Musculoskeletal Risks for using Smart Devices in Online Study of University Students

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Abstract

The use of smart devices has become a basic necessity for college or university students mainly to attend to lectures, to access the digital material, and to complete given tasks or assignments or project. The longer use and wrong posture can adhere risks leading onto the conditions related to musculoskeletal disorders. The longer use can cause strain in the muscles and the tendons, bone, and joints. All of which can result in causing the pains. Any such symptom is technically referred to as musculoskeletal symptoms. The main motivation is to support and educate the university students about the musculoskeletal disorder, its negative impact, and then suggest how the students can deal with strategies to overcome such pain. The topic of our research is 'Musculoskeletal Risks for using Smart Devices in Online Study for University Students'. Through this study, risks among the students at University of Sharjah is investigated. Focusing on the ergonomics issues and university students, our research is contributing with other similar studies conducted in the UAE. The sample considered is consisting of randomly selected students at University of Sharjah. Quantitative analysis is carried out with self-administered survey and posture analysis applying the well-known Rapid Upper Limb Assessment (RULA) and Rapid Entire Body Assessment (REBA) tools. The results have shown that most affected body parts are neck, upper back, and shoulder locations in majority of cases among university students. Top three ache, pains or discomfort experience 'several time every day' are neck, upper back, and shoulder related. This is accounting for students experienced in neck are 10.85%, upper back is 7.16%, and shoulder are 6.7%. The results of posture analysis have provided evidence that students at University of Sharjah are at musculoskeletal 'Medium Risk' with respect to their postures while using smart devices and further investigated is required.

Keywords (12 font)
MSD, Musculoskeletal Risk, MSD Disorder, Smart device etc.

1. Introduction
Musculoskeletal means the combination of muscular and skeletal body system. The use of computer or other smart devices specifically lets the person to focus on given static position that is using the particular upper limb posture. The longer use can cause strain in the muscles and the tendons, bone, and joints. All of which can result in causing the pains. Any such symptom is technically referred to as musculoskeletal symptoms (MSS) (Dockrell et al., 2015). Excessive use of smart devices from younger age and for longer term will lead to musculoskeletal disorders (MSDs). For example, having strain on the forearms and thumbs can lead to thumb arthritis which is also referred to as carpometacarpal (CMC) arthritis that is caused due to excessive texting on the smart phones (Gustafsson et al., 2017). The negative impact on body is also observed from exposure of sources of electromagnetic fields (EMFs) and blue light exposure (Mortazavi & Mortazavi, 2016).

The concept of DASH – Disabilities of the arm, shoulder, and hand are commonly addressed when examining the postural issues and correction measures which are part of training programs (Abdelhameed & Abdel-aziem, 2016).

1.1 Objectives
The aim of the research project is to examine the musculoskeletal symptoms among the university students that is caused due to the use of smart devices.

2. Literature Review
Use of Smart Devices by University Students
The development in the educational system using information technology (IT) have left no options for students to use laptop apart from personal use to use it for academic study. These include mainly the college and university students. As mentioned by Dockrell et al. (2015), majority of students spent 6 hours daily on computer. Apart from those other smart devices used by students, smart phones and tablets are extensively used (Legan & Zupan, 2020). As mentioned by Xie (2017), in last 7 to 8 years, touchscreen smart devices are dominating the market and research on use of these devices clearly signifies the associated risks with musculoskeletal symptoms. Long-term effect can lead to musculoskeletal disorder, diseases, discomfort, and related traumas (Xie et al., 2017). The over-use of smart devices has reflected complaints as observed from literature a study in Canada found neck-shoulder problems, majorly neck problems 68% and 46 to 52% complain about shoulder problems. This observation was also seen in a study conducted in China (Abdelhameed & Abdel-aziem, 2016). Smart devices also cause effect from blue light and electromagnetic fields affecting the circadian rhythm (Mortazavi & Mortazavi, 2016).

Musculoskeletal Risks
Xie et al. (2017) reviewed past studies to signify the most important risks associated with MSS for the smart phone users. The study collected journal articles on this topic and examined the results to note the major prevailing symptoms. The findings of this study showed that the risk factors are majorly associated with the neck complaints. The highest number of risks is shown from neck symptoms 67.8% and the posture of neck, time, texting activity, and gaming on the smart phones have high frequency effect on the risks associated.

A similar study is carried out by Eom et al. (2013) in which the smart phones users were tested to have strong relationship with the musculoskeletal disorder symptoms. The results obtained by the study had listed the highest rate of symptoms related to the hand with 11.3% cases, related to neck 8.1%, related to shoulder 5.6%, and related elbow were 4.1%. The associated risk was compared among two groups: the group who were experienced in typing/texting and group without much experience in typing/texting while using the touchscreen devices. It was found that experienced group had higher risk than inexperienced group as they type more judged based on ‘amount of text message’ and time spent on the devices (Eom et al., 2013).

Texting or typing has prevailed as a major activity from empirical studies which is contributing towards musculoskeletal disorders. Study done by Gustafsson et al. (2017) among the young Swedish adults between 20 to 24 years aimed for five years to get the data every year and then observe the musculoskeletal issues during these five years period. The main target was disorders related to neck and upper extremities. The risk assessment is made through the odd ratios (ORs) the ratios were high for upper extremities and neck between 1.3 and 2, whereas the upper back and neck was OR 1.6 (Gustafsson et al., 2017).

Among the university students, Kim and Kim (2015) investigated the musculoskeletal risks subjected due to the use of smart phones in Korea. The hazard ratios of each identified musculoskeletal symptoms were analyzed. The medical-dental study students were taken as sample and results indicated that back pain among students was positively correlated with the size of smart device screen used. Whereas the pain in leges was negatively correlated with the time spent on the smart device. The use of smart phones among students was 58.4% using at home (using when sitting (40%) and using when lying on back (34.9%)). The time spent using the smart phones was found to be 42.1% using more than 4 hours daily, 21.6% using 3 to 4 hours daily (Kim & Kim, 2015).

3. Methods
The primary research is carried out using online survey, and the survey questionnaire is consisting of three sections. The first section is asking questions about the gender, age, year of study, major, and citizenship. The second section is consisting of questions on the habits of using the smart devices (mainly smart phone, tablets, and laptops). The third section is consisting of questions that are related to actions taken by students which help them reduce the risks associate with long term usage (whether they take breaks, do exercise etc.).

For the survey, the total sample was 433 students consisting of both male and female student participations. Apart from this, for the image analysis, 54 images were taken to analyze the posture. This was mainly to apply the RULA and REBA tools. However, for this ONLY female students were considered due to restriction of time and mostly hostel students participated giving permission to take their pictures for our study. This helped in evaluating the risk level.

4. Data Collection

For the survey, the total sample was 433 students consisting of both male and female student participations. Apart from this, for the image analysis, 54 images were taken to analyze the posture. This was mainly to apply the RULA and REBA tools. However, for this ONLY female students were considered due to restriction of time and mostly hostel students participated giving permission to take their pictures for our study. This helped in evaluating the risk level.

5. Results and Discussion

There were 64% female students, and 36% male students who participated in this study. There were 8% of students aged less than 18 years, 33% of students aged between 18 to 20 years, 27% of students aged between 20 to 22 years, 17% of students aged between 22 to 24 years, and there are 15% of students who are aged more than 24 years in this study. So, the majority of students are aged between18 to 20 years, whereas minority of students of students are less than 18 years who participated.

The participated students in this study are from different majors. There are 7% of the students each from sharia and Islamic studies major, business administration major, and computing and informatics major. Engineering major students are high in number who participated with 27%. The rest majors who participated include 15% health sciences, 8% medicine, dental and pharmacy, 9% from law major, 6% from IT and communication major, and 10% from fine arts & design major. Students majorly participated are 23% of undergraduate students of fourth year. There are 22% from undergraduate first year students, 19% from undergraduate second year students, and 18% from undergraduate third year students. From the graduate level (masters and doctorate students, 18% was contributed.
For educational purpose, the use of smart devices by students has dependent for online classes, homework, lectures etc. The majority of students 33% spends about 4 to 6 hours, 25% of students spent 6 to 8 hours, and 15% spent more than 8 hours.

For socializing purpose, the use of smart devices by students has dependent for social media especially like Instagram, WhatsApp, Snapchat etc. The Figure 11 shows that daily time spent of 15% of students is less than 2 hours, 25% spent 2 to 4 hours. The majority of students 27% spends about 4 to 6 hours, and 24% of students spent 6 to 8 hours. Whereas, only 9% of students spent more than 8 hours.
The preference of the student taking the position or posture when using the smart devices: Large number students, 43% of students were found to choose their common position as resting on couch/sofa (relax mode) while using their smart devices. Whereas least number of students, only 7% of students prefer standing position. However, the students preferring to sitting position were found to be 31%. Lastly, the proper desk position choosers are 19%.

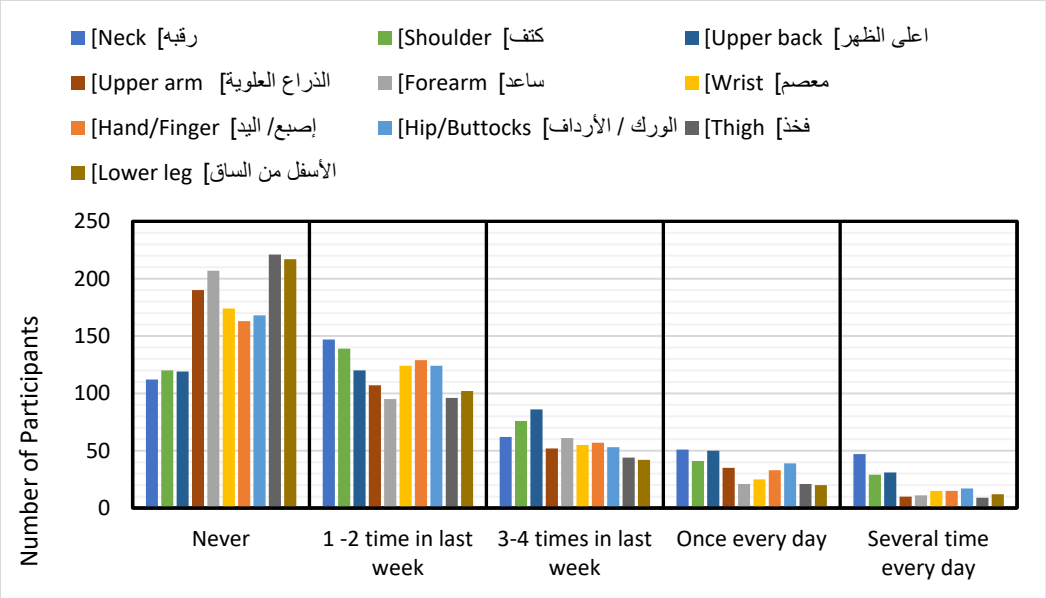

Figure 1: During Online Study, Experiencing Ache, Pain, Discomfort

Online study experience among the students is asked, and the results have indicated clear aspects which are affecting the students with musculoskeletal issues. The bar graph shown in Figure 1 is listing out ache, pain, and discomfort in neck, shoulder, upper back, upper arm, forearm, wrist, hand/finger, hip/buttocks, thigh, and lower leg. Top three categories are noted from each option.

Firstly, for the ache and pains 'never' experienced, top three are 51.04%, in lower leg are 50.35%, and in forearm are 47.81%. Secondly, for the ache and pains experienced '1-2 time in a week', top three are neck, shoulder, and hand/finger related. This is accounting for students experienced in neck are 33.95%, shoulder is 32.79%, and hand/finger are 30.25%. Thirdly, for the ache and pains experienced '3-4 times a week', top three are upper back, shoulder, and neck related. This is accounting for students experienced in upper back are 20.32%, shoulder is 17.78%, and neck are 14.32%. In addition, the top three discomforts experienced 'once every day' are on neck, upper back, and shoulder. This is accounting for students experienced in neck are 12.24%, upper back is 12.01%, and shoulder are 9.7%. Lastly, top three ache, pains or discomfort experience 'several time every day' are neck, upper back, and shoulder related. This is accounting for students experienced in neck are 10.85%, upper back is 7.16%, and shoulder are 6.7%.

So, the neck, upper back, and shoulder locations are noted in majority of cases among university experiencing any kind of ache, pain or discomfort. These results are similar to that observed by Berolo et al., (2011) where neck and upper back cases were noted large in number. The level of discomfort felt is shown in the following Figure.

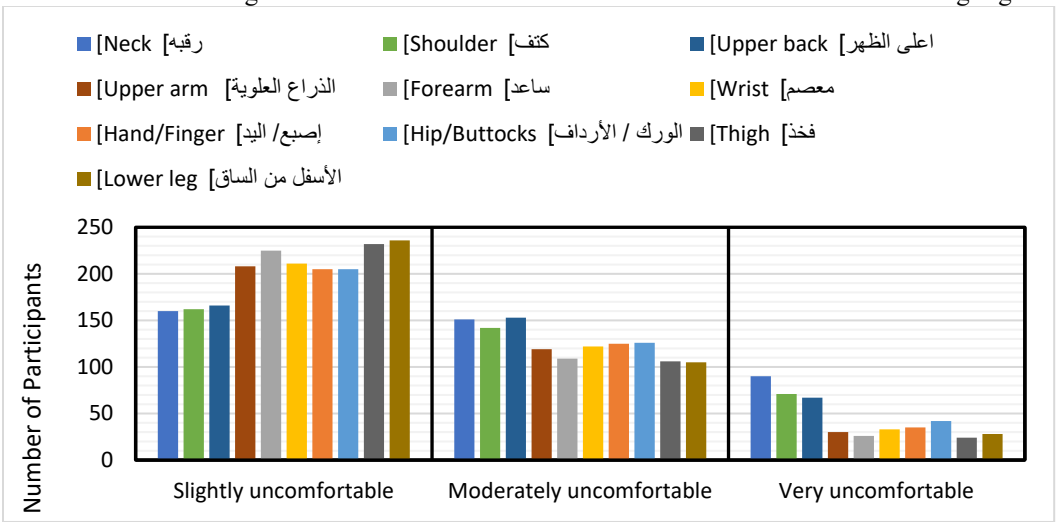

Figure 21: Level of Discomfort

The level of discomfort using the smart devices is observed as shown in Figure 2. The provided options were slightly uncomfortable, moderately uncomfortable, and very uncomfortable. The top three locations under the 'slightly uncomfortable' are lower leg, thigh, and forearm. In other words, students who experienced 'slightly uncomfortable' in thigh are 54.27%, in lower leg are 54.73%, and in forearm are 52.19%. The top three locations under the 'moderately uncomfortable' are upper back, neck, and shoulder. This is accounting for students who experienced 'moderately uncomfortable' in upper back are 36.49%, in neck are 34.87%, and in shoulder are 33.26%. Lastly, the top three locations under the 'very uncomfortable' category are neck, shoulder, and upper back. This is accounting for students who experienced 'very uncomfortable' in neck are 20.78%, in shoulder are 16.39%, and in upper back are 15.47%. The results observing the level of discomfort are showing that least discomfort is in the leg, thigh, and forearm, on the other hand, the most discomfort is observed in neck, shoulder and upper back.

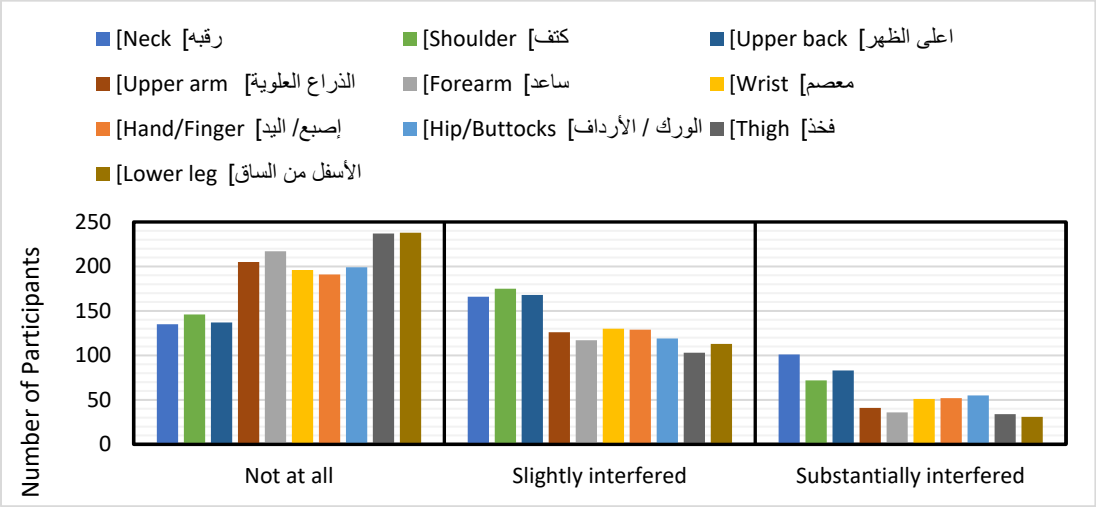

Figure 3: Interference with Ability to Use Smart Devices

The discomfort interferes with the use of the smart device, and this interference with the ability to use is observed from the Figure 3. The top three discomforts that interfere 'not at all' are lower leg, thigh and forearm. In other words, among students, body discomforts which 'not at all' interfere in the use of smart devices are 55.2% lower leg, 55.43% thigh, and 52.19% forearm. The top three discomforts that 'slightly interfere' are shoulder, upper back and neck. This is accounting for students having the body part 'slightly interfere' are 40.65% shoulder, 38.8% upper back, and 38.33% neck. The top three discomforts that 'substantially interfere' are neck, upper back and shoulder. This is accounting for students having the body part 'substantially interfere' are 23.33% neck, 19.17% upper back, and 16.63% shoulder. The results observing the level of interference, it is noticed substantial for and slightly for neck, upper back, and shoulder. These results are similar to that observed to respective very uncomfortable locations.

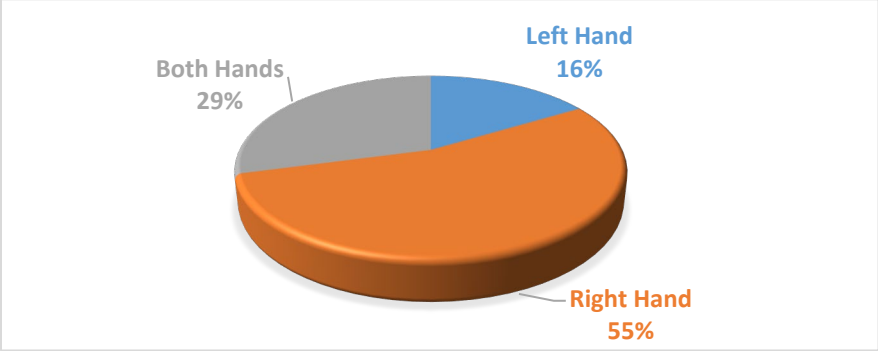

Figure 4: Frequent Hand Used When Using Smart Devices

As shown in Figure 4, participants using their hand most of the time for using the smart devices do use right hand are 55%, left hand are 16%, and both hands are 29%. So, majority of the smart devices are used using the right hand.

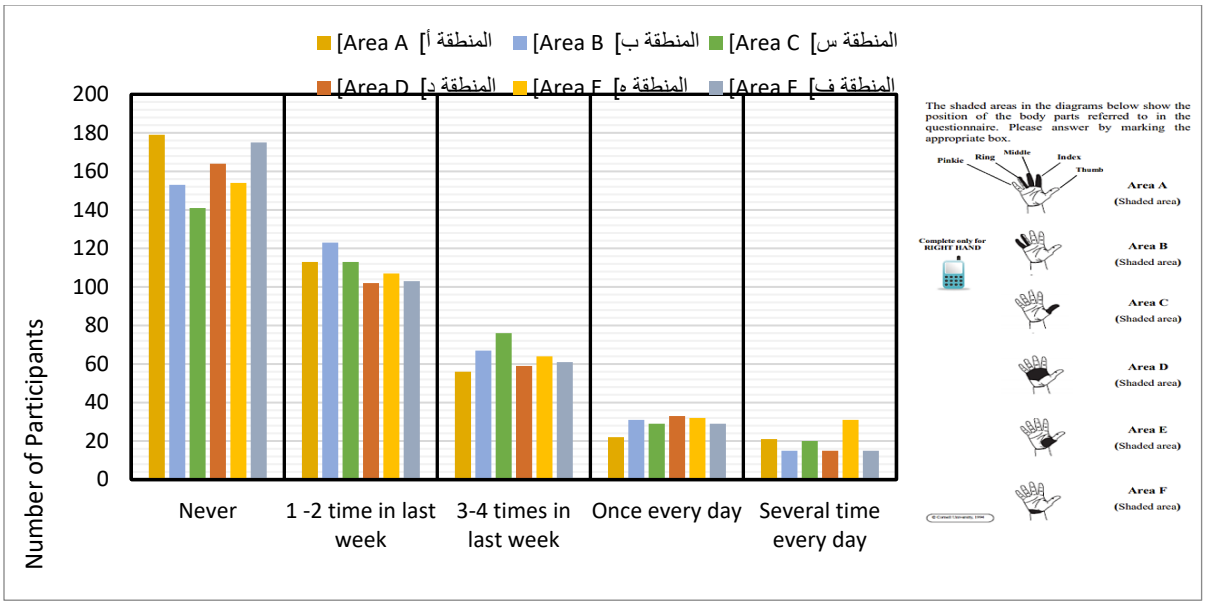

Figure 5: Experiencing Ache, Pain, Discomfort with Mobile Use (Right Hand)

For right-hand users, online study experience among the students is asked, and the results have indicated clear aspects which are affecting the students with musculoskeletal issues. The bar graph shown in Figure 5 is listing out ache, pain, and discomfort in shaded Areas A, B, C, D, E, and F. Top three categories are noted from each option. Firstly, for the ache and pains 'never' experienced, top three are Area A (41.34%), Area F (41.57%), and Area D (39.49%). Secondly, for the ache and pains experienced '1-2 time in a week', top three are Area A (26.1%), Area B (28.64%), and Area C (26.33%). Thirdly, for the ache and pains experienced '3-4 times a week', top three are Area C (17.55%), Area B (15.47%), and Area E (15.01%). In addition, the top three discomforts experienced 'once every day' are on Area D (7.62%), Area E (7.39%), and Area B (7.16%). Lastly, top three ache, pains or discomfort experience 'several time every day' are Area E (7.16%), Area A (4.85%), and Area C related (4.62%).

So, the Area E, Area B and Area C locations are noted in majority of cases among university experiencing any kind of ache, pain or discomfort. The level of discomfort felt is shown in the following Figure 6.

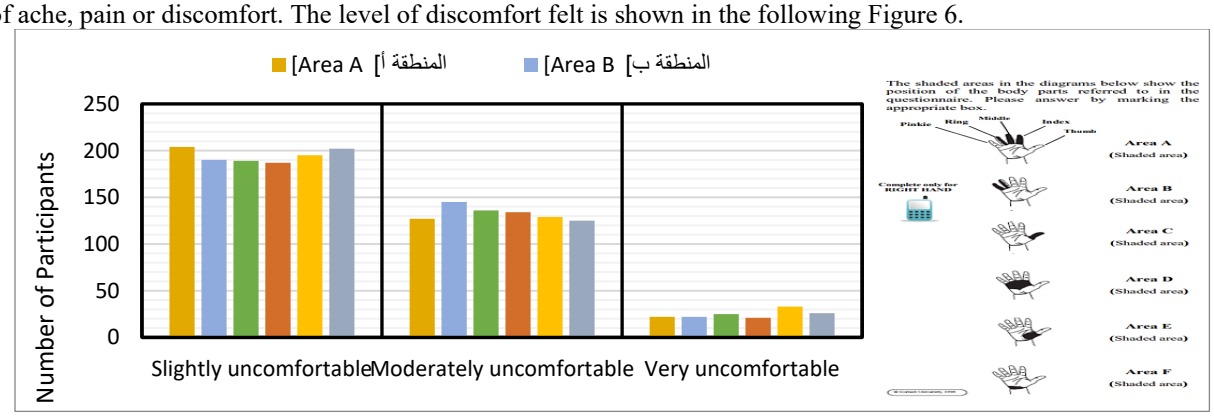

Figure 2: Level of Discomfort Using Mobile Phone (Right Hand)

For the right-hand users, the level of discomfort using the smart devices is observed as shown in Figure 18. The provided options were slightly uncomfortable, moderately uncomfortable, and very uncomfortable. The top three locations under the 'slightly uncomfortable' are Area A (47.34%), Area F (47.81%), and Area E (46.19%). The top three locations under the 'moderately uncomfortable' are Area B (33.49%), Area C (32.10%), and Area D (31.18%). Lastly, the top three locations under the 'very uncomfortable' category are Area E (7.62%), Area F (6.01%), and Area C (5.77%).

The results observing the level of discomfort are showing that least discomfort is in the Area A, Area F, and Area E, on the other hand, the most discomfort is observed in Area E, Area F, and Area C. This shows some experience least discomfort in the Area F, and Area E, but some feel high discomfort in the same Area F, and Area E.

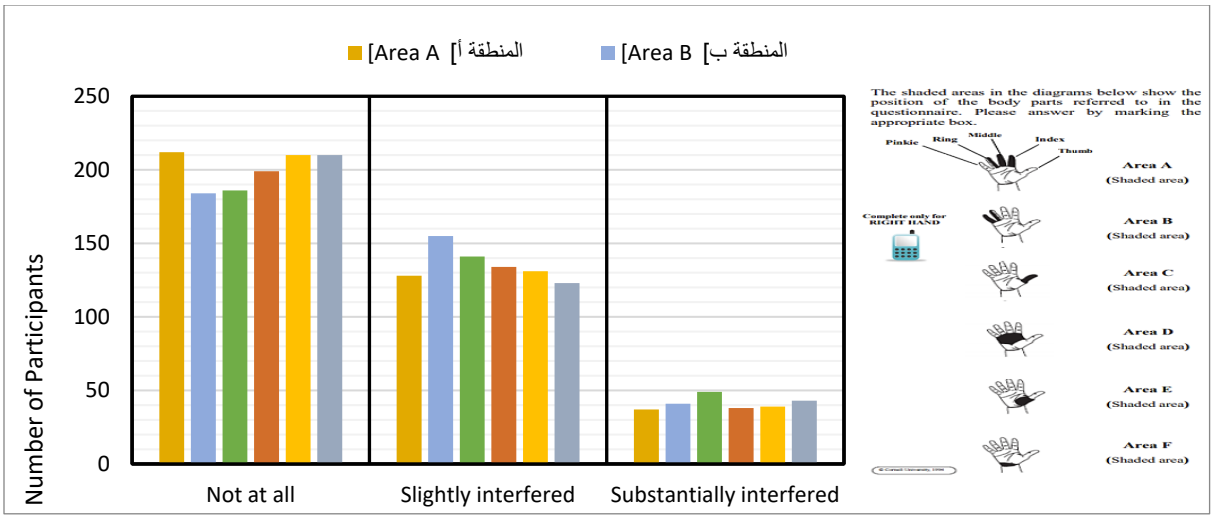

Figure 7: Interference with Ability to Use Mobile Phone (Right Hand)

For the right-hand users, the discomfort interferes with the use of the smart device, and this interference with the ability to use is observed from the Figure 19. The top three discomforts that interfere 'not at all' are Area A (49.19%), Area E (49.65%), and Area F (49.42%). The top three discomforts that 'slightly interfere' are Area B (35.8%), Area C (32.56%), and Area D (30.94%). The top three discomforts that 'substantially interfere' are Area C (11.32%), Area F (9.93%), and Area B (9.47%).

The results observing the level of interference, it is noticed substantial for Area C, Area F, and Area B. The level of discomfort is high in Area F and Area C, and the same Area F and Area C is noticed to interfere more.

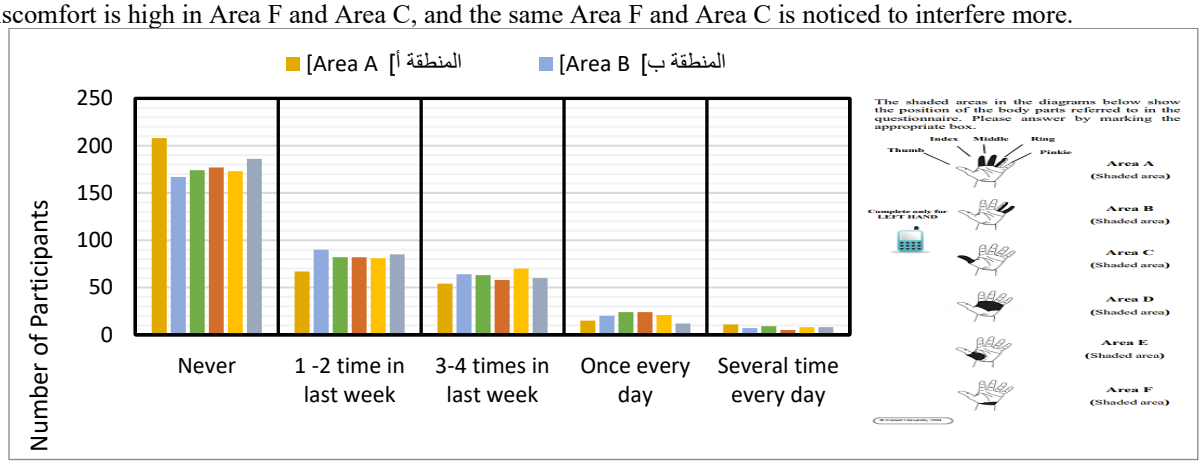

Figure 8: Experiencing Ache, Pain, Discomfort with Mobile Use (Left Hand)

For left-hand users, online study experience among the students is asked, and the results have indicated clear aspects which are affecting the students with musculoskeletal issues. The bar graph shown in Figure 8 is listing out ache, pain, and discomfort in shaded Areas A, B, C, D, E, and F. Top three categories are noted from each option. Firstly, for the ache and pains 'never' experienced, top three are Area A (48.04%), Area F (43.42%), and Area D (41.57%). Secondly, for the ache and pains experienced '1-2 time in a week', top three are Area B (21.02%), Area F (20.09%), and Area D (19.4%). Thirdly, for the ache and pains experienced '3-4 times a week', top three are Area E (16.4%), Area B (14.8%), and Area C (14.55%). In addition, the top three discomforts experienced 'once every day' are on Area C (5.54%), Area D (5.54%), and Area E (4.85%). Lastly, top three ache, pains or discomfort experience 'several time every day' are Area A (2.54%), Area C (2.08%), and Area E (1.85%) and Area F (1.85%) as well.

So, the Area E, and Area C locations are noted in majority of cases among university experiencing any kind of ache, pain or discomfort. The level of discomfort felt is shown in the following Figure.

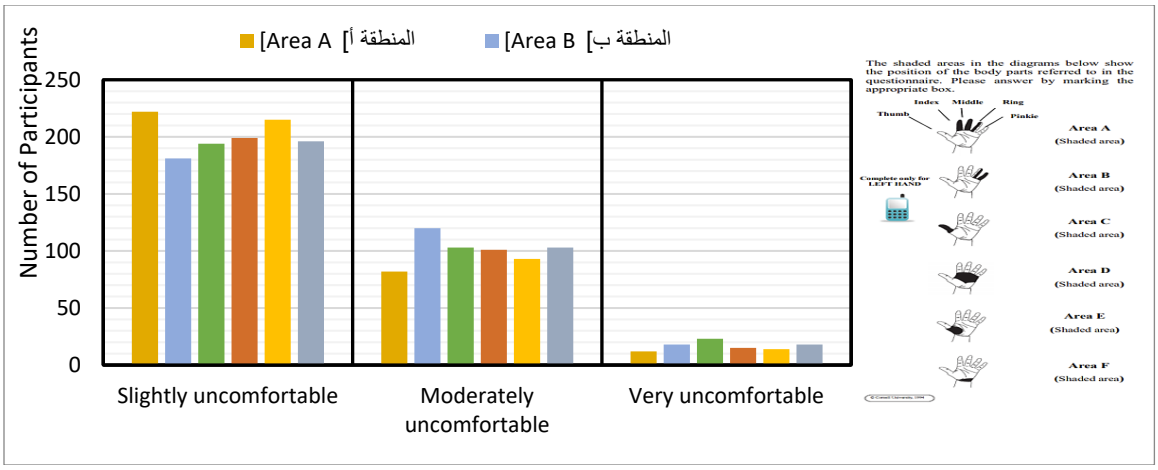

Figure 3: Level of Discomfort Using Mobile Phone (Left Hand)

For the left-hand users, the level of discomfort using the smart devices is observed as shown in Figure 9. The provided options were slightly uncomfortable, moderately uncomfortable, and very uncomfortable. The top three locations under the 'slightly uncomfortable' are Area A (51.7%), Area E (41.34%), and Area D (41.57%). The top three locations under the 'moderately uncomfortable' are Area B (27.95%), Area C (23.79%), and Area F (24.02%). Lastly, the top three locations under the 'very uncomfortable' category are Area C (5.54%), Area B (4.16%), and Area F (4.16%).

The results observing the level of discomfort are showing that least discomfort is in the Area A, Area E, and Area D, on the other hand, the most discomfort is observed in Area C, Area B, and Area F.

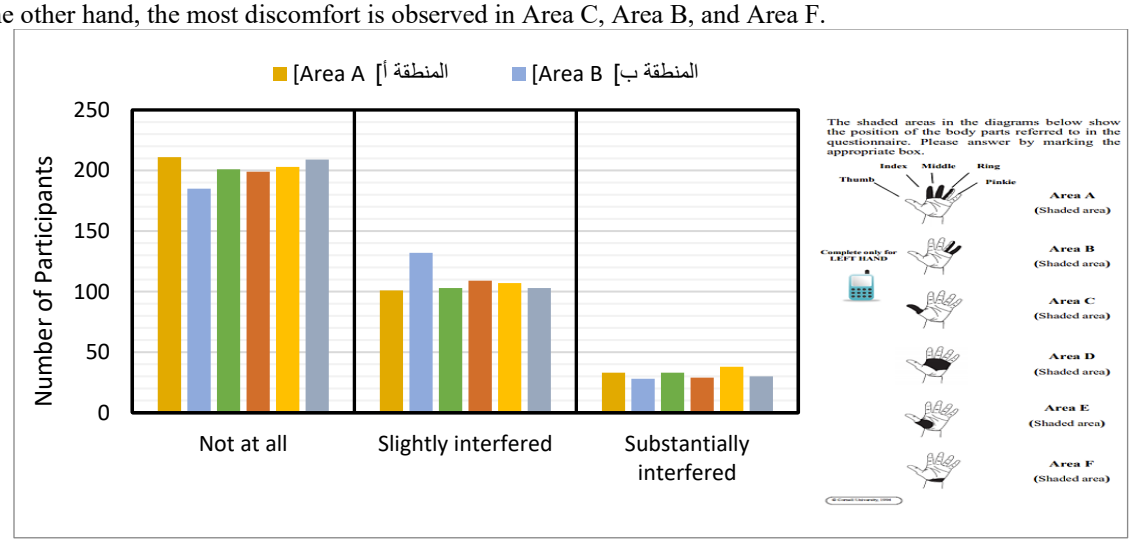

Figure 10: Interference with Ability to Use Mobile Phone (Left Hand)

For the left-hand users, the discomfort interferes with the use of the smart device, and this interference with the ability to use is observed from the Figure 10. The top three discomforts that interfere 'not at all' are Area A (48.73%), Area F (48.97%), and Area E (47.58%). The top three discomforts that 'slightly interfere' are Area B (30.72%), Area D (25.40%), and Area E (21.71%). The top three discomforts that 'substantially interfere' are Area E (8.78%), Area A (7.62%), and Area C (7.62%) as well.

The results observing the level of interference, it is noticed substantial for Area C, Area F, and Area B. The level of discomfort is high in Area B and Area C, and the same Area C and Area B is noticed to interfere more.

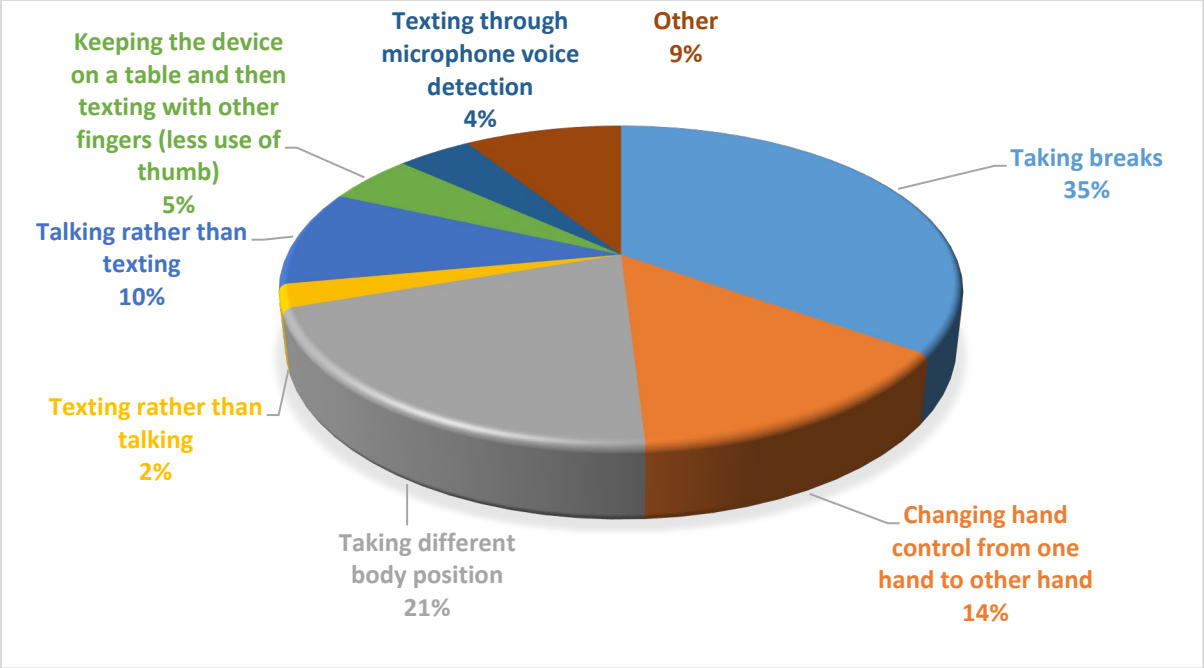

Figure 11: Different Ways to Help Reduce the Discomfort

As shown in Figure 11, different ways in which the students adopt to reduce the discomfort are majority 35% through 'taking breaks', 21% of them through 'taking different body position', 14% of them through 'changing hand control from one to other hand', 10% through 'talking rather than texting', 5% through 'keeping the device on a table and then texting with other finger (less use of thumb)', 4% of them through 'texting through microphone voice detection', and 9% through 'other' ways.

Posture Analysis Results (RULA and REBA)

The posture analysis is one of the main methods which is used in the literature to analyze the associated musculoskeletal risks. In this study, the assessment tools such as RULA – Rapid Upper Limb Assessment and REBA – Rapid Entire Body Assessment are used to analyze the posture and assess the risk level.

The sample of 54 female students participated in providing the image data for posture analysis. The Figure 12 is showing the RULA scores of the students. The distribution of the score with respect to number of students it is clear from Figure 24 that 3 to 4 and 5 to 6 categories are more in number. Students who go score of '3' are 37%, score of '4' are 14.8%, score of '5' are 35.2%, and score of '6' are 9.3%. This is indicating that further investigation is needed, and the change may be needed and needed soon. In addition, there is one student indicating 1.9% of sample who got score of '7' which is high score indicating the posture must be further investigated and change must be implemented.

The Figure 13 is showing the REBA Scores. This Figure as well is showing the distribution of REBA scores with respect to the number of students. Students with score '3' are 9.3%, score '4' are 18.5%, score '5' are highest as 50%, score '6' are 11.1%, and score '7' are 5.6%. It is clear that the distribution is bell shaped and majority of the participants got score in between 3 to 7. This is indicating that they are at 'Medium Risk' and there is need of further investigation and change of posture must be soon. Apart from this, there are two students who were observed to have score of 8 and 9 each. This score comes under the category of 'High Risk' where the implementation of the change is a must.

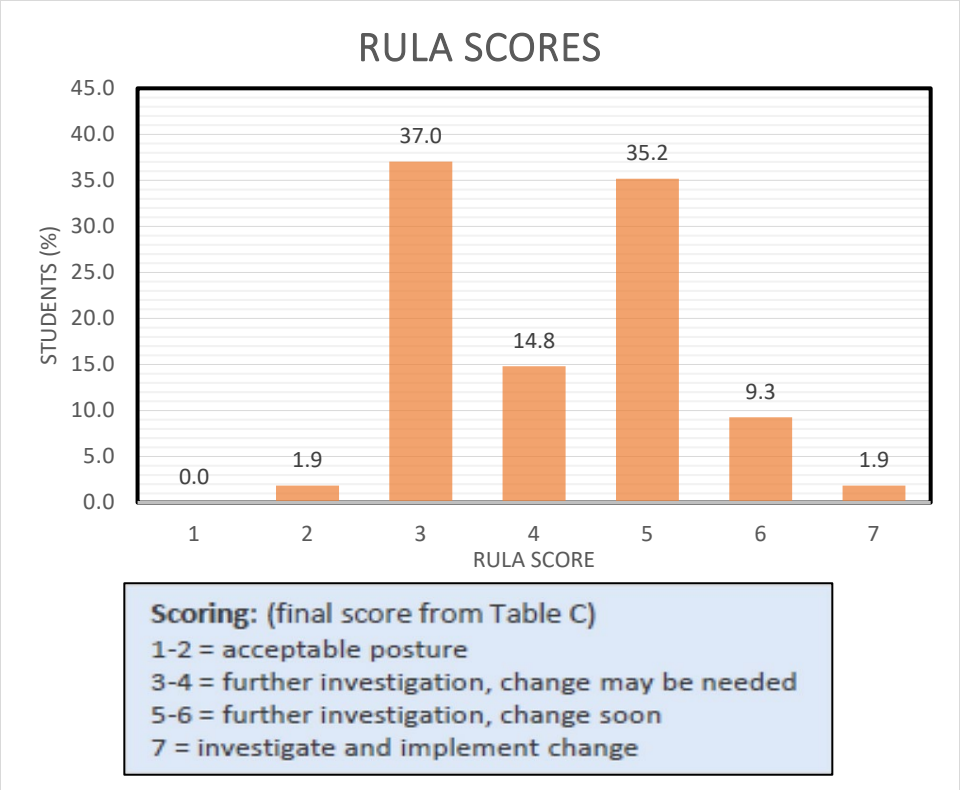

Figure 124: RULA Scores

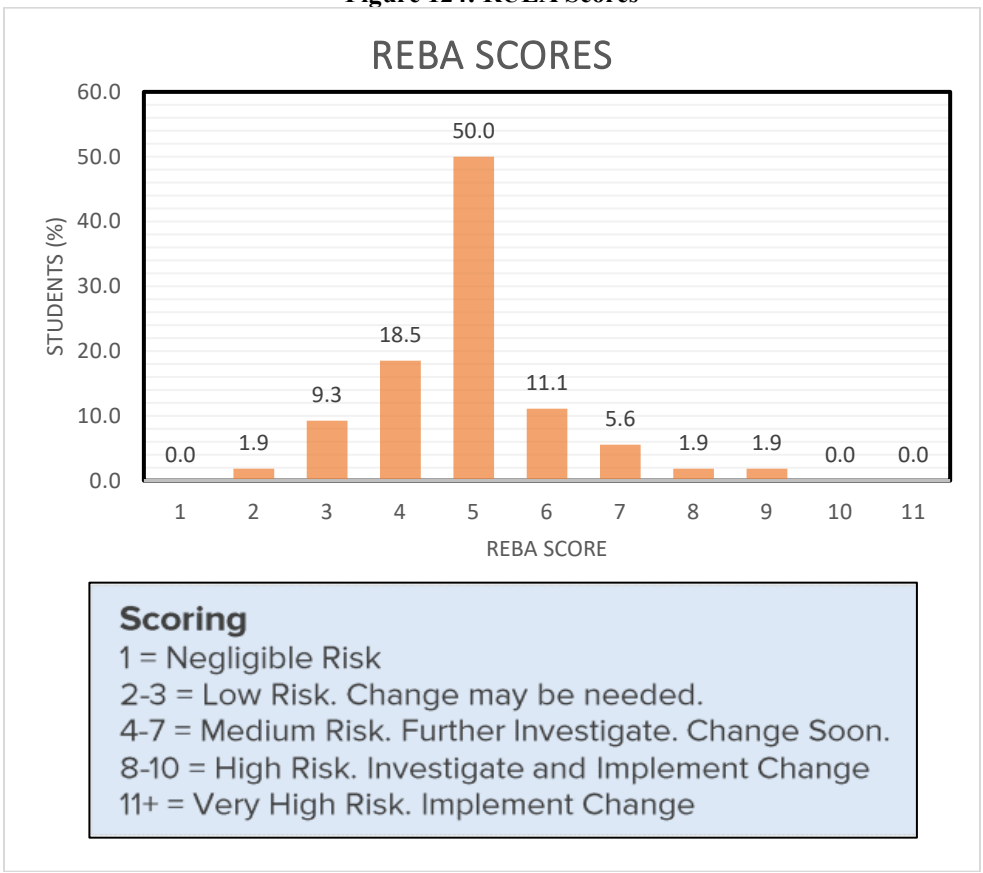

Figure 13: REBA Scores

The results of RULA and REBA have provided evidence that students at University of Sharjah are at musculoskeletal 'Medium Risk' with respect to their postures while using smart devices. This is showing there is need for further investigation and implementation of change of posture.

6. Conclusion

The aim of the project to examine the musculoskeletal symptoms among the university students that is caused due to the use of smart devices is fulfilled. Firstly, analyzing the ergonomic risk factors that are associated with the use of smart devices, it is found that majority of students 33% spends about 4 to 6 hours, 25% of students spent 6 to 8 hours, and 15% spent more than 8 hours. Secondly, the specific parts of the musculoskeletal system that are likely to be affected by the use of smart device among the University of Sharjah is observed to be neck, upper back and shoulder at the top three body parts affected. The results of RULA and REBA indicated that students at University of Sharjah are at musculoskeletal 'Medium Risk' with respect to their postures while using smart devices. This is showing there is need for further investigation and implementation of change of posture.

Common recommendations are to take breaks, change body position (posture), keep the device on table, ergonomic standards and guidelines, and exercise like stretching to ensure body parts are moved not static all the time. Since neck, shoulder, and upper back body parts are observed in majority of the cases. Some of the below recommendations are given to reduce the risk associated with the use of smart devices related to identified body parts:

- Using laptop table: this table ensures that the laptop can be place on the top of it and lets the user position in up-right-straight. This will provide the screen at good level and help in avoiding bending of neck or truck.
- Using ergonomic tools like chair or device holders: the ergonomic chairs have good design which allow the back support such that when the back is rested on it, it takes the up-right-straight position. The device holders can help users to avoid long time static usage of device holder in hands. The risk associated with twisted hands can be avoided.
- Using ergonomic neck support: this will let user feel comfortable at straight position.

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