

Posture and musculoskeletal implications for students using mobile phones because of learning at home policy

Digital Health
Volume 8: 1–9
© The Author(s) 2022
Article reuse guidelines:
sagepub.com/journals-permissions
DOI: 10.1177/20552076221106345
journals.sagepub.com/home/dhj



Bonardo Prayogo Hasiholan  and Indri Hapsari Susilowati

Abstract

There is an increasing trend of awkward postures due to smartphone use among students learning from home. Previous research in several countries has shown that the use of smartphones during a pandemic impacts musculoskeletal complaints. This study aimed to determine the postures performed by the students when using mobile phones and their implications for musculoskeletal complaints. A total of 709 students who learned from home voluntarily completed an online questionnaire regarding identity, work posture, and duration, while muscle and bone complaints experienced when using mobile phones were obtained through the Nordic Musculoskeletal Questionnaire. Furthermore, a bivariate analysis of body postures was carried out to identify perceived complaints using the chi-square method. The results showed a significant relationship between standing and leaning on a table posture (p -value: 0.026) with elbow, knee, and ankle complaints.

Keywords

Mobile phone, student, learning from home policy, musculoskeletal

Submission date: 8 January 2022; Acceptance date: 24 May 2022

Background

The use of technology is rapidly increasing, and data from Statista show that smartphone ownership is expected to rise from 3.7 billion in 2016 to approximately 6.3 billion in 2021.¹ In Indonesia, smartphone users have reached 167 million, with the majority being young people between the ages of 25 to 34 years.² Before the pandemic, studies in several countries showed that smartphone use caused musculoskeletal complaints, especially in the neck, shoulders, and upper back.^{3,4} This condition triggers the occurrence of musculoskeletal disorders later in life.

At the beginning of the pandemic, the Indonesian government implemented a policy of working and studying from home to prevent the transmission of the virus. Most of the activities carried out face-to-face were forced to switch to online, including teaching and learning activities in universities. With the increase in activities carried out online, direct communication device uses also increased. A study shows that online learning increases screen time so that static posture in some parts of the body also

increases.⁵ Based on the integrated model proposed by Karsh,⁶ work posture causes physical strain, such as tissue loads, which then causes physiological changes (muscle tension, tissue deformation, and muscle fatigue) and ultimately causes work-related musculoskeletal disorders. However, this is still influenced by several individual factors, such as physical capacity, psychological capacity, genetics, fatigue tolerance, coping, ageing, and gender.⁶

Previous research in several countries has shown that the use of smartphones during a pandemic impacts musculoskeletal complaints.^{7,8} However, most studies only focus on the distribution of musculoskeletal complaints in certain body parts. A study reveals that postures of

¹Department of Occupational Health and Safety, Faculty of Public Health, Universitas Indonesia, Depok, Indonesia

Corresponding author:

Indri Hapsari Susilowati, Department of Occupational Health and Safety, Faculty of Public Health, Universitas Indonesia, Depok, Indonesia.
Email: indri@ui.ac.id



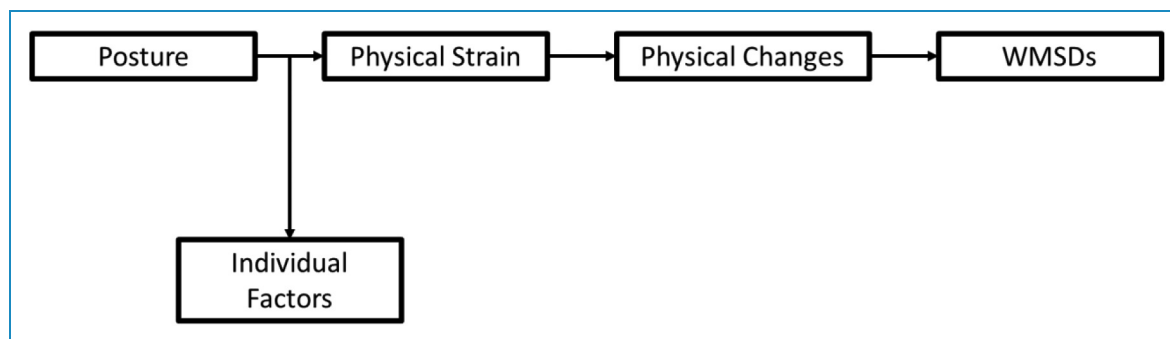


Figure 1. Scope of study adapted from integrated model by Karsh.⁶

Table 1. Sociodemography of respondents.

	Frequency	Percentage (%)
<i>Gender</i>		
Male	227	32.0
Female	482	68.0
<i>Age</i>		
≤20 years	338	47.7
21–30 years	273	38.5
31–40 years	74	10.4
41–50 years	21	3.0
51–60 years	3	0.4
>61 years	0	0
<i>Programme</i>		
Vocational	19	2.7
Bachelor	473	67.4
Master	178	25.4
Doctoral	16	2.3
Profession	16	2.3
<i>Usage period</i>		
≤5 years	54	7.6
6–10 years	343	48.4
>10 years	309	43.6

smartphone use only focus on neck complaints.⁹ In fact, studying from home has implications for static postures in some parts of the body that are performed at the same time. There is little research to identify various body postures when learning to use a smartphone. In addition, research on the posture of smartphone use among Indonesian students during the pandemic is still limited.

Therefore, this study aimed to explain the postures performed by Indonesian university students while using smartphones during the pandemic and the associated musculoskeletal complaints (Figure 1).

Methods

Sample population

This study targeted active students pursuing diplomas, bachelor's, master's, doctoral, and professional education at an Indonesian university. This research includes students who are still registered (not on leave), use smartphones to study online, and are willing to be respondents. The minimum sample required was calculated using Slovin's formula with a 95% confidence interval and 1% standard error (e)¹⁰ as follows:






$$n = \frac{N}{1 + Ne^2}$$

We consider that the student population registered reached 39,791 (N) in the 2019/2020 session. Therefore, the results indicated a minimum sample (n) is 655, but 709 respondents were successfully recruited for this study.

Data collection




The respondents were chosen by stratified random sampling to ensure that the number of vocational, bachelor's, master's, doctoral, and professional students from all faculty was still proportionate. The online questionnaire was distributed to all students through the university's

Table 2. Bivariate analysis of body posture’s frequency and the subjective complaints.

Body posture	Frequency per day	Subjective musculoskeletal complaint				P-value
		Yes		No.		
		N	%	N	%	
	Never	14	73.68	5	26.32	0.138
	<30 min	59	70.24	25	29.76	
	30 min to 1 h	90	73.77	32	26.23	
	1-3 h	217	76.68	66	23.32	
	>3 h	161	82.99	33	17.01	
	Never	239	76.85	72	23.15	0.026*
	<30 min	239	80.47	58	19.53	
	30 min to 1 h	50	70.42	21	29.58	
	1-3 h	0	0	0	0	
	>3 h	13	56.52	10	43.48	
	Never	133	78.70	36	21.30	0.306
	<30 min	294	79.03	78	20.97	
	30 min to 1 h	74	69.81	32	30.19	
	1-3 h	37	72.55	14	27.45	
	>3 h	3	75.00	1	25.00	
	Never	61	75.31	20	24.69	0.622
	<30 min	120	73.17	44	26.83	
	30 min to 1 h	154	79.79	39	20.21	
	1-3 h	154	78.57	42	21.43	
	>3 h	52	76.47	16	23.53	
	Never	48	75.00	16	25.00	0.887
	<30 min	135	78.49	37	21.51	
	30 min to 1 h	143	74.87	48	25.13	

(continued)

Table 2. Continued.

Body posture	Frequency per day	Subjective musculoskeletal complaint				P-value
		Yes		No.		
		N	%	N	%	
	1-3 h	150	77.72	43	22.28	
	>3 h	65	79.27	17	20.73	
	Never	74	74.00	26	26.00	0.634
	<30 min	185	75.20	61	24.80	
	30 min to 1 h	149	77.60	43	22.40	
	1-3 h	104	81.25	24	18.75	
	>3 h	29	80.56	7	19.44	
	Never	91	71.65	36	28.35	0.275
	<30 min	178	77.73	51	22.27	
	30 min to 1 h	113	74.83	38	25.17	
	1-3 h	111	80.43	27	19.57	
	>3 h	48	84.21	9	15.79	
	Never	159	75.36	52	24.64	0.427
	<30 min	297	78.57	81	21.43	
	30 min to 1 h	66	76.74	20	23.26	
	1-3 h	15	65.22	8	34.78	
	>3 h	4	100.00	0	0.00	

*means the p-value is under 0.05 that showed the significant relationship.

internal occupational health, safety, and environment unit. All respondents gave their informed consent before they completed the questionnaire.

Instruments

The data collection was carried out with instruments adapted from the University of Queensland in Australia, which were developed from the previous studies¹¹⁻¹⁹ and consisted of demographic and smartphone information. Furthermore, the duration of smartphone use in relation to work and posture were the independent variables and the skeletal symptoms were the dependent variables. After testing the questionnaire, each question item was tested

using the item validity method. All questions were considered valid with an R_{table} of 108 ($df = N - 2$) because the R_{count} value was greater than the R_{table} (0.108). Meanwhile, reliability was obtained through a Cronbach's alpha value of 0.798. Hence, the questionnaire was reliable because the value was greater than the R_{table} , 0.189. Furthermore, for data on musculoskeletal complaints, the Nordic Musculoskeletal Questionnaire (NMQ) was used.²⁰

Data analysis

Bivariate analysis was performed by performing a chi-square test on body and hand posture variables that have been categorised for musculoskeletal complaints in

Table 3. Bivariate analysis of hand posture's frequency and the subjective complaints.





Hand posture	Frequency per day	Subjective musculoskeletal complaint				P-value
		Yes		No		
		N	%	N	%	
	Never	29	82.86	6	17.14	0.314
	<30 min	107	77.54	31	22.46	
	30 min to 1 h	91	75.21	30	24.79	
	1-3 h	151	72.95	56	27.05	
	>3 h	163	81.09	38	18.91	
	Never	147	72.06	57	27.94	0.345
	<30 min	163	80.30	40	19.70	
	30 min to 1 h	106	79.10	28	20.90	
	1-3 h	88	77.19	26	22.81	
	>3 h	37	78.72	10	21.28	
	Never	47	65.28	25	34.72	0.041*
	<30 min	101	81.45	23	18.55	
	30 min to 1 h	92	73.60	33	26.40	
	1-3 h	174	76.99	52	23.01	
	>3 h	127	81.94	28	18.06	
	Never	232	73.42	84	26.58	0.166
	<30 min	190	80.51	46	19.49	
	30 min to 1 h	68	82.93	14	17.07	
	1-3 h	41	77.36	12	22.64	
	>3 h	10	66.67	5	33.33	

Image source: www.liputan6.com



general. After obtaining a posture that has a significant relationship to musculoskeletal complaints in general, further chi-square testing is carried out on specific body parts that experience musculoskeletal complaints. Data analysis was performed using IBM SPSS version 25.

Results

Sociodemographic factors

Based on the results, 68% of the respondents were female. The majority (47.7%) were below 20 years old, while

Table 4. Follow-up analysis.

Posture	Musculoskeletal parts	Subjective musculoskeletal complaint				P-value
		No		Yes		
		N	%	N	%	
	Neck	64	11.83	477	88.17	0.339
	Shoulder	121	22.37	420	77.63	0.146
	Upper back	136	25.14	405	74.86	0.222
	Elbow	363	67.10	178	32.90	0.001*
	Lower back	129	23.84	412	76.16	0.666
	Wrist	195	36.04	346	63.96	0.796
	Knee	372	68.76	169	31.24	0.003*
	Ankle	365	67.47	176	32.53	0.038*
	Neck	64	11.83	477	88.17	0.498
	Shoulder	121	22.37	420	77.63	0.055
	Upper back	136	25.14	405	74.86	0.563
	Elbow	363	67.10	178	32.90	0.291
	Lower back	129	23.84	412	76.16	0.924
	Wrist	195	30.90	436	69.10	0.275
	Ankle	372	68.76	169	31.24	0.288

47.7% were 21 to 30 years old. In addition, the majority were undergraduates (67.4%), while 48.4% had been using mobile phones for 6 to 10 years (Table 1).

Body and hand posture analysis

The bivariate analysis results (Table 2) showed a statistically significant relationship between the use of smartphones while standing and leaning on a table posture (p -value: 0.026). Table 3 shows that the grasping posture of holding the phone with both hands and thumbs was significantly associated with subjective musculoskeletal complaints (p -value: 0.041).

Further analyses showed that there was a significant relationship between standing and leaning on a table posture with musculoskeletal complaints in the elbow (p -value: 0.001), knee (p -value: 0.003), and ankle (p -value: 0.038). Meanwhile, gripping posture had no

significant relationship with specific complaints (Table 4).

Comparing the duration of the postures (Table 5), those using smartphones more than 3 h per day tended to have 6.5 times the risk of elbow complaints and 3.2 times the risk of knee complaints than respondents who had never performed these postures. Meanwhile, using a smartphone for 30 min to 1 h carried 2.4 times the risk of an ankle complaint.


Discussion

In general, smartphone use contributes to increased musculoskeletal complaints, especially in the neck, shoulders, and upper back.^{3,4} However, this study showed different results, as explained below.

Standing posture with table

The results indicate that a standing posture by leaning on a table is significantly associated with elbow complaints. This is

Table 5. Comparison of duration per day and subjective musculoskeletal complaint.

Posture	Frequency per day	Subjective musculoskeletal complaint				P-value	OR (95% CI)
		No		Yes			
		N	%	N	%		
	<i>Elbow</i>						
	Never	178	74.48	61	25.52		1
	<30 min	151	63.45	87	36.55	0.01*	1.670 (1.128–2.473)
	30 min to 1 h	29	58.00	21	42.00	0.02*	2.113 (1.123–3.977)
	>3 h	4	30.77	9	69.23	0.002*	6.566 (1.952–22.087)
	<i>Knee</i>						
	Never	176	73.64	63	26.36		1
	<30 min	165	69.04	74	30.96	0.266	1.253 (0.842–1.864)
	30 min to 1 h	25	50.00	25	50.00	0.001*	2.794 (1.496–5.217)
	>3 h	6	46.15	7	53.85	0.04*	3.259 (1.055–10.067)
	<i>Ankle</i>						
	Never	173	72.38	66	27.62		1
	<30 min	157	65.69	82	34.31	0.114	1.369 (0.927–2.021)
30 min to 1 h	26	52.00	24	48.00	0.005*	2.420 (1.298–4.512)	
>3 h	9	69.23	4	30.77	0.805	1.165 (0.347–3.912)	

because while using a smartphone with this body posture, the body weight is supported by the elbow with the forearm.^{21,22} Furthermore, Padua et al.²³ showed that the ulnar nerve function is modified when using a smartphone with flexed elbows.

There was also a significant relationship between standing posture by leaning on a table and knee and ankle complaints. Previous studies have shown that a foot volume factor affects the compressive strength and floor temperature related to complex thermoregulation in the foot area.²⁴

Grip posture with two hands

There was a significant association between grip posture with two hands and general musculoskeletal complaints. However, this study did not find a significant association in specific body areas because the NMQ does not consider the findings of specific finger complaints. This condition was supported by previous studies, which stated that grip posture with two hands tends to increase complaints in specific areas, such as the thumb and wrist, due to higher

muscle pull than when using one hand.²⁵ However, previous studies have also shown that this grip posture correlates with improved performance.²⁵

Duration of posture

The duration of smartphone use also contributes to the emergence of musculoskeletal complaints. Previous studies on duration and musculoskeletal complaints stated that pain and fatigue worsened with extended use.²⁶

The results of this study were in line with Karsh's integrated model⁶ that the musculoskeletal complaints felt by students were influenced by their posture while using smartphones. Work postures, such as standing with a table, affect the pressure on the elbows, knees, and ankles, leading to musculoskeletal complaints. The appearance of complaints is caused by physical strain in the tissue load, followed by physiological changes. The same goes for the smartphone gripping posture.

Limitations of the study

This study cannot determine causality because the study design is cross-sectional. Then, it did not consider the confounding factors such as the history of injury and illness, additional work, and gender differences outside of learning activities because the focus was on posture in the general student population. Based on the previous literature, those confounding had a significant relationship with musculoskeletal discomfort.^{27–29} This study also did not consider the differences in faculties and study programmes at the university, which might have different duration of smartphone use. The musculoskeletal complaints felt by the respondents in this study may not only be caused by smartphones because sometimes they also use laptops, tablets, and computers simultaneously when learning online. Therefore, research with a specific population with specific gadgets should be carried out so that it can be more comprehensive.

Implications

Online learning forces many students to do bad postures because the study equipment (tables, chairs, etc.) used at home is not designed for learning. Moreover, the results of this study also show a significant relationship between learning posture and complaints in several body parts, such as the elbow, knee, and ankle. This study complements previous studies that found a significant association between back and neck. This proves that musculoskeletal complaints are getting wider in other body areas. This result makes sense because not all students have a specially designed and the same place to study as on campus. As illustrated in this study, they learn with various postures to suit their respective environments, whether on a bed, sofa, desk,

and others. Musculoskeletal complaints will be more diverse with various learning postures and environments, not limited to the neck and back. Therefore, the policy regarding online learning needs to be reviewed, especially in terms of the duration of screen time and short breaks during online lectures. Students also need to pay attention to posture while using smartphones, prepare comfortable learning equipment, and a conducive condition of a learning environment.

Conclusion

Students using smartphones perform various postures in many variations, whether sitting, standing, supine, or prone. Based on this study, the postures of using a smartphone while leaning on a table are significantly related and have implications for the appearance of musculoskeletal complaints in the elbows, knees, and ankles. Likewise, holding the phone with both hands also has implications for musculoskeletal complaints. Therefore, students need to pay attention to body posture when using smartphones to minimise the physical strain experienced by the body. In addition, students need to pay attention to the duration of smartphone use because it also affects the incidence of musculoskeletal complaints. All students studying from home should be advised, where possible, to create an ergonomic workplace or study to minimise musculoskeletal complaints.

Contributorship: All authors participated in substantial contributions to this article. BPH conceived the idea, conducted the study, and wrote the manuscript and the revision. IHS conceived the idea, designed and conducted the study, and wrote the manuscript.

Declaration of conflicting interests: The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding: The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported by PDUPT Research Grant from Ministry of Research and Technology Republic of Indonesia with number NKB-151/UN2.RST/HKP.05.00/2021.

Ethical statement: This research received clearance from the Research and Community Engagement Ethical Committee Faculty of Public Health Universitas Indonesia, 109/UN2.F10.D11/PPM.00.02 / 2020

Guarantor: Not Applicable

ORCID iD: Bonardo Prayogo Hasiholan  <https://orcid.org/0000-0001-6320-0403>

References

1. Statista. Smartphone users 2021 | Statista, 2021, <https://www.statista.com/statistics/330695/number-of-smartphone-users-worldwide/> (accessed 7 March 2021)
2. Media Indonesia. Kemenkominfo: 89% Penduduk Indonesia Gunakan Smartphone, <https://mediaindonesia.com/humaniora/389057/kemenkominfo-89-penduduk-indonesia-gunakan-smartphone> (accessed 7 March 2021)
3. Can S and Karaca A. Determination of musculoskeletal system pain, physical activity intensity, and prolonged sitting of university students using smartphone. *Biomed Human Kinet* 2019; 11: 28–35
4. Tonga E, Özgül B, Timurtas E, et al. FRI0756-HPR evaluation of musculoskeletal complaints associated with smartphone use among university students and related risk factors. *Ann Rheum Dis* 2017; 76: 1504–1504
5. Singh S, Saini A, Lecturer G, et al. Impact of online teaching on health of university students during COVID-19 pandemic crisis. *Pharm Innov J* 2021; 10: 4.
6. Karsh BT. Theories of work-related musculoskeletal disorders: Implications for ergonomic interventions. *Theor Issues Ergon Sci* 2006; 7: 71–88.
7. Jain R, Meena ML and Rana KB. Risk factors of musculoskeletal symptoms among mobile device users during work from home. *Int J Occup Saf Ergon* 2021; 1–7, <https://doi.org/10.1080/10803548.2021.1979318>
8. Legan M and Zupan K. Prevalence of mobile device-related musculoskeletal pain among working university students: A cross-sectional study. *Int J Occup Saf Ergon* 2020; 28: 734–742.
9. Behera P, Majumdar A, Revadi G, et al. Neck pain among undergraduate medical students in a premier institute of central India: A cross-sectional study of prevalence and associated factors. *J Family Med Prim Care* 2020; 9: 3574
10. Tejada JJ, Raymond J and Punzalan B. On the misuse of Slovin's formula. *Philipp Stat* 2012; 61: 129–136.
11. Balakrishnan R, Chinnavan E and Feii T. An extensive usage of hand held devices will lead to musculoskeletal disorder of upper extremity among student in AMU: A survey method. *Int J Phys Educ Sports Health* 2016; 3(2): 368–372.
12. Berolo S, Wells RP and Amick BC. Musculoskeletal symptoms among mobile hand-held device users and their relationship to device use: A preliminary study in a Canadian university population. *Appl Ergon* 2011; 42: 371–378.
13. Blair B, Gama M and Toberman M. Prevalence and risk factors for neck and shoulder musculoskeletal symptoms in users touch-screen tablet computers. Doctoral Thesis, University of Nevada, 2015. <https://digitalscholarship.unlv.edu/cgi/viewcontent.cgi?article=3321&context=thesisdissertations> (accessed 7 March 2021)
14. Cornell University. Cornell University ergonomics web, <http://ergo.human.cornell.edu/> (accessed 7 March 2021)
15. Eapen C, Kumar B and Bhat AK. Prevalence of cumulative trauma disorders in cell phone users. *J Musculoskelet Res* 2010; 13(03): 137–145. <https://doi.org/10.1142/S0218957710002545>
16. Goldfinch T and Layton C. Observational research methods to explore intercultural competence in engineering. In Research in engineering education symposium 2011, REES 2011, 4–7 October 2011, Madrid, pp. 782–789.
17. Hedge A, Morimoto S and Mccrobie D. Effects of keyboard tray geometry on upper body posture and comfort. *Ergonomics* 1999; 42: 1333–1349.
18. Hegazy A, Alkhail B, Awadalla N, et al. Mobile phone use and risk of adverse health impacts among medical students in Jeddah, Saudi Arabia. *Br J Med Med Res* 2016; 15: 1–11.
19. Shan Z, Deng G, Li J, et al. Correlational analysis of neck/shoulder pain and low back pain with the use of digital products, physical activity and psychological status among adolescents in Shanghai. *PLoS One* 2013; 8: e78109.
20. Ramdan IM, Duma K and Setyowati DL. Reliability and validity test of the Indonesian version of the nordic musculoskeletal questionnaire (NMQ) to measure musculoskeletal disorders (MSD) in traditional women weavers. *Global Med Health Commun* 2019; 7: 123–130.
21. Nag PK, Pal S, Nag A, et al. Influence of arm and wrist support on forearm and back muscle activity in computer keyboard operation. *Appl Ergon* 2009; 40: 286–291.
22. Zhu X and Shin G. Shoulder and neck muscle activities during typing with articulating forearm support at different heights. *Ergonomics* 2012; 55: 1412–1419.
23. Padua L, Coraci D, Erra C, et al. Prolonged phone-call posture causes changes of ulnar motor nerve conduction across elbow. *Clin Neurophysiol* 2016; 127: 2728–2732.
24. Cham R and Redfern MS. Effect of flooring on standing comfort and fatigue. *Hum Factors* 2001; 43: 381–391.
25. Trudeau MB, Asakawa DS, Jindrich DL, et al. Two-handed grip on a mobile phone affords greater thumb motor performance, decreased variability, and a more extended thumb posture than a one-handed grip. *Appl Ergon* 2016; 52: 24–28.
26. Kim SY and Koo SJ. Effect of duration of smartphone use on muscle fatigue and pain caused by forward head posture in adults. *J Phys Ther Sci* 2016; 28: 1669–1672.
27. Kolstrup CL. Work-related musculoskeletal discomfort of dairy farmers and employed workers. *J Occup Med Toxicol* 2012; 7: 23.
28. Min D, Baek S, Park HW, et al. Prevalence and characteristics of musculoskeletal pain in Korean farmers. *Ann Rehabil Med* 2016; 40: 1–13.
29. Yu W, Yu ITS, Li Z, et al. Work-related injuries and musculoskeletal disorders among factory workers in a major city of China. *Accid Anal Prev* 2012; 48: 457–463.