Musculoskeletal Disorders: Associated Risk Factors of the Laptop Usage Among Engineering Students in the University of Santo Tomas

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Abstract

Musculoskeletal Disorders (MSDs) significantly contribute to the disease burden in Asia, thus lead to reduced productivity, quality of life, finances, and work participation. In the Philippines, MSDs were among the leading ten causes of years lived with disability (YLDs). Research studies have identified a high prevalence of MSDs associated with laptops in an academic setting. In the Philippines, the acquisition of laptops linearly increases with a rate of 1.87 yearly. The study aims to statistically analyze personal, nonoccupational, physical, and psychological risk factors that may lead to MSDs, specifically on the neck, shoulders, upper back, elbows, and hands/wrists. This research study developed predictive models for five body regions to help anticipate and prevent MSDs. The regression analysis revealed that the duration of laptop use, height, and years of laptop usage of college students were statistically significant in one or more of the five body regions. Furthermore, gender was significant for the upper back and hands/wrists region, where female gender was 3.01 and 2.69 times more likely to develop MSD. The results of this study can contribute to Engineering students in order to anticipate the likelihood of MSDs and increase productivity of students.

Keywords
Musculoskeletal Disorder (MSD), Laptop, College Student, Predictive Model, Binary Logistic Regression.

1. Introduction

Musculoskeletal Disorders (MSDs) contribute substantially to the disease burden in Asia (Lim et al. 2016), thus significantly impacting concerned individuals regarding reduced productivity, quality of life, finances, and work participation. Emerson and Finch (2020) defined MSDs as an injury-causing state that specifically targets the body's musculoskeletal system which includes bones, muscles and ligaments, tendons, discs, nerves, and blood vessels. In the Global Burden of Diseases, Injuries, and Risk Factors Study (2016), the prevalence in thousands of MSDs was 1,270,630, the incidence in thousands of MSDs was 652,005, and years lived with disability (YLDs) in thousands was 137,832. In addition, the study revealed that MSDs were more prevalent at ages over ten years in the female group than in the male group. This was primarily because of the differences in psychological and biological mechanisms of the male and female gender (Sirajudeen et al. 2018). In the Philippines, Musculoskeletal Disorders (MSDs) were among the leading ten causes of YLDs.

In connection, several studies reported that the high prevalence of MSDs was associated with laptop devices in an academic setting. Arshad et al. (2020) stated that there is a high prevalence of upper extremities musculoskeletal discomfort among university students. In a related study in Saudi Arabia, the prevalence of MSDs in any body region among college students was 52.7% (77 out of 146) (Sirajudeen et al. 2018). Woo et al. (2016) discussed that college students' average weekly computer use was almost the same as professional workers, precisely 33.7 and 35.2 hours, respectively. Although prolonged sedentary activities (i.e., non-upright activities, TV viewing, and computer or laptop

use) were defined as low levels of energy expenditure (Tremblay et al. 2017), MSDs were the most prevalent health problem among individuals who sit for an extended time (Maakip et al. 2016). Moreover, Anwer et al. (2021) stated that the upper extremities of the body are prone to MSD. In the Philippines, laptop penetration linearly increases through the years, with a rate of 1.87 per year since 2015 (Euromonitor 2021). Moreover, the use of laptops and other handheld devices to access the internet was directly proportional to the years, with a rate of increase of 0.49 per year (Euromonitor 2021). The increase in the acquisition of laptops was predominantly due to its practicality and portability. Laptops were commonly used in work, education, personal multimedia (Gautam and Chacko 2017). Relative to the use of the laptop was the increase in access to the internet to utilize the functionality of laptops. It was recorded in 2019 that Global Internet users spent three (3) hours and twenty-eight (28) minutes surfing the internet with the use of laptop and tablet computers (Dixon 2019). Lim et al. (2016) stated that the prevalence of MSDs was common in Urban Cities where rapid industrial growth happens. In connection, Wiitavaara et al. (2017) determined that the Urban Primary Health Care Centers (PHCs) had higher MSD cases based on the three-year analysis.

For this reason, the study aims to statistically analyze personal, nonoccupational, physical, and psychological risk factors that may lead to MSDs, specifically on the neck, shoulders, upper back, elbows, and hands/wrists. In line with this, the study aims to achieve the following (1) to determine the prevalence of MSD in five body regions associated with laptop use, (2) to determine the regressor variables associated with the use of laptops that may contribute to MSD, and (3) to develop statistical models to predict the likelihood of developing MSD among Engineering students in the University of Santo Tomas, Philippines.

2. Literature Review

Exposure to risk factors that refers to environmental, behavioral, or biological attributes or experiences increases the probability of disorders and decreases the likelihood upon removal. In addition, exposure to risk factors can trigger symptoms of a condition but is not solely responsible for developing the specific condition (Emerson and Finch 2020). In relation, exposure to risk factors (i.e., physical, personal, nonoccupational, and occupational) considers the duration of task performance, frequency of exposure, exposure to environmental temperature, and work methods. Furthermore, exposure to specific tasks or activities that combine high repetition with high force requires increased rest time between exertions. The direct relationship between repetition and force exertion may lead to injuries; thus, a rest schedule is vital for soft tissue recovery and the prevention of MSDs. One of the nonoccupational risk factors enumerated by Emerson and Finch (2020) was the use of handheld devices, specifically laptops. Laptops are widely used in the academic or university setting by college students. The laptop's portability caused individuals to use the device away from the designated workstation, thus increasing ergonomic risks (James et al. 2018).

Yu et al. (2018) stated that the most common activities performed while using a laptop were typing and editing, specifically when conducting email, browsing, and searching for pieces of information. In the same study by James et al. (2018), the workload in an academic setting was high resulting in prolonged sitting while using the device, and it limits the variation in working postures. As a result, static posture causes a decrease in oxygen to the muscle, leading to muscle fatigue (Emerson and Finch 2020). In comparison, a research study conducted by Bubric and Hedge (2016) among college students presented 53.8% (100 out of 186) of the respondents experienced musculoskeletal discomfort while using their laptops. The sustained posture causes the prevalence of musculoskeletal pain, hence restricting the user's body movements. The study's risk factors consist of frequency and duration of computer use with a limited rest schedule. Furthermore, high repetition and force exertion during typing tasks contributed to awkward postures and static muscle contraction. In relation, respondents were observed to execute downward head tilt, neck flexion, and wrist extension while using their laptops. Regarding the prevalence of MSD in gender, specifically in the neck region, females had a higher percentage (42.7%) than males (28.9%). It was found that females have a smaller skeletal system and a shorter reach distance than their counterparts. As a result, females frequently adopt awkward postures while using a laptop. This was similar to the study conducted by Sirajudeen et al. (2018), where the female gender has a higher prevalence rate of MSDs of the neck, upper back, lower back, and ankle/feet regions.

3. Research Methodology

3.1 Research Design

The study followed a conceptual framework, as seen in Figure 1, which gave structure to the research study. A total of sixteen (16) risk factors were considered in the study, which is categorized into personal (i.e., gender, age, years of education, height, weight, and smoking), nonoccupational (i.e., physical activities and workstation configuration), physical (i.e., duration, frequency, scheduled/rest break, years of laptop usage, and temperature), and psychological

(i.e., awareness of and perception towards MSDs management and Ergonomics) risk factors. These risk factors or regressor variables were based on existing studies and the book chapter of Emerson and Finch (2020). Furthermore, habitual posture was classified as an extraneous variable due to the limitation of the study. The researchers could not conduct anthropometric and postural assessments because of the COVID-19 pandemic. Although posture was not included in the output, it was used to analyze the results. In definition, posture in this study referred to the habitual position the respondents adopt while using the laptop device. The study includes six (6) common postures adopted by college students particularly supported sitting, forward sitting, slumped sitting, supine, side-lying/lateral recumbent, and lying (Woo et al. 2016).

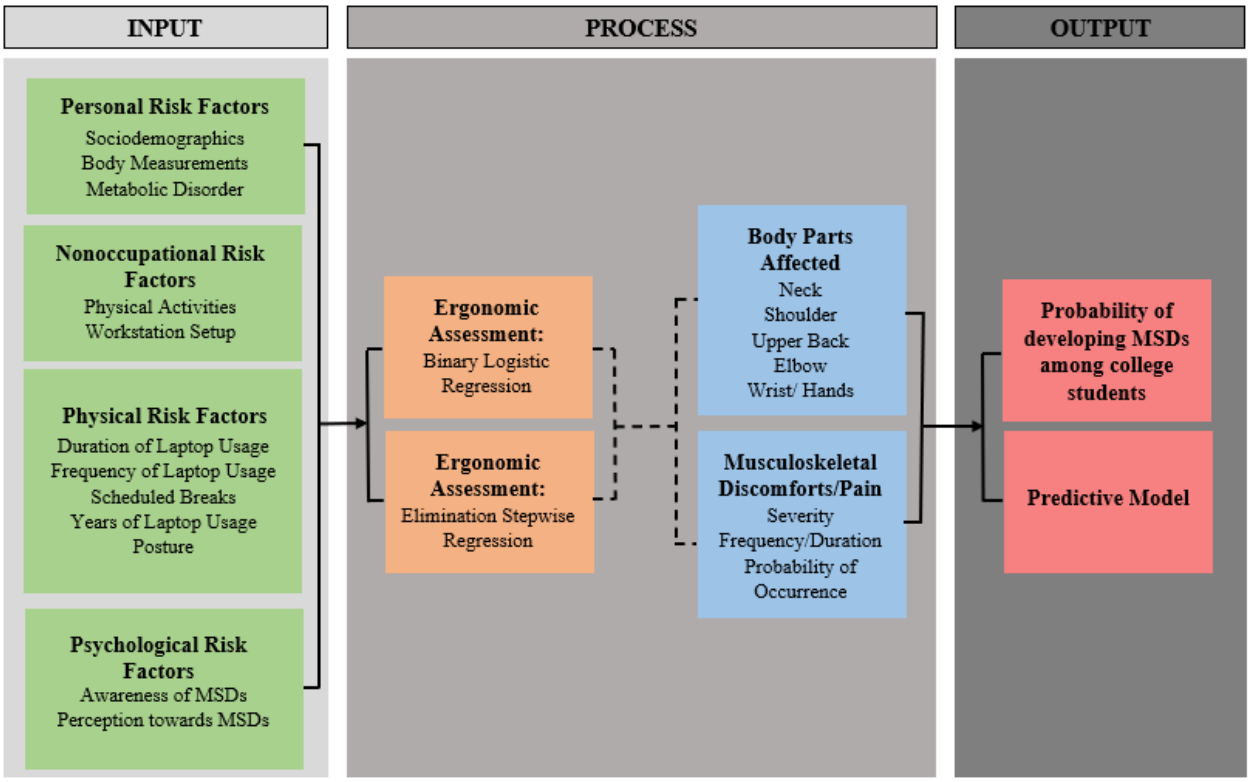

Figure 1. Conceptual Framework

For the body regions, the researchers provided a body map to standardize the location of each body part, as seen in Figure 2. The body map used was adapted from the study conducted by Hossain et al. (2018) among readymade garment workers in Bangladesh, which is being used for several years in Ergonomic assessments. Moreover, the body regions are comprised of the neck, shoulders, upper back, elbows, and wrists/hands. The body map was utilized to gather data for the severity of pain, the likelihood of occurrence of pain, and exposure to ergonomic hazards or risk factors.

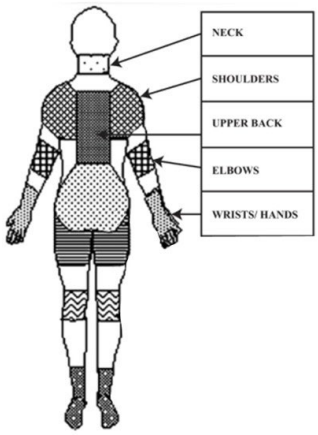

Figure 2: Body Map (Hossain et al. 2018)

3.2 Subject and Study Site

There was a high prevalence of MSDs among college students and in urban cities where rapid industrial growth happens. Furthermore, in the Philippines, there is an increase in the acquisition and usage of laptops among young adults. In the Philippines, the National Capital Region (NCR) is the industrial, economic, political, and educational center due to its urbanized state (National Nutrition Council 2020). Based on Commission on Higher Education (CHED) (2020), in terms of the number of enrollees for higher education by program level and institution type as of the academic year 2019 – 2020, the private institution has the highest number of students enrolled in Baccalaureate with a total of 1, 660, 628. Engineering and Technology is one of the top five most populated programs among the discipline group in higher education. In addition, NCR has the highest number of enrolled students in different institutions with total enrollees of 662,688 for the academic year 2019 – 2020. Of these, 440,708 enrollees belong to private institutions. With this, the study focused on students pursuing a bachelor's degree in Engineering at the University of Santo Tomas (UST). Moreover, chronic systemic illness, recent fractures or surgeries, and pregnancy for the past 12 months were excluded from the study (Sirajudeen et al. 2018).

As for the sample size, the researchers used statistical software, specifically GPower Statistical Power Analysis version 3.1.9.7. The study used a priori power analysis to determine the minimum required number of respondents. Based on the calculation, a minimum of 70 respondents from the Faculty of Engineering at UST were recruited to participate in the study.

3.3 Data Measure and Instrumentation

Self-administered web-based questionnaires were disseminated to gather data and assess significant regressor variables to predict the likelihood of developing MSD. Moreover, for the screener questionnaire, Standardized Nordic Questionnaire (Kuorinka et al. 1987) was adapted that has been used for decades to determine the prevalence of musculoskeletal pain in different body regions (Hossain et al. 2018). In this study, regressor variables consisted of continuous and categorical variables. Continuous variables and categorical variables were presented as mean and percentage, respectively. Meanwhile, the MSD risk index was calculated per body region for the response variable. The study followed MSD risk scoring on the Risk Assessment: A Practical Guide to Assessing Operational Risks by Popov and Hollcroft (2016). Furthermore, Kroemer's guidelines were used to distinguish MSD from Non-MSD (Sasikumar and Binoosh 2018). Pain or discomfort in the body region that subsided overnight or during rest is classified as Non-MSD, and the MSD risk index would be zero (0). Meanwhile, pain that does not subside overnight or during rest is classified as MSD, and the MSD Risk Index would be calculated based on Equation 1. The categorization would result in a binary response variable. Moreover, the study would construct predictive models for five (5) body regions through Binary Logistic Regression and Backward Stepwise Regression. The statistical software used for the regression analysis was IBM Statistical Package for Social Sciences (SPSS) Version 24.

$$MSD\ Risk\ Index\ =\ severity\ \times probability\ \times exposure \qquad (1)$$

3.4 Data Gathering and Procedure

The study consisted of five (5) phases, as seen in Figure 3, the data gathering procedure starts with the deployment of self-administered web-based questionnaires to Engineering college students at UST and ends with the development of predictive models per body region through binary logistic and backward stepwise regression analysis.

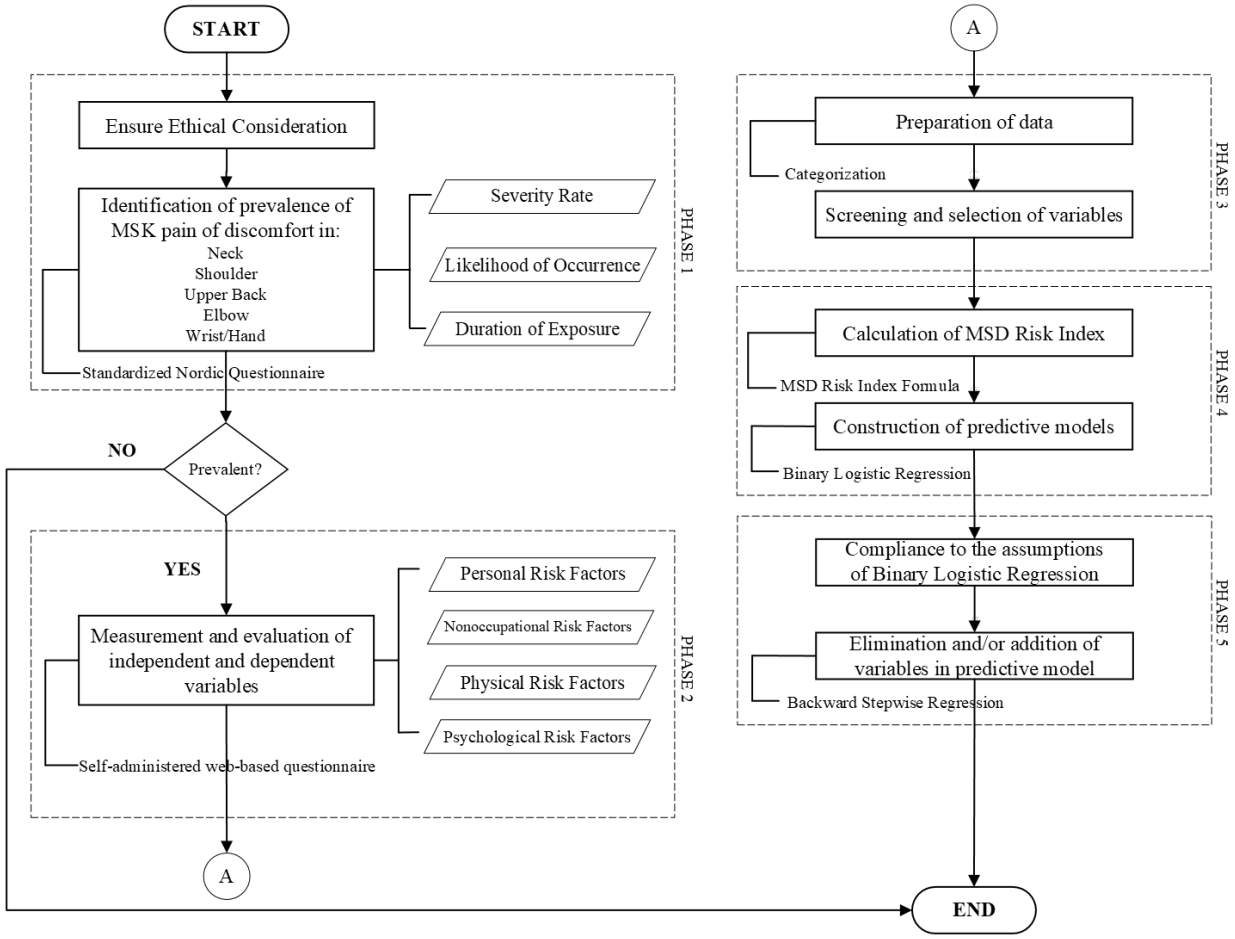

Figure 3. Phases of Data Gathering Procedure

4. Results and Discussion

4.1 Prevalence of Musculoskeletal Disorder (MSD)

645 Engineering students participated in the study conducted from July to September 2021. Table 1 presents the summary of the demographics of the study population for model development. The categorization process revealed 90.39% (583 out of 645) had trouble for the past twelve (12) months in any of the five (5) body regions (i.e., neck, shoulder, upper back, and hands/wrists). Based on Figure 4, the highest prevalence of discomfort in any of the five (5) body regions was neck (79.59%, 464 out of 583), followed by upper back (66.72%, 389 out of 583), shoulder (55.40%, 323 out of 583), hands/wrists (48.03%, 280 out of 583), and elbow (12.35%, 72 out of 583). Figure 5 presents the prevalence of students categorized as MSD. The pattern of MSDs among college students showed that the highest prevalence was upper back (28.04%), followed by shoulders (24.66%), neck (23.99%), hands/wrists (15.88%), and elbow (7.43%).

4.2 Identification of risk factors and development of the predictive models

Table 2 presents the summary of significant predictor variables per body region in this study. Binary logistic regression analysis revealed that the duration of use of laptops of college students was statistically significant in four of the body regions (i.e., neck, shoulder, upper back, and elbow region). First, for neck region, height ($p = 0.015$, OR = 0.966,

95%CI [0.939,0.993]), duration of use of a laptop device (p = 0.044, OR = 1.085, 95%CI [1.002, 1.175]), and years of laptop usage (p = 0.004, OR = 0.877, 95%CI [0.802, 0.960]). Second, for shoulder region, height (p = 0.011, OR = 0.964, 95%CI [0.936, 0.992]), and duration of use of a laptop device (p = 0.047, OR = 1.802, 95%CI [1.001, 1.170]). Third, for upper back region, gender (p = 0.000, OR = 0.332, 95%CI [0.197, 0.560]), and duration of use of a laptop device (p = 0.013, OR = 1.104, 95%CI [1.021, 1.195]) were the regressor variables that significantly predicts the likelihood of developing MSD. In addition, female gender was 3.01 times more likely to develop MSD compared to male gender. The odds support the prevalence of female respondents (68.67%, 57 out of 83) experiencing pain that did not subside overnight or during rest. Fourth, for elbow region, height (p = 0.015, OR = 0.921, 95%CI [0.862, 0.984]), and the duration of use of laptop (p = 0.013, OR = 1.398, 95%CI [1.073, 1.821]). Fifth, for hands/wrists, gender (p = 0.004, OR = 0.372, 95%CI [0.192, 0.723]), and years of laptop usage (p = 0.008, OR = 0.853, 95%CI [0.759, 0.960]) were the regressor variables that significantly predicts the likelihood of developing MSD. Moreover, female gender was 2.69 times more likely to develop MSD compared to male gender. The odds support the prevalence of female respondents (63.83%, 30 out of 47) experiencing pain that did not subside overnight or during rest.

Table 1. Demographics of the study population for model development

	Neck		Shoulder		Upper Back		Elbow		Hands/Wrists	
Category	Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Gender										
Male	264	56.9	164	50.8	202	51.9	37	51.4	153	54.6
Female	200	43.1	159	49.2	187	48.1	35	48.6	127	45.4
Age (years)										
18-19	216	46.5	160	49.5	192	49.3	39	54.2	143	51.1
20-21	221	47.6	147	45.5	176	45.3	31	43.1	121	43.2
22-23	27	5.8	16	4.9	21	5.4	2	2.8	16	5.7
Smoker	5	1.1	2	0.6	6	1.5	1	1.4	2	0.7
Non-smoker	459	98.9	321	99.4	383	98.5	71	98.6	278	99.3
Classification										
Non-MSD	393	84.7	250	77.4	306	78.7	50	69.4	233	83.2
MSD	71	15.3	73	22.6	83	21.3	22	30.6	47	16.8

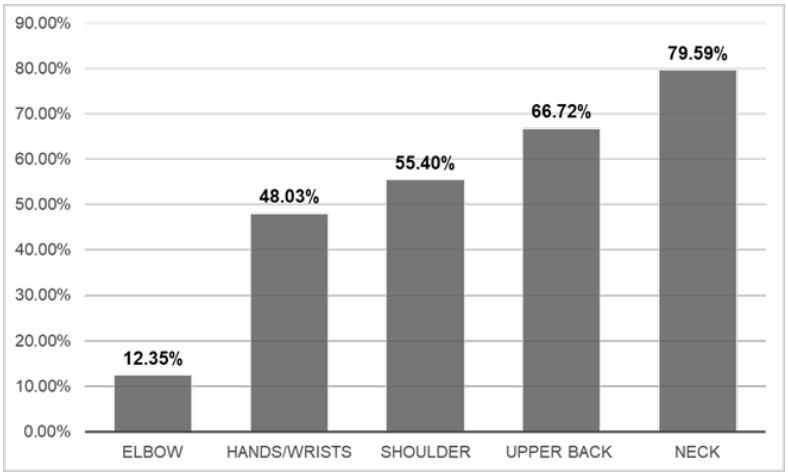

Figure 4. Prevalence of pain in any of the five (5) body regions for the past twelve (12) months

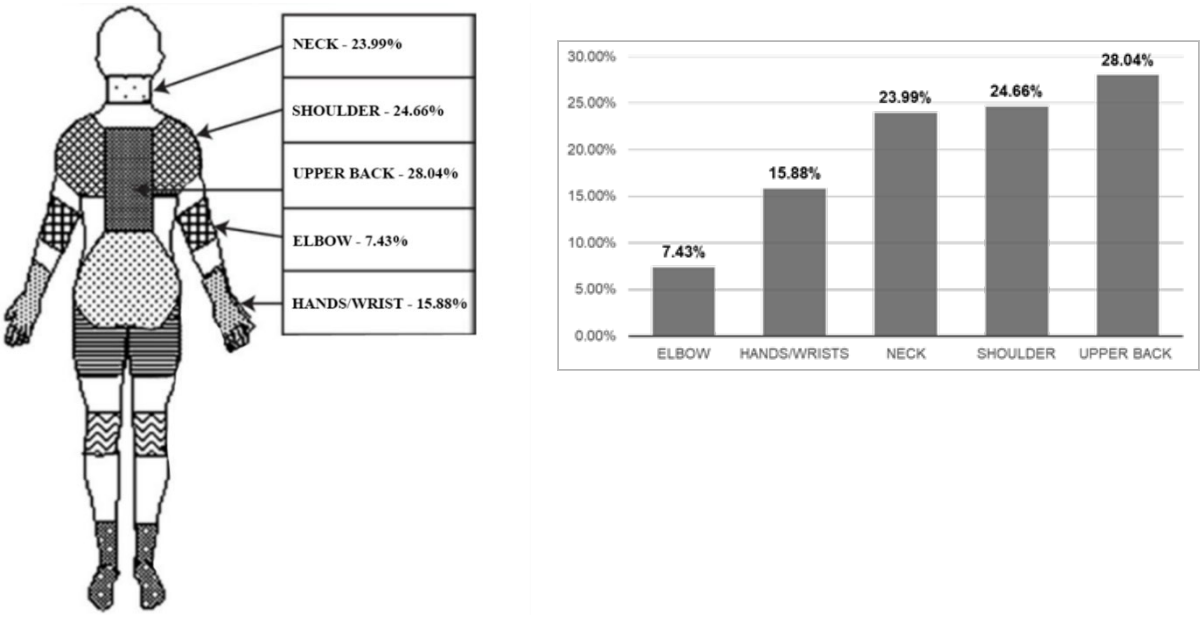

Figure 5. Prevalence of MSD in each of the five (5) body regions for the past twelve (12) months

Table 2. Binary logistic regression analysis of musculoskeletal disorders by personal, nonoccupational, physical, and psychological risk factors among engineering college students

								95% C.I. for EXP(B)	
	Predictor	B	S.E	Wald	df	Sig.	Exp(B)	Lower	Upper
Neck	Height	-0.035	0.014	5.889	1	0.015	0.966	0.939	0.993
	Duration of use	0.082	0.041	4.064	1	0.044	1.085	1.002	1.175
	Years of Laptop Usage	-0.131	0.046	8.092	1	0.004	0.877	0.802	0.960
Shoulder	Height	-0.037	0.015	6.456	1	0.011	0.964	0.936	0.992
	Duration of use	0.079	0.040	3.932	1	0.047	1.082	1.001	1.170
Upper Back	Gender (1)	-1.103	0.267	17.095	1	0.000	0.332	0.197	0.560
	Duration of use	0.099	0.040	6.160	1	0.013	1.104	1.021	1.195
Elbow	Height	-0.082	0.034	5.868	1	0.015	0.921	0.862	0.984
	Duration of Use	0.335	0.135	6.174	1	0.013	1.398	1.073	1.821
Hands/Wrists	Gender (1)	-0.988	0.339	8.507	1	0.004	0.372	0.192	0.723
	Years of Laptop Usage	-0.158	0.060	6.940	1	0.008	0.853	0.759	0.960
*$p < 0.05$.									
Note: B = coefficient of constant; CI = Confidence Interval; Exp(B) = Odds Ratio									

The prevalence and likelihood of developing MSD were caused by the combination of physical risk factors specifically the duration of use, years of laptop usage, awkward and static posture. In this study, college students' average hours spent per day was 11.45. James et al. (2018) stated that the workload in the academic setting was high, resulting in more extended use of laptops. As a result, prolonged sedentary activity limits the variation in working postures.

Furthermore, as seen in Figure 6, 69.47% (405 out of 583) of college students adopt forward sitting, which decreases oxygen in the muscle; thus, leading to muscle fatigue (Emerson and Finch 2020). In relation to this, working or studying in the same position for an extended period increases the risk of developing MSD (Anwer et al. 2021). James et al. (2016) indicated that people who adopt forward sitting while using a laptop were more likely to experience upper extremities pain.

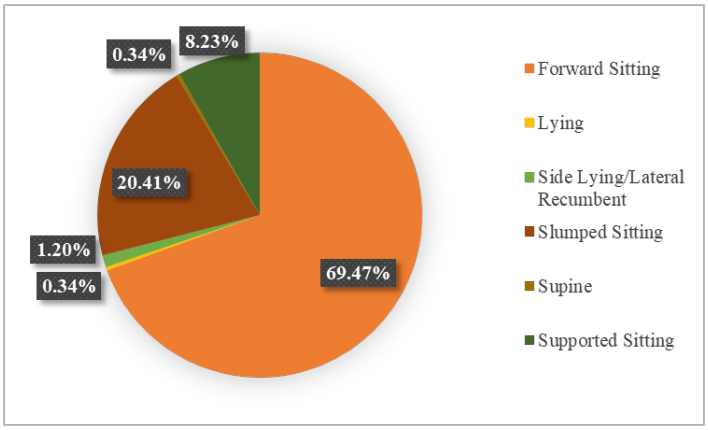

Figure 6. Posture adopted while using a laptop device

In addition, personal risk factors, particularly height and gender, contributed to the prevalence and likelihood of developing MSD among college students. In this study, for the upper back and hands/wrists region, female gender was 3.01 and 2.69 times more likely to develop MSD than male gender. Studies conducted by Sirajudeen et al. (2018) and Bubric and Hedge (2016) explained that the female gender was more likely to develop MSD due to the differences in psychological and biological mechanisms of the male and female gender. The female gender has a shorter reach distance, thus more likely to adopt awkward and sustained posture.

4.3 Validation of Predictive Models

The validation of the predictive models for each body region was conducted through Microsoft Excel. Table 3 summarizes the validated models that the researchers developed based on the data analysis. Given the regressor variables, the mean of significant variables per body region was substituted in the predictive model to demonstrate and show the likelihood of developing MSD.

Table 3. Summary of predictive models with p-hat calculation

Body Region	Predictive Model		
Neck	$\hat{p} = \frac{e^{(3.782-0.035x_{height}+0.082x_{duration}-0.131x_{years\ of\ usage})}}{1+e^{(3.782-0.035x_{height}+0.082x_{duration}-0.131x_{years\ of\ usage})}}$		
	Numerator	0.1523	
	Denominator	1.1523	
	p-hat	**0.1322**	**13.22%**
Shoulder	$\hat{p} = \frac{e^{(3.908-0.037x_{height}+0.079x_{duration})}}{1+e^{(3.908-0.037x_{height}+0.079x_{duration})}}$		
	Numerator	0.2821	
	Denominator	1.2821	
	p-hat	**0.2199**	**22.00%**
Upper Back	$\hat{p} = \frac{e^{(-1.553-1.103x_{gender}+0.099x_{duration})}}{1+e^{(-1.553-1.103x_{gender}+0.099x_{duration})}}$		
	Numerator	0.6659	
	Denominator	1.6659	

	p-hat	**0.3997**	**39.97%**
Elbow	$\hat{p} = \frac{e^{(25.586-0.082x_{height}+0.335x_{duration})}}{1+e^{(25.586-0.082x_{height}+0.335x_{duration})}}$		
	Numerator	8284593.539	
	Denominator	8284594.539	
	p-hat	**0.9999**	**100%**
Hands/ Wrists	$\hat{p} = \frac{e^{(-0.258-0.988x_{gender}-0.158x_{years\ of\ usage})}}{1+e^{(-0.258-0.988x_{gender}-0.158x_{years\ of\ usage})}}$		
	Numerator	0.2999	
	Denominator	1.2999	
	p-hat	**0.2307**	**23.07%**

4.4 Additional Merits of Implementing the Predictive Models

The proponents of the study developed a predictive model that shows the significant factors that may affect college students, specifically Musculoskeletal Disorders, as they use their laptops in their daily lives. The use of the predictive model can contribute to the minimization of the likelihood of MSDs among the students, increasing well-being and productivity in the long run. Among all factors studied by the proponents, the duration of laptop usage is the most common in all body regions, leading to sustained postures and muscle fatigue. Intervention for this is the minimization of the time spent by college students while they use their laptops. The appropriate workstation of college students is vital to avoid MSDs and support the body regions properly. Hence using ergonomically correct devices such as chairs, table, keyboard, and mouse are encouraged for each college student. Furthermore, document holders and proper workspace are highly recommended for females having shorter reach distances. The normal and maximum working space in the horizontal plane for women is 15.8 and 24.3 inches, respectively (Niebel and Freivalds 2014). In connection, there can be barriers in preventing MSDs among college students (Yazdani and Wells 2018). First is students' insufficient time, workload, and schedule that may hinder them in implementing ergonomic strategies in their daily activities. According to the study results, the average duration of laptop usage among students is 11.45 hours a day, which can also contribute to students' resistance to changes in work practices. Second is the lack of students' MSDs and ergonomic awareness, leading to potential MSDs. Third is the lack of resources such as budget and mindset since having ergonomically current workstations requires purchasing several ergonomic equipments as mentioned before. Lastly, process deficiency when it comes to the lack of goal setting, planning, controlling, organizing with the implementation of ergonomic-related activities.

5. Conclusion

Six hundred forty-five (645) respondents from the Faculty of Engineering at the University of Santo Tomas participated in the study conducted from July to September 2021. The categorization processes revealed 90.39% (583 out of 645) had trouble for the past 12 months in any of the five (5) body regions. Of the 583 respondents, 50.77% (296 out of 583) experienced musculoskeletal pain in any five body regions and were considered MSD. 23.99% in the neck, 24.66% in the shoulder, 28.04% in the upper back, 7.43% in the elbow, and 15.88% in the hand/wrist region. The researchers found that the duration of use of laptops was significant in the four body regions, specifically, neck, shoulder, upper back, and elbow, wherein the more prolonged usage of laptops, the more likely it would result in MSD. It was also found that height was a significant variable in the likelihood of MSD for the neck, shoulder, and elbow region, wherein the taller the height of an individual, the more likely it would not result in MSD. Years of laptop usage was also a significant factor for the neck and hands/wrist region. For every additional year of using a laptop, the odds of developing MSD decreases. Lastly, gender was significant for the upper back and hands/wrists region, where the female gender was 3.01 and 2.69 times more likely to develop MSD than the male gender, respectively. Furthermore, it is notable that the prevalence in the female gender for upper back and hands/wrists were 68.67% (57 out of 83) and 63.83% (30 out of 47), respectively. As mentioned, this was because of the biological mechanism of the female gender. The female gender has a smaller skeletal system; thus, they have a shorter reach distance. In addition, 69.47% (405 out of 583) of the college students adopt forward sitting that may contribute to muscle fatigue. As mentioned, the duration of use of the laptop was significant in four body regions. Research studies have stated that prolonged static posture while using a laptop device increases the likelihood of developing MSD. It is recommended to adopt a stand and stretch break for five (5) minutes after forty (40) minutes of sedentary activities such as laptop use for an extended period (Ding et al. 2020).

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Nestor R. Ong is a full-time faculty member and is presently the Deputy Director of the University of Santo Tomas' Office of QS/THE Rankings. Previously, he served as Assistant Director of the University of Santo Tomas, Quality Management Office, chair of the IE Department and dean of the College of Engineering of Lyceum of the Philippines-Laguna, and as senior manager of INTEL Philippines. He is a Professional Industrial Engineer and ASEAN Engineer and was the very first to join the ASEAN Engineer registry in 2012 from the UST Faculty of Engineering. Engr. Ong is currently the only Filipino sitting as a member of the International Academic Advisory Committee of Quacquerelli-Symonds (QS) since 2015. Simultaneously, he has been chosen as the chair of the parallel sessions committee under the different tracks in every QS International Conference and Exhibit annual events. Presently, he is appointed as the sole Filipino by the AppliedHE Rankings Advisory Board (RAB). With his strong background in various key areas of

expertise, he is the prime mover in the successful ISO Certification of UST. Moreover, Engr. Ong crafted a framework of the UST's EQMS (Educational Quality Management System) for excellence which became his research paper as accepted in two international conferences in the same year entitled, "An Integrated Framework: Unifying Diverse Perspectives in EQMS" and turned out in reality when UST earned the distinction of being the first and only university in the Philippines with the four-star rating in QS Stars Rating awarded in 2015 and 2017.