

## EVALUATION OF WORK POSTURE AND PREVALENCE OF MUSCULOSKELETAL DISORDERS AMONG DENTISTS IN LAGOS STATE

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### ABSTRACT

*Dentists spend their work hours performing extremely precise procedures in a small space (the patients' mouth), and dental work is typically characterized by postures with different degrees of distortion, prolonged static postures, repetitive movements, inadequate lighting, and vibrations. This study was designed to evaluate work posture and prevalence of work-related musculoskeletal disorders (WMSDs) among dentists in Lagos State, Nigeria.*

*A total of 47 practicing dentists (males = 25, females = 22) from two Teaching Hospitals within Lagos state, Nigeria participated in this cross-sectional study. Participants were required to complete a standard Nordic musculoskeletal questionnaire; thereafter their work posture was evaluated using Rapid Entire Body Assessment (REBA) tool. Chi-Square statistic was used to determine association among prevalence of WMSDs, REBA scores and anthropometrics.*

*Prevalence of WMSDs was 66.0%, with the low-back having the highest prevalence (51.1%). REBA scores indicated that most respondents (46.8%) were at Medium risk exposure to WMSDs. There was a significant association ( $p=0.025$ ) between REBA scores and years of working experience; however there was no significant association ( $p=0.064$ ) between REBA scores and the report of WMSDs.*

*Work-related musculoskeletal disorder, particularly low back pain, was a common problem among dentists. Awkward postures and sustained contractions can be contributory factors to these disorders. Therefore, interventions such as education on proper work posture, use of personal protective equipment (PPE) such as wrist support, back belt and vibration attenuation gloves, and work-station ergonomics may be essential to reduce risk factors.*

**Keywords:** Dentists, Ergonomics, Musculo-skeletal-disorders, REBA, work-posture

## INTRODUCTION

Work-related musculoskeletal disorders (WMSDs) are induced or aggravated by work, and the circumstances of its performance (Kakosy and Németh 2003). Musculoskeletal Disorders (MSDs) are some of the most important work-related problems currently reported (Kakosy and Németh 2003; Choobineh *et al* 2007; Centre for Disease Control 2012). Musculoskeletal Disorders are common among dentists, being one of the main occupational hazards affecting dental personnel (Kuopio 2014). The prevalence of WMSDs among dentists has been reported to vary from 65% to 95% (Biller 1994, Chowanadisai *et al.* 2000; Roivainen and Hatakka 2007, Muralidharan *et al.* 2013). According to Rice and co-workers (1996), there is a greater risk of developing upper extremity disorders among dental workers due to the long hours of dental scaling and root planning, operative dentistry and dental surgery. Conditions can vary from mild recurrent symptoms, to severe and incapacitating ones. The importance of the effect of MSDs in dental practice lies in its cumulative physiological damage which can lead to an injury, or a career ending disability (Valachi and Valachi 2003). A Nigerian study reported that neck, knee, and upper back were more affected, particularly in males and that generalists are more affected than specialists (Udoye and Aguwa 2007).

The high prevalence of WMSDs among dentists has been attributed to the peculiar dental profession factors which are characterized by assumption of awkward postures, i.e. postures with different degrees of distortion, prolonged static postures, repetitive movements, inadequate lighting, and vibrations (Anghel *et al* 2007). This is expected, as dentists spend their work hours performing extremely precise procedures in a “2-inch by 2.5-inch” space i.e. the patient’s mouth (Gosavi *et al* 2012). Shaik *et al* (2011) also noted, that even in optimal seated postures, more than half of the muscles of the body are contracted statically, and there is little movement of the vertebral joints. Poor working postures involving high static loads (increased muscle tension) have been reported to create musculoskeletal discomfort or fatigue in the neck, shoulders, and upper back among professionals (Alexopoulos *et al* 2004). Also musculoskeletal pain and fatigue may influence posture control which can increase the risk of errors and may result in low work efficiency (Anghel *et al* 2007).

Work-related musculoskeletal disorders (WMSDs) not only cause suffering to dentists and their families, they also add to the overall cost to the society by a reduction in productivity, and increased use of medical and welfare services (Montakarn 2005). Therefore, it is necessary for clinicians to find a posture that allows them to achieve optimum access, visibility, comfort, and control at all times (Pollack 1996). Various methods and tools have been developed to record and describe workers’ postures. These methods include observational techniques, self-report, and direct methods. Observational technique makes use of postural tools such as Rapid Entire Body Assessment (REBA), Rapid Upper Limb Assessment (RULA), Load on Upper Body Assessment (LUBA), and Ovaco Working Posture Analysis System (OWAS) among others (Sanders 2004). The

REBA tool was proposed by Hignett and McAtamney in 2000 as a means of assessing posture for risk of WMSDs. Although studies have assessed the prevalence of WMSDs among oral health practitioners (Udoeye and Aguwa 2007, Sokunbi *et al* 2015), none of these studies assessed posture in their participants. However, prolonged sitting and standing, and working in an awkward posture have been suggested as the most common ergonomic hazards among health workers in Nigeria, including dental practitioners (Sokunbi *et al* 2015). Thus, there is a need to determine the association between working posture and the report of WMSDs among dental health practitioners. Availability of such data would not only provide relevant national data, which might be useful in epidemiological research, it might also encourage safe and efficient work practices and provide data for the development of guidelines for planning and implementing interventional ergonomics, aimed at reducing the incidence and prevalence of WMSDs, work absenteeism, early retirement, healthcare and economic impacts, maximizing productivity, and improving the quality of life of dentists. This study was therefore, designed to determine the prevalence of MSDs, and evaluate the work posture of dentists in a population of Nigerian dentists. It also sought to determine the association between working posture for dental work and MSDs.

## **MATERIALS AND METHODS**

A total of forty-seven (47) dentists participated fully in this cross-sectional study. They were recruited from dental departments of two teaching hospitals within the Lagos metropolis (Lagos University Teaching Hospital and Lagos State University Teaching Hospital) during the study period of three months. Only dentists who had at least twelve (12) months working experience post-graduation, and were involved in instrumentation and direct service to patients were recruited into this study. Dentists who had pre-existing physical deformity, which primarily altered a neutral position, such as kyphosis were excluded from the study. Participants who fit into the inclusion criteria were recruited, using simple random sampling technique, from the four clinical departments where dental surgeries are performed on patients at the two institutions.

Prior to the commencement of the study ethical approval was obtained from Health Research and Ethics Committees of the two Institutions. The detail of the research protocol was explained to the participants and only those who consented were recruited into the study. Participants were assured of the confidentiality of the information collected. Permission was also sought from the Head of Department or clinical directors of the departments of Restorative dentistry, Oral & maxillofacial surgery, Child dental health, and Preventive dentistry at the institutions.

Participants were visited at their work-station in a manner that would not influence their usual work-posture, i.e. walk-through observation. They were observed at their duty posts while carrying out their routine dental procedures for the most frequently adopted postures and their posture assessed using the REBA tool. Scores were then assigned to each body part on the REBA worksheet. Thereafter, the participants were required to

complete the Nordic questionnaire and bio data forms, which were self-administered. Experiences of musculo-skeletal pain and stiffness over the past 12 months were elicited. Rapid Entire Body Assessment is a validated postural analysis tool developed by Hignett and McAtamney in 2000 to assess posture for risk of work-related musculoskeletal disorders and this was used for postural analysis. Also Nordic questionnaire has been reported to be a valid instrument (Kuorinka *et al* 1987, Dickinson *et al* 1996, Pinheiro *et al* 2002).

Data analysis was done using SPSS version 22.0 for windows. Descriptive Statistics of mean, standard deviation, bar charts and percentages were computed for the anthropometric characteristics of participants and reported occurrence of WMSDs and REBA. Student t-test was used to compare the anthropometric characteristics (height weight, BMI) of male and female participants. Inferential statistics of Chi-square was used to determine if any significant association existed between prevalence of WMSDs, selected socio-demographic variables and number of years of dental work. Chi-square test was used to find out if any significant association existed between prevalence of WMSDs, REBA and anthropometric variables. The level of significance was set at  $p < 0.05$ .

## RESULTS

A total of 47 dentists, who gave consent, participated in this cross-sectional survey. Their mean age was  $33.23 \pm 6.20$  years; while their mean years of working experience was  $7.42 \pm 5.89$  years. Except for height which showed males to be taller ( $p < 0.05$ ), independent t-test showed no significant difference ( $p > 0.05$ ) in age, weight and body mass index (BMI) between male and female participants (Table 1).

**Table 1: Physical Characteristics of the Study Participants**

	All (N=47) Participants X $\pm$ SD	Males (n=25) X $\pm$ SD	Females (n=22) X $\pm$ SD	t	p-value
<i>Bio data</i>					
Age (years)	33.23 $\pm$ 6.20	33.64 $\pm$ 6.06	32.77 $\pm$ 6.47	-0.474	0.638
Height (m)	1.70 $\pm$ 0.10	1.74 $\pm$ 0.08	1.65 $\pm$ 0.09	4.095	0.000*
BMI (kg/m <sup>2</sup> )	25.13 $\pm$ 4.32	25.29 $\pm$ 3.69	24.96 $\pm$ 5.03	0.258	0.798

\*Significant at  $p < 0.05$

KEY: X= Mean, SD= Standard Deviation, BMI= Body Mass Index.

Twenty-five (53.2%) participants were males while 22 (46.8%) were females. Sixty-six percent of the participants were between the ages of 27-35 years while 10.6% were over 40 years-old. Fourteen (29.8%) participants were dental officers, others were registrars and senior registrars. The majority (83%) of participants had been practicing for 1-10 years while 17% had been practicing for more than 10 years. Participants were observed in Oral Surgery, Restorative Dentistry, Child Dental Health and Preventive Dentistry. (Table 2).

A total of 31 of the 47 respondents indicated pain/discomfort in at least one of the body regions, resulting in 12-month prevalence of 65.9%. More males than females reported pain but this was not statistically significant. The 22-26 years age group reported the highest prevalence (80%) of musculo-skeletal pain but the difference in prevalence of pain among the age groups was not statistically significant ( $p=0.524$ ). Participants from Restorative Dentistry (92.8%) reported the highest prevalence of WMSDs among the dental postings (Table 2) but the difference among the dental postings was not statistically significant ( $p>0.05$ ).

**Table 2: Participants 12-month Prevalence of Work-Related musculoskeletal disorders**

	<i>N (%)</i>	<i>Frequency of WMSDs (% of sub-group)</i>	$\chi^2$	<i>p-value</i>
<i>All participants</i>	47	31(65.9)		
<i>Sex</i>				
Males	25 (53.2)	16 (34.0)	0.091	0.763
Females	22 (46.8)	15 (32.0)		
<i>Age Group</i>				
22-26	5 (10.6)	4 (80.0)	3.206	0.524
27-31	15 (31.9)	10 (66.7)		
32-35	16 (34.1)	12 (75.0)		
36-40	6 (12.8)	3 (50.0)		
>40	5 (10.6)	2 (40.0)		
<i>Work Experience</i>			1.702	0.427
1-5 years	19 (40.4)	12 (63.2)		
6-10 years	20 (42.6)	15 (75.2)		
>10 years	8 (17.0)	4 (50.0)		
<i>Cadre</i>				
Dental officers	14 (29.8)	9 (64.3)	1.333	0.721
Registrars	18 (38.3)	13 (72.2)		
Senior Registrars	15 (31.9)	9 (60.0)		
<i>Dental Postings</i>				
Restorative	14 (29.8)	13 (92.8)	1.333	0.721
Oral Surgery	10 (21.3)	9 (90.0)		
Child Dental Health	15 (31.9)	8 (53.3)		
Preventive	8 (17.0)	1 (12.5)		
<i>Total</i>	47 (100.0)	31		

\*Significant at  $p<0.05$

Pain was reported to affect different body parts among the participants. Neck was affected in 12.8% participants, wrist/hand was affected in 14.9%. There was no significant difference in the report of WMSDs between the male and female participants. Chi-square analysis showed no significant ( $p>0.05$ ) association in the reported prevalence of WMSDs at various body regions between the male and female participants (Table 3). The participants also reported on the number of body parts/regions in which they had

pain. While 16 (34%) reported no pain in any body part, 13 (27.7%), 9 (19.1%), 8 (17%) and 1 (2.1%) reported pain in one, two, three and five body parts respectively.

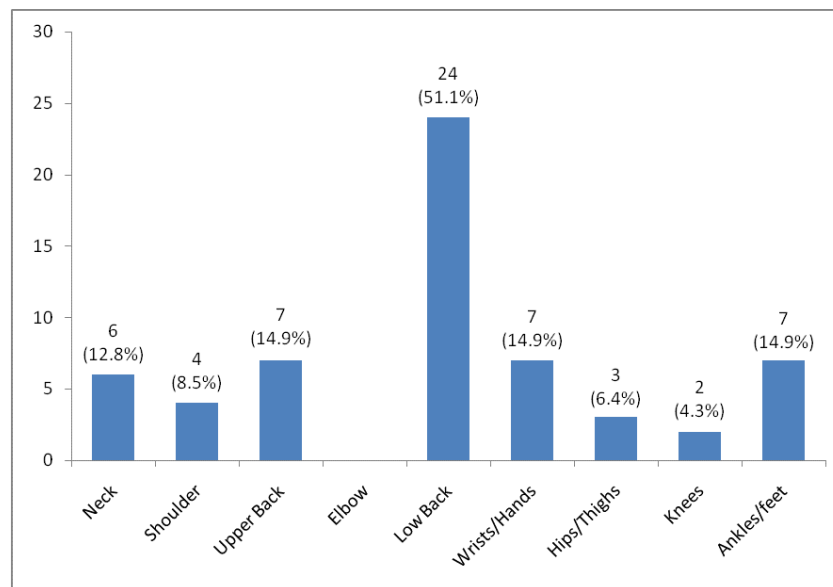
**Table 3: Work-Related musculoskeletal disorders in relation to Body Parts affected**

Variables	Male=25 n (%)	Female=22 n (%)	Total=47 (%)	$\chi^2$	p-value
<i>Body Parts Affected:</i>					
Neck	5 (20.0)	1 (4.5)	6 (12.8)	2.510	0.113
Shoulder	1 (4.0)	3 (13.6)	4 (8.5)	1.396	0.237
Elbows	0 (0.0)	0 (0.0)	0 (0)	-	-
Wrist/hand	4 (16.0)	3 (13.6)	7 (14.9)	0.052	0.820
Upper back	2 (8.0)	5 (22.7)	7 (14.9)	2.002	0.157
Low back	12 (48.0)	12 (54.5)	24 (51.1)	0.201	0.654
Hips/thigh	2 (8.0)	1 (4.5)	3 (6.4)	2.715	0.099
Knees	1 (4.0)	1 (4.5)	2 (4.3)	0.009	0.926
Ankle/feet	4 (16.0)	3 (13.6)	7 (14.9)	0.052	0.820

\*Significant at  $p < 0.05$

Note: The total of percentages added up to more than 100 percent because multiple body parts were affected in some subjects.

No association was found between the anthropometric values and report of WMSDs (Height  $\chi^2 = 12.336$ ,  $p = 0.829$ ; BMI  $\chi^2 = 5.163$ ,  $p = 0.160$ ). The low-back (51.1%) was the body part/region most affected by musculo-skeletal pain while the least reported was pain at the knees (4.3%) (Figure 1).



**Figure 1: Participants' body parts distribution of 12-month prevalence of WMSDs (N=47)**

Note: The total of the percentages added up to more than 100 percent because multiple body parts were affected in some subjects.

The postural analysis of the participants' REBA scores was done and compared to WMSDs, work experience and dental postings (Table 4). None of the respondents had a REBA grand score of 1 (action level 0), while those participants at "Very high risk" (>11 score), (which requires immediate implementation of change), had a frequency of eight (17%). Participants at "Low risk" (2-3 score), which indicates that change may be needed, had the least frequency of two (4.3%), and most participants falling into the category of "Medium risk" (4-7 score), (which indicates that further investigation be performed, and implementation of change soon), had a frequency of twenty-two (46.8%)(Table 4). Also, participants with a "no risk" REBA categorization, reported no WMSDs, while 5 out of 8 participants with "very high risk" categorization reported WMSDs in at least one body part. There was a statistically significant association between REBA scores and the prevalence of WMSDs by participants' work experience (Table 4). Most respondents with record of medium risk and high risk categorization were found to be in the 6 – 10 and 1-5 years work experience groups respectively (Table 4). Overall, most respondents were found to be categorized in the medium risk group, and were in the 6-10 year experience group. The least reported association was seen in those within >10 year experience group (Table 4). Also chi-square analysis showed no significant association between the REBA scores and dental postings (Table 4). Preventive Dentistry overall had the lowest risk and REBA scores, with only a frequency of 8 (17.0%), while Child Dental Health had the highest accumulated risk and REBA scores with a frequency of 15 (31.9%)(Table 4).

**Table 4: Postural Analysis (REBA scores) of participants compared by occurrence of WMSDs, work experience and dental postings**

	REBA Scores					Total N (%)	$\chi^2$	P-value
	Negligible Risk n (%)	Low Risk n (%)	Medium Risk n (%)	High Risk n (%)	Very High Risk n (%)			
<b>All participants</b>	0 (0)	2 (4.3)	22 (46.8)	15 (31.9)	8 (17.0)	47 (100)		
<b>Work Experience (years)</b>								
1-5	0 (0)	0 (0)	6 (27.3)	9 (60.0)	4 (50.0)	19	14.444	0.025*
6-10	0 (0)	0 (0)	12 (54.5)	5 (33.3)	3 (37.5)	20		
>10	0 (0)	2 (100)	4 (18.2)	1 (6.7)	1 (12.5)	8		
<b>Dental Postings</b>								
Oral Surgery	0 (0)	1 (50.0)	4 (18.2)	3 (20.0)	2 (25.0)	10	5.511	0.788
Restorative	0 (0)	0 (0)	7 (31.8)	5 (33.3)	2 (25.0)	14		
Child Dental Health	0 (0)	1 (50.0)	9 (40.9)	3 (20.0)	2 (25.0)	15		
Preventive	0 (0)	0 (0)	2 (9.1)	4 (26.7)	2 (25.0)	8		
<b>WMSDs</b>								
Absent	0 (0)	2(100)	9 (40.9)	2 (13.3)	3 (37.5)	16	7.245	0.064
Present	0 (0)	0 (0)	13 (59.1)	13 (86.7)	5 (62.5)	31		
Total	0 (0)	2 (100.0)	22 (100.0)	15 (100.0)	8 (100.0)	47		

\*Significant at  $p < 0.05$

There was no association found between the prevalence of WMSDs and REBA scores ( $\chi^2 = 7.245$ ,  $p = 0.064$ ). Also no correlation was found between the REBA scores and anthropometric values (Height  $r = -0.055$ ,  $p = 0.713$ ; BMI  $r = -0.165$ ,  $p = 0.268$ ).

## DISCUSSION

This study was designed to evaluate work posture and prevalence of work-related musculoskeletal disorders (WMSDs) among dentists in Lagos State. The findings of this study revealed that WMSDs was a common problem among participants in this study. The 12-month prevalence of WMSDs was found to be 65.9% with a higher prevalence observed among the male dentists compared to the female dentists, though this was not statistically significant. This finding agrees with the finding of Udoeye and Aguwa (2007) and, Pargali and Jowkar (2010), who in their studies reported that WMSDs was common among dentists. Among all the body parts/regions studied, the low-back was generally most affected. Also low back pain (LBP) occurred more among the female participants, while neck pain occurred more among male participants. There was, however, no statistically significant difference in the report of WMSDs between the male and female dentists, this finding is corroborated by the finding of previous studies (Alirezia *et al* 2007, Tella *et al* 2009). The prevalence of WMSDs was highest for the low-back (51.1%) and the least reported pain was at the knees (4.3%) of respondents. The finding that the occurrence of low back pain was commonest among the participants is in line with the trend in the literature and it agrees with the finding of other studies (Shaik *et al* 2011, Pargali and Jowkar 2010). Also the finding that none of the participants reported pain at the elbows agrees with the finding of previous studies (Shaik *et al* 2011, Pargali and Jowkar 2010). The increased prevalence of WMSDs among dental practitioners has been attributed to work-related ergonomic hazards (*vis-à-vis* prolonged standing and awkward posture) and the number of patients attended to per day showed relationship with WMSDs (Gosavi *et al* 2012, Sokunbi *et al* 2015).

The singular most frequent number of body parts with reported WMSDs among the participants was one body part, however, cumulatively most of the respondents reported multiple body parts as being affected. This corroborates the findings of Alexopoulos and co-workers of a high frequency on WMSDs in one body part (Alexopoulos *et al* 2004). The finding that no significant association was observed in the occurrence of WMSDs among the body parts/regions between male and female participants suggests that sex may not influence the occurrence of WMSDs. Thus, suggesting that both the males and females are affected alike. This finding is in agreement with the work of Shaik *et al* (2011), who in their study of WMSDs among dental surgeons reported that there was no significant association in the occurrence of WMSDs among the body parts/regions between male and female participants.

The highest frequency of WMSDs was observed in 22-26 years age range, which was the youngest age group of participants, although there was no significant difference between



age and the occurrence of WMSDs among participants. This observation could be as result of the probability that members of this age group are likely to be of lower cadres who possess less working experience of the dental practice as to develop better postures. The finding that WMSDs occurred more among younger age group and/or early career cadre is in conformity with the findings of Muralidharan *et al* (2013), who in their study also recorded higher prevalence of WMSDs in the youngest age groups. Also, the observed reduction of WMSDs among respondents with high work experience may suggest that this category of dentists, who are mostly in the higher cadre, must have learnt to adjust their work posture, as corroborated by the findings of Khan and Yee Chew (2013).

The results of this study revealed that there was a significant association between the REBA scores and the years of working (experience) of the participants in this study. REBA scores were higher in the younger cadre, suggesting that the posture assumed by the participants may predispose to the occurrence of WMSDs in this category of individuals. The highest prevalence of WMSDs was found among the participants in the 6 – 10 years working experience, whereas participants in the greater than 10 years category reported less WMSDs. This finding is similar to the results of the study by Udoeye and Agunwa (2007). There are two possibilities for this observation – participants with more experience tend to adopt better work postures due to experience, and/or enjoy less patient-load. Also, participants in the higher cadres are often experienced in carrying out procedures compared to those in the lower cadres. The findings from this present study suggests that musculoskeletal disorders may occur more in the respondents' earlier years/cadres due to their continual exposure to the risk factors of these disorders and the likelihood of chronicity of musculoskeletal disorders as suggested previously by Valachi and Valachi (2003). However, there was no significant association between the occurrence of WMSDs and years of experience and cadre.

In this present study postural evaluation using the rapid entire body assessment tool (REBA) revealed that most dentists (46.8%) were at "Medium risk", the implication of this finding is that further investigation needs to be performed, and implementation of change done soon. This could also be attributed to insufficient training, skills, and knowledge of most dental practitioners to practice in a manner that is ergonomically correct (Gosavi *et al* 2012). The findings of this present study showed that most dentists who had REBA scores indicating "high risk" and "very high risk", were in the 1-5 years working experience range, which suggests that an increased work experience, is likely to encourage better work postures. The finding that there was no statistically significant association between the participants REBA scores, and anthropometric variables (particularly height) may be due to the fact that the dental chair is adjustable to the dentist's height. The highest risk in relation to REBA scores were observed among respondents in the Child Dental Health posting. This may not be unconnected with the fact that children are generally more apprehensive than adult patients during treatment,

this may force the dentists to adopt more awkward posture, more so that the dental chairs are often not specifically designed for children.

## CONCLUSION

Based on the findings of this study, it was concluded that there is a high prevalence of WMSDs among dentists in the hospitals visited, with the low back being the most affected body part followed by the upper back, wrists/hands, and ankles/feet. The posture adopted by the respondents may be a contributing factor to the occurrence of MSDs among the dentists. The relatively high REBA scores observed among the participants may be attributed to work conditions, inexperience, patient-load, assumption of awkward posture and equipment used by the dentists. Dentists with more years of experience showed lower REBA scores, therefore reducing risk of WMSDs, which could be attributed to the possibility of acquisition of good postural knowledge/skills gained over time. Regular ergonomic assessment and training of the dentists may be essential for prevention; also preventive measures such as the use of Personal Protective Equipment (PPE), like wrist support, back belt and vibration attenuation gloves may be adopted.

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## REFERENCES

- Alexopoulos EC, Stathi IC, Charizani F (2004). Prevalence of musculoskeletal disorders in dentists. *Biomed central: Musculoskeletal Disorders*, **5**:16
- Anghel M, Argesanu V, Talpos-Niculescu C, Lungeanu D (2007). Musculoskeletal disorders - Consequences of prolonged static postures. *Journal of Experimental Medical & Surgical Research*, **4**: 167-172
- Choobineh A, Tabatabaei SH, Tozihian M, Ghadami F (2007). Musculoskeletal problems among workers of an Iranian communication company. *Indian J Occup Environ Med*, **11**: 32-36
- Biller FE (1994). Occupational hazards in dental practice. *Oral Hygiene*, **36**: 1994-1999
- Centre for disease control and prevention. NIOSH program portfolio: Musculoskeletal disorders 2012. Available at <http://www.cdc.gov/niosh/programs/msd/>
- Chowanadisai S, Kukiattrakoon B, Yaping B, Kedjarume U, Leggat PA (2000). Occupational health problems of dentists in Southern Thailand. *Int Dent J*, **50**: 36-40
- Cohen J (1988). Statistical power analysis for the behavioral sciences (2nd Ed.). New Jersey: Lawrence Erlbaum.
- Dickinson CE, Campion K, Foster AF, Newman SJ, O'Rourke AM, Thomas PG (1992). Questionnaire development: an examination of the Nordic Musculoskeletal Questionnaire. *Appl Ergon*, **23**: 197-201
- Gosavi SS, Gosavi SY, Jawade RS. (2012) Posturedontics: Reducing the stress in dentistry. *World Journal of Dentistry*, **3**: 335-339

- Hignett S, McAtamney L (2000). Rapid Entire Body Assessment (REBA). *Appl Ergon*, **31**: 201-205
- Kakosy T, Németh L (2003). Musculoskeletal disorders caused by hand-arm vibration. *Global Occupational Health Network*, **4**: 3-6
- Khan SA, Yee Chew K (2013). Effect of working characteristics and taught ergonomics on the prevalence of musculoskeletal disorders amongst dental students. *BMC Musculoskeletal Disorders*, **14**: 118-228
- Kuopio E (2014). Prevention of Work-Related Musculoskeletal Problems Among Dentists In Pori Dental Care Center. Dissertation of a Degree Programme In Physiotherapy 2014. Satakunnan ammattikorkeakoulu, Satakunta University of Applied Sciences.
- Kuorinka L, Jonsson B, Kilbom A (1987). Standardised Nordic questionnaire for the analysis of musculoskeletal symptoms. *Appl Ergon*, **18**: 233-237
- Montakarn, C (2005). Differences in Dentists' Working Postures When Adopting Proprioceptive Derivation vs. Conventional Concept. *Int J Occup Saf Ergon (JOSE)*, **11**: 441-449
- Muralidharan D, Fareed N, Shanthi M (2012). Musculoskeletal Disorders among Dental Practitioners: Does It Affect Practice? *Epidemiol Res Int* 2013 (2013), Article ID 716897, 6 pages. <http://dx.doi.org/10.1155/2013/716897>
- Pargali N, Jowkar N (2010). Prevalence of Musculoskeletal Pain among Dentists in Shiraz, Southern Iran. *Int J Occup Environ Med*, **1**: 69-74
- Pinheiro FA, Troccoli BT, Carvalho CV (2002). Validity of the Nordic Musculoskeletal Questionnaire as morbidity measurement tool. *Rev Saude Publica*, **36**: 307-12
- Pollack R (1996). Dental office ergonomics: How to reduce stress factors and increase efficiency. *J Can Dent Assoc*, **62**: 508-10
- Rice VJ, Nindl B, Pentikis JS (1996). Dental workers, musculoskeletal cumulative trauma, and carpal tunnel syndrome, who is at risk? A pilot study. *Int J Occup Saf Ergon*, **2**: 218-33
- Roivainen S, Hatakka P (2007). Mitä kuuluu hammaslääkäriergonomialle? *Hammaslääkärilehti* 18. 28-31. <http://www.digipaper.fi/hammaslaakarilehti/>
- Sanders MJ. Musculoskeletal Disorders (2004): A Worldwide Dilemma. In: Sanders MJ. *Ergonomics and the Management of Musculoskeletal Disorders*. 2<sup>nd</sup> Ed. London, Butterworth-Heinemann. pp. 4-5
- Shaik AR, Rao SB, Husain A, D'sa J (2011). Work-related musculoskeletal disorders among dental surgeons: A pilot study. *Contemp Clin Dent*, **2**: 308-312
- Sokunbi GO, Olabode JA, Stanley MM, Muhammad I (2015). Patterns of occurrence of work-related musculoskeletal disorders and its correlation with ergonomic hazards among health care professionals. *Niger J Exp Clin Biosci*, **3**: 18-23
- Tella BA, Aiyejunsile CB, Adekunle KM, Odebiyi DO, Okafor UAC (2009). Work-related musculoskeletal disorders among Physiotherapists in Nigeria. *Ghana Journal of Physiotherapy*, **1**: 6-9

- Udoye C, Aguwa E (2007). Musculoskeletal Symptoms: A Survey Amongst A Selected Nigerian Dentists. *The Internet Journal of Dental Science*, **5**(1)
- Valachi B, Valachi K (2003). Mechanisms leading to musculoskeletal disorders in dentistry. *J Am Dent Assoc*, **134**: 1344-1350