A CROSS-SECTIONAL STUDY ON THE MUSCULOSKELETAL DISCOMFORT AND LIMITATIONS AMONG LEFT-HANDED STUDENTS FROM THE FACULTY OF MEDICAL SCIENCE IN A PRIVATE UNIVERSITY, MALAYSIA.

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ABSTRACT

***Introduction**: The majority of workplaces and educational institutes have normalized to accommodate right-handers. This situation leads to left-handers needing to adapt and adjust to the right-hander's world causing inconvenience and bodily discomfort.*

***Objective**: The study aims to identify the limitations of musculoskeletal discomfort, compare the limitations, and determine the association between the limitations and musculoskeletal pain experienced by left-handed students as opposed to right-handed students. **Methods**: A cross-sectional study among 175 students participated with an educational level of year 3 and above was performed using the adaptation of a self-administered questionnaire. The questionnaire contains 3 separate sections; Edinburgh Handedness Inventory Questionnaire, Multiple Choice Questionnaire and Cornell Musculoskeletal Discomfort Questionnaire. Mann Whitney U test was selected to determine the limitations and musculoskeletal discomfort experienced by the left-handed students in comparison to the right-handers. The Chi-square test was applied to determine if an association exists between the limitations faced by the respondents and the musculoskeletal discomfort experienced. SPSS version 21 was applied to tabulate the data.*

***Results**: Left-handed students had higher limitation score and statistically higher discomfort score compared to right-handed students ($U < 0.0001$; p-value $< \alpha$). The Chi-Square test showed a significant association present between the limitation and the musculoskeletal discomfort experienced by the students (116.820^a; p-value $< \alpha$).*

***Discussion**: Findings concludes that left-handed students experienced greater limitations and*

a higher probability of developing musculoskeletal disorder compared to right-handed students.

***Conclusion**: Educational institutions should recognize this minority group with regards to material and equipment available for left-handers as well as modifications to be made in order to orient them to improve their performance with minimal discomfort in relation to their difficulties due to their handedness.*

***Keywords:** Left-handed; Limitations; Musculoskeletal discomfort; Students*

Introduction

Laterality expresses the dissymmetry in the roles carried out by the human brain hemispheres (Silva et al, 2012). During the stages of birth and infancy, the hemispheres of the brain function equally. However, between the ages of 5 and 6 years of age, the dominance of one side of the brain progresses as a result of neurological maturation (Steyer, V.E., 2010). Approximately 90% of the human populace comprises right-handed individuals whereas the remaining 10% of the populace are left-handed individuals (De Kovel, 2019). Similarly, this probability might as well be applied in educational institutions whereby the majority of students would be right-handed and the minority among the student populace would be left-handed students (Kapoor et al., 2016). In addition, it is important to keep in mind that most products in the market are created and manufactured for right-handers by the right-handers. This includes items ranging from household tools to learning equipment in educational institutions and even office tools and machines (Flatt, 2008; Kapoor et al., 2016). Therefore, left-handers are often at a loss when they are required to learn as quickly as possible and adapt as much as possible to the use of the equipment and tools that are designed for right-handers which would result in affecting their performance and occasionally may have safety implications in question (Syed Mohamed et. al, 2019).

A previous study on ergonomic perspectives revealed that injuries were reported from both right-handed and left-handed students when using right-biased tools and equipment. However, the prevalence rate of injuries among left-handed students was significantly higher compared to the right-handed students with a percentage of 20% among the left-handed students and 7% among the right-handed students (Tezel et al., 2005; Arora and Saiya, 2019). In the field of medical science, the requirements of hand skills among medical science students are key aspects of acquiring these professions (S. Al- Johany, 2013). Manual dexterity is defined as the capability of acquiring a combination of skill sets that are accurate and pace

with fine integration of hand, arm and finger movement (Ozcan et al., 2004). However, learning facilities design is mainly catered to right-handed students, whereas the left-handed students who are the minority of the populace are required to adapt and learn to function with their non-dominant side. This adaptation can result in poor performance and skills with an increased rate of discomfort among the left-handed students as opposed to the similar tasks given to the right-handed students (Yarid et. al., 2009).

Although there are many technologies designed and catered for left-handers in this advanced era, they are however not provided for left-handed students during the course of their education due to the fact that accessibility requirements are not taken into consideration (Gomes et al., 2001). This study emphasizes bridging the gap of knowledge by researching further into the experiences faced by left-handed students from medical sciences departments and the effects faced by these students in comparison to right-handers regarding their limitations, difficulties and health effects while performing in a right-handed setup as well as the suitable recommendations that can ergonomically accommodate their individual differences.

Methodology

Study design and population

The cross-sectional study design was carried out among 175 year 3 onwards students from the Department of Dental and Biomedical Science, Faculty of Medical Sciences in one of the private universities of Malaysia due to their high manual dexterity application throughout their academic curriculum. The study data were collected from March 2020 until August 2020.

Research Sampling

An adapted questionnaire was used to serve as an assessment tool in the English language. The questionnaire is divided into three sections**.** The first section is the application of the Edinburgh Handedness Inventory Questionnaire (Oldfield, 1971) using the modified version of the Edinburgh Handedness Inventory Questionnaire (Cohen, 2008) to identify the handedness of the students in a systematic manner. It consists of 10 items listed on hand preference when carrying out a daily task and adds 5 items that are not categorised as standard inventory but are applied on a daily basis. Each questionnaire was calculated by subtracting the right-handed preferences from the left-handed preferences. This is followed by dividing the answer obtained from the total number of items listed and then multiplying by 100 as

stated in the formula [(R-L/R+L) 100]. The scores that indicate the values of -100 to -40 are categorised as left-handed while the value -40 to 40 are ambidextrous and 40 to 100 are categorised as right-handed. This method is used to identify the prevalence of left-handedness in the dental and biomedical faculty of this institution.

The second section aims to collect the socio-demographic details of the students. It comprised questions regarding students' age, gender and level of study adapted from other studies (Adusumilli et al., (2004); Silva MA et al., (2012); Mukhtar Amal Ali et al., (2018); Al-Johany, (2013))**.** A total of 20 questions were prepared with a "yes" or "no" options for the respondents to select as their answers. However, the questions were modified in a manner whereby the "yes" answer options are all limiting factors to the left-handed respondents. The purpose of this tweak was to ease the tabulation process of the data. However, the modification of the answer options remained confidential to prevent biased answers, manipulated data, or partiality of any kind among the respondents. The objective obtained from applying this section of the survey is to identify and determine whether an association existed between the laterality of the students and their limitations and difficulties experienced throughout their practical work. The questionnaire consists of questions that are in relation to the learning facilities design, ergonomic designs, provision of ergonomic instruments as well as the duration taken to complete a specific task.

The third section assesses the musculoskeletal discomfort pain among students using the Cornell Musculoskeletal Discomfort Questionnaire measurement tool to determine if the students are at risk of developing musculoskeletal disorders in relation to their handedness in their respective academic curricula. The first stage assesses the frequency of discomfort, followed by the next stage which is the intensity of discomfort and the final stage determines the impact on the 12 organs of the body (neck, shoulders, upper back, upper arms, lower back, forearms, wrists, hips, thighs, knees, lower back, and leg) in a self-report form. The scores were analysed by summing the rating values for each individual. The rating scores are as follows, Frequency scores in order (0, 1.5, 3.5, 5, 10), discomfort scores in order (1, 2, 2), and interference scores in order (1, 2, 3). The scores were then summed to obtain the discomfort score for individual participants. Once the summed total discomfort score was obtained for each respondent, the data was then analysed to determine if musculoskeletal pain and discomfort exist among the students depending on the variable which is their laterality.

Statistical analysis

Data were categorized and analysed with Statistical Package for Social Sciences (SPSS) for Windows, version 21. (IBM Corporation, USA) with statistical significance accepted at a p-value less than 0.05. Descriptive analysis was used to describe the socio-demographic characteristics of the sample. Mann-Whitney U test was applied to compare the limitations among left-handed and right-handed from both departments. A Chi-square test was used to determine if an association exists between the limitations faced by students and the musculoskeletal discomfort experienced.

Results and Discussion

Sociodemographic Characteristics of the Students

Table 1 reports that out of 175 students, the majority of them were from the Faculty of Dentistry 115 (65.7%) while only 60 (34.3%) students were from the Faculty of Biomedical Science. 90 (51.4%) of the students were female and 85 (48.6%) were male in this study. Many 160 (91.4%) of the students were right-handed while only 15 (8.6%) of them were left-handed. The selection of students in clinical years as compared to non-clinical years was reported to experience higher pain prevalence when carrying practical skills and routine procedures (Rising et al., 2005).

Prevalence and Pattern of Handedness

The pattern of handedness was based on the Edinburgh Handedness Scores. Among 115 (65.7%) students from the Faculty of Dentistry, the majority 64 (55.7%) of the students were male and 51 (44.3%) were female. The results indicate that a total of 104 (90.4%) were right-handed domain by 59 (51.3%) male students whereas only 11 (9.6%) students were left-handed domain by 6 (5.2%) female students. While among 60 (34.3%) students from the Faculty of Biomedical Science, the majority 39 (65.0%) of the students were female and 21 (35.0%) were male. The results indicate that a total of 56 (93.3%) were right-handed domain by 36 (60%) female students. While only 3 (5%) of female students were left-handed.

Table 1: Sociodemographic Characteristics of Students (n = 175)

Characteristic	n	%
Department		
Dentistry	115	65.7
Biomedical Science	60	34.3
Gender		
Female	90	51.4
Male	85	48.6
Handedness		
Right	160	91.4
Left	15	8.6

Data are presented as frequencies and percentages, n (%).

Discomfort and Limitation Score in Relation to Laterality

Mann Whitney U test was applied to analyse the variables in relation to the handedness of the respondents (left-handed and right-handed) and the discomfort and limitation scores in order to obtain the ranks as in Table 2. The left-handed group of students had the highest discomfort score compared to right-handed students. There are significant differences ($U< 0.0001$, $p< 0.0001$) between the musculoskeletal pain and body experienced by left-handed students in comparison to right-handed students. Analysis of the musculoskeletal discomfort from the discomfort scores marked by the respondents using the Cornell Musculoskeletal Disorder Questionnaire was carried out to seek the significant difference in musculoskeletal pain and body discomfort experienced by left-handed students in comparison to right-handed students. The results obtained are rather consistent with a similar study conducted by Silva et. al (2016) which shows that a higher percentage of left-handed dental students experienced musculoskeletal pain compared to the right-handed students.

The study also emphasizes the fact that these students who have declared bodily discomfort did not experience musculoskeletal pain prior to enrolling for the course. Similarly, a study done by Mukhtad et al. (2018) affirms that although a total of 6% of their study population comprises left-handed medical laboratory technicians, a majority of them were prone to develop work-related repetitive motion injuries as most of the technicians are designed to cater to the convenience of right-handed people. The development of musculoskeletal pain and bodily discomfort could stem from a number of reasons. For instance, the results of this study could suggest that left-handed students lack guidance and personalised teaching in left-handed methods or applications in their respective curriculums. Thereby, the left-handed students are left to adapt to the skills and procedures independently.

This form of self-taught adaptation can likely contribute to the development of bodily discomfort and musculoskeletal pain. This very finding supports a previous study conducted by Al-Johanny (2013) that emphasized the learning environment which plays a role in the experiences and difficulties faced by left-handed students.

Based on Table 2, the limitation score among the left-handed group was statistically significantly higher as compared to the right-handed group. Therefore, there is a significant difference in the mean of limitations among left-handed and right-handed students from the medical sciences department ($U< 0.0001$, $p< 0.0001$). As for the difficulties faced by the left-handed students in comparison to the right-handers, this study identified the limitations that may exist by a multiple-choice questionnaire in which the respondents were given to answer. The questions comprised several areas that may or may not be a contributing factor to their performance, perceived difficulties and limitations in relation to a specific variable which is their laterality. These results corroborate a similar study conducted by Kaya and Orbak (2004) who states that one of the many main factors that determine an effective treatment when it comes to dental problems is the positioning adopted by the professional. However, the majority of dental schools are yet to have dental chairs specifically designed for left-handed students. Another study by Canakci et al., (2004) observed that left-handed has a lesser successful rate in subgingival scaling compared to their left-handed colleagues when using a right-sided chair. However, when provided with a chair designed and adapted specifically for left-handers, the performance among the left-handed students when removing biofilm and calculus was seen to improve significantly (Kaya and Orbak, 2004). A study done by Santiago et al. (2017) suggests that immediate modifications to the laboratory designs such as ergonomic laboratory tables and computer workstations can lead to reduced stress among the laboratory technicians. Additionally, the study emphasized the use of pipetting tasks that requires thumb force as well as repetitive hand movements, elbow abduction, and awkward wrist and hand postures which are risk factors that play a role in increased stress on the lumbar spine and the entire body.

Therefore, left-handers who are required to carry out these activities while operating with their non-dominant side will experience increased difficulties and limitations compared to right-handers. Based on the findings and supporting studies, the provision of left-handed tools and equipment may significantly improve the performance among left-handed students. Although there are certain studies that may suggest providing a student with a comfortable left-handed learning environment may not prepare them for the right-handed procedures and work environment in most dental practices (Nasir et al., 2019). These studies should not be

made a reason to not provide this minority group of students with the convenience of left-handed tools, equipment, chairs and stations.

Table 2: Discomfort and Limitation Score in Relation to Laterality among Students

Variables	Handedness		Mann-Whitney U	P-value
	Right (n=160)	Left (n=15)		
	Mean Rank	Mean Rank		
Discomfort	80.50	168.00	0.000	**<0.0001****
Limitation	80.50	168.00	0.000	**<0.0001****

**Nonparametric (Mann-Whitney test)

Association between Limitations and Musculoskeletal Discomfort Experienced by Students

In order to determine if an association exists between the limitations faced by the students and the musculoskeletal discomfort experienced, the Chi-Square test ($X^2 = 116.82$, $p<0.0001$) was applied to test this theory. The current study showed that the findings concluded that there were evidential limitations and difficulties faced by left-handed students which in return have led to the development of musculoskeletal pain and discomfort. However, the study proceeds with determining if an association exists between the limitation faced and the musculoskeletal pain among these students in relation to their laterality.

The results conclude that there is a perfect association between these two variables with the Cramer's V value of 1.00. This finding suggests that the greater the difficulties and limitations faced by the left-handed respondents, the greater the probability of them developing musculoskeletal disorders over time. However, it is safe to say that the learning facilities' design impact on this minority group of students can be averted with proper measures taken. The findings may suggest that students of the minority group find it difficult to handle equipment designed for right-handers to perform certain required tasks or procedures. Therefore, they resort to adapting to the non-ergonomic handling of these instruments by manipulating and applying uneven force or grip to the handle or the instruments given (Kaya and Orbak, 2004; Silva et. al, 2016). This, however, reduced their effectiveness and efficiency in performing required procedures due to their reduced manual dexterity. Some students may even resort to positioning their body and hands in an awkward posture or in a non-ergonomic state which could associate these students with the development of musculoskeletal disorders over time. Puriene et al., (2008) depicted that work-related

musculoskeletal disorder occurs among practitioners that apply excessive force on muscular groups in a repeated motion, isolated force on a specific area for a prolonged period of time as well as insufficient recovery time. Therefore, aligning with another study by Sultane et. al., (2017) found two-thirds of left-handed dental students were affected by pain in the lumbar and cervical area and a progressively worsening condition among the slow adapting left-handers.

CONCLUSION

This study was conducted in an attempt to bring to light the challenges faced by left-handed students in the medical profession. Learning difficulties are more apparent among left-handers as opposed to right-handers which can be commonly observed in a simple learning task such as writing whereby the left-handed students resort to unnatural means and ways to write in order to avoid smudging of ink, placing additional force on the pen instead of pulling as they write, frequently lifting their hands to see their written work. During the timed task, these issues can be time-consuming and tedious and can result in these students not being able to complete their work within the given time. When a simple task such as writing can pose a challenge among left-handed students, it is safe to say that clinical and lab practices can weigh twice as heavily on left-handers. The adjustments in left-handers constantly have to make in order to complete given tasks in time can cause bodily pains and discomfort mainly because of the additional strain on their body as well as the awkward postures that they tend to resort to. Universities should provide a learning environment that accommodates both right-handed and left-handed students. This includes the availability of tools and equipment suitable for both left-handed and right-handed students, provision of left-sided and right-sided chairs, adjustable work tables, modifications of learning or work techniques to best fit students based on their hand preference, and left-handed instructors or mentors to provide practical assistance to students who are left-handed and requires additional assistance.

Besides that, when given a timed task, left-handed students should be given additional time to acclimatize themselves with the task that requires them to follow instructional procedures meant for right-handers. The additional time can allow the left-handers to familiarize themselves with the given task environment. Another measure that can be applied in such a situation would be to provide separate methods or manipulate the procedure method to best fit the left-handed group of students. It is concluded that students are unaware of the knowledge of ergonomics and do not apply them during their practical work. Therefore, in

order to minimize work-related musculoskeletal disorders among the students, laboratory personnel or dental faculty personnel should reposition tools and implement modifications at workstations to ensure students can work comfortably within close reach and to the comfort of their hand preferences. For instance, repositioning of seats or seat angles, repositioning of microscopes, considering the alternative use of pipettes, providing both left-handed apparatus and tools (suturing kits, beakers, scalpels, dental equipment, etc.) and provision of left-handed chairs. To further ensure that the students understand the importance of ergonomics, several preventative and control measures can be taken.

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