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Research Report

Correlation between working positions and lactic acid levels with musculoskeletal complaints among dentists

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ABSTRACT

Background: *Musculoskeletal complaints have been common for dentists since their body is unknowingly often in inappropriate positions when caring for patients. For example, they bend towards patients, suddenly move, and then rotate from one side to another. The repetitive movements are done in long term. High activities and sufficient recovery time can cause a buildup of lactic acid in their blood leading to obstruction of the energy intake from the aerobic system in their muscle cells, resulting in fatigue. As a result, such conditions trigger decreased muscle performances.* ***Purpose:*** *This study aimed to determine the correlation between working positions and lactic acid levels with the risk of musculoskeletal disorders among dentists at Public Health Centers in Surabaya.* ***Method:*** *This research was an analytical observational research using cross sectional approach. Sampling technique used in this research was cluster random sampling with nineteen samples. To evaluate the working positions of those samples, a rapid entire body assessment (REBA) method was used. Meanwhile, to observe the musculoskeletal disorders of those samples, a Nordic body map was used. Data obtained then were analyzed using Pearson correlation test with a significance level ($p<0.05$).* ***Result:*** *Results of data analysis using the Pearson correlation test showed that the significance value obtained was 0.036. It indicates that there was a correlation between the working positions and the lactic acid levels with the musculoskeletal disorders in those dentists. The results of the Pearson correlation test also revealed that there was a correlation between the working positions and the lactic acid levels among those dentists with a significance value of 0.025.* ***Conclusion:*** *It may be concluded that the wrong body positions during working can increase lactic acid level in the body of dentists. The increased level of lactic acid then can affect their muscles, leading to the high risk of musculoskeletal disorders.*

Keywords: *lactic acid; musculoskeletal complaints; working positions; REBA; nordic body map*

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INTRODUCTION

Statistically, musculoskeletal disorders have become common for dentists. Hayes *et al*.[1] conducted a review of 95 reports revealing that musculoskeletal risks are experienced by 64-93% of the respondents. Body regions most commonly involved are back (36.3-60.1%), neck (19.8-85%), and hands (60-69.5%).

The prevalence of musculoskeletal disorders in dentists in Saudi Arabia is 82.9%, Australia 87.2%, India 78%, Lithuania 86.5%, and Turkey reached 94%.[2] From these data, it can be said that the prevalences of musculoskeletal disorders are high among dentists in some countries. In Indonesia, the prevalence of musculoskeletal disorders is still unknown since there have been no data on the prevalence of musculoskeletal disorders among dentists in Indonesia, especially in the city of Surabaya. However, based on screening results conducted in Faculty of Dentistry, Universitas Indonesia using Discomfort Body Map and Brief Survey instruments, there are 80% dentists working in clinics suffering from MSD mainly on neck, shoulders, forearms, hands, and back.[2]

One of factors causing musculoskeletal syndrome suffered by dentists is that they care more with the comfort for patients treated, but less attention to their comfort when caring for patients. Dentists consider more on the

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need to move toward their patients rather than to adjust the seating position of their patients on dental chair. Thus, most musculoskeletal disorders occur because their body is unknowingly often in inappropriate positions when caring for patients. When performing a tooth preparation or tooth extraction, for example, sometimes dentists bend towards patients, suddenly move, and then rotate from one side to another. The entire movement is done many times in long term. As a result, it triggers musculoskeletal syndrome.[3]

In general, factors triggering dentists to suffer musculoskeletal syndrome can be categorized into technical factors and non-technical factors. Technical factors are dental unit, work lights, and other equipments that are not ergonomic. Meanwhile, non-technical factors are their working positions when caring for patients as well as their life style.[3] Consequently, dentists have a high risk of musculoskeletal disorders, such as pain or discomfort in their neck, shoulders, wrist, and back.[4]

Strong muscle contractions in the long term, furthermore, can trigger a condition, known as muscle fatigue. Fatigue is the result of inability of both contraction and metabolic processes of muscle fibers to continually supply the same work output. At first, nerves work well, and nerve impulse runs normally through the muscle-nerve correlation moving into muscle fibers, but the contractions are increasingly getting weaker later because of ATP deficiency in the muscle fibers. This condition is caused by barriers in flow of blood to the muscles contracting, then leading to muscle fatigue in one minute or more due to the loss of the nutrient supply.[5]

Thus, feeling tense or tired in the body can be considered as an indication of accumulated lactic acid in the muscles. Lactic acid occurs due to combustion process in the active muscle. During the combustion process, according to Fox *cit*. Sitepu,[6] in addition to energy, lactic acid is also generated as combustion residue. The longer the activity is executed, the smaller the energy is generated and the greater the combustion residue in the form of lactic acid is deposited. The accumulation of lactic acid then can trigger tiredness or fatigue.

Therefore, lactic acid is closely related to the ability of muscles to contract. Unfortunately, body has a number of limitations to tolerate lactic acid, and each individual has a different lactic acid threshold. Lactic acid levels will increase during moving which source of energy is from anaerobic glycolysis system.[7] For these reasons, this research aimed to determine the correlation between working positions and lactic acid levels with musculoskeletal disorders among dentists. As a result, this research can be expected to give several alternative solutions for the problem.

MATERIALS AND METHODS

This research was an analytic observational research using cross sectional approach. Sampling technique used in this research was cluster random sampling with nineteen samples. Criteria used in sampling were a maximum age of 50 years, premenopausal condition, having no menstruation (during the time of blood sampling), a minimum term of 5 years, physically and mentally healthy condition, and willing to be sampled in this research.

Moreover, to assess the working positions of dentists, REBA method was used. Their working positions were assessed by giving a risk score from one to fifteen. The highest score indicated a high level of risk rising in the working positions, while the lowest score assured that the working positions was free of ergonomic hazard. To reveal the musculoskeletal complaints, furthermore, Nordic Body Map questionnaire technique was used. This questionnaire uses images of the human body that has been divided into nine main sections, namely: neck; shoulder; upper back; elbow; lower back; wrist/ hand; waist/ buttocks; knee; heel/ feet.[8] Meanwhile, assessment of this Nordic Body Map questionnaire can be categorized into four categories, namely low with a score of 0-20, middle with a score of 21-41, high with a score of 42-62, and very high with a score of 63-84.[10]

In addition, blood samples were carried out to examine lactic acid levels of those dentists. Their blood was taken in their vein as much as 2cc syringe. After that the blood samples were stored in red blood sample tubes, and then centrifuged in the laboratory to take the serum. Their blood serum was dropped on test strips, and then inserted into accutrend plus instrument to evaluate lactic acid levels.

The working positions of those dentists were evaluated when they were performing tooth filling. Blood samples were conducted after they had finished the treatment. The data obtained then were analyzed using Pearson correlation test with a significance level $(p)<0.05$.

RESULTS

In this research, the working positions of those samples were evaluated using REBA method. Table 1 shows that the highest frequency was found in 11 respondents (57.9%) with a score of 2-3 indicating the first risk level, low risk category. Nevertheless, this indicates that further treatment was necessary. Table 2, moreover, shows the descriptive overview of the mean and standard deviations of the working positions and lactic acid levels using REBA method. The mean and standard deviations of the working positions were 3.16 ± 1.259, while the mean and standard deviations of the lactic acid levels were 3.28 ± 1.853 Mm/ l. In other words, the physical activities of those dentists led to increase lactic acid levels as much as 3.28 mM/ l.

Table 3 shows that of the 19 respondents, there were only low, moderate, and high-risk categories. 11 respondents (57.9%) had low complaint level, 5 respondents (26.3%) had moderate complaint level, and 3 respondents (15.8%) had high complaint level. The mean and standard

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Table 1. Frequency distribution of the working positions among those dentists at some public health centers in Surabaya in 2016

No	Score of Working Positions (REBA)	Risk Levels	Total	Percentage (%)
1	1	0	0	0
2	2-3	1	11	57.9
3	4-7	2	8	42.1
4	8-10	3	0	0
5	11-15	4	0	0
	Total		19	100

Table 2. Mean values of the working positions and the lactic acid levels among those dentists at some public health centers in Surabaya in 2016

	Working positions (REBA)	Lactic acid levels (mM/l)
N	19	19
Mean ± SD	3.16 ± 1.259	3.28 ± 1.853

Table 3. Frequency distribution of the musculoskeletal complaints among those dentists at some public health centers in Surabaya in 2016

No.	Musculoskeletal complaints	Total	Percentage (%)
1	Low	11	57.9
2	Moderate	5	26.3
3	High	3	15.8
	Total	19	100

Table 4. Mean values of the musculoskeletal complaints among those dentists at some public health centers in Surabaya in 2016

	Musculoskeletal complaints (nordic body map)
N	19
Mean ± SD	19.63 ± 15.148

Table 5. Frequency distribution of the location of the musculoskeletal complaints among those dentists at some public health centers in Surabaya in 2016

No	The location of musculoskeletal complaints	Total	Percentage (%)
1	Upper Neck	12	63.2
2	Lower Neck	10	52.6
3	Left Shoulder	11	57.9
4	Right Shoulder	15	78.9
5	Left Upper Arm	11	57.9
6	Back	13	68.4
7	Right Upper Arm	10	52.6
8	Waist	9	47.4
9	Buttock	6	31.6
10	Bottom	1	5.3
11	Left Elbow	2	10.5
12	Right Elbow	1	5.3
13	Left Forearm	3	15.8
14	Right Forearm	5	26.3
15	Left Wrist	4	21.1
16	Right Wrist	9	47.4
17	Left Hand	8	42.1
18	Right Hand	7	36.8
19	Left Thigh	2	10.5
20	Right Thigh	2	10.5
21	Left Knee	4	21.1
22	Right Knee	2	10.5
23	Left Calf	7	36.8
24	Right Calf	6	31.6
25	Left Ankle	4	21.1
26	Right Ankle	5	26.3
27	Left Leg	5	26.3
28	Right Leg	5	26.3

deviations of musculoskeletal complaints using Nordic Body Map method amounted to 19.63 ± 15.148 as seen in Table 4.

Based on Table 5, the highest frequency of the musculoskeletal disorders was found on the right shoulder (78.9%), followed with on the back (68.4%) and on the upper neck (63.2%). This indicates that the majority of those dentists performed posterior maxillary tooth fillings with the wrong position, resulting in pain on the shoulder area, back, and neck.

In addition, based on Tables 6, 7 and 8, results of the Pearson correlation test showed that there was a significant correlation between the working positions and the lactic acid levels with the musculoskeletal complaints with a significance value of 0036. Similarly, there was also a significant correlation between the working positions and the lactic acid levels with a significance value of 0.025. Each of the correlation coefficients showed positive values. It means that the correlation between the working position,

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Table 6. Correlation between the working positions and the musculoskeletal complaints in those dentists at some public health centers in Surabaya in 2016

Independent variable	Dependent variable	P	R
Working positions (REBA)	nordic body map	0.036	0.484

Table 7. Correlation between the lactic acid levels and the musculoskeletal complaints in those dentists at some public health centers in Surabaya in 2016

Independent variable	Dependent variable	P	R
Lactic acid levels	nordic body map	0.036	0.484

Table 8. Correlation between the lactic acid levels and the working positions in those dentists at some public health centers in Surabaya in 2016

Independent variable	Dependent variable	p	R
Working positions (REBA)	Lactic acid levels	0.025	0.513

the lactic acid levels, and the musculoskeletal complaints was directly proportional. In other words, the working positions might trigger an increase in the lactic acid levels. The higher the lactic acid levels are, the greater the levels of the musculoskeletal disorder risk are.

DISCUSSION

Based on results of the Pearson correlation test, there was a significant correlation between the working positions and the musculoskeletal complaints with a significance value of 0.036. Musculoskeletal disorders in those dentists in this research were mostly found on right shoulder, back, and upper neck. This indicates that during caring for their patients the majority of those dentists took standing and bending positions in a long time repeatedly with the neck position likely to come forward.

Dentists are generally characterized by their static and rigid posture in taking care of their patients. That their patients are treated at top of the dental chair makes them sit, stand or bend for a long time. As results, these positions make them experience pain or discomfort on neck area, shoulder, and spine, leading to musculoskeletal disorders, such as low back pain.[7]

Human body, actually can tolerate with standing position in one posture only for 20 minutes. If more than this limit, tissue elasticity will slowly be reduced, and eventually muscle pressure increases as well as discomfort is felt in the hip area. If the back muscles receive static loads when standing for a long time, it can lead to complaints of damage to the joint, ligaments, and tendons. Complaints to the damages are usually known as musculoskeletal complaints or injuries on the musculoskeletal system.[11]

Dentists during their working often perform a variety of extreme static postures, such as lowered head, bow, lean over, raised hands, and elevated shoulder. The extreme postures, consequently, trigger muscle fatigue and mechanical pain in the neck, shoulder, and lower back.[12]

During working, the need for blood circulation, can increase ten to twenty times. The increased blood circulation in the muscles during working then can force the heart to pump more blood. Standing for long time can make muscles tend to work static. Static muscular work is characterized by long muscle contractions, usually corresponding to the posture of the body. However, the static muscle contractions in the long term are not recommended since they will cause pain. One of the causes of back pain is sitting or standing for long time or having similar motion performed continuously, resulting in muscle stiffness (spasms).[11]

Sitting posture during working, actually requires less energy than standing since this position reduces the amount of static load on leg muscles.[13] However, the wrong sitting posture will lead to several problems, such as back pain, neck pain, and waist pain since pressure on the back of the spine will increase in the sitting posture than in standing or lying down position. Tense sitting posture even requires more muscle or spinal cord activities. Thus, the sitting posture can affect the performance of a worker.

All the activities and movements of the human body actually require contraction of muscles, including respiration processes involving the muscles of inspiration and expiration to contract and relax on an ongoing basis. The process of muscle contraction requires muscle energy sources that are available in the body's metabolism, namely ATP formation, breaking down muscle glycogen into glucose. In aerobic metabolism, this process also requires O_2. This energy-making process is necessary to maintain the quality of contraction and the force of muscle contraction continuously. Nevertheless, this process also generates metabolic wastes. The accumulation of metabolic wastes, such as lactic acid, can trigger fatigue and muscle glycogen reduction. The increased CO_2 during the process also leads to an inability of the muscle to maintain the same work output or a decrease in the muscular endurance.[14]

Muscles get their energy from aerobic and anaerobic metabolisms in the form of adenosine triphosphate (ATP). If the muscle contraction continuously occurs, the need for ATP will not be met only through the aerobic metabolism, as a result, the anaerobic metabolism will become a viable alternative to meet the body's needs. However, the anaerobic metabolism can give disadvantages. For instance, the anaerobic metabolism can generate lactic acid, triggering pain and fatigue sensations.[15]

In addition, lactic acid in the blood is always derived from anaerobic metabolism in erythrocytes.[7] Nevertheless, the total amount of lactic acid in the body is relatively fixed.

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In a healthy person having a rest, the amount of lactic acid is about 1-2 mM/ l or 1-1.8 mM/ l. Therefore, the blood lactic acid level that exceeds 6 mM/ l, according to Jansen can interfere with the working muscle cells, leading to disorientation of the muscle movement coordination. In this research, the mean level of lactic acid in the nineteen respondents was 3.28±1.853 mM/l with the highest mean level of 7.3 mM/ l and the lowest mean level of 0.2 mM/ l.

Tolerance limit to the level of lactic acid concentration in the muscles and blood during physical exercise actually still has not been known. Nevertheless, the tolerance limit to the level of lactic acid in humans is estimated at above 20 mM/ l blood or 25 mM/ kg/ wet muscle weight, and even can reach above 30 mM/ l in the dynamic exercise with high intensity.[7]

Consequently, the lactic acid will lower the pH in the muscles and blood. The decreased pH will inhibit the glycolytic enzyme, and then will interfere with chemical reactions in the muscle cells. This condition, as a result, will lead to weak muscle contraction, and ultimately will make the muscles fatigue.[7] It may be concluded that the wrong body positions during working can increase lactic acid level in the body of dentists. The increased level of lactic acid then can affect their muscles, leading to the high risk of musculoskeletal disorders.

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