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Original Article

Exploring Risk of Posture and Musculoskeletal Disorders among Smartphone Addicted Youth: a Protocol Paper

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ABSTRACT

Introduction: Smartphones with rapid advancement in telecommunication technology causing high usage leads to addiction, especially among youth. Concerning health, smartphone addiction influences posture causing neck-shoulder pain. However, the mechanism of how smartphone addiction causes pain related to posture control is still doubtful. Anticipatory feed-forward motor control mechanism has proposed that smartphone usage is a static low-level activity influenced by muscle fatigue and discomfort. Therefore, this study aimed to explore neck-shoulder muscle fatigue, particularly at the upper trapezius about smartphone addiction behaviors and adopted posture while using smartphones among youth. This study aims to investigate the relationship between smartphone addiction, risk of posture and the relationship between trapezius muscle fatigue, and neck-shoulder pain among youth.

Methods: A cross-sectional study design will be conducted through convenient sampling among students at secondary schools in Malaysia. The Smartphone Addiction Scale, Rapid Assessment Upper Limb, Nordic Musculoskeletal Questionnaire and Electromyogram will be used as outcomes tools.

Discussion: This study investigates the risk of smartphones in terms of duration usage among adults. Fatigue over the upper trapezius muscle has not yet been investigated among youth which will provide fundamental findings on how faulty posture during smartphone usage might cause neck pain.

Keywords: Musculoskeletal discomfort, Risk of posture, Smartphone addiction, Youth

Introduction

Smartphones with rapid advancement in telecommunication technology and their application cause high demand and usage. Smartphones have rapidly become the preferred device for most Malaysians to remain connected. Smartphone users continue to rise from 68.7% in 2016 to 75.9% in 2017 as a result of affordable devices and data packages, aggressive promotions by service providers, increasing demand of use and reliance on smartphone-based applications.[1]

High usage of smartphones causes addiction, especially among youth.[2] Among the population according to age groups, adolescents were addicted to smartphones as a result of demand for the internet, social media, games, communication and entertainment. Therefore, smartphone addiction was shown to be prevalent among adolescents, which was reported recently in Korea, Singapore and New Zealand.[2,3,4]

However, excessive use of mobile phones causes

musculoskeletal health problems. Smartphone addiction found to be associated with neck pain and shoulder pain.[5] Concerning health, a smartphone is one of the devices that influence posture and body mechanics causing upper body pain such as neck pain and shoulder pain.[6] The static and awkward posture during smartphone usage also produces stress on the cervical spine, changing the cervical curvature and pain threshold at the neck which contributes towards neck-shoulder pain and this musculoskeletal pain found to be associated with smartphone addiction.[6,7] Prolonged use of smartphone can lead to forwarding head posture (FHP), which can be accompanied by Guyon Canal Syndrome (GCS).[8]

A study by Lee et al. (2017) has similar findings on the effects of smartphone usage on musculoskeletal health. They reported that neck flexion is affected by posture while using a smartphone. Neck flexion in the standing position is larger than sitting. Neck flexion also was affected by smartphone usage duration.[9,10] Therefore, as usage time increases, the neck flexion angle increases which subsequently increases the risk of neck pain among smartphone users. They justified that these effects were caused by pain in the cervical erector spinae and increased upper trapezius activity, quantified using EMG. The adopted posture with forward head posture in adults increases upper trapezius muscle activity and worsens with longer smartphone usage. Higher mechanical loading and neck muscle control experienced with forward head posture contribute to a higher risk of neck pain. However, the study only investigated the risk of smartphones in terms of duration usage among adults. Fatigue over the upper trapezius muscle was also not yet investigated among youth which will provide fundamental findings on how faulty posture during smartphone usage caused neck pain.

The mechanism of how smartphone addiction causes pain in the neck and shoulder which is related to posture control is still doubtful.[11] Anticipatory feed-forward motor control mechanism has proposed that movement control following a static low-level activity is influenced by muscle fatigue and discomfort.[11,12] Smartphone usage among school students should be integrated with awareness of health concerns through social responsibility and research opportunities. Enhancing awareness of the effect of excessive usage of smartphones and the internet to mediate the upcoming irreversible risk is crucial in promoting healthy lifestyles among youth. This study aims to evaluate smartphone addiction behaviors, the posture adopted, muscle activity and muscle fatigue in relation to posture adoption while using smartphones among youth.

The study objectives are:

i. To determine smartphone addiction behaviors among youth at secondary schools.
ii. To evaluate the risk posture while using smartphones among youth at secondary schools.
iii. To investigate the relationship between smartphone addiction, risk of posture and musculoskeletal disorder.
iv. To determine the relationship between trapezius muscle fatigue, neck-shoulder pain and smartphone addiction among youth.

Methods

A cross-sectional design study will be conducted through Convenient sampling among students at a secondary school in Negeri Sembilan, Malaysia. This study considered a specific type of non-probability sampling method that relied on data collection from students who were available to be the data sources. Respondents will be screened for their eligibility before participation.

The inclusion criteria are secondary school students aged between 13-17 years old and using smartphones for at least 3 months. Respondents who have experienced injury less than six months ago or were suffering from any inflammatory, degenerative, or neuromuscular condition related to the upper extremity and neck for three months, undergo surgical procedures and rehabilitation and be unable to comprehend English or Malay will be excluded in this study which to minimized confounding factors.

Outcome tools:

Assessment tools used are the Smartphone Addiction Scale, Rapid Assessment Upper Limb and Nordic Musculoskeletal Questionnaire.

i. Smartphone addiction scale (SAS) was a scale for smartphone addiction that consisted of 6 factors and 33 items with a six-point Likert scale (1: ''strongly disagree'' and 6: ''strongly agree'') based on self-reporting. The six factors were daily-life disturbance, positive anticipation, withdrawal, cyber space-oriented relationship, overuse, and tolerance.

ii. Rapid Upper Limb Assessment (RULA) was a reliable tool to be used in assessing biomechanical and postural loading, particularly in the neck, trunk and upper limb. Participants' posture while using mobile phones has been observed and assessed without any instruction not to distract their concentration.[13]

Assessment of RULA involves 3 steps: scoring of working posture for each body part, grouping the body part posture and development of grand score. A score from 1 indicates the most neutral position to a range of 4 maximum score which indicates the worst position for each body part. Score A was presented as the combined individual scores for shoulder, elbow and wrist, and score B was calculated from neck, trunk, and legs. Muscle use and force exerted attributed a score of 1 and 0 respectively which represented both groups performed static posture and no adding load. These scores are added to each score of A and B to obtain scores C and D. The combination of scores C and D determined the 'grand score' which reflects the postural and musculoskeletal load. The total grand scores indicate work posture and load are acceptable (score 1 or 2), require investigation further (score 3 or 4), to investigate further and change soon (score 5 and 6), or to investigate and change immediately (score 7). The assessment was carried out using a worksheet.

Ergonomic exposures that might be influenced by smartphone usage were also investigated such as awkward body posture, static body posture, awkward grip, awkward hand movement, repetitive tasks, sitting, standing and usage of vibration mode. They were asked to rate the frequency of exposures during smartphone usage on a 5-Likert scale ranging from 0 = never (does not occur at all), 1 = occasional (1-2 times per day), 2 = often (3-5 times per day) and 3 = always (more than 5 times per day or continuously). Descriptive analysis has explained physical exposures and ergonomic risk by using frequency distribution. A frequency table was used to present the analysis of findings.

iii. The Nordic Musculoskeletal Questionnaire will be used to determine musculoskeletal symptoms that might be experienced by respondents. The questionnaire consists of 12 items. The survey questionnaire was divided into five sections including socio-demographic, physical exposures and musculoskeletal symptoms experienced by respondents. Physical exposures comprise eleven (11) physical factors including awkward body posture, static body posture, awkward grip, awkward hand movement, lifting load, pushing load, pulling load, repetitive task, sitting, standing and usage of vibrating tools to assess the physical exposures experienced by subjects. Body part-specific musculoskeletal symptoms will be determined by using a body map of nine anatomical body regions which evaluate discomfort, pain, and severe pain for the last 6 months. The frequency of musculoskeletal symptoms: never (does not occur at all), occasional (1-2 times per day), often (3-5 times per day) and always (more than 5 times per day or continuously) and severity of musculoskeletal symptoms: no discomfort (feel comfortable and no bodily distress), discomfort (feel uncomfortable), pain (aches, stiffness, numbness, tingling or burning sensations) and severe pain (extreme sensation of aches, stiffness, numbness, tingling or burning sensations that causing great bodily distress) were determined.

iv. Electromyogram (EMG) will be used for an experiment on experiment on muscle activity to be conducted. EMG assessment can be used to investigate the myoelectric manifestation of cervical muscle fatigue, analysis of cervical muscle

activation patterns and analysis of cervical neuromotor control. Analog data of muscle activity with sample rate up to 100-10 000Hz interfaced with a 6-channel signal amplifier with gain amplification of (8-500Hz and 15-500Hz) will be collected. The measurement will be performed by placing electrodes on the skin's surface and the electrical activity of upper trapezius muscles underneath will be recorded. Skin inspection will be demonstrated before the electrode placement to reduce the skin impedance and avoid noises on the EMG readings. The EMG electrodes paste directly on the upper trapezius muscle belly of both sides after careful palpation and parallel to its muscle fibers. The electrodes are fixed in bipolar with both active electrodes for measuring and ground electrodes for reference point.

The procedure for electrode placement is below:

a) Location of electrodes – electrodes will be placed at 50% on the line from the acromion to the spine on the seventh vertebrae (C7).
b) Orientation – in the direction of the line between the acromion and the spine on the seventh vertebrae (C7).
c) Reference electrode placement – on the spinous process of the seventh cervical or around the wrist.
d) Clinical test - elevate the acromion end of clavicle and scapula; extend and rotate head and neck toward the elevated shoulder with face rotated in the opposite direction.

Respondents will perform 3 trials of resisted Maximum Voluntary Isometric Contractions (MVC) and 1 trial of 20% MVC. Then 15 minutes of muscle activity will be taken for each subject. The frequency and variation of the EMG signal for baseline are to be calculated initially.

Later, the MVC and trail of 20% MVC readings is used to normalize the raw data. The raw data will be collected using offline mode which is later transferred into the software. Analog data of muscle activity with a 6-channel signal amplifier will be collected. The myo-electrical signal of the surface will be converted to analog data which is later converted to digital data at the signal analysis personal computer interface. Analysis of EMG will be conducted by using the amplitude probability distribution function (APDF) to evaluate the static, median, and peak levels of upper trapezius activities during activity. Fatigue analysis for upper trapezius muscles for each group of respondents will be determined.

Procedures of Study

Data collection requires a minimum of 1-2 days of working period for each school to complete 2 phases of the survey. A total of 750 respondents is required to participate. Data collection involves 3 phases.

The procedures of the study were divided into 3 phases (Figure 1). The details as below:

Phase 1 of data collection:
Students are required to complete a self-administered questionnaire:

i. Smartphone Addiction Questionnaire to determine the behaviors of smartphone addictions
ii. Nordic Musculoskeletal Questionnaire to investigate musculoskeletal pain they might experience within 3 months.

Phase 2 of data collection:
Posture assessment using Rapid Upper Limb Assessment (RULA) will be conducted by researchers to identify the level of postural risk while using a smartphone. Researchers will observe and assess respondents' posture without any instruction so as not to distract their concentration with smartphone activity. Subjects performed their favorable posture and usual norm with smartphones without any specific instruction.

Phase 3 of data collection:
A total of 25 respondents will be allocated using stratified random sampling for muscle activity testing using EMG assessment. The experiment aims to determine muscle activity during smartphone activity. EMG measurement will be performed by placing electrodes on the skin's surface and the activity of upper trapezius muscles underneath will be recorded. The procedure is non-invasive and does not require physical samples/body samples from respondents.

The researcher will apply a safe and non-invasive technique with a pair of electrodes over the bilateral upper trapezius because the upper trapezius muscles are the most superficial and palpable of neck muscles and major stabilizing muscles of the neck. At the end of phase 2, the findings for objectives 1, 2 & 3 will be obtained through descriptive analysis.

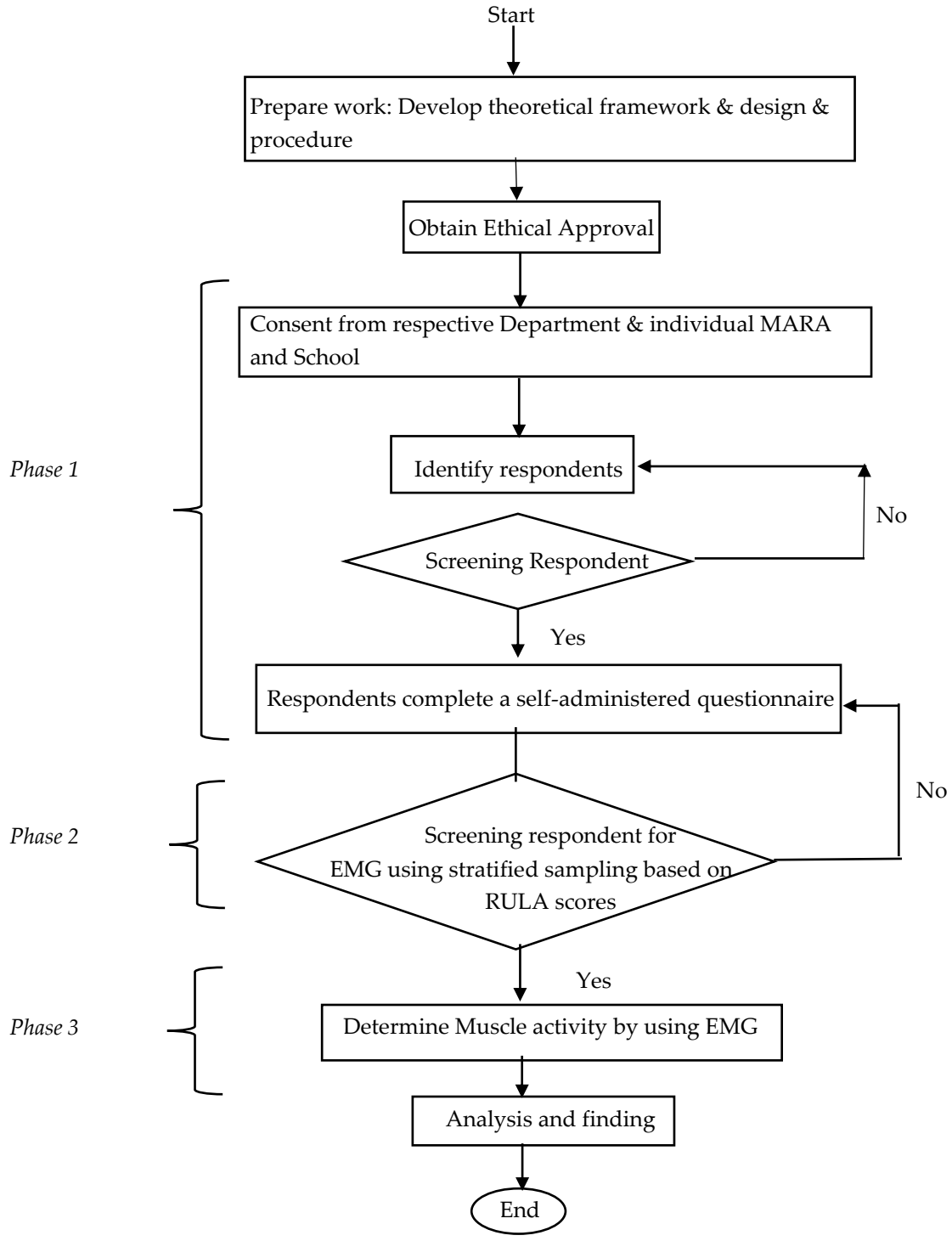

Figure 1: The research flow and phase of the data collection procedure

Data analysis

Descriptive analysis will be used to determine addictive behavior among secondary school students. To evaluate and investigate the relationship between addiction and risk of posture will be determined through the Chi-Square and Pearson Correlation analysis. The relationship between upper trapezius muscle fatigue and neck-shoulder pain will be determined through SPSS analysis by using Linear regression analysis. The

analysis will be conducted to assess the ability of upper trapezius muscle fatigue to predict neck-shoulder pain. At the end of this study, a regression model between upper trapezius fatigue and musculoskeletal neck-shoulder pain will be obtained.

Discussion

The findings from this study will contribute to new knowledge on why smartphone addiction impaired health, especially neck and shoulder pain. Evidence-based understanding of how musculoskeletal disorder is caused by smartphones would enhance awareness of smartphone usage, especially among youth. Ergonomic awareness of health is fundamental to overcoming the health problem specifically referring to the cause root of musculoskeletal disorders among youth. In Malaysia, a lack of ergonomic awareness is a great concern that contributes to musculoskeletal health complaints. The awareness of smartphone addiction is crucial among young as they are exposed to long duration of activity on social media and internet usage. Therefore, enhancing awareness of the effect of smartphone usage excessively which to mediate the upcoming irreversible risk is crucial in promoting a healthy lifestyle among youth. Musculoskeletal health impairment also contributes to increased medical expenditure. Awareness of the source of pain related to muscle fatigue among smartphone addicts for prevention measures would lower medical expenditure and enhance physical health. Research output will contribute towards Malaysian legislative efforts in health and education to minimize complaints of musculoskeletal problems among youth.

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References

1. Malaysia Communications and Multimedia Commission (MCMC). Annual report 2017. Malaysia Government, 2017. Available from: https://www.mcmc.gov.my/skmmgovmy/media/General/pdf/AR-2017-Eng.pdf
2. Haug S, Castro RP, Kwon M, Filler A, Kowatsch T, Schaub MP. Smartphone use and smartphone addiction among young people in Switzerland. Journal of Behavioural Addictions. 2015;4(4):299-307. Available from: https://pubmed.ncbi.nlm.nih.gov/26690625/
3. Lee H, Kim JW, Choi TY. Risk Factors for Smartphone Addiction in Korean Adolescents: Smartphone Use Patterns. Journal of Korean Medical Science. 2017;32(10): 1674. Available from: https://pubmed.ncbi.nlm.nih.gov/28875613/
4. Tang CSK, Koh YYW. Online social networking addiction among college students in Singapore: Comorbidity with behavioural addiction and affective disorder. Asian Journal of Psychiatry. 2017;25:175-8. Available from: https://pubmed.ncbi.nlm.nih.gov/28262144/
5. Kalirathinam D, Manoharlal MA, Mei C, Ling CK, Sheng TW, Jerome A et al. Association between the usage of Smartphone as the risk factor for the prevalence of upper extremity and neck symptoms among university students: A cross-sectional survey-based study. Research Journal of Pharmacy and Technology. 2017; 10(4): 1184. Available from: http://dx.doi.org/10.5958/0974-360X.2017.00213.X
6. Tonga E, Özgül B, Timurtas E, Can M, Hasırcı Y, Polat M. Evaluation of musculoskeletal complaints associated with smartphone use among university students and related risk factors. Proceedings-Poster Presentations. Health Professionals in Rheumatology Abstracts (FRI 0756-HPR). 16 June 2017. Available from: https://ard.bmj.com/content/76/Suppl_2/1504.1
7. Namwongsa S, Puntumetakul R, Neubert MS, Boucaut R. Factors associated with neck disorders among university student smartphone users. Work. 2018;61(3):367-78. Available from:

https://pubmed.ncbi.nlm.nih.gov/30373996/

8. Shinde S, Vaidya A, Bhore PR. Correlation between the Guyon Canal Syndrome and the Forward Head Posture in Prolonged Smartphone Users. International Journal of Occupational Safety and Health. 2022; 12(4), 276–83. Available from: https://doi.org/10.3126/ijosh.v12i4.42537

9. Nawawi R, Deros BM, Daruis DDI, Ramli A, Md Zain R. A Pilot Study on Work-Related Neck-Shoulder Pain among Sewing Machine Operators. Applied Mechanics and Materials. 2013;471:167–71. Available from: https://www.scientific.net/AMM.471.167

10. Lee S, Choi Y, Kim J. Effects of the cervical flexion angle during smartphone use on muscle fatigue and pain in the cervical erector spinae and upper trapezius in normal adults in their 20s. Journal of Physical Therapy Science. 2017; 29(5): 921-3. Available from: https://pubmed.ncbi.nlm.nih.gov/28603372/

11. Lee S, Lee D, Park J. Effect of the cervical flexion angle during smartphone use on muscle fatigue of the cervical erector spinae and upper trapezius. Journal of Physical Therapy Science. 2015;27(6):1847-9. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4499996/

12. Kim H, Kim J. The relationship between smartphone use and subjective musculoskeletal symptoms and university students. Journal of Physical Therapy Science. 2015;27(3):575-9. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4395668/

13. Kwon M, Lee JY, Won WY, Park JW, Min JA, Hahn C et al. Development and validation of a smartphone addiction scale (SAS). PloS One. 2013;8 (2). Available from: https://doi.org/10.1371/journal.pone.0056936