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DENTISTS' WORKSPACE AND MUSCULOSKELETAL DISORDERS PREVENTION: PRELIMINARY STUDY

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Abstract. *The importance of studying and analyzing the ergonomics concepts in dentistry is to reduce dentists' health problems that may be faced through time, such as musculoskeletal disorders, which result the most often in neck and shoulders pain. This paper is a preliminary study for dentists' workplace modeling through anthropometric measurements analysis and ergonomic principles application, using sample of 25 dentists in Belgrade region and smaller control sample to confirm study results, all that in aim to minimize musculoskeletal disorders and injury risk reduction over time due neck flexion issues. Special attention is paid to the proper position of patients' dental chair that may give more comfort for dentists that work in standing position, through minimizing the dentists' neck flexion.*

Key words: *musculoskeletal disorders, anthropometric measurements, dental chair, neck flexion*

1.INTRODUCTION

Dental work is a vision-demanding very precise task that needs high concentration with repetitive movements of arms and hands sometimes in combination with exertion of force and in combination with postural loads of upper back and head and improper fixed postures during work. The musculoskeletal disorders (MSDs) have high influence on dentist occupation and appear as neck, shoulder, back and headache pain [10]. It is evident that biomechanical factors, such as awkward posture, force, repetition, and equipment design, are affecting the development of dentists` musculoskeletal problems, namely neck, shoulder, upper and lower back pain, CTS (carpal tunnel syndrome), tendonitis, ulnar and radial nerve entrapment syndromes and repetitive strain injuries [11]. Pain, swelling, burning sensation, cramping, blanching, decreased range of motion, stiffness, muscle weakness, and sensory nerve disturbances like tingling and numbness are some of the symptoms seen during the dentists career [5]. Table 1 shows some available previous studies results of musculoskeletal disorders prevalence among dental professionals. It can be seen that dentists have high prevalence of musculoskeletal disorders especially in neck, shoulders, and wrist/hands and they have been ascribed to the nature of the dental work [1]. The studies in Table 1 also find out that MSDs are not related to gender, years of practice, or operating style**.** It is also evident that those studies did not mention specifically the working posture of dentist (standing or sitting) and it's relation with MDS and the optimum position of dental chair. Work related MSDs may developed gradually as result of repeated stresses to soft tissues, such as muscles, tendons, nerves, ligaments, joints, cartilage, and blood vessels **[**13**].** The most commonly reported MSDs in dental hygienists include tension neck syndrome and shoulder impingement **[**13**].** The prevalence of general musculoskeletal pain among dentists are much higher, and is ranging from 63% to 95% for combined low back, neck, shoulder, arm, and hand pain **[**13**].**

Study	Population	Sample size	Back pain (%)	Neck pain(%)	Shoulder pain (%)
Basset(1983)	General dentist	465	62	-----	-----
Shugars et al.(1984)	Ortho-dentists General dentist	32 347	41 57	----- -----	----- -----
Kuroinka et al.(1987)	General dentist	359	----	72	----
Marshall et al. (1997)	General dentist	355	82% (MDSs in general)		
Kerosuo et al.(2000)	Ortho-dentists General dentist	81 147	70%(MDSs in general) 28 56		53
Lalumandier et al.(2001)	Ortho-dentists General dentist	59 647	43 35	19 28	15 21

Table 1.Previous studies of musculoskeletal disorder prevalence among dental professionals [10,9]

It is also known that increasing neck inclination for 30degrees more causes a decrease in duration from 5 to 2 h to reach fatigue in the neck muscles **[**11**].**Previous research

show that the need to survey dentist workplace design still exists and according to that fact the aim of this paper is to analyze the proper position of patients dental chair the may give more comfort for dentist in standing position, that still is prevalent, with minimal MSDs. Eccles[3] also confirms that still exist the need for application of ergonomic principles to the study of the man/machine system leading to improvement in the design of dental equipment and better comfort of the dentist.

2. METHODOLOGY

The static anthropometric measurements for 25 dentists in Belgrade(Serbia) that agreed to participate in experiment were collected, followed by an interview on even smaller sample, since only one dental clinic agreed to participate in an interview. In Serbia there are about 6000 licensed dentists in both private and public sector. Data for Belgrade region are not given on site http//www.stomkoms.org.rs[2].butsite http://zubari.cu.rs/beograd/[3].gives information for 188 private dentists in Belgrade and we used that data as starting point in this survey. The work place design is considered for the standing position since all the dentists in our sample are working in standing position. Sitting, as the preferred position for the dentist to adopt, was introduced in the 1960s in an attempt to reduce the fatigue and musculoskeletal problems associated with dental practice assuming that back problems would decrease [1]. However, a questionnaire survey that appears in 1977 [16] showed problems still exist while dentists in our sample confirm that in way that they feel better when working in standing position. Ergonomic designs must accommodate a range of user dimensions, typically from a 5th to a 95th percentile and this range will accommodate 9.5 out of 10 users. Most work chairs are designed on a "middle-out" model of anthropometrics intended to accommodate the middle 95 percent of the user population from the 5th-percentile to the 95th-percentile [14]. Accordingly, percentiles analysis is performed for P95 (95th-percentile) and P5 (5th-percentile) for both male and female, since they are working on same dental chair in order to establish the appropriate dental chair height that should allow comfort working position with minimum musculoskeletal disorders and better dental task control [8 ,12]. Since dental operators often cannot avoid prolonged static postures, more than one-half of the body's muscles are contracted statically with neck flexion [16]. According to that neck flexion angle is measured for lower jaw tasks. The inclined angle (β) of neck flexion (as can be seen in Figure 1) is measured for a dentist during performing a task, since this angle is the most usually applied in performing different dental tasks with patients, as concluded from the interview. This angle could be controlled or reduced through adequate dental chair height that gives minimum neck flexion through suitable patient posture which we aimed for. The recorded measurements for neck flexion angle and dental chair height during performing inspection task for lower jaw are given in Table 2.

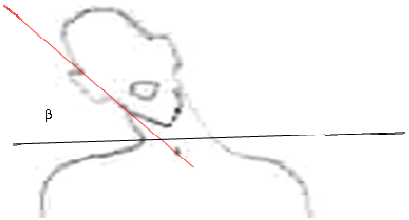

Figure 1. Geometry of neck flexion angle measurement

Average dental chair height (B) (measured)	670 mm
Average neck flexion angle to the right side β (measured)	55 degrees
Working field height (standing position) (A) (measured)	1150 mm
Mouth seat level (C) (measured)	410mm
Inclined chair angle (α) (fixed)	30 deg.

Table 2. Recorded measures of current dentist inspection task (lower jaw task)

3. DATA AND STATISTICAL ANALYSIS

The sample data for 25 dentists are summarized in Table 3. There were18 male and 9 female dentists in the sample. Their average age is around 45 years with standard deviation 9.41 while average weight is 77.56 kgwith standard deviation 14.87. From Table 3 the result shows P95=1268mm and P5=1018mm for the working field height of dentists in standing position.

Table 3. Data statistics including percentiles

	Mean value	Standard deviation	P95	P5
Shoe number	41,52	2,815955	45,8	37,4
Standing Height in mm	1744,2	100,8462	1868	1618
Sitting Height in mm	881,2	51,52427	974	810
Lower Leg Length in mm	573	40,07805	635	512,5
Upper Leg Length in mm	584,12	60,25109	668	483,6
Shoulder Width in mm	435,2	48,87228	522	381
Hip Breadth in mm	374,8	46,08597	420	310
Arm length in mm	656,8	74,74791	728	582
Arm working field height	1144,2	96,99914	1268	1018

That means that 1268-1018=250mm is the range needed to cover dentists in our sample. The figures 2&3 are illustrating percentiles P95 and P5 for working field height in order to find out the suitable dental chair height. Figure (4) is illustrating the domain of dimensions on dental chair and adjustable height. The dimensions are as follows:

A (A5-A95): the dentist working field height needed between 1268mm and 1018mm

B: average dental chair height needed amounts 610mm
C: patient mouth seat level needed amounts 500mm.

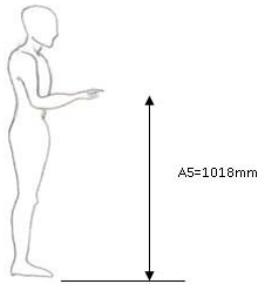

Figure 2. P5 working field height

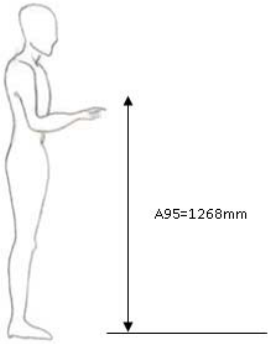

Figure 3. P95 working field height

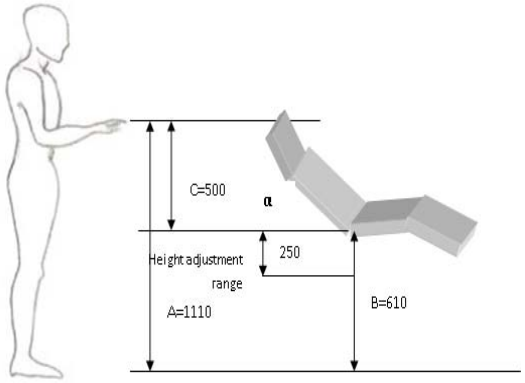

Figure 4.Illustration of Max.and Min. dental chair height in mm

4. RESULTS AND DISCUSSION

Using percentile analysis for P95&P5 it was found that the height adjustment range of patient chair needed amounts 250mm as shown in Figure 4 while inclined chair angle (α) was fixed without change 30 degree as indicated in ergonomic requirements for dental equipment according to **[5].**By applying this survey results on female dentists that accepted to participate in interview and in performing inspection task (lower jaw task), the gained results in control experiment are given in Table 4.

The mouth seat level is increased from 410mm to 500mm which indicates a slight difference equal to 9cm, while the neck flexion angle was increased from 55 degrees to 63 degrees using recommendations of this study that this gives reduction in neck flexion.

Table 4. Recorded measures for calculated P95 and P5 of dentist - inspection task

Average dental chair height (B)	610 mm
Average neck flexion angle to the right side direction (lower jaw task)	63 degrees
Working field height (standing position)	1110mm (within the limits)
Mouth seat level	500mm
Inclined chair angle (α)	30 degrees

4. CONCLUSION

The use of ergonomic principles and workplace design using anthropometric measurements not for the whole population but for the specific occupation professionals results in more comfort and safety over time for any career. This study has confirmed that neck flexion for dentist career is the one of the largest problems that causes musculoskeletal disorders. The dental chair high has strong relation with neck flexion angle of dentist and the suitable adjustment of this high is result in minimum flexion of the neck , this flexion is reduced by 8 degrees (before applying anthropometry measures was 53degrees and after adjusting the chair according to anthropometry measures is found 63degrees). This conclusion gives possibility for lowering musculoskeletal disorders over time for the dentist career. Further studies will be performed as continuation of this preliminary study in aim to study the problem on larger sample size. Updated records will highly contribute in safer and more comfortable dental career in Belgrade region and Serbia. Organizational factors, such as work space, length of the shift, and breaks schedule are also contributing factors to the MS issues and they could be also analyzed in the future research.

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