

# Physical Activity Intensity, Total Modes, and Neck Muscle Stiffness

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**ABSTRAK** Kekakuan otot leher merupakan gejala nyeri leher yang paling sering ditemukan. Pengaruh aktivitas fisik terhadap kekakuan otot leher masih menunjukkan hasil yang beragam. Saat ini, bekerja dari rumah akibat pandemi COVID-19 telah mengubah aktivitas fisik sehari-hari setiap orang, termasuk mahasiswa kedokteran. Penelitian ini bertujuan untuk mengetahui hubungan antara intensitas aktivitas fisik dengan total mode aktivitas dan frekuensi kejadian kekakuan otot leher. Penelitian ini merupakan penelitian observasional dengan desain penelitian cross sectional. Pengambilan sampel secara acak sederhana digunakan dalam penelitian ini. Pengumpulan data menggunakan EPIC-PAQ2 yang dimodifikasi. Data dihitung dan dikonversi ke MET-jam/minggu dan unit untuk menilai intensitas aktivitas fisik dan mode total. Intensitas aktivitas fisik dan total mode aktivitas tidak menunjukkan hubungan yang bermakna secara statistik dengan frekuensi kekakuan otot leher pada mahasiswa kedokteran praklinik Fakultas Kedokteran Universitas Sumatera Utara. Parameter jenis kelamin menunjukkan hubungan yang signifikan. Kategori laki-laki menunjukkan rasio ganjil 0,358 (OR = 0,358, 95% CI) untuk mengembangkan lebih sering kekakuan otot leher. Studi yang lebih akurat harus dilakukan untuk menyesuaikan faktor perancu pada kejadian kekakuan otot leher.

**Kata Kunci:** aktivitas, intensitas, kekakuan, leher, mode.

**ABSTRACT** Neck muscle stiffness is the most common finding of neck pain. The effect of physical activity on neck muscle stiffness is still showing various results. Currently, working from home as the result of COVID-19 pandemic had changed the daily physical activity of each person, including medical students. This study aims to determine the relationship between physical activity intensity along with total modes of activity and frequency of neck muscle stiffness events. This is an observational study with cross-sectional study design. Simple randomized sampling was used in this study. Data collection utilized modified EPIC-PAQ2. Data calculated and converted to MET-hour/week and units to assess physical activity intensity and total modes. Physical activity intensity and total modes of activities showed no statistically significant relationship with the frequency of neck muscle stiffness in preclinical medical students in Faculty of Medicine, University of Sumatera Utara. Sex parameter showed significant relationship. Male category showed odd ratio of 0.358 (OR = 0.358, 95% CI) for developing more frequent neck muscle stiffness. More accurate studies have to be conducted to adjust confounding factors on the incidence of neck muscle stiffness.

**Keywords:** activity, intensity, mode, neck, stiffness.

## PENDAHULUAN

Neck pain, whether due to traumatic events or non-traumatic events, is the leading cause of disability in the world (1). Globally, the annual prevalence of neck pain stands at 30%. Most patients with neck pain recover without any medical intervention. However, 50% of neck pain patients reported still having neck pain of different degrees (2). Neck pain due to work in certain professions is more common to be found than knee pain or back pain (3).

Neck muscle stiffness is an essential indicator which shows shock absorption in the muscle-tendon unit and joints. Increase in muscle stiffness limits joints movement and control. Neck muscle stiffness, in this case, reduction in cervical range of motion, is one of the most common findings in neck pain. The cervical range of motion reduction degree might relate to subjectively assessed level of pain. (4)

The effect of physical activity in the incidence of neck pain is still giving various results (5). Sports and vigorous physical activity is giving beneficial effect on neck and lower back pain. Jensen and Harms-Ringdahl stated that muscle strength and fitness exercises were found to be effective in reducing prevalence of neck and back pain (6). In a more modern, present era, modern living conditions increase the tendency of someone developing sedentary lifestyle (7). A study by Hanna et al found that sedentary lifestyle related significantly in lower or upper back pain patients. The mentioned study showed that participants with sedentary lifestyle developed more risk of having back pain as much as 1,74 times than normal population (8).

In the past 2 years, COVID-19 pandemic has caused a big portion of general public to work from home. An article posted on The Back Letter by Lippincott in August, 2020 stated that less ergonomic working places at home has led to more frequent neck pain events (9). In March, 2021, a study by Aegerter et al found a 0.68 point

reduction on neck pain intensity during lockdown in 69 study participants from 2 organizations in Switzerland. Results may differ if studies are conducted on different working sectors. However, from the conducted studies, we can assume that studies on the relationship between physical activity and neck pain may change, considering activity changes before and after pandemic (10).

In students, neck muscle pain and stiffness possess socioeconomic impact on individuals. Weleslasiie citing a study by Rose in 2000 found that neck muscle stiffness be the main reason medical students taking sick leave. Neck muscle stiffness reduced students' attendance on lectures and increased truancy. These might affect the further career of students (11).

According to the initial survey conducted for this study on the study population, 75% of the 32 randomly selected students in the population admitted experiencing at least 1 neck muscle stiffness event in the past 12 months. Moreover, 15.6% admitted 6 to 9 neck muscle stiffness events. Those numbers are much larger than global prevalence. This showed that neck muscle stiffness is a frequent event among preclinical medical students in University of Sumatera Utara. Neck muscle stiffness discloses underlying health and ergonomic related problems. Hence, a study on neck muscle stiffness is essential to overcome one of the underlying problems of the events, namely physical activity.

## METODE

In this study, we used cross-sectional study design. Cross-sectional study is one of many study designs used in observational study. In this study design, we only collected data at a certain range of time. In cross-sectional study, any intervention which may influence or interfere with the outcome of the study is not to be given. (12). This study was held online by spreading questionnaire through social media. This was done recalling the ongoing COVID-19 pandemic. Data collection was done in July to September 2021.

The population of this study included all preclinical medical students in Faculty of Medicine, University of Sumatera Utara. This included students of 2018, 2019, and 2020 admissions.

Simple randomized sampling was used to determine participants from whom data would be collected. By this means, we expected all students among the population had the same probability of being participant in this study.

Several exclusion criteria were applied in this study. Exclusion criteria were as follows: 1) Students who was amputated, paralyzed, or having mental illness in the past 12 months. 2) Students who suffer from congenital disorder which causes him/her unable to contract his/her neck muscles perfectly (e.g. Klippel-Feil syndrome, congenital torticollis). 3) Students who underwent surgery on the neck and head region in the past 6 months before the onset of neck muscle stiffness. 4) Students who suffer from inflammatory disorder in the neck region in the past 12 months. 5) Students who experience neck muscle stiffness due to traumatic events or accident (traffic or sports) in the past 12 months. 6) Students who need human or non-human aid to walk.

This study utilized the Slovin formula to calculate sample size needed to represent the population. Until this script was made, the study population stood at 760 students. With expected margin of error at 5%, the sample size is determined as follows:

$$n = \frac{N}{1 + Ne^2} = \frac{760}{1 + (760 \times 0,05^2)} = \frac{760}{1 + 1,9} = \frac{760}{2,9} = 262,069 \approx 262$$

## Questionnaire

To assess physical activity, we utilized modified EPIC-PAQ2 (EPAQ2) to suit the study population, medical students in specific. Units used for physical activity intensity variable and total modes of physical activity are MET-hour/week and units consecutively. Validity and reliability testing of modified EPAQ2 had been done on 30 respondents, and was found valid and reliable (Alpha Cronbach = 0,482). To assess neck muscle stiffness, we utilized simple neck muscle stiffness questionnaire. This questionnaire assessed the frequency of neck muscle stiffness events in the past 12 months. This questionnaire was found valid and reliable (Alpha Cronbach = 0,876).

Obtained data were analyzed using Statistical Packages for the Social Sciences (SPSS). All obtained data were converted to their corresponding units. Conversion to physical activity intensity variable refers to MET standardization by Compendium of Physical Activity 2011. Ordered logistic regression was used in this study. This test was chosen due to its ability to assess relationship between several categorical or continuous independent variables and an ordinal dependent variable. PLUM procedure was chosen for this study.

## HASIL PENELITIAN DAN PEMBAHASAN

270 students responded to our questionnaire. 7 respondents were excluded from the research, meeting one of the six exclusion criteria, with criterion 5, having experienced neck muscle stiffness due to trauma or accident in the past 12 months, as the most prevalent.

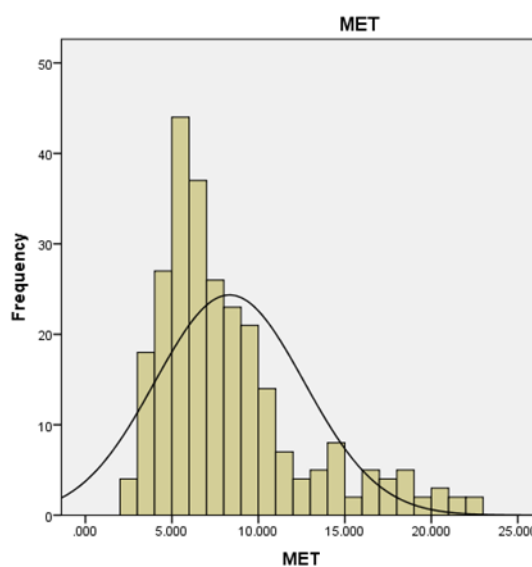
Of all participants, 79 were males, and the rest, 184 were females. All participants were medical students of University of Sumatera Utara, coming from different age groups and year, of which no classifications were made. The proportion of participants experiencing neck muscle stiffness over the past 12 months had been 50.6%, with 20.3% of the number were males, and the remaining 79.7% were females. This number is much higher compared to the previous study by Paracha et al in Sargodha Faculty of Medicine, (13) and also exceeds global annual prevalence showed by another study which stands at 30% (2). But it is important to note that this study result is less than of the initial survey conducted.

The expanding number of respondents must be taken into account, which resembled more of the population than the initial survey. Of 133 participants reported having experienced neck muscle stiffness, 32 admitted experiencing stiffness once, 79 admitted 2 to 5 stiffness events, 15 admitted 6 to 9 stiffness events, and 7 admitted 10 to 12 stiffness events, all in the past 12 months. MET-hour/week values were obtained from each participant. The mean value

of MET-hour/week found in this research stands at 8.33 MET-hour/week. This value meets WHO recommendation on minimum daily activity intensity at 7.5 MET-hour/week (14). To be noted that MET-hour/week assessed in this research was based on the activities done in the past 12 months, when online learning has been implemented in the university. Total modes of activities were also assessed in this research. We found that our

participants did up to 17 of activities on average, out of 45 activities assessed in the questionnaire, in the past 12 months. The median value of this parameter is at 16 activities.

**Figure 1.** Histogram of Physical Activity Intensity



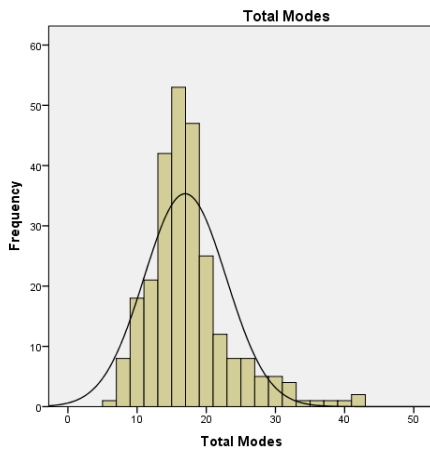
**Table 1.** MET-hour/week Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation
MET	263	20.331	2.596	22.928	8.33001	4.308718
Valid N	263					

**Table 2.** Total Modes Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation
<b>Total mode</b>	<b>263</b>	<b>36</b>	<b>6</b>	<b>42</b>	<b>16.94</b>	<b>5.939</b>
<b>Valid N</b>	<b>263</b>					

**Figure 2.** Histogram of Total Modes of Activity



Running the PLUM procedure for ordered logistic regression analysis, it was shown that physical activity intensity (shown in MET-hour/week) and total mode of activities (shown in unit) have no significant correlation with the frequency of neck muscle stiffness experienced by our research participants. The p-value shown for physical activity intensity is at 0.467, and 0.296 for total mode of activities. These results are in accordance to previous study by Sitthipornvorakul et al in 2011, stating that the effect of physical activity on the incidence of neck muscle pain is still giving various results (5).

**Table 3.** Sex x Stiffness Frequency Cross tabulation

		Stiffness Frequency					Total
		0	1x	2-5x	6-9x	10-12x	
Sex	Male	52	10	13	3	1	79
	Female	78	22	66	12	6	184
Total		130	32	79	15	7	263

From our results, we also serendipitously found that sex parameter, instead, is giving a significant contribution to the incidence of neck muscle stiffness. P-value for sex parameter is seen lower than 0.05. As shown by the parameter estimates, we interpreted that male participants has odd ratio of 0.358 for developing more frequent neck muscle stiffness events than the female counterpart. In plain, males are less prone to experiencing neck muscle stiffness events than females (OR = 0.358, 95% CI). Further research

common. One explanation on this finding would be blamed on the proportion of time used by medical students to remain seated, for example during lectures sessions and doing work, is more than human in general population. This reason correspondences with a study by Colicchia in 2005, stating that sustaining a seating position with

Additional flexed posture will increase the risk of developing neck pain, (15) which in turn will also cause neck muscle.

**Table 4.** Parameter Estimates

		Sig.	95% Confidence Interval		Exp. B
			Lower Bound	Upper Bound	
Threshold	[Frequency = 0]	.746	-0.889	.637	.881
	[Frequency = 1]	.308	-.367	1.162	1.488
	[Frequency = 2]	.000	1.532	3.220	10.760
	[Frequency = 3]	.000	2.544	4.628	36.081
Location	MET	.467	-.077	.036	.979
	Total modes	.296	-.019	.064	1.022
	[Sex =1]	.000	-1.568	-.484	.358
	[Sex =2]	.	.	.	1.000

Frequency order are stated as follows : 0 = no events; 1 = 1 event; 2 = 2 to 5 events; 3 = 6 to 9 events

Sex categories are stated as follows: 1 = male; 2 = female



In our study of 263 medical students, neck muscle pain seemed to happen more in medical students than the global population in common. One explanation on this finding would be blamed on the proportion of time used by medical students to remain seated, for example during lectures sessions and doing work, is more than human in general population. This reason correspondences with a study by Colicchia in 2005, stating that sustaining a seating position with

Additional flexed posture will increase the risk of developing neck pain, (15) which in turn will also cause neck muscle stiffness. In complementing our study, we also asked if any event had occurred prior to the events of stiffness. We found that 13 respondents reported possible event which had preceded stiffness events. 10 of the respondents admitted having sustained an awkward position prior to stiffness, most results from wrong sleeping position. Lee and Ko in 2017 have found that several sleeping positions may increase the activities of trapezius muscle and scalene muscle of the neck (16). Sleeping positions might be a confounding factor in the current study. The other event which was reported to have preceded stiffness events is sudden movement, such as in doing sports activity without warming-up. This is supported by etiologies of neck strain proposed by Sofianos (17). Of the etiologies proposed in 2017, are collision and fall, and performing new activity. The event which had preceded stiffness events. 10 of the respondents admitted having sustained an awkward position prior to stiffness, most results from wrong sleeping position. Lee and Ko in 2017 have found that several sleeping positions may increase the activities of trapezius muscle and scalene muscle of the neck (16). Sleeping positions might be a confounding factor in the current study. The other event which was reported to have preceded stiffness events is sudden movement, such as in doing sports activity without warming-up. This is supported by etiologies of neck strain proposed by Sofianos (17). Of the etiologies proposed in 2017, are collision and fall, and performing new activity. The concept is that collision and fall gives sudden impact to move the muscles too quickly. Performing a new activity also has similar course. By putting the muscle in sudden movements, they are more susceptible to strain. This process is analogous to what happened in people who started doing sports activity without warming-up session.

Two important findings of our study are as follows: 1) Physical activity intensity and total modes of activities have no statistically significant influence on the frequency of neck

muscle stiffness. 2) Males are significantly having lower odd ratio of developing neck muscle stiffness than females. The latter finding is in line with previous study, (18) which also found that females claimed to experience more chronic neck pain than males. Inevitably, the range of motion for neck muscle will be reduced which in cascading turn might cause neck muscle stiffness.

It is noteworthy that this study was carried out during the COVID-19 pandemic. Due to the pandemic, movements had been limited and so had physical activities. We formerly predicted a lower MET-hour/week value than WHO recommendation to be found in the study. Surprisingly, our study showed a slightly higher value than WHO recommendation. Even so, it is important to note that there was a wide range of MET-hour/week values among the respondents. The lowest MET-hour/week was recorded 2.60 and the highest at 22.93. The idea that there is no decrease in activity levels during the pandemic thus cannot be eliminated.

The same condition need to also be considered for total modes of activities. Though we see that the average activities done by respondents were at 16 to 17 activities, we should note that this number ranged from 6 to 42 activities per person. Thus, it is not wise to assume the general population to have done more or less activities during the pandemic. We are unable to state a decline in total modes of activities done during the pandemic since we have no data of total modes of activities before the pandemic.

There are several limitations in this study. First, we were unable to assess physical activities duration for recreational activities. This limitation occurred due to the fact that the online platform we utilized does not support additional fill-in column beside multiple choices columns. We recommend a direct on-the-spot questionnaire filling for upcoming studies utilizing similar forms to accurately obtain data. Second, sleeping might need to be considered as an important confounding factor in studying neck muscle stiffness. In our study, we calculated that sleep gives 1 MET as recommended by the compendium of physical activity as resting metabolic rate (19). While physiologically, sleeping tends to be the activity with the least muscle activity. Adjustment may be needed.

## SIMPULAN

Physical activity intensity and total modes of activities have shown no statistically significant relationship with the frequency of

neck muscle stiffness in preclinical medical students in Faculty of Medicine, University of Sumatera Utara. Further studies are needed to verify the relationship between sexes and neck muscle stiffness. Directly observed interview is a more recommended method of data collection. The author declares that there is no conflict of interest in the writing of the manuscript.

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