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Original Article

Smartphone addiction and its association with upper body musculoskeletal symptoms among university students classified by age and gender

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Abstract. [Purpose] The purposes of this study were to: 1) survey smartphone addiction among university students, 2) survey the prevalence of upper body musculoskeletal symptoms in relation to the respondents' sitting posture, and 3) determine the association between smartphone addiction and upper body musculoskeletal symptoms, classified by age and gender. [Participants and Methods] Two self-report questionnaires were employed to collect data from 2,645 university students in Chiang Mai, Thailand. [Results] Of 2,027 respondents (860 males and 1,167 females), the participants' ages ranged from 18 to 26 years with a mean age of 20.5 ± 1.38 years. The prevalence of smartphone addiction and upper body musculoskeletal symptoms among participants were 15.9% and 30%, respectively. Overall, the mean value of pain severity was 3.66 ± 1.67 out of 10 on the visual analog scale. Multivariate logistic regression analysis revealed that smartphone addiction (OR=6.05, 95% CI: 4.68–7.84), was significantly associated with upper-body musculoskeletal symptoms when adjusted by age and gender. [Conclusion] The prevalence of upper body musculoskeletal symptoms was relatively high, especially for female smartphone users and students aged over 20 years. These results suggest that smartphone addiction may be a potential risk factor for upper body musculoskeletal symptoms in university students.

Key words: Smartphone addiction, Musculoskeletal symptoms, University students

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INTRODUCTION

We are living in an era of globalization. The smartphone is one of the most important technologies that helps people connect with others, by providing an easy and fast way to communicate. The number of smartphone users has increased rapidly in recent years. Globally, there are 3.5 billion smartphone users at present with Thailand ranked first worldwide in terms of smartphone use[1, 2)]. In 2015, there were approximately 40 million smartphone users in Thailand[3)]. By 2020, it is predicted that a number of smartphone users will reach 52.71 million across the country[4)]. The users typically spend an average of 160 minutes daily on their devices[5)]. Smartphone users range in age, with children and adults of all ages using smartphones[6)]. Compared to other age groups, however, university students interact the most with smartphones[7)].

A typical posture when using a smartphone involves holding the device with one or both hands below eye level, looking down at the small visual display terminals, and using one's thumb to touch or swipe the screen. This pattern of use forces the user to adopt an awkward posture such as forward neck flexion, which is often maintained for long periods. Prolonged and frequent use of smartphones as well as repeated movement of the upper extremities in an awkward posture are the main

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contributing factors to the occurrence of musculoskeletal symptoms[8–12]. According to previous studies, the prevalence of musculoskeletal symptoms in at least one area among smartphone users ranged from 47.7% to 84.0%. The most common pain areas were the neck (67.8%), shoulders (54.8%) and upper back (24.5%)[10, 11, 13].

Today, smartphone addiction is a matter of concern in many countries. Based on behavioral characteristics, smartphone addiction is very similar to internet addiction which has been categorized as a non-substance-related addictive disorder. Smartphone addiction consists of four main components: compulsive phone use, tolerance, withdrawal, and functional impairment. These characteristics are similar to those of internet addiction[14, 15]. The prevalence of smartphone addiction among university students in different counties has been reported to range from 3% to 63%, which indicates that smartphone addiction is one of the major global health challenges of the 21st century[16, 17].

Several studies have reported that smartphone addiction is associated with negative impacts on physical and mental health[18–23]. Specifically, there have been some concerns about the correlation between smartphone addiction and dependence on the one hand, and musculoskeletal problems on the other[18–20]. Tonga et al.[18] found that frequency of smartphone use and addiction level is associated with abnormal postures while using smartphones, and that the participants complain about at least one area out of their neck, upper extremities, and upper back. The results of a study by Elserty et al.[19] indicated that there is a significant correlation between musculoskeletal discomfort and posture during smartphone use. Moreover, there is a high prevalence of smartphone addiction among physical therapy students in Egypt and a higher level of addiction in females than in males. Another study demonstrated a significant relationship between smartphone addiction and musculoskeletal pain in certain regions of the body, such as the neck, wrist/hand, and knees. The results also showed that the students' academic level was statistically associated with the level of smartphone addiction[20].

Although it is clear that smartphone addiction is associated with musculoskeletal pain, investigation of the relationship between smartphone addiction and upper body musculoskeletal symptoms classified by age and gender remains limited. It has been suggested that musculoskeletal pain symptoms differ between the sexes and may also be related to age[24]. In recent years, a study by Chen et al.[25] highlighted gender differences in smartphone addiction. In addition, Ai-Hadidi et al.[26] demonstrated associations between the age of smartphone users, duration of smartphone use, and the severity of musculoskeletal pain in the neck region. This implies the necessity of taking into consideration the specific factor of gender and age in the relationship between smartphone addiction and musculoskeletal problems. To date, there is still a dearth of large-population research that examines the association between smartphone addiction and musculoskeletal symptoms. Importantly, smartphone addiction and its relationship with upper-body musculoskeletal symptoms may differ according to users' demographics such as gender and age. Moreover, in Thailand, data regarding the prevalence of smartphone addiction among smartphone users, especially among university students, has yet to be reported despite the pervasive use of smartphones among this group.

Based on the previous research mentioned above, risk factors must be carefully considered to come up with active efforts to prevent musculoskeletal problems. To bridge the knowledge gap, in this study we will 1) survey smartphone addiction among university students classified by age, gender, and smartphone use behavior, 2) survey the prevalence of upper body musculoskeletal symptoms with respect to sitting posture, and 3) determine the association between smartphone addiction and upper body musculoskeletal symptoms in relation to age and gender.

PARTICIPANTS AND METHODS

A descriptive cross-sectional study design was used in this work. The participants were undergraduate students recruited from 21 faculties in Chiang Mai University, Chiang Mai, Thailand.

The sample size, n1, was calculated by finite population sampling, given by the following equation: $n1=Np(1-p)z^2/e2(N-1)+p(1-p)\ z^{2,}$ [27]. Assuming prevalence of smartphone addiction, p=0.5 (50%), e=0.025 (5% of p), and confidence interval (CI)=0.95 (95%). For N=28,630, corresponding to the total university student population, the sample size, n1, is calculated to be 1,459. The sample was then adjusted for non-response with a rate of 30%, giving a final sample size estimation of 2,085.

In this study, stratified random sampling was conducted from each faculty of Chiang Mai University and accidental samples were selected in each stratum. Thai male and female students from 21 faculties of Chiang Mai University with a minimum smartphone usage of six months were included as participants. Collectively, a total of 2,645 indiviudals agreed to participate in the study, but only 2,329 questionnaires (88.05%) were completed. A final sample size of 2,027 remained for data analysis as some subjects were excluded because they did not often use the smartphone in a sitting position.

The procedures were explained to the participants and all participants signed informed consent forms before data collection. The study was approved by the Ethics Review Board of the Faculty of Associated Medical Sciences, Chiang Mai University (Reference Number: AMSEC59EX042).

Two self-report surveys were administered to collect data in the form of paper-based survey questionnaires. The first questionnaire contains the Thai version of the Smartphone Addiction Proneness Scale (Thai-SAPS) for adults[28]. The Smartphone Addiction Proneness Scale (SAPS) is one of the most well-known self- report questionnaires across the country. It was developed by the National Information Society Agency (South Korea) for use as a screening indicator to determine whether smartphone users are addicted to their smartphones or not. The score increases as the level of addiction increases[29]. The SAPS has been shown to be valid and reliable[29, 30]. It consists of 15 items with four subdomains that are designed to assess the following: (A) disturbance of adaptive functions, (B) withdrawal, (C) tolerance, and (D) virtual life orientation. The total

score is the sum of the 15 items, with a maximum score of 60 points. The results of the self-report questionnaire are interpreted as follows: if the score is very high, there is a greater likelihood of addiction. Scores less than or equal to 39 indicate normal usage; scores between 40 and 43 indicate at-risk usage; and scores greater than or equal to 44 indicate high-risk usage[29]. The second questionnaire, which the visual analog scale (VAS) and body chart image were also included, dealt with factors associated with smartphone usage and musculoskeletal symptoms. It consisted of three parts: (1) a demographics and health profile; (2) smartphone use behavior; and (3) the previous 6-month prevalence of musculoskeletal symptoms in upper body region. Data collection took place from 2nd of November, 2016, to 30th of March, 2017. The self-report questionnaires were administered during lunch break or after class. Questionnaires were collected from all university students who were willing to participate in research. Each university student was asked to fill in the questionnaire, which required approximately 10–20 minutes.

All data were analyzed using the statistical program for social sciences (SPSS) version 17 (Licensed by Chiang Mai University, Chiang Mai, Thailand). First, descriptive statistics including the mean, standard deviation (SD), minimum (min), maximum (max), and median values were calculated for general characteristics and smartphone use behavior. Next, the prevalence of upper body musculoskeletal symptoms in sitting position and smartphone addiction were analyzed using percentages with a 95% confidence interval for each age group and gender. The χ^2 test was used to test association between smartphone addition, age, and gender with upper body musculoskeletal symptoms. After the chi-square test, multiple logistic regression was used to discover the association between smartphone addiction and upper body musculoskeletal symptoms with adjustment for age and gender. The Hosmer-Lemeshow test was used to assess the fit. All analyses were set as statistically significant at $p<0.05$.

RESULTS

Among the 2,027 respondents analyzed, university students less than or equal to 20 years old made up 48.10% of all respondents. Participants' ages ranged from 18 to 26 years, with a mean age of 20.5 years and a median age of 20 years. The mean body mass index (BMI) was 21.4 kg/m^2. Slightly more than half of the participants were female (57.6%). The breakdown of the subjects with respect to academic year level is as follows: 25.1% were first-year students (509 persons), 25.2% were second-year students (511 persons), 26.3% were third-year students (534 persons), 18.5% were fourth-year students (376 persons), and 4.8% were fifth-year students or above (97 persons). Regarding field of study, a large proportion of the sample were studying science- or technology-related degrees (38.0%). Overall, most participants were right-handed (91.3%). Out of the total sample size, about 8.2%, 4.6%, and 0.8% of participants had an underlying disease, history of injury, and history of surgery, respectively. In their leisure time, the most preferred activity was smartphone usage (62.1%) (Table 1).

Most of the participants (95.7%) had less than or equal to nine years of experience using a smartphone. In general, 48.8% of the participants spent 1−4 hours per day on their smartphones. Ninety-three (93.0%) of the participants prefer to hold their phone in their hands while using it, and more than half of the participants (59.1%) used one hand while operating the device. While using smartphones, 96.8% of participants tilted the screen back away from the anterior body. Nearly half of all participants (48.0%) used smartphones at a distance of 11–15 cm from their eyes to the device. In total, the typical postures when using devices were head flexion (94.7%) and neutral shoulder (94.7%). Regarding the Thai-SAPS score, the results showed that 84.1%, 12.3%, and 3.6% of participants had no risk, low risk, and high risk of smartphone addiction, respectively (Table 2).

Thirty percent of the respondents had upper body musculoskeletal symptoms with an average pain score of 3.66 ± 1.67. The prevalence of smartphone addiction was 15.9%. For all age groups, upper body musculoskeletal symptoms seem to be more prevalent in females than in males. The pain levels of the symptoms are comparable across the board, albeit varying slightly per age group and gender. The prevalence of upper body musculoskeletal symptoms in males versus females by age group was 22.3% versus 32.4% for age ≤20 years and 26.6% versus 36.0% for age >20 years. The level of pain symptoms in males and females by age group was 3.41 and 3.78, respectively, for age ≤20 years and 3.79 and 3.58, respectively, for age >20 years. The prevalence of smartphone addiction in male and female by age group was 17.4% and 15.8%, respectively, for age ≤20 years and 17.0% and 13.8%, respectively, for age >20 years (Table 3).

A χ^2 test of independence showed that there were significant associations between upper body musculoskeletal symptoms and smartphone addiction ($p<0.05$), gender ($p<0.05$), and age ($p<0.05$). Multiple logistic regression analysis revealed smartphone addiction ($OR_{adjusted}$ 6.05 [4.68–7.84]), female gender ($OR_{adjusted}$ 1.80 [1.46–2.22]), and students over 20 years of age ($OR_{adjusted}$ 1.27 [1.04–1.56]) as predictors for increased musculoskeletal symptoms in the upper body (Table 4).

DISCUSSION

The present study was the first attempt to estimate the prevalence of smartphone addiction and determine its association with upper-body musculoskeletal symptoms among university students classified by age and gender. Initial findings from the study show that the over-all prevalence of smartphone addiction among university students was 15.9%. Although male participants have a higher prevalence of smartphone addiction than females, the difference in prevalence between genders is relatively low. However, inconsistencies remain in the prevalence of smartphone addiction between males and females.

Table 1. Participants' demographic profile and general characteristics (*n*=2,027)

General characteristics	n (%)
Age (years)	
≤20	1,052 (51.9)
>20	975 (48.1)
Mean ± SD	20.5 ± 1.38
median (min–max)	20 (18–26)
Body mass index (kg/m^2)	
mean ± SD	21.38 ± 3.42
median (min–max)	20.7 (15.04–35.54)
Gender	
Male	860 (42.4)
Female	1,167 (57.6)
Year of study	
1st year	509 (25.1)
2nd year	511 (25.2)
3rd year	534 (26.3)
4th year	376 (18.5)
5th year or above	97 (4.8)
Field of study	
Health sciences	494 (24.4)
Sciences and technology	771 (38.0)
Social sciences and humanities	762 (37.6)
Dominant side	
Right	1,851 (91.3)
Left	176 (8.7)
Underlying disease	
No	1,860 (91.8)
Yes	167 (8.2)
History of injury	
No	1,933 (95.4)
Yes	94 (4.6)
History of surgery	
No	2,011 (99.2)
Yes	16 (0.8)
Leisure (first priority)	
Smartphone use	1,259 (62.1)
Computer use	281 (13.9)
Tablet, game player	145 (7.2)
Other: Sport, TV, reading	342 (16.9)

Data presented using number (%) for categorical data and using mean ± SD and median (min–max) for continuous data.

Table 2. Participants' smartphone use behavior (*n*=2,027)

Smartphone use behavior	n (%)
Experience using a smartphone	
≤9 years	1,939 (95.7)
>9 years	88 (4.3)
Duration of daily smartphone use	
<1 hour/day	92 (4.5)
1–4 hours/day	990 (48.8)
5–8 hours/day	783 (38.6)
>8 hours/day	162 (8.0)
Preferred way to use a smartphone	
Placed on the table	141 (7.0)
Held in hands	1,886 (93.0)
Preferred holding style	
One-handed style	1,198 (59.1)
Two-handed style	322 (15.9)
Preferred inclination of the monitor	
Tilted away from the user	1,963 (96.8)
Parallel with the user	64 (3.2)
Distance between eyes and device	
≤10 cm	120 (5.9)
11–15 cm	972 (48.0)
16–20 cm	823 (40.6)
>20 cm	112 (5.5)
Head posture	
Neutral	107 (5.3)
Head flexion	1,920 (94.7)
Shoulder posture	
Neutral	699 (70.0)
Round shoulder	608 (30.0)
Thai-SAP score	
Normal (≤39)	1,705 (84.1)
At risk (40–43)	249 (12.3)
High risk (≥44)	73 (3.6)
mean ± SD	33.60 ± 5.96
median (min–max)	34 (14–56)

Data presented using number (%) for categorical data and using mean ± SD and median (min–max) for continuous data.

Our findings reveal a low prevalence of smartphone addiction in a large population of university students, which is an optimistic outlook for this demographic at Chiang Mai University. According to previous epidemiological data, the prevalence of smartphone addiction ranged from 3% to 63%. This large range found in different studies might have been influenced by several factors such as differences in instruments, classification methods, sample size, and characteristics of the surveyed population. Although the prevalence of smartphone addiction was fairly low in this study, the prevalence rate identified in this study should not be overlooked. In the situation described above, the health care team should remain vigilant of adverse effects following smartphone addiction. Monitoring the prevalence of smartphone addiction may be necessary to avoid negative health consequences at an early age.

Table 3. Prevalence of upper body musculoskeletal symptoms and smartphone addiction classified by age and gender

Respondents classified by age and gender	Upper body musculoskeletal symptoms		Smartphone addiction
	Prevalence (95% CI)	Mean pain scores	Prevalence (95% CI)
Total (n=2,027)	30.0 (28.0–32.0)	3.66 ± 1.67	15.9 (14.3–17.5)
Male (n=860)			
≤20 years (n=413)	22.3 (18.2–26.3)	3.41 ± 1.52	17.4 (13.8–21.1)
>20 years (n=447)	26.6 (22.5–30.7)	3.79 ± 1.77	17.0 (13.5–20.5)
Female (n=1,167)			
≤20 years (n=639)	32.4 (28.8–36.0)	3.78 ± 1.68	15.8 (13.0–18.6)
>20 years (n=528)	36.0 (31.9–40.1)	3.58 ± 1.66	13.8 (10.9–16.8)

Table 4. Association between smartphone addiction and upper body musculoskeletal symptoms adjusted for age and gender

Variables	Upper body musculoskeletal symptoms		χ^2 test	Multiple logistic regression[#]
	Yes [n (%)] (n=608)	No [n (%)] (n=1,419)	OR_{crude} (95% CI)	$OR_{adjusted}$ (95% CI)
Smartphone addiction				
Not addict	403 (66.3)	1,302 (91.8)	Ref.	Ref.
Addict	205 (33.7)	117 (8.2)	5.66 (4.40–7.29)*	6.05 (4.68–7.84)*
Gender				
Male	211 (34.7)	649 (45.7)	Ref.	Ref.
Female	397 (65.3)	770 (54.3)	1.59 (1.30–1.93)*	1.80 (1.46–2.22)*
Age				
≤20 years	299 (49.2)	753 (53.1)	Ref.	Ref.
>20 years	309 (50.8)	666 (46.9)	1.17 (0.97–1.41)	1.27 (1.04–1.56)*

* Significant at the level 0.05, [#] adjusted for all variables in table.

On the other hand, overall, a relatively high prevalence of upper body musculoskeletal symptoms was found in this study (30%), with a medium perceived pain intensity (severity of pain at 3.66 out of 10). This is similar to results obtained in previous investigations[9, 11, 13]. Specifically, female participants have been found to have a higher prevalence of upper body musculoskeletal symptoms than males. In a study published in 2003, Hartrick et al.[31] pointed out that a pain severity score of 4 out of 10 is frequently given special significance in this regard, suggesting that this pain value is the potential threshold value for pain severity in clinical practice. Based on our results on pain intensity, we suggest that appropriate measures be taken to promote proper posture when using a smartphone to reduce cumulative strain injury.

We also found a highly significant association between upper body musculoskeletal symptoms and smartphone addiction. Our analysis shows that smartphone addiction (OR=6.05) was significant and could be used as predictive factors for prognosis of upper body musculoskeletal symptoms. This study corroborates reports from previous studies[18–20]. Our results confirm that smartphone overuse can lead to smartphone addiction and, consequently, cause symptoms of musculoskeletal damage. Based on the results, an addicted smartphone user is more likely to develop upper body musculoskeletal symptoms than a non-addicted smartphone user.

Multivariate analysis also revealed that females are 1.8 times more likely to have upper body musculoskeletal symptoms than males, which is consistent with a previous study[25]. Evidence suggests that females have a low sensitivity threshold and an emphasized pain tolerance than males[32]. Another reason for this result may be the higher muscle-mass to the body-mass ratio of males[33]. Participant age was also found to be significantly and positively related to upper-body musculoskeletal symptoms. Subgroup analysis showed that people over 20 years of age are 1.27 times more likely to have upper-body musculoskeletal symptoms than people 20 years old or younger. This finding is in line with previous research in this area. Ai-Hadidi et al.[26], for example, suggested that there was an association between the severity of neck pain and the age of smartphone users. Additionally, an association between the severity of neck pain and the age of smartphone users was found in the study investigated by Alsalameh et al[20]. These findings are also supported by Tsang et al.[34] who suggested that the prevalence of pain increased with age, and women were generally more likely to report persistent pain than men.

The strengths of this lie in the large sample size used and the variety of academic profiles of the participants, who were recruited from various faculties (21 faculties), representing the whole university. However, several limitations need to be addressed before making generalizable conclusions. Firstly, participants who volunteered might not be representative of

the whole population, as this study specifically focused on university students. Secondly, all participants in this study were students at the same university in Northern Thailand. To be useful, future studies should be conducted in the five main regions in Thailand (north, south, east, west, and central) to represent participants from different locations around the country. Thirdly, most of the participants (57.6%) were female. This may affect the outcome with respect to gender. Fourthly, there were not enough factors to analyze and prove the relationship between smartphone addiction and upper body musculoskeletal symptoms, classified by age and gender. Further research is required to provide evidence to clarify this point. Fifthly, the research design cannot demonstrate cause-and-effect; hence, the findings should be confirmed in further studies. Lastly, it should be noted that a self-administered questionnaire increases the risk of response bias.

In conclusion, the present study found a relatively low prevalence of smartphone addiction among university students, whereas the prevalence of upper body musculoskeletal symptoms is relatively high. Survey results also indicate that smartphone addiction associated with musculoskeletal symptoms for university students when adjusted by age and gender. Altogether, this study provides information on risk and protective factors to alleviate the symptoms of musculoskeletal damage due to the use of smartphones in the future. In terms of health care, females aged over 20 years and addicted to smartphones may have a higher probability of developing upper body musculoskeletal symptoms. Although the smartphone device is an essential tool for most people today, it is likely a "double-edged sword" that can adversely affect people's health. We cannot deny that smartphones have become an integral part of human life. We suggest that health problems associated with excessive use of smartphones should not be overlooked, particularly in young people who are more prone to technology addiction. It is time to provide knowledge and follow-up measures to ensure the appropriate use of smartphones and to avoid adverse effects in the future. Going forward, finding more factors that are related to the smartphone addiction and upper body musculoskeletal symptoms should be investigated in order to explain this association.

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Conflict of interest

No conflict of interest was declared.

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