Prevalence and Risk Factors for Neck and Shoulder Musculoskeletal Symptoms in Users of Touch-Screen Tablet Computers

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PREVALENCE AND RISK FACTORS FOR NECK AND SHOULDER MUSCULOSKELETAL SYMPTOMS IN USERS OF TOUCH-SCREEN TABLET COMPUTERS

By
Betina Bair
Mariana Gama
Marissa Toberman

A doctoral project submitted in partial fulfillment of the requirements for the

Doctorate of Physical Therapy

Department of Physical Therapy
School of Allied Health Sciences
The Graduate College

University of Nevada, Las Vegas
May 2015
We recommend the doctoral project prepared under our supervision by

Betina Bair, Mariana Gama, and Marissa Toberman

entitled

Prevalence and Risk Factors for Neck and Shoulder Musculoskeletal Symptoms in Users of Touch-Screen Tablet Computers

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Department of Physical Therapy

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ABSTRACT

Background and Purpose: Neck and upper extremity symptoms are common health complaints in the general population and cause a substantial financial burden to the health care system. Neck pain is known to be a multi factorial disorder, with head and spinal posture being one of the most important factors. Currently there is little evidence showing a relationship between touch-screen tablet computer usage and neck/upper extremity pathologies. However, it is fair to postulate that the incidence of neck/upper extremity pathologies is higher within touch-screen tablet computer users, considering how users maintain static postures while using the device. The primary purposes of the current study were to 1) investigate the prevalence of neck and shoulder symptoms and potential risk factors, 2) identify risk factors associated with symptoms during device use, especially in sitting postures. The secondary purpose was to investigate gender differences in device usage behavior, symptoms, and postural factors.

Subjects: A cross-sectional survey study was conducted in a population of university students, staff, faculty, and alumni (N = 412).

Methods and Results:

Prevalence of symptoms during device use was 67.9%. Most symptoms were reported in the neck (84.6%) and upper back/shoulder areas (65.4%). With sitting postures, significant symptoms during tablet use included sitting without back support (p= 0.016) and sitting with device in the lap (p= 0.002) based on Chi-square analyses. A multiple logistic regression analysis further demonstrated that female gender (p=0.004) and sitting in a chair without back support (p=0.006) are the predictors of experiencing symptoms during the use of tablets. For other general postures, the significant factors are lying on the side (p= 0.002) and lying on the back (p= 0.016) during tablet use. Furthermore, our results showed that 70.1% of the female
respondents reported to have musculoskeletal symptoms during device usage, in comparison to 29.9% of the male respondents (p = 0.019). Additionally, women (75.7%) demonstrated significantly more symptoms at the upper back and shoulder regions than men (24.3%) (p = 0.014).
ACKNOWLEDGEMENTS

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Introduction

Prevalence and financial burden of neck and upper extremity discomfort

Neck and upper extremity symptoms are common health complaints in the general populations throughout the lifespan. It has been shown that up to 75% of adults are affected neck and shoulder pain at some point in their life. A recent epidemiologic study by Hoy et al. demonstrated that the annual incidence rate of neck pain to be 10.4-21.3% with a higher rate in office and computer workers. Additionally, many cases run an episodic course over a person’s lifetime with multiple relapses of the symptoms. In the undergraduate student population, a one-year prospective cohort study demonstrated a high incidence rate at 46% and of whom 33% reported persistent neck pain. Neck and shoulder symptoms present a substantial financial burden to the health care system. For example, the total cost of neck pain in the Netherlands was estimated to be $686 million, which was about 1% of total health care expenditures in 1996. The indirect cost (absenteeism from work and disability) was estimated to account for 77% of the total cost related to the condition.

Risk factors of neck and upper extremity discomfort

The neck and upper extremity conditions are assumed to have a multi-factorial origin with contributors such as individual, physical, and psychosocial factors. Current evidence suggests that risk factors include female gender, older age, having high job demands, low social and work support, being an ex-smoker, and having a history of spinal disorders. Studies have also shown that the prevalence of neck pain is highest during the middle years, after which it begins to reduce. Noticeably, some physical
factors are associated with neck pain, including prolonged computer work for undergraduate students\textsuperscript{9-11} and prolonged sitting and neck flexion for office workers\textsuperscript{12}. A systematic review regarding individuals with documented musculoskeletal disorders revealed weak evidence for an association between computer use and musculoskeletal disorders, including tension neck syndrome\textsuperscript{13}. Posture and workplace ergonomics play important roles to the development of neck and shoulder symptoms associated with computer use. For example, Marcus et al (2002) found that keying with a more extended elbow, greater downward head tilt, and use of arm rests could reduce risks of developing neck and shoulder symptoms and disorders. Since computer use often involves maintaining the same posture for prolonged periods of time, the muscles of the neck and shoulder may become overworked to maintain the static posture and supporting the head in improper postures. Several studies have documented a relationship between trapezium muscle load and the development of musculoskeletal discomfort in the upper part of the body\textsuperscript{14,15}.

**Recent increases in the use of touchscreen tablet computers**

In recent years, usage of mobile touch screen computers, including tablets and smartphones, has increased dramatically. According to the report from International Data Corporation in 2013, tablet computers account for 14.6\% of all connected-device market and the growth rate of these devices was expected to be the highest over the next few years\textsuperscript{16}. Findings from a survey by the Pew Research Center’s Internet Project in 2013 showed that 43\%, nearly 103 million Americans, own a tablet computer or e-book reader\textsuperscript{17}. Despite the increased popularity of the tablet computers, this device is new
enough that only few studies have investigated the association between touch-screen tablet computer usage and neck/upper extremity discomfort. A recent study in a university population showed significant associations between the total time spent using a mobile device on a typical day and pain in the neck and shoulder regions\textsuperscript{18}. Also, time spent gaming or Internet browsing on the mobile device was significantly associated with pain in the hands\textsuperscript{18}.

Studies have suggested that the usage of mobile devices have the tendency to lead to even poorer head and neck posture than desktop computers\textsuperscript{19}. During use, one’s posture often depends on the available supporting surfaces and usage environment (hand held, desk/table, lap, device stands, chair, couch, floor, or in bed). Prolonged cervical flexion is commonly observed when the tablet computer is placed flat on a desk or when held in a position below eye level. This may cause the cervical extensor muscles to assume a lengthened position and puts a larger load on the musculoskeletal structures of the neck\textsuperscript{20}. Symptomatic subjects often stated that they did not sit with back support while using a hand-held electronic device\textsuperscript{21}. On the other hand, using a touch-screen tablet computer at an angled position, such as when a stand is used, resulted in more neutral postures\textsuperscript{15}. Furthermore, literature regarding office workers and students has revealed ergonomic and biomechanical factors during computer use while sitting are associated with musculoskeletal complaints in the neck and upper extremities. Touch-screen tablet computers are a convenient and portable tool for productivity or accessing content without the constraints of a traditional computer. It is logical to believe that various seated, standing or casual postures during touch-screen tablet computer use may
be an important factor in the development of neck and shoulder musculoskeletal symptoms in device users.

The advanced technology makes the touch-screen tablet computers very desirable. This is especially true for those who are most likely to be using such devices throughout their day (students, teachers/professors, office workers, and other sedentary type professions). A common postural position for these individuals is to spend quite a bit of time sitting in a chair (could be with or without back support – depending on the type of chair). We postulate that the ubiquity of touch-screen tablet computers, and the frequent use of them while sitting, will lead to more neck and upper extremity symptoms. Additionally, the tablet computers weigh substantially more than mobile phones, and the heavier weight may stress the upper extremity muscles when held for prolonged period of time. We believed that the proliferation of tablet computers have the potential of creating a larger public health concern. However, the prevalence and the association between the usage risk factors and neck/upper extremity symptoms are little known. The current study aims to identify specific factors related to the risk of musculoskeletal symptoms of the neck and shoulder. The primary purposes were to 1) investigate the prevalence of neck and shoulder symptoms and potential risk factors, 2) identify risk factors associated with symptoms during device use, especially in sitting postures. Our secondary purpose was to investigate gender differences in device usage behavior, symptoms, and postural factors.
Methods

The cross-sectional survey study was conducted in a population of university students, staff, faculty, and alumni. Self-reported usage of touch-screen tablet computers, device usage behavior, musculoskeletal complaints, and demographic data were collected via an internet-based survey using Qualtrics Research Suite (Qualtrics, LLC. www.qualtrics.com) between March 5, 2014 and May 30, 2014.

Subject selection and recruitment

Participants were recruited using word of mouth solicitation and online communication. The word of mouth solicitation consisted of visits to university faculty and staff, presenting the survey to various undergraduate classes, and soliciting the survey on campus. Online communication consisted of social media, university mass email announcements, campus e-newsletters, and a publicly accessible survey link on the department website. The inclusion criteria are: 1) having computer access to the survey, 2) being able to read the survey written in English, 3) being a university student, staff, faculty, or alumni. The study was approved by the Institutional Review Board of Office of Research Integrity – Human Subjects at the University of Nevada, Las Vegas.

Survey Instrument

The online questionnaire is composed of 22 items and includes three components: 1) demographic information, 2) device usage, size and behavior: usage and sizes of touch-screen tablet computers, environment of device use, common use posture, specific device position during use, and the use of external keyboard, 3) current symptoms and
symptoms during use which include duration, types, severity, and location of symptoms, sleep quality affected by symptoms, and discontinuation of device use due to symptoms. For some questions, participants are able to select multiple responses according to the habits of the device use, such as common use posture, device placement during use, and the locations and types of symptoms. All the items related to specific postures or environments are illustrated in images to help participants understand the description correctly. (See Appendix 1: Sample postures and symptom locations). Noticeably, the responses regarding the use conditions while sitting in a chair or sitting at a desk (questions 11 and 12) were recoded into new variables with two categories for statistical analysis: back support (with and without) and device position (device in lap, device on stand, and holding device with hands while sitting in a chair; device flat on desk, or device on stand while sitting at a desk.)

The questionnaire was reviewed and revised by two experts in the field of the musculoskeletal injuries and psychosocial studies to establish face validity. Also, a pilot study was conducted to examine the validity and reliability of the survey. Validity of the survey was determined after administering a pilot survey to a small group (n= 53) of physical therapy students at the university. The same survey was administered on two separate occasions, approximately one week apart without changes to the questions, to determine the measurement validity of the survey questions. The two experts examined the anonymous responses, and determined that the responses to the questions were consistent throughout both measurements. (See Appendix 2: Full Survey)
**Statistical analyses**

The collected data were analyzed using the Statistical Packet for the Social Sciences (IBM SPSS Statistics Version 22.0, Copyright IBM Corporation and other(s)). Descriptive statistics were used to report prevalence of usage of touch-screen tablet computers, musculoskeletal symptoms of neck and upper extremity, and various postural factors. Demographic information was also reported.

Due to the format of the questionnaire, the collected data, except for severity of symptoms (continuous, ranged from 0-10), is categorical, including gender (women, men), age (18-25 years, 26-39 years, 40-59 years, 60 years and older), role (students, faculty, staff, alumni), and typical usage time (< 3 hours, 3-6 hours, > 6 hours). The other variables are dichotomous and answered by “yes” or “no”, such as tablet ownership, current symptoms, symptoms during use and postural factors. Chi-Square statistics were applied to investigate gender differences and to identify significant risk factors associated with current symptoms and symptom during use in a univariate level. The potential risk factors were included in a logistic regression analysis to examine the association in a multivariate level.

The regression model investigates the association between various sitting postures and symptoms during use, with demographic and behavioral risk factors. Furthermore, the Homsmer and Lemeshow test for logistic regression was used for an indicator of goodness of fit. Odds ratios were reported to compare the magnitude of the risk factors included in the model and 95 % confidence interval was used to estimate the precision of the odds ratios. The significant level was set at .05. Since researchers intended to liberally explore potential risk factors, variables with a $p$-value close to the significant
level (i.e. \( p \)-value between 0.05-09), along with the other significant variables, were included in the logistic regression model to investigate the association in a multivariate level.

Results

Demographics

The final sample size of this survey is 412, which is composed of 135 men (32.8%) and 275 women (66.7%), with ages ranging from 18 to 70 years or older. Since two participants preferred not to identify their gender, the two cases were excluded only when any statistical procedure is related to the gender effect. The majority of the participants were students (69.4%), and then faculty (12.4%), staff (10.4%), and alumni (7.0%). A summary of the demographic information of the participants is included in Table 1A and 1B.

Prevalence of device uses, neck and upper extremity symptoms and postural factors

315 out of 412 participants (76.5%) reported owning at least one touch-screen tablet computer devices. Prevalence of any current musculoskeletal symptoms (regardless of device ownership) was 60% (247/412) and prevalence of symptoms during device use was 67.9% (214/315; tablet device users only). For device users with musculoskeletal symptoms during use (n =214), most symptoms were reported in the neck (84.6%), upper back/shoulder areas (65.4%), arms/hands (33.6%), and head (15.0%). The most common types of symptoms are stiffness (74.3%), soreness (48.1%)
and aching or pain (42.5%). The typical level of symptoms were usually reported as mild (73.7%) or moderate (25.3%), defined respectively as 0-3 or 4-6 out of 10 on a visual analog scale (VAS) for severity of symptoms. The most severe level of discomfort during use was usually moderate (55.4%), but noticeably, 10.0% of participants reported severe symptoms (VAS: 7-10) during use. Only 46.1% of the respondents reported that they would stop using the device when experiencing discomforts. Only 15% reported their symptoms affect their sleep (See Table 1A).

**Pattern of the device use and postural factors**

Most of the device owners have a typical usage time of less than three hours per day (57.1%). The most common posture during use was sitting on chairs or couches (84.4%), lying on back (50.5%) and lying on the sides (35.9%). (See Table 2)

When using the device while sitting in a chair, the most common positions were holding the device with hands with back support (53.0%) and putting the device in lap with back support (41.3%). After recoding the variables, we found that most respondents held their tablet computers with hands only (59.7%), followed by held in lap (46.0%), and with a tablet stand (34.6%). 25.4% of the respondents sitting in a chair without back support during device use. (See Table 2)

When using the device at a desk, the most common positions were having the device on a tablet stand with back support (57.1%) followed by placing the device flat on the desk with back support (41.9%). After recoding the variables, we found that most respondents use their devices with a tablet stand (63.5%) and followed by placing them
flat on a desk (49.5%). 27.6% of the respondents do not have any back support when sitting at a desk. (See Table 2)

**Risk factors associated with current symptoms and with symptoms during device use**

Chi-square analysis identified only two significant risk factors associated with current symptoms: role (faculty, staff, alumni, and students) ($p = 0.041$) and symptom during use ($p < 0.001$). Analysis also found that women tend to have more current musculoskeletal symptoms than men ($p = 0.054$). (See Table 3)

For risk factors associated with symptoms during the use of tablet computers, the results showed that female gender ($p = 0.019$) and role ($p = 0.022$) are significant factors. For risk factors related to usage habits, typical hours of usage exhibited a trend of positive association with symptoms during use ($p = 0.075$). When examining risk factors while sitting, sitting without back support ($p = 0.016$) and sitting with the device in lap ($p = 0.002$) are significant positional scenarios associated with symptoms during use. When sitting in a chair at a desk, placing the device flat on the desk surface tends to have an association with symptom during use ($p = 0.053$) (See Table 4). These potential risk factors in sitting postures would be further examined in the multiple logistic regression analysis using likelihood ratio with the forced entry procedure. Interestingly, we also found some general postures, including lying on the sides ($p = .002$) and lying on the back ($p = .016$) are significantly associated with symptoms during use. Since the primary
interest is in sitting postures, these two variables were not further included in the regression model.

**Gender Differences in Symptoms, Device Usage Behavior, and Postural Factors**

Gender differences in symptoms during device usage were observed (p = 0.019): 70.1% of the female respondents reported to have musculoskeletal symptoms during device usage, in comparison to 29.9% of the male respondents. Women (75.7%) have significantly more symptoms at the upper back and shoulder regions during device use than men (24.3%) (p = 0.014) (See Table 1B).

**Identify Significant Predictors in Sitting Postures for Symptoms during Device Use:**

**Multiple Logistic Regression**

The regression model includes gender, role, typical device usage per day, and sitting postures on a chair (with back support, without back support, and device in lap) and at a desk (device placing flat on surface) to investigate the association between various sitting postures and symptoms during use. The model was significant ($\chi^2(9)=36.003$, $p < .001$) and the Hosmer and Lemeshow test indicated a good model fit ($\chi^2(8)=7.601$, $p = .473$). Gender was shown to be a significant predictor (Odd Ratio = 2.183, 95% CI [1.276, 3.736], $p = 0.004$). Sitting in a chair without back support (Odd Ratio = 2.821, 95% CI [1.341, 5.934], $p = 0.006$) is the only significant postural factor among all the sitting postures included. When controlling for the investigated sitting postures in the model, the odds of having symptoms during use for individuals who sit in a chair without support is 2.821 times the odds for those with back support. Also, the odds for women to
have symptoms during use are 2.183 times the odds for men. Spending more than 3 hours per day using the device seemed to be associated with symptoms during use (p = 0.064). For sitting postures, we have identified specific postural factors associated with symptoms during the use of tablet computers, including sitting without back support (p= 0.016) and sitting with device in the lap (p= 0.002) based on Chi-square analyses. A multiple logistic regression analysis further demonstrated that female gender (p=0.004) and sitting in a chair without back support (p=0.006) are the predictors of experiencing symptoms during the use of tablets.

**Discussion**

With the increasing popularity of touch-screen tablet computers for personal, school, and even employment usage, it is pertinent to address the risk factors associated with musculoskeletal symptoms in the neck and upper extremities during the use of these devices. Our study has revealed that females and individuals with current musculoskeletal symptoms are more likely to be at risk for neck and upper extremity symptoms during use of touch-screen tablet computers. Another significant risk factor associated with symptoms during use is female gender. In regards to sitting positions, sitting without back support and sitting with the device in the lap were significantly associated with symptoms. After considering the possible interactions among the risk factors in the regression model, sitting without back support is the strongest postural predictors for symptoms during use. In addition, we found that some other postures, including lying on either side and lying on the back, were also associated with symptoms during use in the univariate model.
From our current survey study, we have discovered that females are significantly more likely to have symptoms during use, especially in the neck and upper extremity regions. This finding was consistent with the current literature for neck and shoulder symptoms. For example, according to the data from Stockholm Public Health Cohort, the one-year prevalence of neck pain was 25% for women and 16% for men. Also, women are more likely to develop neck pain than men and less likely to recover\textsuperscript{22}. A recent review article regarding 10 years of research, discussed comprehensive biopsychosocial factors related to gender differences in pain perception\textsuperscript{23}. Biologically, the authors summarize that women are more likely to present allodynia and secondary hyperalgesia, indicating increased central sensitization, while the hormonal and physiological factors shows either small magnitude in gender differences or inconsistent findings. From psychosocial perspectives, pain coping strategies and gender role expectancies may partly explain gender-related differences in pain sensitivity. Finally, past history, such as recent pain episodes and the familial pain model may alter pain sensitivity in women, but not in men. However, some factors still remain understudied\textsuperscript{23}.

There have also been a small number of laboratory studies that have examined the gender and anthropometric differences in upper extremity biomechanics. It has been shown that in the workplace women assume neck flexion more often. These factors (females and neck flexion) are significant predictors of musculoskeletal symptoms\textsuperscript{24}. For office workers, Karlqvist and Bernmark examined computer mouse tasks and reported more extreme postural positions in female computer operators who are of shorter stature and narrow-shouldered\textsuperscript{25}. Wahlstrom et al. presented with similar findings: women worked with greater ulnar deviation and greater range of motion and had higher wrist
velocity when using a computer mouse compared to males. They postulated those findings may be due to women’s smaller stature, lower muscular strength of women and anthropometrics differences which influence biomechanical loads. Furthermore, Won et al., compared applied forces among computer tasks, upper extremity muscle activities and upper extremity postures between genders, and also explored the associations of the biomechanical factors and anthropometry. The results indicate when typing, women have significantly higher normalized keyboard forces than men and they tend to have higher muscle activities, and less neutral shoulder postures, particularly for external rotation of the shoulder. The muscle activities and shoulder postures were also higher for the office workers with smaller stature. In addition, the study found shoulder width and arm length were significantly, negatively correlated with typing forces, muscle activation levels, and postural measurements. For example, individuals with small shoulder width have significantly higher Trapezius muscle activities, more external rotation of the shoulder, and more range of motion in shoulder flexion and the wrist joint. Finally, the authors suggest anthropometric differences could partly explain the differences appeared between genders. Also, differences of muscle strength could explain the differences in normalized forces and muscle activities between genders. Finally, considering that women typically are smaller in stature around the shoulder and arms than men, muscle activity in the arms and shoulder affect postural accommodations.

For individuals performing computer related activities, one previous study has suggested that prolonged sitting and neck in forward flexion are risk predictors of neck pain. Neck flexion postures can lead to an increase in gravitational load moment, which increases cervical extensor muscle activity and causes strain on the neck extensors. Our
study revealed that sitting without back support, resulting in a slumped position, during device use was identified as a significant factor for developing musculoskeletal symptoms. In a slump sitting position, greater cervical and thoracic extensor activities are required to support the head in the forward position and the combination of neck flexion and cervical extensor activities may produce specific stress regions and cause postural neck pain. On the other hand, sitting postures that offer support to the lumbo-pelvic region in a neutral position significantly reduces the levels of the cervical extensor activities that are associated with prolonged neck flexion and forward neck posture. In addition, a recent study, utilizing a sophisticated model of neck musculature, concluded that positions that cause the gaze angle to be less than 45 degrees from neutral can cause significant increases in strain on neck extensors and should be avoided. In our study, by placing the device in the lap or flat on the desk it is reasonable to postulate that either of these positions could result in excessive gaze angle and neck flexion, which may lead to musculoskeletal discomfort during use. Thus, further investigations are required in the future studies.

Our data showed that using the tablet computer while lying on the side or on the back was significantly associated with neck and shoulder symptoms. This was in agreement with previous findings that non-neutral joint angles from non-desk usage of laptop computers can lead to greater levels of discomfort. Additionally, sustained non-neutral joint angles during laptop use has also been reported to exacerbate symptoms of in the neck and upper back. In our study, the side lying postures in the survey demonstrate non-neutral joint angles in bilateral upper extremities and cervical spine.
With this posture, passive structures are at risk of sustained forces that could lead to symptoms of discomfort or impaired neuromuscular control.

According to the evidences above, we suggest tablet computer users adopt a proper back-supported sitting position with less neck flexion and avoid prolonged usage in order to prevent symptoms in neck and shoulder regions due to potential mechanical stress and muscular imbalance. Also, the side lying posture, recognized as a significant risk factor for symptoms during use, needs to be prevented since it could place the cervical spine and upper extremities in non-neutral joint angles and therefore, cause musculoskeletal discomforts, especially during long sustained usage. More biomechanical investigations on the side lying posture and symptoms for tablet computer users are required in future studies.

This is the first study, to our knowledge, that assesses prevalence and risk factors of neck and upper extremity symptoms during the use of touch-screen tablet computers. While the results were informative, the observational nature of the design prevented direct inference of our results. This study had a number of limitations: first, we could not control for unknown confounding factors that may contribute to risk factors being surveyed such as: previous injury, repetitive activities, exposure to other technology, and sleep positions. Second, there may have been a gender bias in this survey study since there were more female respondents.

For future research areas of interest should continue to focus on current symptoms prior to device use, symptoms during device use, (postures/behaviors with use, and specific anatomical structures involved during use and how these structures may differ
from males on an anatomical and physiological level. We also postulate that other habits/behaviors/lifestyle choices [not related to device use] between the male and female genders may play a role in females having higher incidences of symptoms. For example, it is of interest to investigate the health status of the survey respondents and whether daily fitness plays a role in respondents having symptoms.

**Conclusion**

This study has gained valuable information regarding tablet computer usage patterns and symptoms during use. Being female and sitting without back support are shown as the significant factors most associated with symptoms during tablet computer use in the regression model. Touch-screen tablet computers are useful tools incorporated into our daily lives. It has become apparent that there are potential physical implications with tablet computer use. As discussed, tablet computer users alter their postures that result in a less neutral spine position. Musculoskeletal stresses unique to tablet computer users vary from those who use desktop and laptop computer users, thus we cannot solely rely on research focused on the musculoskeletal stresses of laptop users as a guideline for tablet computer users. Additional research should further investigate touch-screen tablet computer user risk factors: cervical and upper extremity biomechanics of usage postures, anatomical structures implicated in symptoms during use, symptoms with prolonged usage, and gender differences among device usage. Our findings are preliminary in nature and future research that recommends appropriate ergonomic solutions may be useful in preventing associated symptoms.
Appendix 1: Sample postures and symptom locations
Appendix 2: Full Survey

Survey Disclosure Statement

TITLE: Musculoskeletal Symptoms of the Neck and Shoulder in Users of Touchscreen Devices

INVESTIGATOR(S) AND CONTACT PHONE NUMBER: Dr. Szu-Ping Lee (702-895-3086)

Purpose of the study: To determine the relation between touchscreen tablet usage and shoulder and neck symptoms

You can participate in the study if you are:
1. At least 18 years old
2. Willing to participate

If you volunteer to participate in this study, you will complete a multiple choice survey that takes about 3 minutes of your time.

This survey study includes minimal risks.

Your participation in this study is voluntary. You may withdraw at any time. If you have any question about the study, please feel free to contact the researcher.

For questions regarding the rights of research subjects, any complaints or comments regarding the manner in which the study is being conducted you may contact the UNLV Office of Research Integrity – Human Subjects at 702-895-2794, toll free at 877-895-2794, or via email at IRB@unlv.edu.

Participant Consent:
I have read the above information and agree to participate in this study. I am at least 18 years of age.

Musculoskeletal Symptoms of Neck & Upper Extremity in Touch Screen Tablet Users

Q1. What is your age?
Q2. What is your gender?

- Male
- Female
- Prefer not to answer

Q3. What is your role at the University of Nevada, Las Vegas?

- Student
- Faculty
- Staff

Q4. Do you currently have any feelings of discomfort in your neck, shoulder, arm, and/or hand?

- Yes
- No

Q5. Rate your current level of discomfort or pain on a scale of 0-10.
(use the image below as guidance: 0 being no discomfort/pain, 10 being the worst discomfort/pain ever experienced)
Q6. Do you use a touch-screen tablet device? (e.g. iPad)

- Yes
- No

Q7. What size tablet(s) do you own? Please select all that apply.

- Large Tablet (9-10" ex: iPad)
- Medium Tablet (7-8" ex: Amazon Kindle Fire, iPad Mini)
- Small Tablet (4-6" ex: Samsung Galaxy Note)

Q8. On a typical day in the last week, how many hours have you used your tablet(s)?

- Less than 1 hour
- 1-2 hours
- 2-3 hours
- 3-4 hours
- 4-5 hours
- 5-6 hours
- Greater than 6 hours

Q9. Where do you typically use your tablet(s)? Please select all that apply.

- Work
Q10. Please use the images below as reference. In what position(s) do you usually assume when using your tablet(s)? Please select all that apply.

- ☐ A - Standing
- ☐ B - Sitting on floor
- ☐ C - Sitting in a chair or on a couch
- ☐ D - Lying on your side
- ☐ E - Lying on stomach
- ☐ F - Lying on back
Q11. Please use the images below as reference.
When using your tablet while sitting in a chair (not at a desk), which position(s) do you usually assume? Please select all that apply.

- A - With back support and tablet in lap
- B - No back support and tablet in lap
- C - With back support and using a tablet stand
- D - No back support and using a tablet stand
- E - With back support and holding tablet with hands only
- F - No back support and holding tablet with hands only
- I do not use my tablet when sitting in a chair.

Q12. Please use the images below as reference.
When using your tablet while sitting at a desk/table, what position(s) do you usually assume?
Please select all that apply.

- A - Tablet flat on desk/table with back support
- B - Tablet flat on desk/table with no back support
- C - Tablet on stand on desk/table with back support
- D - Tablet on stand on desk/table with no back support
- I do not use my tablet when sitting at a desk/table.

**Q13.** How do you **MOST** often hold your tablet?

- One handed
- Both hands
- No hands - Device(s) placed on support surface

**Q14.** Do you use an external keyboard with your tablet?

- Yes
- No
Q15. During tablet use, have you ever experienced any feelings of discomfort in your neck, shoulder, arm, wrist, and/or hand?

☐ Yes
☐ No

Q16. During tablet use, how long does your discomfort last?

☐ Less than 30 min
☐ 30 min to 1 hr
☐ 1-2 hrs
☐ Over 2hrs

Q17. When using your tablet, what type of discomfort do you experience? Please select all that apply.

☐ Stiffness
☐ Soreness
☐ Aching or pain
☐ Tingling or numbness
☐ Cramping
Q18. Base on your response in the previous question, rate your **TYPICAL** level of discomfort during tablet use on a scale of 0-10.
(Use the image above as guidance: 0 being no discomfort/pain, 10 being the worst discomfort/pain ever experienced)


Q19. Rate your **MOST SEVERE** level of discomfort during tablet use on a scale of 0-10.
(Use the image above as guidance: 0 being no discomfort/pain, 10 being the worst discomfort/pain ever experienced)


Q20. Using the image below as guidance.
In which area(s) do you experience discomfort? Please select all that apply.

- A - Head
- B - Neck
- C - Upper back and shoulder
- D - Arm and hand
Q21. Does your discomfort from tablet use affect your sleep?
- Yes
- No

Q22. Do you usually stop using your tablet because of your discomfort?
- Yes, I stop until the discomfort goes away
- No, I continue regardless
Table 1A: Descriptive statistics for demographics

<table>
<thead>
<tr>
<th>Total Percentage Distribution</th>
<th>Total %</th>
<th>(Frequency)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (years):</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• 18-25</td>
<td>60.2</td>
<td>248/412</td>
</tr>
<tr>
<td>• 26-39</td>
<td>19.4</td>
<td>80/412</td>
</tr>
<tr>
<td>• 40-59</td>
<td>16.0</td>
<td>66/412</td>
</tr>
<tr>
<td>• 60 &amp; older</td>
<td>4.4</td>
<td>18/412</td>
</tr>
<tr>
<td><strong>Role:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Student</td>
<td>68.9</td>
<td>284/412</td>
</tr>
<tr>
<td>• Faculty</td>
<td>12.4</td>
<td>51/412</td>
</tr>
<tr>
<td>• Staff</td>
<td>10.4</td>
<td>43/412</td>
</tr>
<tr>
<td>• Alumni</td>
<td>7.0</td>
<td>29/412</td>
</tr>
<tr>
<td><strong>Tablet Holding Pattern:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• One handed</td>
<td>31.7</td>
<td>100/315</td>
</tr>
<tr>
<td>• Both hands</td>
<td>39.4</td>
<td>124/315</td>
</tr>
<tr>
<td>• No hands – Device on support surface</td>
<td>28.9</td>
<td>91/315</td>
</tr>
<tr>
<td><strong>External Keyboard Use:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• No</td>
<td>73.3</td>
<td>231/315</td>
</tr>
<tr>
<td>• Yes</td>
<td>26.7</td>
<td>84/315</td>
</tr>
<tr>
<td><strong>Usage Hours:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Less than 3</td>
<td>57.1</td>
<td>180/315</td>
</tr>
<tr>
<td>• 3-6</td>
<td>23.2</td>
<td>73/315</td>
</tr>
<tr>
<td>• Greater than 6</td>
<td>19.7</td>
<td>62/315</td>
</tr>
<tr>
<td><strong>Current Symptoms:</strong></td>
<td>60.0</td>
<td>247/412</td>
</tr>
<tr>
<td><strong>Symptoms During Use:</strong></td>
<td>67.9</td>
<td>214/315</td>
</tr>
<tr>
<td><strong>Regions of Musculoskeletal Symptoms During Tablet Use:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Head</td>
<td>15.0</td>
<td>32/214</td>
</tr>
<tr>
<td>• Neck</td>
<td>84.6</td>
<td>181/214</td>
</tr>
<tr>
<td>• Upper-back/Shoulder</td>
<td>65.4</td>
<td>140/214</td>
</tr>
<tr>
<td>• Arm/Hand</td>
<td>33.6</td>
<td>72/214</td>
</tr>
<tr>
<td><strong>Types of Symptoms:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Aching</td>
<td>42.5</td>
<td>91/214</td>
</tr>
</tbody>
</table>
- Cramping 20.6 44/214
- Tingling/Numbness 27.6 59/214
- Soreness 48.1 103/214
- Stiffness 74.3 159/214

Typical Level of Symptoms:
- Mild (0-3) 73.7 154/209
- Medium (4-6) 25.3 53/209
- Severe (7-10) 1.0 21/209*

Note. * missing data n= 5
Composition of Samples: Noticed that the total frequency of participants decreases from n=412 to n=315 to n=214. This is due to the nature of the survey. Initially 412 participants started the survey, if participants answered “no” to question 6 (“Do you use a touch-screen tablet device?”) the survey would end. After question 6, 315 participants were left to continue, if participants answered “no” to question 15 (“During tablet use, have you ever experienced any feelings of discomfort in your neck, shoulder, arm, wrist, and/or hand?”) the survey would end. After question 15, this left 214 participants that answered all 22 questions.

Table 1B: Descriptive statistics for demographics by gender

<table>
<thead>
<tr>
<th>Percentage Distribution by Gender</th>
<th>Female %</th>
<th>Male %</th>
<th>Chi-square Statistics</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>67.1</td>
<td>32.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tablet Holding Pattern</td>
<td></td>
<td></td>
<td>0.79</td>
<td>0.674</td>
</tr>
<tr>
<td>• One handed</td>
<td>65.7</td>
<td>34.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Both hands</td>
<td>63.4</td>
<td>36.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• No hands – Device on support surface</td>
<td>69.2</td>
<td>30.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>External Keyboard Use</td>
<td></td>
<td></td>
<td>0.96</td>
<td>0.328</td>
</tr>
<tr>
<td>• No</td>
<td>67.4</td>
<td>32.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Yes</td>
<td>61.4</td>
<td>38.6</td>
<td></td>
<td></td>
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<tr>
<td>Usage Hours:</td>
<td></td>
<td></td>
<td>1.72</td>
<td>0.424</td>
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<tr>
<td>• Less than 3</td>
<td>66.1</td>
<td>33.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• 3-6</td>
<td>70.4</td>
<td>29.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Greater than 6</td>
<td>59.7</td>
<td>40.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current symptoms:</td>
<td>70.7</td>
<td>29.3</td>
<td>3.73</td>
<td>0.054</td>
</tr>
<tr>
<td>Symptoms during use:</td>
<td>70.1</td>
<td>29.9</td>
<td>5.51</td>
<td>0.019</td>
</tr>
<tr>
<td>Regions of musculoskeletal symptoms during tablet use:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

29
<table>
<thead>
<tr>
<th>Postural Factor</th>
<th>Total Percentage Distribution</th>
<th>Percentage Distribution by Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total %</td>
<td>(Frequency)</td>
</tr>
<tr>
<td>Head</td>
<td>65.6</td>
<td>34.4</td>
</tr>
<tr>
<td>Neck</td>
<td>68.0</td>
<td>32.0</td>
</tr>
<tr>
<td>Upper-back/Shoulder</td>
<td>75.7</td>
<td>24.3</td>
</tr>
<tr>
<td>Arm/Hand</td>
<td>69.4</td>
<td>30.6</td>
</tr>
</tbody>
</table>

Table 2: Percentage Distribution in Pattern of Postural Factors

<table>
<thead>
<tr>
<th>Use Position:</th>
<th>Total Percentage Distribution</th>
<th>Percentage Distribution by Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total %</td>
<td>(Frequency)</td>
</tr>
<tr>
<td>Sitting on Floor</td>
<td>23.8</td>
<td>75/315</td>
</tr>
<tr>
<td>Sitting on Chair/Couch</td>
<td>84.4</td>
<td>266/315</td>
</tr>
<tr>
<td>Lying on Sides</td>
<td>35.9</td>
<td>113/315</td>
</tr>
<tr>
<td>Lying on Stomach</td>
<td>31.7</td>
<td>100/315</td>
</tr>
<tr>
<td>Lying on Back</td>
<td>50.5</td>
<td>159/315</td>
</tr>
</tbody>
</table>

Use Positions Sitting in a Chair:

<table>
<thead>
<tr>
<th>Use Position:</th>
<th>Total Percentage Distribution</th>
<th>Percentage Distribution by Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total %</td>
<td>(Frequency)</td>
</tr>
<tr>
<td>With Back Support</td>
<td>84.8</td>
<td>267/315</td>
</tr>
<tr>
<td>Without Back Support</td>
<td>25.4</td>
<td>80/315</td>
</tr>
<tr>
<td>Device in Lap</td>
<td>46.0</td>
<td>145/315</td>
</tr>
<tr>
<td>Device on stand</td>
<td>34.6</td>
<td>109/315</td>
</tr>
<tr>
<td>Holding Device with Hands</td>
<td>59.7</td>
<td>188/315</td>
</tr>
</tbody>
</table>

Use Positions Sitting in a Chair at a Desk:

<table>
<thead>
<tr>
<th>Use Position:</th>
<th>Total Percentage Distribution</th>
<th>Percentage Distribution by Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total %</td>
<td>(Frequency)</td>
</tr>
<tr>
<td>Chair With Back Support</td>
<td>79.7</td>
<td>251/315</td>
</tr>
<tr>
<td>Chair Without</td>
<td>27.6</td>
<td>87/315</td>
</tr>
<tr>
<td>Back Support</td>
<td>% With current symptoms</td>
<td>% Without current symptoms</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-------------------------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>Device Flat on Desk</td>
<td>49.5</td>
<td>156/315</td>
</tr>
<tr>
<td>Device on Stand</td>
<td>63.5</td>
<td>200/315</td>
</tr>
</tbody>
</table>

Table 3: Risk factors associated with current symptoms

<table>
<thead>
<tr>
<th>% With current symptoms</th>
<th>% Without current symptoms</th>
<th>Chi-square Statistics</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Role:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student</td>
<td>57.4</td>
<td>42.6</td>
<td>8.23</td>
</tr>
<tr>
<td>Faculty</td>
<td>54.9</td>
<td>45.1</td>
<td></td>
</tr>
<tr>
<td>Staff</td>
<td>76.7</td>
<td>23.3</td>
<td></td>
</tr>
<tr>
<td>Alumni</td>
<td>72.4</td>
<td>27.6</td>
<td></td>
</tr>
</tbody>
</table>

| Gender:                  |                             |                       |         |
| Female                  | 63.3                        | 36.7                  | 3.73    | 0.054  |
| Male                    | 53.3                        | 46.7                  |         |        |

| Symptoms During Use:     |                             |                       |         |
| Yes                     | 72.4                        | 27.6                  | 3.69    | <0.001 |
| No                      | 36.6                        | 63.4                  |         |        |

Table 4: Risk factors associated with symptoms during device use

<table>
<thead>
<tr>
<th>% With Current Symptoms</th>
<th>(Frequency)</th>
<th>% Without Current Symptoms</th>
<th>(Frequency)</th>
<th>Chi-square Statistics</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Role:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student</td>
<td>73.4</td>
<td>152/207</td>
<td>26.6</td>
<td>55/207</td>
<td>9.58</td>
</tr>
<tr>
<td>Faculty</td>
<td>54.5</td>
<td>24/44</td>
<td>45.5</td>
<td>20/44</td>
<td></td>
</tr>
<tr>
<td>Staff</td>
<td>64.9</td>
<td>24/37</td>
<td>35.1</td>
<td>13/37</td>
<td></td>
</tr>
<tr>
<td>Alumni</td>
<td>52.0</td>
<td>13/25</td>
<td>48.0</td>
<td>12/25</td>
<td></td>
</tr>
</tbody>
</table>

<p>| Gender:                 |             |                             |             |                        |         |
|                         |             |                             |             |                        | 5.51    | 0.019  |</p>
<table>
<thead>
<tr>
<th></th>
<th>Women</th>
<th>Men</th>
<th>Usage Hours:</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Women</td>
<td>72.8</td>
<td>150/206</td>
<td>27.2</td>
<td>56/206</td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>59.8</td>
<td>64/107</td>
<td>40.2</td>
<td>43/107</td>
<td></td>
</tr>
<tr>
<td><strong>Usage Hours:</strong></td>
<td>5.18</td>
<td>0.075</td>
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<tr>
<td>Less than 3</td>
<td>62.8</td>
<td>113/180</td>
<td>37.2</td>
<td>67/180</td>
<td></td>
</tr>
<tr>
<td>3-6</td>
<td>74.0</td>
<td>54/73</td>
<td>26.0</td>
<td>19/73</td>
<td></td>
</tr>
<tr>
<td>Greater than 6</td>
<td>75.8</td>
<td>47/62</td>
<td>24.2</td>
<td>15/62</td>
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</tr>
<tr>
<td><strong>Use Positions:</strong></td>
<td></td>
<td></td>
<td>9.48</td>
<td>0.002</td>
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</tr>
<tr>
<td>Lying on Sides</td>
<td>78.8</td>
<td>89/113</td>
<td>21.2</td>
<td>24/113</td>
<td></td>
</tr>
<tr>
<td>Lying on Back</td>
<td>74.2</td>
<td>118/159</td>
<td>25.8</td>
<td>41/159</td>
<td></td>
</tr>
<tr>
<td><strong>Sitting in a Chair:</strong></td>
<td>5.81</td>
<td>0.016</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Without Back Support</td>
<td>78.8</td>
<td>63/80</td>
<td>21.3</td>
<td>17/80</td>
<td></td>
</tr>
<tr>
<td>Device in Lap</td>
<td>76.6</td>
<td>111/145</td>
<td>23.4</td>
<td>34/145</td>
<td></td>
</tr>
<tr>
<td><strong>Sitting at a Desk:</strong></td>
<td>3.75</td>
<td>0.053</td>
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</tr>
<tr>
<td>Device Flat on Desk</td>
<td>73.1</td>
<td>114/156</td>
<td>26.9</td>
<td>42/156</td>
<td></td>
</tr>
</tbody>
</table>
References


17. Rainie L, Smith A. Tablet and E-reader ownership update. 2013; The number of Americans ages 16 and older who own tablet computers has grown to 35%, and the share who have e-reading devices like Kindles and Nooks has grown to 24%. Overall, the number of people who have a tablet or an e-book reader among those 16 and older now stands at 43%. Available at: http://www.pewinternet.org/2013/10/18/tablet-and-e-reader-ownership-update/. Accessed October 18, 2013.
CURRICULUM VITAE

Betina Bair, SPT, BA

- **Education**
  - University of Nevada, Las Vegas
  - University of Nevada, Las Vegas
    - Bachelor of Arts, Communication Studies. May 2003

- **Clinical Experience**
    - Clinical internship: Adult outpatient orthopedics
  - Cleveland Clinic Lou Ruvo Center for Brain Health: Las Vegas, Nevada. October-December 2014
    - Clinical internship: Outpatient neurological rehabilitation
  - University Medical Center: Las Vegas, Nevada July-September 2014
    - Clinical internship: Inpatient acute care
    - Clinical internship: Adult outpatient orthopedics

- **Research Experience**
  - Student worker, trainer, data entry, data analysis: “Effects of lower extremity strength training on knee osteoarthritis in obese women over 65: a randomized control trial.” Sept 2013 – March 2014

Mariana Gama, SPT, BS

- **Education**
  - University of Nevada, Las Vegas
  - Universidade Federal de Santa Catarina
    - Bachelor of Biological Sciences, March 2009

- **Clinical Experience**
  - Scripps Green, San Diego CA. January to May 2015
    - Clinical internship: Acute Care
  - High Desert Medical Center, Twentynine Palms CA. October to December 2014
    - Clinical internship: Adult outpatient orthopedics
  - Sunrise Hospital and Medical Center, Las Vegas NV. July to September 2014
    - Clinical internship: Inpatient Acute Rehabilitation
  - Matt Smith’s Physical Therapy, Las Vegas NV. July to August 2013
    - Clinical internship: Adult outpatient orthopedics

- **Research Experience**
  - Scientific Research in a Neurobiology lab at Universidade Federal de Santa Catarina, Brazil: researched pharmacological alternatives for Parkinson's patients. (2006-2009)
  - Scientific Research in Behavioral Genetics at Universidade Federal de Santa Catarina, Brazil: researched genetics components of anxiety, depression and stress. (2005-2006)
Marissa Toberman, SPT, BS

- **Education**
  - University of Nevada, Las Vegas
  - University of Nevada, Las Vegas
    - Bachelor of Science, Kinesiology. May 2012

- **Clinical Experience**
  - Sunrise Hospital: Las Vegas, Nevada. January – April 2015
    - Clinical internship: Acute Care
  - Children’s Therapy Center: Las Vegas, Nevada. October – December 2014
    - Clinical internship: Outpatient Pediatrics
  - Mountain View Hospital: Las Vegas, Nevada July – September 2014
    - Clinical internship: Inpatient Acute Rehabilitation
    - Clinical internship: Adult outpatient orthopedics

- **Research Experience**
  - Participant for Nancy Estocado & Dr. Daniel Young’s research study (Sunrise Hospital & UNLVPT) on “Reliability and Validity Testing of a New Tool for Measuring Wound Healing” (2014)
  - Participant in UNLV Kinesiology Department’s “1 Repetition Maximum Study” (2013)
  - Participant in UNLV DPT’s “Effects of Dry Needling the Multifidus on the Cross Sectional Area of the Transverse Abdominis” (2012)