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Musculoskeletal Effects in Adult Consumers of Smartphones and Tablet Devices

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Abstract – The goal of the research was to study the prevalence of musculoskeletal symptoms among users of the adult smartphone or tablet (e.g. forms, locations and temporal distributions). The survey further examined the utilisation of equipment in terms of duration of use, postures taken during use, operating procedures and computer use for the purpose of explaining symptoms. In the intervening two weeks, participants from eastern Australian states recorded online use of devices and symptoms retrospectively. Data were analysed using a Chi-Square analysis [β2] to determine the relationships between categorical variables; Mann-whitney U tests were carried out to compare two smartphone users versuses tablet users, for example, where the dependent variables are regular; Spearman's correlation analysis was performed to evaluate the links between categorical variables.

Of the 207 patients, 59.9% registered signs of musculoskeletal musculoskeletal before or after use, 64.5% of which were first observed within the first 30 minutes of use (mostly between 15 and 30 minutes). There were no statistically important variations in the proportion of symptoms recorded during mobile usage between smartphone-only users and tablet users (μ2 = .350, N = 207, p = .554). Rigidity is the most common sign. The symptoms in the neck were more common (18.1 percent in smartphone-only users and 19.3 percent in tablet device users). Tablet consumers aged from 18-24 and longer than 30 minutes using a tablet in each use session more frequently experienced symptoms (82.4% prevalence) than devices with 30 minutes or less (52.2%) (μ2 = 4.723, N = 63, p = 0.030).

These results indicate that consumer age, length, frequency, and types of system are significant considerations that should be considered to minimise the experience of muscular symptoms between the consumers of smartphones and tablets while developing evidence-based guidance. The bulk of consumers of smartphones and tablets would escape symptoms if use was limited to < 15 min.

Key Words – Musculoskeletal Symptoms, Smartphone, Tablet, BMI

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1. INTRODUCTION

Handheld mobile ownership is growing rapidly, such as cell phones and tablets. Utilisation of smartphones and tablets penetrates all aspects of society, allowing increased living conditions through improving access to content, improving schooling and employment and health inclusion. However, lengthy use, mostly the neck and upper extremities, have been shown to have a detrimental effect on physical wellbeing. A variety of risk factors, including gender, posture, overall time spent on a system, and styles of work done on computers, have been studied to connect them with musculoskeletal symptoms. It is also proposed that based on the individual communities relative significance of the risk factors can vary.

Young et cetera have shown to be consistent with enhanced neck flexion and handle expansion in broader displays and holder styles. Since smartphones and tablets vary in height, weight and way of use, they may produce different patterns of symptoms. However, insufficient study is being carried out on which various smartphones and tablets induce distinct postures and musculoskeletal symptoms. With continuing technical advances, the use of these instruments is expected to grow. To provide recommendations for healthy usage of the Mobile and tableter, a clearer understanding of musculoskeletal symptoms is essential.

In this context, current research aims to: 1) examine the prevalences and patterns among smartphone and tablet users of musculoskeletal symptoms (including types, locations, and temporal patterns); 2) explore the time use of smartphones and tablet devices, and compares use positions, operating methods, and use purposes (e.g., work). The research was intended to collect evidence on the highest number of times before the occurrence of musculoskeletal symptoms a mobile or tablet computer should be used safely and how the

population and use variables are correlated with the symptoms.

2. METHOD

2.1 Study design

In a survey design, participants were asked to update on the symptoms and use of the musculoskeletals in the last two weeks, utilising an online questionnaire. In the report, the word 'musculoskeletal symptoms' covered all physical symptoms, including pain, weakness, aches, fatigue, numbness and paraesthesia, in muscles, limbs, bones, and soft tissue. Survey designs are widely used to perform investigations on this subject and enable users to anonymously report their symptoms and use. The thesis was endorsed by the Human Research Ethics Committee of Charles Sturt University (Protocol number: H18271).

2.2 Participants and recruitment strategy

Community census involved Australian (over 18 years old) adults in eastern Australian states (Victoria, New South Wales, and Queensland, who were using either a mobile or tablet computer, and the overall population at the time of the survey was about 19.5 million[3]. These states were included as system use and network use were considered to be equivalent due to their common networks, identical coverage levels and device access. In order to capture metropolitan and geographical perspectives the survey was marketed specifically for communities in the NSW, like Western Sydney and the Greater West in NSW. However, being an online poll, the survey was open to everyone, and the answers were deleted during data cleaning from outside the eastern countries. At least one hundred participants were required to have a community sample estimation of about 10% of the underlying population values based on the survey sample, suppose that 95% of the population was trust and significant numbers of adults who reside in the Australian East States are supposed to have

Via advertising, tv, email and online, the participants were recruited. In particular, the Charles Sturt University (CSU) Facebook page and the CSU News article got 967 unique views. Specifically, publicity was provided. Facebook updates were created, and CSU student groups and researchers' personal pages were informed about the News storey. CSU study panels, staff physiotherapy and CSU students have been issued e-mails, centred on the existing networks of researchers. The ABC radio station (Greater West) broadcast an interview which led people to an article in the CSU News. Only Facebook has hired QLD and VIC participants.

By clicking on the survey link, potential participants were initially provided with an information sheet and a declaration of consent, in which they acknowledged and consented to participate in the survey.

2.3 Data collection procedure and tools

Both data have been gathered online using SurveyMonkey, an encrypted survey website. An additional file is accessible with a backup of the survey used. During the two-week timeframe before the survey access, participants were asked to answer questions about specific demographic and smartphone and tablet (including frequency and duration) data. Participants were questioned about their knowledge with some symptoms such as pain and stiffness in musculoskeletals over this two-week span. The respondents were also requested to record their symptoms using a corporal diagram (Fig. 1). Participants have reported typical body positions during the use of a computer and how the device was held and worked.

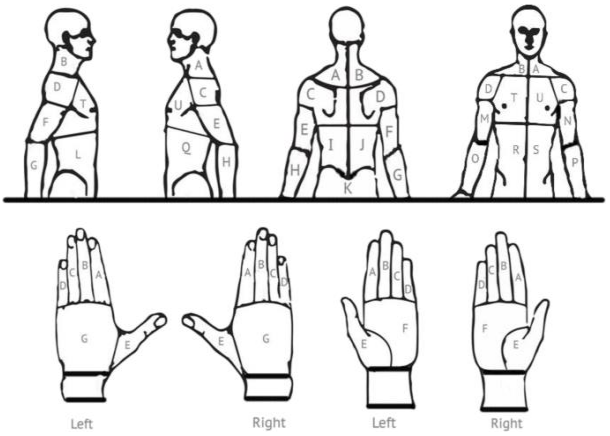

Fig 1: Body chart showing the individual regions on the questionnaire

2.4 Outcome measures

The questionnaire employed a Visual Analog Scale (VAS), with 10 representing worst pain and 0 showing no pain, to rate pain at a scale of 0–10. Olaogun et al. have shown good intra-tester correlations between VAS of each tester (P <.05), high VAS and semantic differential scale inter-tester correlations (P <.05) of the population of muscleskeletal pain. In order to increase the accuracy of disclosing musculoskeletal symptoms, a body map (Fig. 1) was created. While corporate charting in this field of study have not been widely used, Xie et al. considered it to be useful for supporting the relevance of main results in review.

2.5 Additional explanatory variables

The questions often included gender, age, height, and weight, used to compute the body mass index (BMI), past accidents, postural patterns during system usage, and cause for devices use, which could have added to the explanations for device or

musculoskeletal symptoms (work, education, leisure and other).

2.6 Data analysis

For cleaning and review the data was exported from SurveyMonkey to the SPSS (IBM SPSS Version 25, 2017). Responses that have not come from the Eastern States or are incomplete have been omitted (>3 population queries have not been replied to or no reply concerning the prevalence of symptoms). In order to provide an analysis of demographic statistics, prevalence of the symptoms, and trends, data have primarily been analysed descriptively. Visual analysis of histograms advised the collection of parametric or non-parametric statistical tests to see whether distributions of variables approximate a regular distribution. The following have been analysed for specific data: 1) The Chi-square [β2] analysis was used to evaluate category component relations; 2) Mann-Whitney U-tests were used to equate two sets of dependent variables (e.g. levels of use between men and women) with individual samples t-tests whether the dependent variables had been continuous and approximated to their regular distribution; 3) The similarity analysis used for Spearman's evaluation of the relationships between pairs of two constant or ordinal variables - selected by Pearson because of the ordinary or not natural distribution of main variables.

Survey response rates were not calculable by recruiting techniques, so the precise number of persons that were received by the survey announcements could not be evaluated. Numbers of respondents have nevertheless been registered.

3. RESULTS

In this analysis, data were analysed from 207 qualifying respondents (148 women and 59 men). Typical explanations for omission were: involvement non-consent (3), non-geographical range (7) and incomplete responses (47). The bulk (75.1%) came between the ages of 18 and 34. The recorded median BMI was 23.9 (IQR 5.2, upper boundary 26.7 and lower boundary 21.5). Handedness has been identified in the general population trend: 87.9% report a rectangular preferences, 9.2% left hand and 2.9% show ambidextrous (Table 1).

Table 1: Characteristics of participants

Gender		
Female	148	71.5
Male	59	28.5
Total	207	100
Age (years)		
18–24	96	46.4
25–34	58	28
35–44	17	8.2
45–54	23	11.1
45–54	23	11.1
55–64	7	3.4
65+	4	1.9
Total	205	99
BMI		
< 18.5	6	2.9
18.5–24.9	115	55.6
25–29.9	59	28.5
30–39.9	24	11.6
Total	204	98.6
Handedness		
Right	19	9.2
Left	182	87.9
Ambidextrous	6	2.9
Total	207	100

Note: n refers to the number of participants who reported the particular characteristics

3.1 Smartphone and tablet device use

The frequency (time of usage per user per day) and the length (average time spent in one session of device utilisation) and intent of use for smartphones and tablet devices were registered (Table 2). Frequencies and device length were divided into ranges allocated to a segment number between 0 and 6. The increasing number of categories reflects expanded usage of the device (Table 2). The frequency category number and session category number product has been determined for each respondent to determine a total system consumption level (between 0 and 36). This represented every respondent's overall regular use of individual devices (Table 3).

Table 2: Distribution of device usage - daily frequencies and average session durations for smartphones and tablet devices

Frequency category for device use	Daily frequency of device use (times per day)	Smartphone users (n)	Tablet users (n)	Session duration category	Typical duration per usage session (minutes)	Smartphone users (n)	Tablet users (n)
0	None reported	0	42	**0**	None reported	0	67
1	0–5	14	146	**1**	0–5	63	76
2	6–10	29	15	**2**	6–10	67	10
3	11–20	50	3	**3**	11–20	45	27
4	21–50	55	0	**4**	21–50	9	19
5	51–100	21	0	**5**	51–100	9	5
6	Too many to count	38	1	**6**	More than 2 h	14	3
	Total	207	207		Total	207	207

Note: n refers to the number of participants who reported particular items

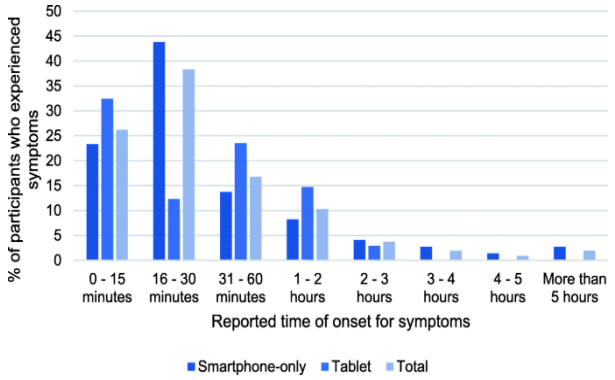

Fig 2: Proportions of participants with symptoms who began to experience them within each time interval

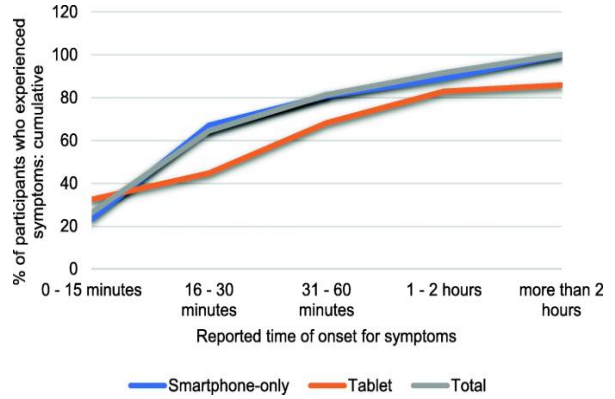

Fig 3: Cumulative proportions of participants with symptoms who began to experience them within each time interval

3.2 Associations of gender, age, BMI and handedness with musculoskeletal symptoms

Over the previous two week span, 94 out of 148 women participants (64 percent) and 30 out of 59 men (51 percent) recorded musculoskeletal symptoms related to system usage. It did not have a statistically meaningful gender gap (το2 = 2.818, N = 207, p = 1.116). In the Spearman association analysis (BMI – rS = .101. N = 204. p = .151; Age = rS = 205. p = –593). The connection between a symptoms occurring and the participants' BMI levels or ranges of age (18–24, 25-34, 35–34, 45–54, 55-64 or 65+ years) was quite poor and did not achieve any statistical significance.

From the right, 59.9% experienced symptoms relative to 52.6% of the right-hand participants, and in particular 83.3% (5 of 6) experienced symptoms among ambidextrous participants. No major right or left handedness correlation with symptom experiences existed (μ2 = .43, N = 201, p = .540), regardless of the ambidextrous (only 2.9 percent of participants).

Along with the period of device use by Smartphone and tablet owners, we also studied age as possible factors on the perception of symptoms. In the Chi-square [·2] correlation experiments, the age was dichotomized to ensure minimum observed number of cell levels in age groups. Dichotomy was also carried out for the same purpose and a cut-off of 30 minutes was selected based on data in the figure 2 and the other sedentary behaviours recorded in previous studies due to the importance of a 30 min time-office for creation of symbols. There was no mean correlation of mobile users either among the aged 18–24 years (Ś2 =.412, N =.109, p =.551) or over the aged of 25 years (β2 =.392, N =.96, p=.5531) between the experience of the symptoms and their length of time. However, Table 4 indicates a statistically relevant relationship between tablet usage durations and signs, such that tablet users with use times >30 min were more likely than users with less tablet use durations (·2 = 0.083, =.140, p =0.043). Table 4 shows a statistically significant correlation with tablet use. More research has shown that in the 18-24-year-old population (Ś2=4.723, N=63, p=.030), but not in the over25-year-old group, this relationship was important (Table 4).

Table 4: Associations in tablet users between dichotomised durations of usage per session (≤ 30 min or > 30 min) and symptom experience, by age group. Note: n refers to the number of participants in the specified category

Tablet use ≤30 mins % (n) with symptoms	Tablet use > 30 mins % (n) with symptoms	*P* value	
All ages	56.6 (27)	77.8 (113)	.043*
18–24	52.2 (17)	82.4 (46)	.030*
25+	58.5 (10)	70 (65)	.488

4. DISCUSSION

The thesis examined the occurrence and trends of musculoskeletonal signs in the usage of an online questionnaire for mobile and tablet users. It also looked at trends with regard to time, place, operating methods and uses for mobile and tablet computers. During smartphone usage, the plurality of consumers of mobile devices experienced symptoms. The symptoms mostly started within the first 30 minutes of use of the appliance, particularly 15 to 30 minutes of use. The use of tablets (but not smartphones) and the incidence of symptoms is significantly favourable. There have been no major variations in the use and symptom experience of smartphone-only and tablet consumers. Symptoms appeared less often with computer users who sometimes took a stable stance, often changed direction, didn't keep the system while it was being used or used both hands to use their device fairly.

4.1 Musculoskeletal symptoms: onset and duration of device use

In the last two weeks of use, most of the participants suffered symptoms. This discovery reflects an earlier comprehensive study of handheld interface symptoms performed by Xie et al. This study found that symptoms most often started 15 to 30 minutes after a mobile or tablet computer was first started. This result shows that more than 70 per cent of mobile device users will prevent the emergence of symptoms by limiting their use to 15 minutes in one session. No prior trials are conducted to correlate these findings specifically regarding the threshold duration during usage of the system before symptoms start. The results are therefore consistent with those suggested for the purpose of reducing the likelihood of detrimental health impacts for sedentary behaviours. For instance, accruing sedentary period less than 29 min in each session was correlated with a lower risk of Diaz et al all-cause mortality. These results also reinforce Australia's latest guidelines for sedentary lifestyle minimisation. In such guidelines, though, there is no particular timeline.

4.2 Differences between smartphone and tablet device users

Both participants used certain electronic devices; they used a smartphone (96,6 percent significantly), but only one third used a tablet computer significantly. As predicted by the research inclusion criterion. The concentrations of musculoskeletal complaints were comparable among smartphone users and tablet users.

The most frequent signs of stiffness, accompanied by malaise, aches, pain and needles, and stupidity were registered to smartphone-only users and important tablet computer users. The collar, with almost one fifth of all symptoms recorded occurring in this area, was the most common place of symptoms for either unit. The results of a high-grade systemic evaluation, which found that the most frequent signs of neck problems arise in 17.3 to 67.8 percent of mobile device users, was reliable. Right-sided neck symptoms have become more frequent in mobile users in the latest research than in left-sided symptoms. As far as we are aware, no prior research has differentiated between the effects of the right and the wrong neck. Many mobile users could have more symptoms on the 'right side of the body' and their handset is still in their right hands and so the muscle pressure on the right side is increased. By comparison, tablet device users indicated that the device is holding evenly in both hands, which may clarify how the symptoms found on the right and left sides of the neck are more similarly distributed in the tablet device population. For more research into the impact of these causes on symptoms, further laboratory-based experiments could be conducted.

4.3 Age, BMI, gender, handedness and symptom prevalence

Although the age-specular association was not substantially linked with symptom experience between tablet usage time and the prevalence of symptoms described in section 4.1.

No statistically meaningful correlations were also found between the prevalence of ethnicity, BMI, or handling and symptoms. The results of gender disparities were 2.1 times more likely to have symptoms than men in comparison to the findings of previous studies. Further examination could be necessary.

4.4 Posture, operational methods and symptom prevalence

The prevalence of symptoms continued to vary little depending on the location of the system. Symptoms appeared less often among computer consumers who took a standing stance at times. In all classes of mobile types (and the most normal posture), a sitting was more prevalent and the handset users lying on their back showed a similar incidence of symptoms. Previous findings of stance of neck flexion during system usage as a common risk factor for musculoskeletal symptoms. Vasavada et al. stated the bending of the neck during system use up to 3–5 times the demand on the neutral location of the neck muscles. For further trials, retrospective actions for postures and self-reported effects may be helpful.

In people who shifted places more often (every 5 min) the lowest incidence of musculoskeletal symptoms was found. Every 30 minutes for the mobile consumer and every 30 – 60 minutes for the tablet user were the most popular timeline for change of location. Increased time from shifting places continued to raise the proportion of people with symptoms for mobile users until every 30–60 minutes and for tablet users every hour or more. This may be because of the limited number of patients in these extended periods and the symptoms prevalence has been decreased and plateaued since this.

Symptoms were less likely to occur among participants that had not held the unit at all (i.e., a cradle or other external device aid). In contrast, holders on the left only are at greatest risk of symptoms, although it may be a tiny cell number artefact. The use of the system with both hands proved to be less likely than other operating methods to cause hallucinations among mobile users. This form was also low risk to users of Tablets, but only the right hand was the lowest risk method for users of Tablets. This may be attributed to the increased asymmetry of muscle demands and pressure by single hand use.

5. CONCLUSION

The results will help to formulate evidence-based recommendations to minimise the experience of

smartphone and tablet users with musculoskeletal symptoms and to direct potential research into potential danger associated with smartphone and tablet use. In particular, a number of posture and operational variables that influence perceptions of musculoskeletal symptoms has been established, including the importance of the length of tablet usage and the younger age. The most frequent symptoms appeared in both device-type categories between 15 and 30 minutes after the beginning of appliance use. If the participants had their use reduced to 15 minutes a day, more than 70 percent may have spared symptoms.

The results suggest that adult cellular system users can limit their use to less than 15 minutes per session, avoid rigid postures when the device is used, use outside assistance for their devices and use the device similarly while using both hands, to minimise your likelihood of musculoskeletal symptoms. The recommended use of adult cellular device is appropriate.

These results should also be used to promote further research on the effects of musculoskeletal symptoms and to increase knowledge of the ever-changing problems of mobile devices and human wellbeing. Further testing is warranted to assess the efficacy and validity of these guidelines for infants.

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