.69	0.02
Elbow	1.52	1.82	0.61
Elbow	3.67	5.4	0.02
Carpal tunnel syndrome variables			
CTS (self-report based on questionnaire)	0.58%	2.45%	0.09
CTS (based upon positive hand diagram and median nerve slowing)	0.58%	0%	1
Median sensory peak latency (dominant side)	3.075	3.073	0.92
Ulnar sensory peak latency (dominant side)	3.063	3.005	0.01
Median – ulnar sensory peak latency	0.012	0.067	0.01
Difference (dominant side)			
Regional tendinitis variables			
Shoulder tendinitis	2.33%	3.05%	0.63
Elbow tendinitis	0.29%	3.05%	0.02
Wrist/hand/finger tendinitis	1.46%	6.71%	<0.01
Tendinitis (overall tendinitis based on self-report)	4.66%	11.66%	<0.01
Psychosocial variables			
Education level*	5.94	4.14	<0.01
Skill discretion**	36.56	20.47	<0.01
Social support**	12.75	11.48	<0.01
Job dissatisfaction**	0.195	0.338	<0.01
Colleague support**	12.75	11.67	<0.01
Job insecurity**	4.16	6.17	<0.01

*Education level: 4=High school diploma, 5=some college, 6=college degree, 7=graduate degree

**Psychosocial variables as defined by Karasac[16]

Table 3

LOGISTIC REGRESSION MODEL FOR HAND/WRIST DISCOMFORT (YES/NO), ODDS RATIO AND 95% CI.

Variable	Odds ratio	P value	95% CI
Smoking	2.13	.03	1.04, 2.98
Elbow/forearm discomfort	5.41	<0.01	2.74, 10.65
Neck/shoulder discomfort	2.85	<0.01	1.72, 4.72
History of tendinitis	2.71	.03	1.12, 6.55
Skills discretion	0.93	<0.01	0.91, 0.96

N=487, p value for model<.01, Pseudo R^2=.26

many shoulder complaints (33 percent vs. 6 percent, p<.01). The clerical workers had a higher body mass index and were less likely to exercise regularly. Clerical workers also were more likely to have a history of carpal tunnel syndrome or upper extremity tendinitis. The prevalence of both of these disorders was low. The electrophysiologic measures of the median sensory nerves were similar however, there was a slight difference in the ulnar sensory nerves; clerical workers had a shorter peak latency. Clerical workers had a significantly lower level of job satisfaction, job security, skill discretion, and social support on the job compared to the student population.

Table 3 presents the logistic regression model using hand discomfort (yes/no) as the dependent variable and assessing the influence of demographic, psychosocial, symptoms and medical history as independent variable. The final model demonstrated that other regional symptoms such as shoulder and elbow complaints as well as a history of an upper extremity tendinitis, smoking, and decreased skill discretion were independent risk factors. Most of the psychosocial variables were highly correlated and there was a significant difference when stratified by job classification. The skill discretion variable was the best fit in the model and if the variable for job classification (student vs. clerical) was forced into the model, the psychosocial variables would no longer be significant in the model. Age or years in training did not influence the model.

Despite the wide disparity in symptoms between the students and the clerical workers, their nerve function was almost identical.

Discussion

This study demonstrates that dental and dental hygiene students start their respective careers with few symptoms of upper extremity musculoskeletal disorders. They are less likely to complain of upper extremity musculoskeletal symptoms than age-matched clerical workers. Age and duration of time in their respective training program did not appear to influence their symptoms or the function of the median nerve; i.e. senior dental students did not have more symptoms compared to freshmen and their nerve conduction measures were similar.

Some psychosocial variables, such as job discretion, appear to influence the reporting of hand discomfort. The authors chose to evaluate a student's perception of their training in a similar fashion as a "job." The psychosocial assessment was developed by Karasek for active workers, not students, but an argument could be made that the training phase is their job.[16] This is a potential limitation of the interpretation of this study.

Other influences include smoking and reports of other regional upper extremity discomfort. A history of proximal upper extremity tendinitis or other proximal musculoskeletal complaints in the upper limb is strongly associated with reporting hand symptoms. This association of symptoms has been demonstrated in several recent studies and are known to be associated with higher reports of carpal tunnel syndrome and upper extremity tendinitis.[21,22] This relationship may be due to an underlying diagnosis of carpal tunnel syndrome and the associated pain

referral patterns to the elbow and the shoulder. Alternatively, these individuals may compensate for one region of the arm by overusing another group of muscles. A third explanation would be related to some underlying genetic predisposition to soft tissue injury or delayed repair of connective tissue.

Despite the wide disparity in symptoms between the students and the clerical workers, their nerve function was almost identical. The differences in the prevalence of complaints of pain are not due to measurable nerve impairment. The median nerve function among practicing dental professionals does deteriorate over time with more impairment in the median nerve compared to the ulnar nerve function. This is the hallmark of carpal tunnel syndrome.

Unanswered questions include: when does the stress on the median nerve begin in dental professions; how is it influenced by work activity versus other avocational activities; and are there changes in psychosocial variables such as job satisfaction that may influence later reporting of hand discomfort? A prospective study is necessary to fully understand the process. It has been demonstrated among hand intensive industries that changes in the median nerve function can occur in the early stages of employment in a new, and physically stressful, work environment.[23] This is not the case when evaluating workers who have been on the same job for many years. We have looked at prospective studies of industrial and clerical workers as well as dentists who have been working for a number of years and demonstrated that the rate of change after the first five to 10 years on the job are minimal.[21] A

prospective study of these dental and dental hygiene students would be an ideal study to help define the role of work versus avocational risk factors. We have baseline data that demonstrates a very healthy population and have demonstrated that these dental professionals will have upper extremity musculoskeletal problems during their careers but, when do they occur and which factors are the ones temporally related to their problems? A prospective study would allow cause and effect to be evaluated and would elucidate preventive measures that could be taken. We hope to evaluate these students during their career to identify the risk factors for upper extremity musculoskeletal disorders, some of which may be responsive to primary or secondary preventive measures, and the identify the timing of the change in median nerve function. If we can separate the work-related ergonomic factors from the aging process, we will greatly contribute to an improved understanding of the process associated with upper extremity musculoskeletal disorders.

The practicing dentist and dental hygienist have a high rate of upper extremity symptoms and musculoskeletal disorders, however, when starting in the profession they are relatively symptom free. When does the practicing dentist or dental hygienist start to develop symptoms and how much can be attributable to the type of work they perform are questions that remain unanswered. Differentiating the impact of aging from work activity is sometimes difficult but this could be assessed with a longitudinal study. Determining when the changes occurred in these populations will allow for preventive strategies to be developed and tested. CDA

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