



Contents lists available at ScienceDirect

## Safety and Health at Work

journal homepage: [www.e-shaw.net](http://www.e-shaw.net)

## Original article

## The Risk Factors for Musculoskeletal Symptoms During Work From Home Due to the Covid-19 Pandemic



Sjahrul Meizar Nasri<sup>1</sup>, Indri Hapsari Susilowati<sup>1,\*</sup>, Bonardo Prayogo Hasiholan<sup>1,2</sup>, Akbar Nugroho Sitanggang<sup>1,2</sup>, Ida Ayu Gede Jyotidiwy<sup>1</sup>, Nurrachmat Satria<sup>1</sup>, Magda Sabrina Theofany Simanjuntak<sup>3</sup>

<sup>1</sup> Department of Occupational Health and Safety, Faculty of Public Health, Universitas Indonesia, C Building 1st Floor Kampus Baru UI, Depok, 16424, Indonesia

<sup>2</sup> Directorate of Productive and Elderly Age Health, Ministry of Health Republic of Indonesia, Indonesia

<sup>3</sup> National Population and Family Planning Board Republic of Indonesia, North Sumatera Office Representative, Indonesia

## ARTICLE INFO

## Article history:

Received 19 December 2022

Received in revised form

15 January 2023

Accepted 25 January 2023

Available online 1 February 2023

## Keywords:

Factors

Gadget

Musculoskeletal

Posture

Symptoms

## ABSTRACT

**Background:** Online teaching and learning extend the duration of using gadgets such as mobile phones and tablets. A prolonged usage of these gadgets in a static position can lead to musculoskeletal disorders (MSD). Therefore, this study aims to identify the risk factors related to musculoskeletal symptoms while using gadgets during work from home due to the COVID-19 pandemic.

**Method:** A cross-sectional survey with online-based questionnaires was collected from the University of Indonesia, consisting of lecturers, students, and managerial staff. The minimum number of respondents was 1,080 and was defined by stratified random sampling. Furthermore, the dependent variable was musculoskeletal symptoms, while the independent were age, gender, job position, duration, activity when using gadgets, and how to hold them.

**Result:** Most of the respondents had mobile phones but only 16% had tablets. Furthermore, about 56.7% have used a mobile phone for more than 10 years, while about 89.7% have used a tablet for less than 10 years. A multivariate analysis found factors that were significantly associated with MSD symptoms while using a mobile phone, such as age, gender, web browsing activity, work, or college activities. These activities include doing assignments and holding the phone with two hands with two thumbs actively operating. The factors that were significantly associated with MSD symptoms when using tablets were gender, academic position, social media activity, and placing the tablet on a table with two actively working index fingers.

**Conclusion:** Therefore, from the results of this study it is necessary to have WFH and e-learning policies to reduce MSD symptoms and enhance productivity at work.

© 2023 Occupational Safety and Health Research Institute, Published by Elsevier Korea LLC. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

## 1. Introduction

The educational institutions enforced home learning for students and work from home (WFH) for teaching staff during the COVID-19 pandemic to prevent the spread of the virus. This also applies to the University of Indonesia, which has implemented online teaching and learning since March 17, 2020. The online learning or WFH was

conducted by students, lecturers, and administrative staff through electronic devices such as laptops and gadgets (mobile phones and tablets). This will certainly increase the working time of the gadget for lectures, meetings, tutoring, webinars, and other online activities. Therefore, the working time can be more than 8 hours/day.

Originally, cellphones were intended for communication but with the development of technology, they have become a

Sjahrul Meizar Nasri: <https://orcid.org/0000-0002-9734-4058>; Indri Hapsari Susilowati: <https://orcid.org/0000-0001-9903-5331>; Bonardo Prayogo Hasiholan: <https://orcid.org/0000-0001-6320-0403>; Akbar Nugroho Sitanggang: <https://orcid.org/0000-0002-3676-3697>; Ida Ayu Gede Jyotidiwy: <https://orcid.org/0000-0002-2676-6253>; Nurrachmat Satria: <https://orcid.org/0000-0001-8382-4627>; Magda Sabrina Theofany Simanjuntak: <https://orcid.org/0000-0002-5794-4876>

\* Corresponding author. Department of Occupational Health and Safety, Faculty of Public Health, Universitas Indonesia, C Building 1st Floor Kampus Baru UI, Depok, 16424, Indonesia.

E-mail address: [indri@ui.ac.id](mailto:indri@ui.ac.id) (I.H. Susilowati).

2093-7911/\$ – see front matter © 2023 Occupational Safety and Health Research Institute, Published by Elsevier Korea LLC. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

<https://doi.org/10.1016/j.shaw.2023.01.002>

smartphone used to perform professional activities such as accessing news, e-commerce, e-learning systems, stock trading, etc. These devices offer many advantages and comforts, but their prolonged use with the neck and shoulder in a static position can cause disadvantages too.

Several studies have examined musculoskeletal disorders (MSD) due to the use of mobile phones for a long duration, such as the Hashimoto et al (2015) study [1]. The results showed that after using the cell phone for 300 seconds, the angle of the head was found to be bent or elongated. Guan et al reported that the tilt angle of the head increased significantly from 74.55° to 95.22° when the respondents were using the mobile phone [2]. Furthermore, Hansraj (2014) stated that the cervical spine pressure increases during prolonged neck declination while looking at a smartphone screen. The cervical spine connects the spinal cord to the brain-carrying signals to the rest of the body that can be dangerous when the pressure is too high [3].

Increased working time will also increase the risk of muscle and skeletal disorders in certain body parts caused by poor posture when using gadgets and laptops [3,4]. Therefore, this study aims to identify the risk factors related to musculoskeletal symptoms by using gadgets during WFH due to the COVID-19 pandemic.

## 2. Materials and methods

A cross-sectional survey by an online-based questionnaire was conducted after 3 months of being applied online with stratified random sampling. All the university communities were represented by all the faculties and schools.

The determination of the study sample was conducted by observing the data contained on the DSDM UI website. After calculating the Slovin's formula for three groups of respondents, a minimum sample of 1,080 was obtained. The data collected were 1,107 respondents but became 1,083 after the cleaning was conducted. The details of the respondents are Lecturers (118), Students (709), and Administrative Staff (256), obtained from 14 faculties, three schools, and university staff in the administrative center.

The independent variables were age, gender, job position, duration, and activity when using gadgets, while the dependent was musculoskeletal symptoms as measured by complaints using a Nordic Body Map questionnaire [5]. Furthermore, data processing used chi-square statistical and logistic regression tests for the multivariate analysis. This was conducted using the enter method of IBM SPSS Statistics Version 24 software.

## 3. Results

Most of the respondents that filled out the questionnaire were under the age of 25 years (51.3% mobile phone users; 58.6% tablet users) and female (66% mobile phone users; 67.8% tablet users). This is also related to the position of the respondents since they were mostly students (65.5% mobile phone users; 66.1% tablet users) under the age of 25 years. About 56.7% used mobile phones for more than 10 years, while 89.7% used tablets for less than 10 years. This is also in line with technological developments, where mobile phones have existed before tablets. Most respondents (70.4%) complained about MSD when using gadgets during WFH. MSD complaints were analyzed bivariate with individual factors and activities when using the gadget, as shown in Tables 1 and 2.

The bivariate table above showed that there is a significant relationship between age over 20 years, females, students, and those who have used mobile phones for more than 10 years with musculoskeletal complaints. Meanwhile, activities conducted using a mobile phone for more than 2 hours per day can have a significant

**Table 1**  
Bivariate analysis results of mobile phone use

Mobile phone	Musculoskeletal disorders complaints				Total		p	95% CI
	No		Yes		N	%		
	n	%	n	%				
<b>Age</b>								
<25 years	122	38.6	431	56.6	553	51.3	0.000*	0.369–0.631
≥25 years	194	61.4	331	43.4	525	48.7		
<b>Gender</b>								
Male	151	47.8	215	28.2	366	34	0.000*	1.00
Female	165	52.2	547	71.8	712	66		
<b>Status</b>								
Lecturer	48	15.2	70	9.2	118	10.9	0.000*	1.545–3.488
Student	161	50.9	545	71.5	706	65.5		
Educational Staff	107	33.9	147	19.3	254	23.6		
<b>Using time</b>								
<10 years	115	36.4	352	46.2	467	43.3	0.004*	0.509–0.873
≥10 years	201	63.6	410	53.8	611	56.7		
<b>Activities performed</b>								
<b>Reading</b>								
<2 h	113	35.8	216	28.3	329	30.5	0.020*	1.065–1.860
≥2 h	203	64.2	546	71.7	749	69.5		
<b>Typing</b>								
<2 h	155	49.1	265	34.8	420	39.0	0.000*	1.384–2.356
≥2 h	161	50.9	497	65.2	658	61.0		
<b>Send and receive email</b>								
<2 h	257	81.3	605	79.4	862	80.0	0.523	0.810–1.577
≥2 h	59	18.7	157	20.6	216	20.0		
<b>Surf the web</b>								
<2 h	94	29.7	150	19.7	244	22.6	0.000*	1.280–2.332
≥2 h	222	70.3	612	80.3	834	77.4		
<b>Calling, watching, or listen to something</b>								
<2 h	102	32.3	167	21.9	269	25.0	0.000*	1.269–2.273
≥2 h	214	67.7	595	78.1	809	75.0		
<b>Set a schedule of activities</b>								
<2 h	275	87.0	647	84.9	922	85.5	0.421	0.831–1.741
≥2 h	41	13.0	115	15.1	156	14.5		
<b>Create assignment documents</b>								
<2 h	158	50.0	343	45.0	501	46.5	0.154	0.939–1.589
≥2 h	158	50.0	419	55.0	577	53.5		
<b>Use related to study/work activities</b>								
<2 h	98	31.0	137	18.0	235	21.8	0.000*	1.517–2.773
≥2 h	218	69.0	625	82.0	843	78.2		
<b>Playing social network</b>								
<2 h	101	32.0	165	21.7	266	24.7	0.000*	1.269–2.277
≥2 h	215	68.0	597	78.3	812	75.3		
<b>Take a photo or video</b>								
<2 h	271	85.8	647	84.9	918	85.2	0.792	0.737–1.554
≥2 h	45	14.2	115	15.1	160	14.8		
<b>Playing games</b>								
<2 h	247	78.2	584	76.6	831	77.1	0.644	0.796–1.495
≥2 h	69	21.8	178	23.4	247	22.9		

relationship with musculoskeletal complaints. These include reading, typing, web surfing, calling, watching, listen to something for study/work activities, and playing social networks.

The bivariate test table showed that there is a significant relationship between students and typing activity for more than 2 hours with musculoskeletal complaints in the past week (Tables 3 and 4).

Furthermore, the multivariate results above showed that the dominant variables causing musculoskeletal complaints when using mobile phones are those over 25 years and females (two times more at risk than males). Meanwhile, the dominant activities related to musculoskeletal complaints are surfing the web,

**Table 2**  
Bivariate analysis results of tablet use

Tablet	Musculoskeletal disorders complaints				Total	<i>p</i>	95% CI
	No		Yes				
	n	%	n	%			
<b>Age</b>							
<25 years	17	43.6	55	40.7	72	41.4	0.894
≥25 years	22	56.4	80	59.3	102	58.6	
<b>Gender</b>							
Male	18	46.2	38	28.1	56	32.2	0.054
Females	21	53.8	97	71.9	118	67.8	
<b>Status</b>							
Lecturer	12	30.8	19	14.1	31	17.8	0.018*
Student	21	53.8	94	69.6	115	66.1	
Educational Staff	6	15.4	22	16.3	28	16.1	
<b>Using time</b>							
<10 years	34	87.2	122	90.4	156	89.7	0.781
≥10 years	5	12.8	13	9.6	18	10.3	
<b>Activities performed</b>							
<b>Reading</b>							
<2 h	32	82.1	112	83.0	144	82.8	1.00
≥2 h	7	17.9	23	17.0	30	17.2	
<b>Typing</b>							
<2 h	39	100	121	89.6	160	92.0	0.041*
≥2 h	0	0	14	10.4	14	8.0	
<b>Send and receive email</b>							
<2 h	38	97.4	129	95.6	167	96.0	1.00
≥2 h	1	2.6	6	4.4	7	4.0	
<b>Surf the web</b>							
<2 h	31	79.5	111	82.2	142	81.6	0.878
≥2 h	8	20.5	24	17.8	32	18.4	
<b>Calling, watching, or listen to something</b>							
<2 h	28	71.8	102	75.6	130	74.7	0.790
≥2 h	11	28.2	33	24.4	44	25.3	
<b>Set a schedule of activities</b>							
<2 h	39	100	132	97.8	171	98.3	1
≥2 h	0	0	3	2.2	3	1.7	
<b>Create assignment documents</b>							
<2 h	34	87.2	116	85.9	150	86.2	1
≥2 h	5	12.8	19	14.1	24	13.8	
<b>Use related to study/work activities</b>							
<2 h	30	76.9	98	72.6	128	73.6	0.738
≥2 h	9	23.1	37	27.4	46	26.4	
<b>Playing social network</b>							
<2 h	32	82.1	125	92.6	157	90.2	0.066
≥2 h	7	17.9	10	7.4	17	9.8	
<b>Take a photo or video</b>							
<2 h	39	100	135	100	174	100	—
≥2 h	0	0	0	0	0	0	
<b>Playing games</b>							
<2 h	7	87.5	52	83.9	59	84.3	1
≥2 h	1	12.5	10	16.1	11	15.7	

making assignment documents, and study activities or work conducted for more than 2 hours.

The multivariate table above showed that females are also more at risk of complaining of MSD than males. Meanwhile, students are known to be 3.5 times more likely to complain than lecturers. The activities that contribute to musculoskeletal complaints are playing social networks with tablets for more than 2 hours.

#### 4. Discussion

The scope of implementing WFH at universities for lecturers, students, and staff is related to teaching and learning activities that

**Table 3**  
The final model of multivariate for mobile phone

Variable	B	SE	<i>p</i>	POR	95% CI
<b>Age</b>					
<25 years	-0.569	0.144	0.000*	0.566	0.427–0.751
≥25 years					
<b>Gender</b>					
Male	0.729	0.143	0.000*	2.073	1.567–2.743
Female					
<b>Activities performed</b>					
<b>Surf the web</b>					
<2 h					
≥2 h	0.345	0.169	0.042*	1.412	1.013–1.968
<b>Create assignment documents</b>					
<2 h					
≥2 h	-0.330	0.166	0.048*	0.719	0.519–0.997
<b>Use related to study/work activities</b>					
<2 h					
≥2 h	0.598	0.187	0.001*	1.818	1.260–2.625

**Table 4**  
The final model of multivariate for tablet

Variable	B	SE	<i>p</i>	POR	95% CI
<b>Gender</b>					
Male	-0.873	0.401	0.030*	0.418	0.190–0.917
Female					
<b>Position category</b>					
Lecturer					
Student	1.240	0.475	0.009*	3.455	1.363–8.759
Educational Staff	1.009	0.638	0.114	2.742	0.786–9.567
<b>Activities performed</b>					
<b>Playing social network</b>					
<2 h					
≥2 h	-1.410	0.577	0.015*	0.244	0.079–0.757

are carried out online. Learning activities in face-to-face classes are replaced by using virtual meeting applications such as Zoom, MS Team, or Google Meet. In addition, university administrative activities such as regular meetings have also switched to using virtual applications.

Because activities are carried out at home, work and study equipment that is usually on campus such as tables, chairs, and LCDs, which are intended for teaching and learning process in class, is not available at home. They use makeshift facilities such as dining tables, sofas, mattresses, dining tables and chairs, and the floor. In addition, using a laptop with a longer duration in working posture forces their eyes to be close to the screen, their neck to look down, and their back legs not to be well supported [6,7].

The results showed that musculoskeletal complaints are mostly experienced by users over the age of 25 years. This is similar to a previous study, which showed an increase in musculoskeletal complaints in several areas of the body. This was conducted on a cohort of respondents aged 25–29 years for 5 years from the age of 20–24 years [8]. Other studies have also shown that older people tend to have greater complaints, especially in the neck area, and the duration of use also contributes [9,10].

Furthermore, females experience more musculoskeletal complaints than males in the use of mobile phones. This is consistent with the results of previous studies showing how gender affects smartphone use, where there are 14,523 female respondents. In the study, the female and male respondents used smartphones for 166.78 and 154.26 minutes every day [11]. Similarly, another study reported neck text syndrome, involving complaints of discomfort, which was found more in female respondents than males [12].

This study showed that there is a relationship between student smartphone users and the occurrence of musculoskeletal complaints. These results are consistent with previous studies, which showed an association between text messages and reported musculoskeletal pain in the neck/upper back, shoulders/upper extremities, and numbness/tingling in the hands/fingers [13]. Another study with a multivariate regression analysis showed that the interaction of posture and the duration of smartphone use significantly contributed to musculoskeletal symptoms in students [14]. Furthermore, a study conducted with university group smartphone users showed that most respondents (84%) reported musculoskeletal discomfort in the last seven days in the neck (64.7%), back (53.8%), and shoulders (38.3%) [15]. Another study showed that ergonomic factors such as flexion posture (OR 2.44, 95% CI 1.21–4.90) were factors associated with the occurrence of neck MSD among student smartphone users [16].

According to the result, individuals who have used their mobile phones for more than ten years are more prone to experiencing musculoskeletal complaints. This is consistent with previous cohort studies, which showed a tendency to report pain among mobile phone users after several years of use [8]. Therefore, excessive repetitive muscle movements during smartphone use can result in structural changes, which may cause pain [17,18]. This was reported to be more common in the prolonged smartphone user group.

The study showed that student tablet users were 3.45 times more likely to complain about musculoskeletal symptoms than lecturers and educators. This is consistent with another study, where 37.5% and 30% of college students reported tablet-related symptoms on the neck and shoulders, respectively [19]. Furthermore, in a group of high school students, 50% or more of students reported discomfort in the neck, and upper and lower back with tablet use [20]. In another large survey among secondary school students in China ( $n = 3,016$ ), neck/shoulder pain was significantly associated with tablet users (OR 1.311, 95% CI 1.117–1.538). However, it was not associated with the number of daily tablet use after controlling the confounding factors [21].

The study results showed that females experience more musculoskeletal complaints than males at universities. This is because the prevalence of neck pain was higher in female than male respondents when using all gadgets, including the iPad classified as a tablet [22].

Musculoskeletal complaints can be caused by using mobile phones and tablets for a long duration of more than 2 hours per day. Due to the static posture of certain body parts, mobile phones and tablets users will experience aches or stiffness in the neck, shoulders, and wrists. The study by Berolo et al (2011) involving students, staff, and faculty members in Canada found that internet browsing through the mobile phone was significantly associated with pain in the right thumb, neck, and right shoulder [13].

In the study by Gustafsson et al (2017) among young people in Sweden, it was found that texting activities of mobile phone users for a long time were significantly associated with the emergence of complaints in the neck and upper back (short term effect) or the neck and upper extremities [8]. The risk factor for human interaction with handheld mobile devices is the long duration of use, causing complaints of neck flexion when texting, gaming, or calling [23].

## 5. Conclusion

Overall, 70.4% of respondents complained about MSD, with the majority being those aged over 25 years (56.6%), women (71.8%), and university students (71.5%). This study found factors that were significantly associated with MSD symptoms while using mobile phones, such as age, gender, web surfing activities, work, or college activities. These include doing tasks and holding the mobile phone

with two hands with two thumbs actively. For the tablet, the factors were sex, status, activity for social media, and put a tablet on the table in which two index fingers actively operated. When the research was conducted, policies regarding WFH, especially guidelines and adjustments to work and study at home, had not been regulated. Therefore, from the results of this study it is necessary to have WFH and e-learning policies to reduce MSD symptoms and enhance productivity at work.

## Ethics approval

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

## Authors contribution

Please check the following as appropriate:

All authors have participated in (a) the conception and design or the analysis and interpretation of the data, (b) drafting the article or revising it critically for important intellectual content, and (c) approval of the final version.

This manuscript has not been submitted to nor is under review at another journal or other publishing venue.

The authors have no affiliation with any organization with a direct or indirect financial interest in the subject matter discussed in the manuscript.

The following authors have affiliations with organizations with direct or indirect financial interest in the subject matter discussed in the manuscript.

## Conflicts of interest

The authors declared no potential conflicts of interest.

## Acknowledgments

The study is funded by Hibah Penelitian Dasar Unggulan Perguruan Tinggi (PDUPT) Kementerian Riset dan Teknologi/ Badan Riset Inovasi Nasional Tahun 2021 with number NKB-151/UN2.RST/HKP.05.00/2021.

## References

- [1] Hashimoto D, Kotani K, Suzuki S, et al. Influence of posture awareness signals to the upper extremity posture and muscular loads during mobile device use.
- [2] Guan X, Fan G, Wu X, et al. Photographic measurement of head and cervical posture when viewing mobile phone: a pilot study. *Eur Spine J* 2015;24:2892–8. 2015 24:12.
- [3] Hansraj KK. Assessment of stresses in the cervical spine caused by posture and position of the head. *Surg Technol Int* 2014;25(25):277–9.
- [4] Gupta H. Smartphone based cervical spine stress prevention. *J Software Eng Appl* 2018. <https://doi.org/10.4236/jsea.2018.112006>. Epub ahead of print.
- [5] Kuorinka I, Jonsson B, Kilbom A, et al. Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. *Appl Ergon* 1987. [https://doi.org/10.1016/0003-6870\(87\)90010-X](https://doi.org/10.1016/0003-6870(87)90010-X). Epub ahead of print.
- [6] Susilowati IH, Kurniawidjaja LM, Nugraha S, et al. The prevalence of bad posture and musculoskeletal symptoms originating from the use of gadgets as an impact of the work from home program of the university community. *Heliyon* 2022;8:e11059.
- [7] Hasiholan BP, Susilowati IH. Posture and musculoskeletal implications for students using mobile phones because of learning at home policy. *Digit Health* 2022;vol. 8. [https://doi.org/10.1177/20552076221106345/ASSET/IMAGES/10.1177\\_20552076221106345-IMG1.PNG](https://doi.org/10.1177/20552076221106345/ASSET/IMAGES/10.1177_20552076221106345-IMG1.PNG). Epub ahead of print 9 June.
- [8] Gustafsson E, Thomée S, Grimby-Ekman A, et al. Texting on mobile phones and musculoskeletal disorders in young adults: a five-year cohort study. *Appl Ergon* 2017. <https://doi.org/10.1016/j.apergo.2016.06.012>. Epub ahead of print.
- [9] Al-Hadidi F, I B, AlRyalat S, et al. Association between mobile phone use and neck pain in university students: a cross-sectional study using numeric rating scale for evaluation of neck pain. *PLoS One* 2019;14. <https://doi.org/10.1371/JOURNAL.PONE.0217231>. Epub ahead of print 1 May.

- [10] Hanphitakphong P, Keeratisiroj O, Thawinchai N. Smartphone addiction and its association with upper body musculoskeletal symptoms among university students classified by age and gender. *J Phys Ther Sci* 2021;33:394–400.
- [11] Andone I, Blazskiewicz K, Eibes M, et al. How age and gender affect smartphone usage. In: *UbiComp 2016 adjunct - proceedings of the 2016 ACM international joint conference on pervasive and ubiquitous computing 2016*. <https://doi.org/10.1145/2968219.2971451>. Epub ahead of print 2016.
- [12] Vovk ENIAK. Phenomenon of text neck in higher education students. *Actual Probl Mod Med* 2020;6:20–5.
- [13] Berolo S, Wells RP, 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. <https://doi.org/10.1016/j.apergo.2010.08.010>. Epub ahead of print.
- [14] Szeto G, To D, Tsang S, et al. Neck postures during smartphone use in university students and office workers: a field study. In: *Advances in intelligent systems and computing* 2019. [https://doi.org/10.1007/978-3-319-96083-8\\_15](https://doi.org/10.1007/978-3-319-96083-8_15). Epub ahead of print 2019.
- [15] Alzhirani A, Cook M, Johnstone K, et al. Handheld mobile devices—how do we use them at work? A university case study. In: *Advances in intelligent systems and computing* 2019. [https://doi.org/10.1007/978-3-319-96083-8\\_16](https://doi.org/10.1007/978-3-319-96083-8_16). Epub ahead of print 2019.
- [16] Namwongsa S, Puntumetakul R, Neubert MS, et al. Factors associated with neck disorders among university student smartphone users. *Work* 2018. <https://doi.org/10.3233/WOR-182819>. Epub ahead of print.
- [17] Inal EE, Demirci Kadir, Çetintürk A, et al. Effects of smartphone overuse on hand function, pinch strength, and the median nerve. *Muscle Nerve* 2015. <https://doi.org/10.1002/mus.24695>. Epub ahead of print.
- [18] Lee M, Hong Y, Lee S, et al. The effects of smartphone use on upper extremity muscle activity and pain threshold. *J Phys Ther Sci* 2015. <https://doi.org/10.1589/jpts.27.1743>. Epub ahead of print.
- [19] Chiang HY, Liu CH. Exploration of the associations of touch-screen tablet computer usage and musculoskeletal discomfort. *Work* 2016. <https://doi.org/10.3233/WOR-162274>. Epub ahead of print.
- [20] Sommerich CM, Ward R, Sikdar K, et al. A survey of high school students with ubiquitous access to tablet PCs. *Ergonomics* 2007. <https://doi.org/10.1080/00140130701194793>. Epub ahead of print.
- [21] 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. <https://doi.org/10.1371/journal.pone.0078109>. Epub ahead of print.
- [22] Almalki MM, Algarni SS, Almansouri BH. Use of smartphones, ipads, laptops and desktops as a risk factor for non-specific neck pain among undergraduate university students. *Egypt J Hosp Med* 2017. <https://doi.org/10.12816/0041690>. Epub ahead of print.
- [23] Xie Y, Szeto G, Dai J. Prevalence and risk factors associated with musculoskeletal complaints among users of mobile handheld devices: a systematic review. *Appl Ergonom* 2017. <https://doi.org/10.1016/j.apergo.2016.08.020>. Epub ahead of print.