

# Prevalence and Causes of Musculoskeletal Disorders in Korean Dentists

Taebeum Ryu<sup>†</sup>

Department of Industrial and Management Engineering, Hanbat National University

## 한국 치과의의 근골격계질환 실태 및 원인 조사

류 태 범<sup>†</sup>

한밭대학교 산업경영공학과

Dentists are known to be highly exposed to the musculoskeletal disorders (MSD). The present study investigated the prevalence of MSD among Korean dentists and association between their MSD and physical workload. In addition, detailed causes related to the physical workloads were identified in dental operation, and needs for improvement of dental instrument and environment were collected from Korean dentists. The standardized Nordic questionnaire was used to survey body troubles and three types of questionnaires were made to investigate the physical workloads, causes of the physical workloads and improvement priority of dental equipments, respectively. A total of 104 Korean dentists were participated in the survey. Neck trouble (82%) was the most prevalent in Korean dentists, and shoulder (68%) and low back trouble (56%) followed, while low back trouble was reported to be most frequent in previous studies. The body troubles were related to the physical workload of the corresponding body parts, although they were not associated with personal characteristics. Most Korean dentists selected 'to keep direct view inside patient's mouth' and 'no support of the hand with dental instruments' as the causes of awkward and strenuous work postures. They wanted design improvement for some equipment in their operating room such as operating light and arrangement of workplace.

**Keywords :** Musculoskeletal Disorders, Korean Dentists, Work-related Risk Factors

### 1. Introduction

Dentists are highly exposed to the musculoskeletal disorders (MSD) because they usually take awkward postures, keep them in prolonged time and even use vibration tools. Prevalence

of the MSD among dentists has been studied by using the standardized Nordic questionnaire of [5] in many studies. These studies surveyed the troubles of body segments and most of them reported that the low back trouble was most prevalent in dentists, followed by neck and shoulder troubles [1, 2, 6, 7, 8, 10]. However, Kerosu et al. [4] stated that troubles in the neck and shoulder were more dominant than in the low backs among dentists in Finland.

Since the troubles associated with the MSD can be varied by anthropometric, racial and cultural factors etc., a study is required to identify the characteristics of the troubles among Korean dentists. The previous studies of [3] and [11] investigate the prevalence of the MSD among Korean dentists and

Received 21 June 2012; Finally Revised 17 August 2012;  
Accepted 1 December 2012

<sup>†</sup> Corresponding Author : tbryu@hanbat.ac.kr

© 2012 Society of Korea Industrial and Systems Engineering

This is Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited(<http://creativecommons.org/licenses/by-nc/3.0>).

reported that Korean dentists experienced troubles more frequently in the neck and shoulder than low back. Because they used their own survey method, it is difficult to directly compare the characteristics of their troubles with those of previous studies which were mostly conducted in western countries.

It is necessary to identify the causes of physical workload in the aspects of dental operation to reduce the MSD of dentists in a direct manner. There have been attempts to find out the relations between the body troubles and personal characteristics such as age, gender, year of practice and hour of work [4, 6, 10]. In addition, the previous studies of [1] and [7] investigated the association between the troubles and physical/psychosocial workload such as working posture and stress. However, there were few studies to find the dental operation-related causes of the troubles, which can be used directly to solve the problems related to the MSD of dentists.

The present study surveyed the prevalence of the MSD in Korean dentists and attempted to find causes of the physical workloads in dental operation. A self-administered questionnaire including the standardized Nordic questionnaire was used to investigate body troubles, physical workload and causes of the physical workloads. In addition, the priority of improving dental instrument and environment was surveyed from Korean dentists.

## 2. Methods

### 2.1 Questionnaire

A questionnaire was prepared to survey 1) troubles of each body part, 2) physical workload, 3) causes of physical workload and 4) improvement priority of equipments in dental operating room. First, troubles related to MSD were examined using the standardized Nordic questionnaire. The questionnaire surveyed the occurrence of trouble for each body part during the last 12 months and last 7 days, and prevention of daily activity. More detailed questions such as change of job, prevention of work and leisure activity, and sought professional treatment due to the troubles were prepared for the neck, shoulder and low back. Moreover, the questionnaire had the basic questions regarding personal data such as age, height, weight, year of practice and hour of work per week.

The Physical workload of dental operations was assessed by using the method of [1] which assessed awkward posture, repetitive movements, strenuous exertion and use of vibration

tools. The questionnaire about physical workload had the questions concerning the occurrence frequency of awkward posture in the neck, should, wrist/ hand and low back in routine dental operation. The questions on the frequencies of repetitive and strenuous movements of arms and hand, use of vibration tools and prolonged static posture were also included in the questionnaire. An ordinal four-point scale was used to answer the questions with ratings 'seldom or never,' 'now and then,' 'often' and 'always.'

To identify the causes related to the physical workloads with respect to dental operation, potential candidates were collected from a group of dentists and the significance of them was evaluated. The potential candidates were collected from an interview of the focus group of five dentists (see <Table 1>). For example, 'to keep direct view inside patient's mouth', 'no support of hand with dental instruments', 'trouble in using dental instruments and operator stool' and 'delicacy and complexity of dental operation' were selected as potential candidates related to the causes of awkward posture. The significance of the candidates on physical workload was evaluated with an ordinal four-point scale with ratings 'not at all or little,' 'a little,' 'relative large' and 'large.'

Improvement priority of the equipments in dental operating room was assessed with an ordinal four-point scale with ratings 'very appropriate,' 'appropriate,' 'better to be improved' and 'Need urgent improvement.' Typical ten equipments were collected in dental operation room including operator stool, dental chair, operating light, dental units, cabinet of operating essentials and etc.

<Table 1> Potential Candidates of Causes Related to Physical Workload

Physical workload elements	Potential risk candidates in dental operation
Awkward and strenuous postures (neck, low back, arm, hand/wrist)	To keep direct view inside patient's mouth
	No support of hand with dental instruments
	Trouble in using dental instruments
	Trouble in using operator stool
Repetitive movements (arm and hand/wrist)	Delicacy and complexity of dental operation
	Many patients
	Repetitiveness in dental operation itself
	Trouble in using dental instruments
Strenuous exertion of arm	Delicacy and complexity of dental operation
	Use of dental instruments
	Location of treatment or teeth
	No support of hand with dental instruments

## 2.2 Participants

A total of 104 dentists (male : 76, female : 28) were participated in the survey; all of them had work experience of more than one year and lived in Seoul, capital of South Korea. Out of all the participants, survey data for 79 were used in the analysis, who answered the questionnaire in a complete manner. The rest respondents did not answer all of questions by mistake. The personal data of the available respondents was shown in <Table 2>.

## 2.3 Statistical Analysis

In the present study, the frequency of trouble occurrence for each body part was analyzed, and the dominant troubles were identified among Korean dentists. Next correlations between the troubles and personal data were conducted by using a contingency table and chi-square test. Then logistic regression analysis was performed to find the effect of physical workload on the trouble occurrence; odd ratios (OR) with 95% confidence intervals (CI) were calculated. In addition, causes in dental operation associated with the physical workloads were identified with the frequency analysis and the improvement priority of dental operating room equipments were also analyzed in the same way.

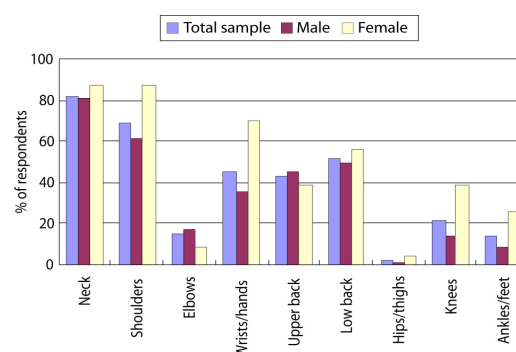
## 3. Results

### 3.1 Occurrence of Body Troubles

<Figure 1> shows the percentage of respondents reporting trouble in each body part in the last 12 months. Most Korean

dentists had the body trouble in the neck and shoulder, and over 40% of respondents experienced the troubles in the low back, wrist/hand and upper back. Neck trouble (82%) was the most prevalent in Korean dentists, and shoulder (68%) and low back trouble (56%) followed. Especially, female dentists (69%) had wrist/hand trouble much more than males (37%).

<Table 3>~<Table 5> provide more detailed data of body troubles such as chronic troubles, work and leisure prevention and medical care for the neck, shoulder and low back, respectively. A quarter of the dentists who experienced the neck trouble suffered chronically over a month, and about 18% of them experienced the sick absence of work over eight days. Moreover, 26% of the dentists with the neck trouble had a medical treatment, and 43% reported recent neck trouble in the last week. The shoulder trouble of the dentists was similar to the neck trouble in the aspects of the detailed troubles. Over 50% of the dentists with the low back trouble suffered chronically, and 29% of them was absent in work on account of the low back trouble. In addition, the percentages of the respondents who had medical treatment and recent trouble in the last week were 24 and 29%, respectively.



<Figure 1> Percentage of Respondents with Body Part Trouble in the Last 12 Months

<Table 2> Demographic Information of Respondents

		Age (year)	Height (m)	Weight (kg)	Year of practice (year)	Hour of work per week (hour)	Hand dominance	Type of Employment
Total (n = 79)	Mean	36.6	1.68	63.5	10.2	48.1		Self employed : 47
	SD	10.4	0.06	12.0	9.5	18.8	Right : 77	Professor : 4
	Min	25	1.53	43	0.8	8	Left : 2	Resident : 17
	Max	75	1.82	88	40	120		Intern : 11
Males (n = 56)	Mean	39.4	1.71	70.9	12.6	47.9		Self employed : 38
	SD	10.9	0.05	7.3	10.1	15.1	Right : 55	Professor : 3
	Min	26	1.60	54	0.8	8	Left : 1	Resident : 10
	Max	75	1.84	88	40	119		Intern : 5
Female (n = 23)	Mean	29.8	1.64	50.9	4.3	48.4		Self employed : 9
	SD	4.4	0.05	4.2	4.0	26.1	Right : 22	Professor : 1
	Min	25	1.53	43	0.8	12	Left : 1	Resident : 7
	Max	44	1.77	60	18	120		Intern : 6

&lt;Table 3&gt; Number of Respondents and Percentage (in Parentheses) on the Details of Neck Troubles

	Ever had neck trouble	Changed jobs due to trouble	Ever been hospitalized due to trouble	Total # of days having neck trouble in the last 12 months		Trouble in the Last 12 months (45 males, 20 females)					
						Trouble reduced work activity	Trouble reduced leisure activity	Total # of days of work prevented		Sought medical treatment	Trouble in the last 7 days
Total (n = 79)	65(82.3)	1(1.5)	2(3.1)	0 1~7 8~30 30+	0 16(24.6) 33(50.8) 16(24.6)	18(27.7)	21(32.3)	0 1~7 8~30 30+	29(44.6) 24(36.9) 9(13.8) 3(4.6)	17(26.2)	28(43.1)
Males (n = 56)	45(80.4)	1(2.2)	2(4.4)	0 1~7 8~30 30+	0 15(33.3) 20(44.4) 10(22.2)	14(31.1)	16(35.6)	0 1~7 8~30 30+	19(42.2) 18(40.0) 5(11.1) 3(6.7)	13(28.9)	18(40.0)
Females (n = 23)	20(87.0)	0	0	0 1~7 8~30 30+	0 1(5.0) 13(65.0) 6(30.0)	4(20.0)	5(25.0)	0 1~7 8~30 30+	10(50.0) 6(30.0) 4(20.0) 0	4(20.0)	10(50.0)

&lt;Table 4&gt; Number of Respondents and Percentage (in Parentheses) on the Details of Shoulder Troubles

	Ever had shoulder trouble	Changed jobs due to trouble	Had trouble in last 12 months	Total # of days having trouble in the last 12 months		Trouble in the Last 12 months (34 males, 20 females)					
						Trouble reduced work activity	Trouble reduced leisure activity	Total # of days of work prevented		Sought medical treatment	Trouble in the last 7 days
Total (n = 79)	54(68.4)	1(1.7)	54(93.1)	0 1~7 8~30 30+	0 17(31.5) 23(42.6) 14(25.9)	18(33.3)	16(29.6)	0 1~7 8~30 30+	25(46.3) 20(37.0) 7(13.0) 2(3.7)	16(29.6)	24(44.4)
Males (n = 56)	36(64.3)	1(2.8)	34(94.4)	0 1~7 8~30 30+	0 13(38.2) 14(41.2) 7(20.5)	14(41.2)	14(41.2)	0 1~7 8~30 30+	12(35.3) 16(47.1) 4(11.8) 2(5.9)	12(35.3)	12(38.2)
Females (n = 23)	22(95.7)	0	20(90.9)	0 1~7 8~30 30+	0 4(20.0) 9(45.0) 7(35.0)	4(20.0)	2(10.0)	0 1~7 8~30 30+	13(65.0) 4(20.0) 3(15.0) 0	4(20.0)	11(55.0)

&lt;Table 5&gt; Number of Respondents and Percentage (in Parentheses) on the Details of Low Back Troubles

	Ever had low back trouble	Changed jobs due to trouble	Ever been hospitalized due to trouble	Total # of days having low back trouble in the last 12 months		Trouble in the last 12 months (28 males, 13 females 13)					
						Trouble reduced work activity	Trouble reduced leisure activity	Total # of days of work prevented		Sought medical treatment	Trouble in the last 7 days
Total (n = 79)	44(55.7)	2(4.5)	0	0 1~7 8~30 30+	3(6.8) 19(43.2) 15(34.1) 7(15.9)	12(29.3)	15(36.6)	0 1~7 8~30 30+	18(43.9) 11(26.8) 8(19.5) 4(9.8)	10(24.4)	12(29.3)
Males (n = 56)	31(55.4)	2(6.5)	0	0 1~7 8~30 30+	3(9.7) 14(45.2) 9(29.0) 5(16.1)	9(32.1)	12(42.9)	0 1~7 8~30 30+	11(39.3) 7(25.0) 6(21.4) 4(14.3)	9(32.1)	8(28.6)
Females (n = 23)	13(56.5)	0	0	0 1~7 8~30 30+	0 5(38.5) 6(46.2) 2(15.4)	3(23.1)	3(23.1)	0 1~7 8~30 30+	7(53.8) 4(30.8) 2(15.4) 0	1(7.7)	4(30.8)

### 3.2 Correlation between Body Troubles and Personal Characteristics

After the difference of body troubles between males and females was tested, the correlations between body troubles and age, height, weight, year of practice were analyzed for each gender by using the chi-square tests. This is because the age (male : 39.4 yrs, female : 29.8 yrs in average), height (m : 1.72 m, f : 1.64 m), weight (m : 70.9 kg, f : 50.9 kg) and year of practice (m : 12.6 yrs, f : 4.3 yrs) were significantly different depending on gender ( $p < 0.05$ ).

Although some significant correlations were found between body troubles and personal data, most of them were not significant. Female dentists reported body troubles more than males in the shoulder, wrist/hand, knee and ankle/foot, and the male dentists whose height was below 1.65 m reported neck troubles more than the others ( $p < 0.05$ ). In addition, the male dentists with less than five years of practice had wrist/hand troubles more than the others ( $p < 0.05$ ). However, significant correlations between body troubles and height, year of practice were not found in females, and age and weight were not associated with body troubles for both

of male and female ( $p > 0.05$ ). Moreover, there were no significant correlations between detailed data of body troubles and personal data in all of the shoulders, neck and low back ( $p > 0.05$ ).

### 3.3 The Effect of Physical Workload on Body Troubles

The occurrence of body troubles in the shoulder, low back and wrist/hand were associated with the physical workload related to the corresponding body part, except for the neck. Logistic regression analysis between body troubles and physical workload elements (see <Table 6>) showed that the occurrence of low back trouble was related to the awkward posture of the low back (95% CI of OR = 1.1-6.9). The occurrence of shoulder trouble was associated with the strenuous exertion of the arm movement (95% CI of OR = 1.3-10.5) as shown in <Table 7>. In addition, the occurrence of wrist/hand trouble was related to the awkward wrist posture (95% CI of OR = 1.8-13.4), the strenuous exertion of the arm movement (95% CI of OR = 1.0-6.6), and strenuous exertion of the wrist movement (95% CI of OR = 1.0-6.8).

<Table 6> Univariate Association between Neck and Low back Trouble in Last 12 Months and Physical Workload Elements

Physical workload elements	Neck trouble OR (95% CI)	Low back trouble OR(95% CI)
Awkward neck posture	1.28 (0.40 to 4.14)	0.91 (0.37 to 2.26)
Awkward shoulder posture	2.67 (0.55 to 13.04)	1.16 (0.43 to 3.11)
Awkward wrist posture	1.37 (0.39 to 4.86)	1.57 (0.61 to 4.03)
Awkward low back posture	0.53 (0.17 to 1.71)	2.77 (1.10 to 6.95)*
Use of vibration tools	0.47 (0.12 to 1.84)	1.00 (0.40 to 2.54)
Repetitive arm movements	1.01 (0.30 to 3.39)	1.76 (0.69 to 4.46)
Repetitive wrist movements	0.57 (0.14 to 2.27)	1.42 (0.54 to 3.71)
Strenuous arm movement	1.67 (0.47 to 5.88)	1.10 (0.44 to 2.73)
Strenuous wrist movement	1.03 (0.32 to 3.27)	1.05 (0.43 to 2.54)
Prolonged static posture	1.13 (0.35 to 3.62)	1.14 (0.46 to 2.79)

Note) \*  $p < 0.05$ .

<Table 7> Univariate Association between Shoulder and Hand/Wrist Trouble in Last 12 Months and Physical Workload Elements

Physical workload elements	Shoulder trouble OR (95% CI)	Hand/wrist trouble OR (95% CI)
Awkward neck posture	1.45 (0.55 to 3.81)	0.75 (0.30 to 1.87)
Awkward shoulder posture	1.84 (0.59 to 5.72)	1.65 (0.61 to 4.44)
Awkward wrist posture	0.89 (0.33 to 2.40)	4.89 (1.78 to 13.41)*
Awkward low back posture	1.02 (0.39 to 2.65)	1.53 (0.63 to 3.74)
Use of vibration tools	0.87 (0.32 to 2.38)	0.85 (0.34 to 2.17)
Repetitive arm movements	1.04 (0.39 to 2.79)	1.19 (0.47 to 3.00)
Repetitive wrist movements	1.12 (0.40 to 3.11)	2.07 (0.76 to 5.64)
Strenuous arm movement	3.45 (1.13 to 10.53)*	2.58 (1.02 to 6.57)*
Strenuous wrist movement	1.17 (0.45 to 3.01)	2.71 (1.08 to 6.75)*
Prolonged static posture	1.23 (0.47 to 3.23)	0.60 (0.24 to 1.48)

Note) \*  $p < 0.05$ .

### 3.4 Correlation between Body Troubles and Personal Characteristics

The occurrence of body troubles in the shoulder, low back and wrist/hand were associated with the physical workload related to the corresponding body part, except for the neck. Logistic regression analysis between body troubles and physical workload elements (see <Table 6>) showed that the occurrence of low back trouble was related to the awkward posture of the low back (95% CI of OR = 1.1-6.9). The occurrence of shoulder trouble was associated with the strenuous exertion of the arm movement (95% CI of OR = 1.3-10.5) as shown in <Table 7>. In addition, the occurrence of wrist/hand trouble was related to the awkward wrist posture (95% CI of OR = 1.8-13.4), the strenuous exertion of the arm movement (95% CI of OR = 1.0-6.6), and strenuous exertion of the wrist movement (95% CI of OR = 1.0-6.8).

Causes in dental operation related to physical workload were

selected among the potential candidates for which the sum of the percentages of respondents' ratings with 'relatively large' and 'large' was over 50%. As the causes associated with the awkward and strenuous neck posture, dentists dominantly selected 'to keep direct view inside patient's mouth' (99%) and 'delicacy and complexity of dental operation' (80%) as shown in <Table 8>. The causes related to the other physical workload were summarized in <Table 9>. The causes selected by male and female dentists were slightly different. For example, male dentists selected 'delicacy and complexity of dental operation' (64%) as the causes of the awkward and strenuous arm posture, while females selected 'trouble in using dental instruments' (57%). In general 'to keep direct view inside patients' mouth', 'no support of the hand with dental instruments', and 'delicacy and complexity of dental operation' were dominantly regarded as the causes of awkward and strenuous postures by dentists. In particular, female dentists frequently selected 'troubles in using dental instruments' as the causes of physical workload.

<Table 8> Significance of Causes Related to Awkward and Strenuous Neck Posture in Dental Operation

		To keep direct view inside patient's mouth <sup>*†‡</sup>	No support of hand with dental instruments	Trouble in using dental instruments	Trouble in using operator stool	Delicacy and complexity of dental operation <sup>*†‡</sup>
Total (n = 79)	not at all or little	0(0.0%)	21(26.6%)	10(12.7%)	12(15.2%)	1(1.3%)
	a little	1(1.3%)	40(50.6%)	41(51.9%)	38(48.1%)	15(19.0%)
	relative large	29(36.7%)	16(20.3%)	22(27.8%)	22(27.8%)	35(44.3%)
	large	49(62.0%)	2(2.5%)	6(7.6%)	7(8.9%)	28(35.4%)
Males (n = 56)	not at all or little	0(0.0%)	14(25.0%)	7(12.5%)	9(16.1%)	1(1.8%)
	a little	1(1.8%)	27(48.2%)	29(51.8%)	30(53.6%)	11(19.6%)
	relative large	21(37.5%)	13(23.2%)	15(26.8%)	13(23.2%)	23(41.1%)
	large	34(60.7%)	2(3.6%)	5(8.9%)	4(7.1%)	21(37.5%)
Females (n = 23)	not at all or little	0(0.0%)	7(30.4%)	3(13.0%)	3(13.0%)	0(0.0%)
	a little	0(0.0%)	13(56.5%)	12(52.2%)	8(34.8%)	4(17.4%)
	relative large	8(34.8%)	3(13.0%)	7(30.4%)	9(39.1%)	12(52.2%)
	large	15(65.2%)	0(0.0%)	1(4.3%)	3(13.0%)	7(30.4%)

Note) \*Sum of percentage in 'relative large' and 'large' is more than 50% in total, † in males, ‡ in females.

<Table 9> Summarized Causes of Physical Workload in Dental Operation

Physical workload element	Gender	Risk factors in dental operation
Awkward and strenuous neck posture	Common	To keep direct view inside patient's mouth(98.7%) Delicacy and complexity of dental operation(79.7%)
	Common	To keep direct view inside patient's mouth(56.9%) No support of hand with dental instruments(60.8%)
Awkward and strenuous arm posture	Males	Delicacy and complexity of dental operation(64.2%)
	Females	Trouble in using dental instruments(56.5%)
Awkward and strenuous wrist posture	Common	No support of hand with dental instruments(65.8%) Delicacy and complexity of dental operation(55.7%)
	Females	Trouble in using dental instruments(56.5%)
Awkward and strenuous low back posture	Common	To keep direct view inside patient's mouth(91.1%)
	Males	Delicacy and complexity of dental operation(51.8%)
	Females	Trouble in using operator stool(60.9%)
Repetitive arm and hand movement	Common	Many patients(59.5%) Delicacy and complexity of dental operation(60.8%) Repetitiveness in dental operation itself(78.5%)
Strenuous arm movement	Common	Use of dental instruments(64.5%) Location of treatment or teeth(73.4%)
	Males	No support of hand with dental instruments(51.8%)

&lt;Table 10&gt; Improvement Priority of Equipments in Dental Operating Room

	Dental chair	Operator stool	Operating light	Dental instruments	Dental unit
Very appropriate	0(0.0%)	0(0.0%)	1(1.3%)	1(1.3%)	1(1.3%)
Appropriate	23(29.1%)	22(27.8%)	15(19.0%)	23(29.1%)	24(30.4%)
Better to be improved	49(62.0%)	40(50.6%)	53(67.1%)	49(62.0%)	47(59.5%)
Need urgent improvement	7(8.9%)	17(21.5%)	10(12.7%)	6(7.6%)	7(8.9%)

	Control panel	Monitor or film viewer	Cabinet of operating essentials	Arrangement of room	Convenience
Very appropriate	0(0.0%)	1(1.3%)	1(1.3%)	0(0.0%)	0(0.0%)
Appropriate	26(32.9%)	38(48.1%)	21(26.6%)	17(21.5%)	18(22.8%)
Better to be improved	47(59.5%)	35(44.3%)	40(50.6%)	44(55.7%)	49(62.0%)
Need urgent improvement	6(7.6%)	5(6.3%)	17(21.5%)	18(22.8%)	12(15.2%)

&lt;Table 11&gt; Comparison of Details of Body Troubles between the Present Study and Newell and Kumar (2004)

Trouble details	Neck		Shoulder		Low back	
	A	B	A	B	A	B
Occurrence in the last 12 months	82%	69%	68%	53%	56%	69%
Chronic troubles (> 1 month)	25%	27%	26%	24%	16%	33%
Work prevented due to troubles (> 8 days)	18%	6%	17%	0%	29%	0%
Sought medical treatment	26%	28%	30%	27%	24%	42%
Recent trouble in the last seven days	43%	56%	44%	33%	29%	58%

Note) A : the present study, B : Newell and Kumar (2004).

As results of analyzing improvement priority of the equipments in dental operating room, those of operating light, arrangement of workplace and conveniences were high showing the percentage sum of respondents ratings with 'better to be improved' and 'urgent' was over 75% (see <Table 10>). Additionally, the demand of urgent improvement for operator stool, cabinet of operating essentials and arrangement of workplace was fairly large showing more than 20%.

#### 4. Discussion and conclusions

Neck trouble was most prevalent among Korean dentists, while the western dentist suffered from low back trouble mostly. Same as the studies of [3] and [11], the present study identified that the neck trouble was most prevalent in Korean dentists followed by the shoulder trouble. However, in most previous western studies, the low back trouble was reported to be more common than the shoulder and neck trouble. This seems to be caused by the difference of height between Korean and western dentists. For example, while the mean heights of Korean male and female dentists were smaller (1.71 and 1.64 m, respectively) than those (1.79 and 1.68

m, respectively) of the participants in [6]. It seems that the taller western dentists bent their low back more in routine dental operation than smaller Korean dentists who used neck more.

Moreover, there was a difference between Korean and western dentists in detailed body troubles. The response rates of all detailed body troubles for the neck and shoulder were larger than those of the low back in the present study (see <Table 11>). In contrast, in the previous study, the response rates of all detailed body troubles for the low back were larger than the other parts. Furthermore, the work prevention rates of Korean dentists were larger than those of western dentists for the three body parts.

Although the shoulder, low back and wrist/hand troubles were related with the physical workload of the corresponding body segments, there was no significant physical workload associated with the neck trouble in the present study. This is because while most dentists (82%) experienced the neck trouble, the physical workload was in large variation.

In particular, Korean female dentists had wrist/hand trouble more than the males, and most of them thought that its causes were related to dental instruments. The wrist/hand trouble of female dentists (70%) was as about twice large

as that of males, and the females selected 'trouble in use of dental instruments' as the causes of related physical workload. They reported that the weight and grip size of dental instruments were not appropriate to them, therefore ergonomic design of the instruments will be necessary for preventing wrist/hand troubles in female dentists.

In addition, a new method to view the patient's mouth should be considered in dental operation to reduce the neck and low back troubles. To keep direct view inside patient's mouth was identified as the most dominant cause related to the awkward neck and low back postures by more than 90% of Korean dentists. In recent alternative methods to view the patient's mouth indirectly were being developed using video camera or prism glasses. They were known to reduce muscle activity and discomfort by requiring less flexions in the neck and low back [9]. The new methods to view the mouth indirectly will be helpful to reduce the body troubles for dentists.

The dental equipment/environment needed to be improved was identified in the present study. Dentists experienced discomfort in using operating light because the light was frequently hid by his/her head and hand or dental instruments. Moreover, they thought that the back and arm rest of operator stool were not designed usefully and had difficulties in finding appropriate hand instrument in their cabinet of operating essentials.

## Acknowledgement

This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology (2012-0003457).

## References

- [1] Alexopoulos, E.C., Stathi, I., and Charizani, F., Prevalence of musculoskeletal disorders in dentists, *BMC Musculoskeletal Disorders*, 2004, Vol. 5.
- [2] Finsen, L., Christensen, H., and Bakke M., Musculoskeletal disorders among dentists and variation in dental work. *Applied Ergonomics*, 1998, Vol. 29, No. 2, p 119-125.
- [3] Joen, M.J., Sakong, J., Lee, J.J., Lee, H.K., and Chung, J.H., Assessment of job related cumulative trauma disorders of dentist in Daegu metropolitan city. *Korean Journal of Occupation Environment Medicine*, 2001, Vol. 13, No. 1, p 55-63.
- [4] Kerosuo, E., Kerosuo, H., and Kanerva, L., Self-reported health complaints among general dental practitioners, orthodontists, and office employees. *Acta Orthodontologica Scandinavica*, 2000, Vol. 58, p 207-212.
- [5] Kuorinka, I., Jonsson, B., Kilbom, A., Vinterberg, H., Biering-Sorensen F., Andersson, G., and Jorgensen, K., Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. *Applied Ergonomics*, 1987, Vol. 18, No. 3, p 233-237.
- [6] Newell, T.M. and Kumar, S., Prevalence of musculoskeletal disorders among orthodontists in Alberta. *International Journal of Industrial Ergonomics*, 2004, Vol. 33, p 99-107.
- [7] Palliser, C.R., Firth, H.M., Feyer, A.M., and Paulin, S.M., Musculoskeletal discomfort and work-related stress in New Zealand dentists. *Work and Stress*, 2005, Vol. 19, No. 4, p 351-359.
- [8] Ratzon, N.Z., Yaros, T., Mizlik, A., and Kanner, T., Musculoskeletal symptoms among dentists in relation to work posture, *Work*, 2000, Vol. 15, No. 3, p 153-158.
- [9] Smith, C.A., Sommerich, C.M., Mirka, G.A., and George, M.C., An investigation of ergonomic interventions in dental hygiene work. *Applied Ergonomics*, 2002, Vol. 33, p 175-184.
- [10] Szymanska, J., Disorders of the musculoskeletal system among dentists from the aspect of ergonomics and prophylaxis. *Ann. Agric. Environ Med*, 2002, Vol. 9, p 169-173.
- [11] You, J.H. and Chung, S.C., A study of the musculoskeletal disorders among dentists. *The Journal of Korean Academy of Craniomandibular Disorders*, 1994, Vol. 6, No. 2, p 103-115.