Original Article

Predictors of Mobile Video Gaming on Musculoskeletal Pain among University Students in Selangor, Malaysia

Preditores de videogames para dispositivos móveis na dor do músculo esquelético entre estudantes universitários em Selangor, Malásia

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ABSTRACT | INTRODUCTION: Mobile video gaming among university students has increased rapidly, more than before the COVID-19 pandemic. This is very concerning as this could spark various problems, such as musculoskeletal pain and gaming disorders. **OBJECTIVES:** The present study is to identify the predictors of mobile video gaming on musculoskeletal pain among university students in Selangor, Malaysia. **PARTICIPANTS AND METHODS:** This study was conducted online using a self-reported online questionnaire via Google Form and sent to university students in Selangor, Malaysia. Participants' gaming addiction was measured using the Ten Item Internet Gaming Disorder Test (IGDT-10) questionnaire, and the prevalence of musculoskeletal pain was assessed by the Modified Nordic Musculoskeletal Questionnaire (MNMQ). The data was analyzed using SPSS version 25. A descriptive and binomial linear regression test was used to predict the variables. The statistical significance was set at $p < 0.05$, and odds ratios were calculated with confidence intervals of 95%. **RESULTS:** The prevalence of Internet Gaming Disorder among university students in Selangor, Malaysia is 1.8% (n=3). The neck region (74.2%) was the most commonly reported body region with musculoskeletal pain, followed by the shoulder region (60.7 %), lower back region (55.8 %), and upper back region (50.9 %). The body position was the only predictor of mobile video gaming with musculoskeletal pain ($p = 0.002$) in the lower back region. **CONCLUSION:** According to the findings of this study, the prevalence of Internet Gaming Disorder (IGD) among university students was low and not addicted to gaming in the Covid-19 lockdown. We also found that participants who sat while playing mobile video games were more likely to develop low back pain. However, one of the limiting factors could be prolonged sitting in virtual classes during the lockdown, which causes low back pain.

KEYWORDS: Covid-19 pandemic. Gaming disorder. Mobile video gaming. Musculoskeletal pain. University students.

RESUMO | OBJETIVOS: Jogar videogames em dispositivos móveis tem aumentado rapidamente entre estudantes universitários, mais do que antes da pandemia do COVID-19. Isso é muito preocupante, pois pode desencadear vários problemas, como dores musculoesqueléticas e distúrbios de jogo. Vários estudos semelhantes foram realizados em vários países, mas limitados na Malásia. O presente estudo tem como objetivo investigar o efeito dos videogames móveis na dor musculoesquelética entre estudantes universitários em Selangor, Malásia. **PARTICIPANTES E MÉTODOS:** Este estudo foi conduzido online usando um questionário online auto-relatado por meio do Formulário Google e enviado a estudantes universitários em Selangor, Malásia. O vício em jogos dos participantes foi medido por meio do questionário Ten Item Internet Gaming Disorder test (IGDT-10) e a prevalência de dor musculoesquelética foi avaliada pelo *Modified Nordic Musculoskeletal Questionnaire* (MNMQ). **RESULTADOS:** A prevalência de Transtorno de Jogos na Internet entre estudantes universitários em Selangor, Malásia, é de 1,8% (n = 3). A região do pescoço (74,2%) foi a região do corpo mais comumente relatada com dor musculoesquelética, seguida pela região dos ombros (60,7%), região lombar (55,8%) e região superior das costas (50,9%). Houve associação significativa entre a posição corporal durante o videogame móvel ($p = 0,002$) e a dor musculoesquelética na região lombar. **CONCLUSÃO:** De acordo com os resultados deste estudo, a prevalência de Transtorno de Jogos na Internet entre estudantes universitários era baixa e não viciados em jogos no bloqueio Covid-19. Também descobrimos que os participantes que se sentaram enquanto jogavam videogames para celular tinham maior probabilidade de desenvolver dor lombar.

PALAVRAS-CHAVE: Pandemia de Covid-19. Transtorno do jogo. Videogame móvel. Dor musculoesquelética. Estudantes universitários.

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Introduction

In this era of globalization, the functions of computers, including game applications, are slowly being designed into mobile devices and tablets like iPad and smartphones. Exposure to internet access and mobile devices is every day in almost every developed country, and this promotes children to adopt a sedentary lifestyle.[1] These days, the frequency and amount of time spent on smartphones are more common because these devices are small, portable, and easily used in almost all settings. Furthermore, with the current Covid-19 pandemic, normal activities are being disrupted, and people are more engaged in digital entertainment, including online and offline gaming.[2] In 2018, the World Health Organization (WHO) accepted and labelled gaming addiction as a disease in the 11th Revision of the International Classification of Diseases (ICD-11).[3]

Being in a prolonged, poor, and awkward posture or position would overload the muscles. This can cause several negative effects, such as a reduction in physiological function, disruption of the autonomic nervous system, the formation of various problems in daily life, and effects on both the visual and the musculoskeletal systems.[4] That will result in increased muscle tone and the risk of muscle pain and discomfort.[5,6] According to the study, the most common musculoskeletal disorders (MSDs) associated with smartphone use among university students are fatigue and pain over the neck and shoulder.[4] A study from Thailand proposed that the prevalence of MSDs in mobile phone users was highest in the neck (32.5%), followed by the shoulder (26.91%), upper back (20.69%), and wrist & hand (19.75%). They also found out that the majority of smartphone users have adopted neck flexion (82.74%), shoulder protraction (56.61%), elbow flexion (65.16%), wrist and hand flexion during keying (22.40%), wrist and hand supination to support the device (21.62%).[5]

Social media apps such as WhatsApp, Facebook, and Instagram are commonly used as a platform for people to communicate, interact, share content, and much more with repetitive movements while utilizing these apps. These frequent typing movements can cause musculoskeletal pain or discomfort in the hands and fingers of smartphone users, especially in the thumb.[7] Another study concluded that overusing smartphones would enlarge the median nerve, cause pain in the thumb, and decrease the pinch strength and hand functions of the user.[8] Besides that, smartphone users are prevalent in having discomfort in the upper back or neck.[9,10] In addition, a study in Japan suggested that the duration of smartphone usage was closely related to low back pain and shoulder pain among college students.[11]

Therefore, appropriate prevention and management of such musculoskeletal pain or discomfort are crucial. However, there is a lack of studies on the effects of mobile video gaming and musculoskeletal pain among university students in Malaysia. The purpose of this study is to determine the prevalence and identify the predictors of mobile video gaming on musculoskeletal pain among university students. The study findings may help health care professionals gain a deeper understanding of the predictors of mobile video gaming that cause musculoskeletal pain.

Materials and methods

Participants

A cross-sectional study was conducted online through Google forms between March and May 2021. The participants were recruited through a purposive sampling method from public and private universities in Selangor, Malaysia. A brief explanation of the purpose and background of the research was explained to the participants before signing the informed consent form. University students from Selangor, Malaysia, aged 18 to 30 years and who played mobile video games for less than a year were included. Participants with a history of traumatic injuries, graduates, and only playing computer games were excluded. The Research Ethics Committee approved this study of International University, Malaysia. (INTI-IU/FHLS-RC/BPHTI/7NY12020/010).

Questionnaire

The questionnaire consists of four parts. The first part was demographics, including age, gender, year of study, current education level, and mode of study.

The second part is mobile gaming behaviour, in which questions are asked about the types of games played, smartphone screen size, body position, hours of mobile video gaming per day, and the frequency of mobile video gaming per week. The third part of the questionnaire is related to mobile video gaming disorders. The Ten Item Internet Gaming Disorder Test (IGDT-10) questionnaire used to find gaming addiction, which consists of a 3-point Likert scale, was used as an option for the participants to respond (never, sometimes, and often). However, the ten items were recoded into 'yes' and 'no' formats during the scoring of IGDT-10. This is to follow the dichotomous structure of the Diagnostic and Statistical Manual (DSM 5) criteria. Because Items 9 and 10 were part of the same criteria, only a single score was recorded (for example, when they responded to "often" on either item, only 1 point was awarded). According to research, it has been proven to support the validity and reliability of the IGDT-10 to assess IGD using the DSM-5 framework.[12] The IGDT-10 composite score ranges from 0 to 9, with higher scores indicating more severe IGD. For this IGDT-10, the diagnostic criteria had a cut-off point of 5/9, which means that if five out of nine criteria were met, the participant was considered to have problematic gaming.[12]

Moreover, the last part of the questionnaire was related to musculoskeletal pain or discomfort. The Modified Nordic Musculoskeletal Questionnaire (MNMQ) was chosen and used to determine the participants' prevalence of muscle pain or discomfort within the last seven days, last 12 months, and trouble with performing activities or work within the past 12 months. It was a self-reported questionnaire and commonly used to assess musculoskeletal pain in different body areas. This MNMQ can help identify musculoskeletal disorders in various body areas such as the neck, shoulder, elbow, wrist/ hand, upper back, lower back, hip/ thigh, knee, ankle/foot. Participants were instructed to respond with a "yes" or "no," depending on their encountered problem. This instrument assists in performing comparisons regarding body areas that have had musculoskeletal pain present in the past seven days and 12 months.

Data analysis

The IBM Statistical Package for the Social Sciences on Windows Version 25 (SPSS 25) was used to analyze the data. Descriptive analysis for the categorical variables such as gender, age, year of study, mode of study, current pursuing education level, mobile gaming background were analyzed and reported as frequency (n), percentage (%), mean and standard deviation (SD). Data collected from the IGDT-10 questionnaire and MSP were analyzed using descriptive analysis in the form of frequency and percentages. The independent variables (the size of the screen, body position, period, number of hours per day, and number of days per week) and the dependent variables (musculoskeletal pain within 12 months) predictions were evaluated using binary logistic regression. The statistical significance level p-value was set at less than 0.05 ($p < 0.05$), and odds ratios were calculated with confidence intervals of 95% (CI=95%). The sample size calculation was calculated using Epi Info software. The minimum sample size was fixed at 383 participants, considering the population size of 91,000 university students in Selangor, Malaysia, with a design effect of 1.0 and a confidence level of 95%. The expected frequency was 50%.

Results

Among 224 respondents, 61 respondents who played only computer games were excluded, and finally, 163 participants fulfilling the criteria were included in the study. Of these, 82 were females, and 81 were males. The mean age of the participants was 22.43 years. The participants' characteristics and mobile video gaming behaviour were shown in Table 1. Most of the participants (55.8%) used a smartphone with a screen size of (6.0-6.9) inches, and 68.7% preferred to be in a sitting position when playing mobile video games. Furthermore, most of the participants played mobile video games 7 days a week, with the majority of them playing 2 hours a day for a total of 2.1 hours on a single day. Finally, more than half of the participants (56.4%) preferred to play mobile video games at night.

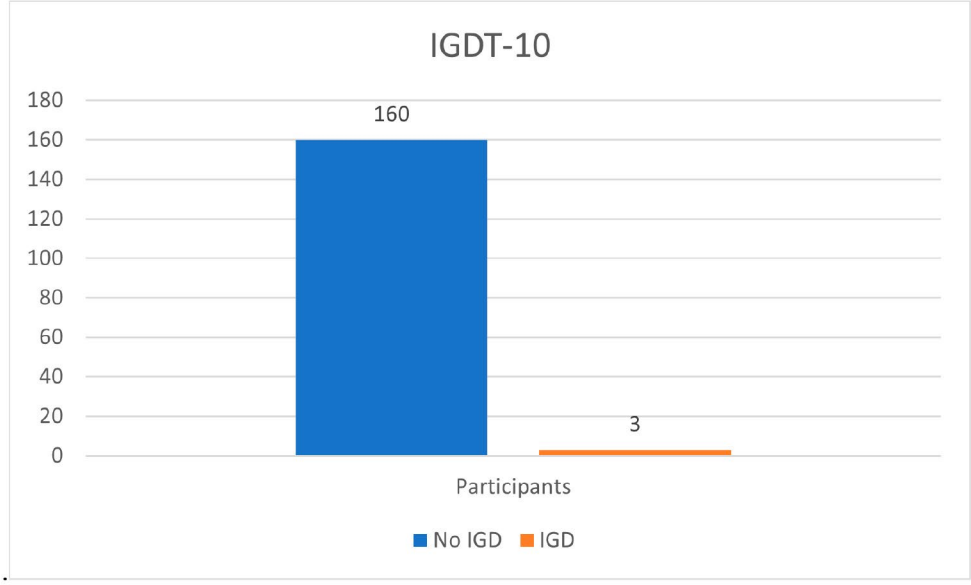
Table 1. Participant characteristics and mobile video gaming behaviour (n= 163)

	Numbers	Percentage	Mean(SD)
Age (years)			22.43(2.05)
Education level			
Pre-University	3	1.8	
Diploma	24	14.7	
Undergraduate	121	74.2	
Postgraduate	15	9.2	
Year	33		
Year 1	29	20.2	
Year 2	36	17.8	
Year 3	49	22.1	
Year 4	16	30.1	
Year 5		9.8	
Smartphone screen size			
(4.0-4.9) inches	5	3.1	
(5.0-5.9) inches	56	34.4	
(6.0-6.9) inches	91	55.8	
7.0 inches and above	11	6.8	
Body position			
Lying on back	11	6.7	
Lying on stomach	24	14.7	
Side lying	12	7.4	
Sitting	112	68.7	
Squatting	3	1.8	
Standing	1	0.6	
Frequency on mobile video gaming (days/week)			4.36(2.15)
1 day	18	11	
2 days	19	11.7	
3 days	33	20.2	
4 days	17	10.4	
5 days	18	11	
6 days	8	4.9	
7 days (Everyday)	50	30.7	
Mobile video gaming per day (h/day)			2.1(1.32)
0.5 hour	4	2.5	
1 hour	50	30.7	
2 hours	62	38.0	
3 hours	33	20.2	
4 hours	5	3.1	
5 hours	1	0.6	
6 hours	4	2.5	
7 hours	4	2.5	
Time Period			
Morning	2	1.2	
Afternoon	15	9.2	
Evening	30	18.4	
Night	92	56.4	
Mid Night	24	14.7	

SD: standard deviation

As shown in figure 1, the prevalence of Internet Gaming Disorder among university students is very low. For example, there were only 1.8% (n=3) of the participants with Internet Gaming Disorder, whereas 98.2% (n=160) of the participants did not have any Internet Gaming Disorder.

Figure 1. Prevalence of Internet Gaming Disorder (IGD) among the participants



Nota: Os dados foram recuperados com base nas respostas dos participantes.

As shown in Table 2 the MNMQ findings, the number of participants that had musculoskeletal pain (MSP) in the previous 12 months was a sum of 121 (74.2%) in the neck, 99 (60.7%) in the shoulder, 83 (50.9%) in the upper back, 25 (15.3%) in the elbow, 72 (44.2%) in the wrist and hands and 91 (55.8%) in the lower back. For the prevalence of musculoskeletal pain in the past 7 days, the results were almost the same. The neck region was the most common with 66 (40.5%) participants, followed by the lower back region of 63 (38.7%), shoulder region 54 (33.1%), upper back region 37 (22.7%), wrists & hand region 31 (19%) and elbows 10 (6.1%).

Table 2. Prevalence rates of MSP based on body region previous 12 months and 7 days

Body region with MSP	Previous 12 months		Previous 7 days	
	n	%	n	%
Neck				
Yes	121	74.2	66	40.5
No	42	25.8	97	59.5
Shoulder				
Yes	99	60.7	54	33.1
No	64	39.3	109	66.9
Elbows				
Yes	25	15.3	10	6.1
No	138	84.7	153	93.9
Wrist/Hand				
Yes	72	44.2	31	19.0
No	91	55.8	132	81.0
Upper back				
Yes	83	50.9	37	22.7
No	80	49.1	126	77.3
Lower Back				
Yes	91	55.8	63	38.7
No	72	44.2	100	61.3

MSP: Musculoskeletal pain

The logistic regression analysis (Table 3) indicated that all the variables, including screen size, body position, period, hours per day, and days per week of mobile video gaming, showed no significant relationship with musculoskeletal pain in the neck, shoulder, and upper back as $p > 0.05$. However, the omnibus model for logistic regression was statistically significant for low back pain, $\chi 2$ (df=5, N= 163) = 12.815, p= 0.025. Hosmer and Lemeshow test results confirmed that the model was a good fit for the data $\chi 2$ (df = 8, N = 163) = 5.027, p = 0.755. The model explained 10.1% (Nagelkerke R Square) of the variance in MSP in the lower back region and correctly classified 62.6% of cases. The body position was the only predictor which significantly improved the model's predictive capability with a p-value of 0.002. The odds ratio for body position indicates that those who do not sit while playing mobile games have a 79.3% lower probability of developing low back pain than those who sit while playing mobile games [OR=0.307, 95% CI (0.146-0.646)]. Screen size, period, hours per day, and days per week did not appear to significantly influence the probability of getting MSP in the lower back region as the binary logistic regression showed a $p > 0.05$.

Table 3. Predictors of musculoskeletal pain in four body regions

Predictors	Neck			Shoulder			Upper Back			Lower Back		
	OR	95%CI	p	OR	95%CI	p	OR	95%CI	p	OR	95%CI	p
Screen size	1.034	[0.492-2.172]	0.929	1.071	[0.553-2.076]	0.839	0.644	[0.334-1.243]	0.19	0.999	[0.510-1.959]	0.999
Body position	0.681	[0.306-1.518]	0.348	0.765	[0.380-1.541]	0.453	0.88	[0.441-1.757]	0.718	0.307	[0.146-0.646]	0.002*
Time period	0.626	[0.293-1.339]	0.227	0.72	[0.359-1.446]	0.356	2.038	[1.002-4.147]	0.049	0.954	[0.464-1.964]	0.899
Hours per day	0.924	[0.404-2.114]	0.851	1.346	[0.647-2.797]	0.427	0.588	[0.280-1.235]	0.161	0.899	[0.422-1.912]	0.781
Days per week	1.12	[0.521-2.406]	1.12	1.011	[0.510-2.002]	0.975	1.124	[0.572-2.207]	0.741	0.66	[0.331-1.313]	0.236

Binary logistic regression *$p < 0.05$; OR= odd ratios; CI= confidence intervals

Discussion

The prevalence of IGD among university students was surprisingly low, and the participants were not addicted to gaming during the Covid-19 lockdown. However, the prevalence of MSP was high over the neck, followed by the shoulder and low back in the past 12 months and seven days. Based on the participants' responses, it is predicted that playing mobile video games in a sitting position was more likely to cause low back pain among university students.

Even though they are not addicted to gaming, most participants preferred a smartphone with a screen size of 6 inches or above for gaming. Our data support the previous findings that larger screen sizes are more comfortable to be used. Hence gaming on a large screen size may reduce the rate of musculoskeletal pain complaints about the neck and shoulders.[4] However, larger smartphone screen sizes commonly increase device weight, and it may cause fatigue to the user's arm and shoulder muscles when using it for a long period of time.[13] Furthermore, the smaller smartphone screen size causes participants to bend their necks more to bring their eyes closer to the screen, which tends to develop neck pain as the activation of neck muscle increases.[5] In contrast, the current study reported that the majority of the participants with neck pain though they used larger screen size. This suggests that, when using a smartphone or mobile video game, neck posture should be considered in addition to screen size.[14]

Besides screen size, smartphone addiction is a common problem. A study among young populations in Turkey reported that smartphone addiction has a significant relationship with musculoskeletal pain in the neck, wrists & hands, upper back, and shoulders.[15] Further, the mobile or IGD occurs based on the type of games/genre.[16] However, the current study shows that the prevalence of IGD among university students is very low (1.8%), which is comparable to the prevalence rate of (3.1%) among adolescents in Taiwan.[17] Mobile gamers with a higher level of education would devote more time and effort to their careers than mobile gamers with a lower level of education, resulting in less time spent playing video games.[18] Since the majority of the participants are pursuing undergraduates and above; as a result, this study found a lower prevalence of IGD among university students.

In terms of average daily mobile video gaming duration, most participants (68.7%) spend at least 2 hours (in a day) playing mobile video games. More than half (57.6%) of the participants played mobile video games for more than 3 days a week. As smartphones have many different functions, these results do not include the total duration university students spent browsing apps, texting, and watching videos. Nevertheless, most people use their phones by lowering their head down while placing the phones close to their waist or lap, and this may strain the cervical spine as the Cranio-Vertebral angle (CVA) increases which causes upper back pain.[9,19] The CVA leads to Forward Head Posture (FHP) and a slouched posture, commonly seen in people who use computers or smartphones for a long period of time.[20] Hence, playing mobile video games or even using a smartphone for a long period with a poor and awkward posture may increase the chances of musculoskeletal pain.[14] Similar to Kim & Kim (2015), the current study participants had musculoskeletal pain in the neck, shoulder, upper back, elbow, wrist, hand, and lower back in the last 12 months.[4]

The participants in the present study preferred sitting than lying positions when playing mobile video games. Generally, in a sitting position, the neck and trunk flexion angles increase within 5 minutes as smartphone usage continues to increase as time passes.[21] With this, the muscle activation pattern of the neck and trunk extensors might change, and it causes musculoskeletal pain in the neck and trunk regions. Nevertheless, when using the smartphone in a sitting position without support around the arms, the weight of the smartphone device might tend to pull the shoulders down into a depression. Consequently, the user will try to compensate by bending their body more towards the smartphone increases shoulder protraction to get closer to the device. This would result in an increased risk of musculoskeletal pain in the neck, shoulder regions, and thumb or fingers while gaming.[21,22] MSP prevalence is high among the current study participants because participants have adapted to a sitting posture while mobile gaming. The logistic regression findings showed that participants who adapted to sitting during mobile gaming develop lower back pain compared with those who do not sit. Therefore, sitting is not a risk factor for low back pain, but it may turn into a risk when combined with awkward posture and contribute to low back pain.[23]

In contrast, a study has discovered that smartphone use has no significant relationship with lower back pain in adolescents.[24]

Therefore, it is evident that musculoskeletal pain of the neck, shoulder, upper back, and lower back muscles are more prevalent. It is most likely caused by static loading from long periods of smartphone use, which is often combined with awkward body postures and results in excessive strain on various body muscles.

Limitations and future directions

The sample size of the participants is one of the study's limitations; a larger sample size of participants should be recruited to achieve a better outcome. Next, the survey is a self-administered questionnaire, and the data might have a bias when answered by the participants. In future studies, the participants' posture when playing mobile games could be objectively measured as different postures may lead to different types of musculoskeletal pain. Finally, the field of study of university students can be gathered. For example, students who study information technology (IT) may spend more time using computers and mobile phones, contributing to increased musculoskeletal pain. Another limiting factor that influences low back pain might be prolonged sitting in virtual classes during the lockdown.

Conclusion

This study identified the prevalence and predictors of mobile video gaming with musculoskeletal pain among university students in Selangor, Malaysia. The prevalence of Internet Gaming Disorder (IGD) was low, and not addicted to mobile gaming in the Covid-19 lockdown. However, musculoskeletal pain of the neck, shoulder, upper back, and lower back regions was most prevalent among university students who play mobile video games. In addition, participants who sat for a prolonged time while playing mobile games had a higher risk of developing low back pain. There were no other predictors observed between smartphone screen sizes, body position, period, hours per day, and

days per week of mobile gaming with musculoskeletal pain in different parts of the body.

Authors' contributions

Yao JPR participated in the Investigation, Formal analysis, Writing-Original draft. Sundar V participated in the Conceptualization, Supervision, Reviewing, and Editing. Ramalingam V participated in the Supervision, Methodology, Writing- Reviewing and Editing.

Conflicts of interest

No financial, legal, or political conflict involving third parties (government, companies, and private foundations, etc.) has been declared for any aspect of the work submitted (including, but not limited to, grants and funding, board membership consulting, study design, manuscript preparation, statistical analysis, etc.).

References

1. Tremblay MS, Aubert S, Barnes JD, Saunders TJ, Carson V, Latimer-Cheung AE, et al. Sedentary behavior research network (SBRN)–terminology consensus project process and outcome. Int J Behav Nutr Phys Act. 2017;14(1):75. https://doi.org/10.1186/s12966-017-0525-8

2. King DL, Delfabbro PH, Billieux J, Potenza MN. Problematic online gaming and the COVID-19 pandemic. J Behav Addict. 2020;9(2):184–6. https://doi.org/10.1556/2006.2020.00016

3. Jo YS, Bhang SY, Choi JS, Lee HK, Lee SY, Kweon Y-S. Clinical characteristics of diagnosis for internet gaming disorder: comparison of DSM-5 IGD and ICD-11 GD diagnosis. J Clin Med. 2019;8(7):945. https://doi.org/10.3390/jcm8070945

4. Kim H-J, Kim J-S. The relationship between smartphone use and subjective musculoskeletal symptoms and university students. J Phys Ther Sci. 2015;27(3):575–9. https://dx.doi.org/10.1589%2Fjpts.27.575

5. Namwongsa S, Puntumetakul R, Neubert MS, Boucaut R. Factors associated with neck disorders among university student smartphone users. Work. 2018;61(3):367–78. https://doi.org/10.3233/wor-182819

6. Namwongsa S, Puntumetakul R, Neubert MS, Chaiklieng S, Boucaut R. Ergonomic risk assessment of smartphone users using the Rapid Upper Limb Assessment (RULA) tool. PLoS One. 2018;13(8):e0203394. https://doi.org/10.1371/journal.pone.0203394

7. Sharan D, Ajeesh PS. Risk factors and clinical features of text message injuries. Work. 2012;41(Suppl 1):1145–8. https://doi.org/10.3233/wor-2012-0294-1145

8. İnal EE, Demirci K, Çetİntürk A, Akgönül M, Savaş S. Effects of smartphone overuse on hand function, pinch strength, and the median nerve. Muscle Nerve. 2015;52(2):183–8. https://doi.org/10.1002/mus.24695

9. Lee H, Lee S, Choi YS, Seo Y, Shim E. A new posture monitoring system for preventing physical illness of smartphone users [Internet]. In: 2013 IEEE 10th Consumer Communications and Networking Conference (CCNC). IEEE; 2013. p. 713–6. Available from: https://ieeexplore.ieee.org/document/6488532

10. AlAbdulwahab SS, Kachanathu SJ, AlMotairi MS. Smartphone use addiction can cause neck disability. Musculoskeletal Care. 2017;15(1):10–2. https://doi.org/10.1002/msc.1170

11. Yamamoto Y, Miyatake N, Owari Y, Kataoka H, Katayama A. Influence of Smartphone Usage on Low Back Pain and/or Shoulder Pain in College Students in a Judo Therapist Training Course: A pilot study. J allied Heal Sci. 2019;10(1):1–9. https://doi.org/10.15563/jalliedhealthsci.10.1

12. Király O, Sleczka P, Pontes HM, Urbán R, Griffiths MD, Demetrovics Z. Validation of the ten-item Internet Gaming Disorder Test (IGDT-10) and evaluation of the nine DSM-5 Internet Gaming Disorder criteria. Addict Behav. 2017;64:253–60. https://doi.org/10.1016/j.addbeh.2015.11.005

13. Ning X, Huang Y, Hu B, Nimbarte AD. Neck kinematics and muscle activity during mobile device operations. Int J Ind Ergon. 2015;48:10–5. https://doi.org/10.1016/j.ergon.2015.03.003

14. Ramalingam V, Subramaniam A. Prevalence and Associated Risk Factors of Forward Head Posture among University Students. Indian J Public Health Res Dev [Internet]. 2019;10(7):775-80. Available from: http://eprints.intimal.edu.my/id/eprint/1388

15. Mustafaoglu R, Yasaci Z, Zirek E, Griffiths MD, Ozdincler AR. The relationship between smartphone addiction and musculoskeletal pain prevalence among young population: a cross-sectional study. Korean J Pain. 2021;34(1):72-81. https://doi.org/10.3344/kjp.2021.34.1.72

16. Triberti S, Milani L, Villani D, Grumi S, Peracchia S, Curcio G, et al. What matters is when you play: Investigating the relationship between online video games addiction and time spent playing over specific day phases. Addict Behav Reports. 2018;8:185–8. https://doi.org/10.1016/j.abrep.2018.06.003

17. Chiu Y-C, Pan Y-C, Lin Y-H. Chinese adaptation of the Ten-Item Internet Gaming Disorder Test and prevalence estimate of Internet gaming disorder among adolescents in Taiwan. J Behav Addict. 2018;7(3):719–26. https://doi.org/10.1556/2006.7.2018.92

18. Wittek CT, Finserås TR, Pallesen S, Mentzoni RA, Hanss D, Griffiths MD, et al. Prevalence and predictors of video game addiction: A study based on a national representative sample of gamers. Int J Ment Health Addict. 2016;14(5):672–86. https://dx.doi.org/10.1007%2Fs11469-015-9592-8

19. Yuen GK, Clements JB, Sundar V, Ramalingam V. Understanding upper body playing-related musculoskeletal disorders among piano and non-piano players using a photogrammetry. Clin Ter. 2021;172(2):162-7. https://doi.org/10.7417/ct.2021.2305

20. Gigante MR, Sciascia G, Basso A, Lovreglio P, Russo A, De Frenza MD, et al. Could VDT use induce thoracic hyperkyphosis? Preliminary data. G Ital Med Lav Ergon. 2005;27(1):119–23. Cited: PMID: 15915685

21. Park JH, Kang S-Y, Lee S-G, Jeon H-S. The effects of smart phone gaming duration on muscle activation and spinal posture: Pilot study. Physiother Theory Pract. 2017;33(8):661–9. https://doi.org/10.1080/09593985.2017.1328716

22. Sharan D, Mohandoss M, Ranganathan R, Jose J. Musculoskeletal disorders of the upper extremities due to extensive usage of hand held devices. Ann Occup Environ Med. 2014;26(1):22. https://dx.doi.org/10.1186%2Fs40557-014-0022-3

23. Lis AM, Black KM, Korn H, Nordin M. Association between sitting and occupational LBP. Eur Spine J. 2007;16(2):283–98. https://dx.doi.org/10.1007%2Fs00586-006-0143-7

24. Hakala PT, Rimpelä AH, Saarni LA, Salminen JJ. Frequent computer-related activities increase the risk of neck–shoulder and low back pain in adolescents. Eur J Public Health. 2006;16(5):536–41. https://doi.org/10.1093/eurpub/ckl025