DOI: 10.37990/medr.1309585 Med Records 2023;5(3):523-31

MEDICAL RECORDS-International Medical Journal

Research Article

Investigation of the Effects of Smartphone Use on the Dominant Thumb and Wrist of University Students

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Abstract

Aim: In this study, the effects of the addiction level of smartphone use in university students on the range of motion and proprioception of the dominant hand, wrist range of motion (ROM), and thumb ROM were investigated.

Material and Methods: Wrist and thumb ROMs were measured with a manual goniometer with a sensitivity of 1 degree, and hand grip strength was measured with a hand grip dynamometer in a total of 100 volunteer university students with a mean age of 18-25. Smartphone Addiction Scale-Short Form (SAS-SF) and Patient Rated Wrist and Hand Evaluation (PRWHE) questionnaire were applied to the students. Statistical analyzes were made using the SPSS 25 program.

Results: The students' usage time of smartphones and addiction levels do not affect the hand grip strength; the increase in smartphone addiction statistically correlates with the right thumb flexion (0.016) and abduction ROMs (0.015), statistically correlated with increased pain level in daily life and statistically correlated with the decrease of the wrist radial deviation ROM (0.009). As the duration of smartphone use increases, the error rate in right thumb abduction proprioception statistically increases (0.027). In addition, we determined the statistically correlations in both thumb flexion and abduction movements.

Conclusion: We determined that the excessive usage of smartphones affects the ROM of thumb flexion and abduction, the ROM of wrist radial deviation, and the proprioception of thumb abduction, and it does not affect the hand grip strength. The findings of our research will be a source for future studies.

Keywords: Proprioception of thumb, smartphone addiction, hand grip strength, wrist ROM

INTRODUCTION

In recent times, communication tools have started to take more place in our daily lives; smartphones are also one of the most important tools. Since smartphones provide many conveniences with their applications, they are used extensively (1).

Besides the communication function, smartphones also perform many functions, such as reading books, shopping online, exchanging e-mails, sending messages, meeting new people, and providing faster access to information. Students use smartphones for many subjects, such as taking pictures of presentations or materials instead of taking (2,3).

Excessive and uncontrolled use of applications on smartphones causes addiction (1). Smartphone addiction has recently manifested itself as a widespread addiction problem around the world it seems that people are busy with a smartphone even when they have a job (4). Smartphone addiction includes being unable to stay separate from the smartphone, feeling anxious when it stays separate, spending unnecessary money despite its economically high costs, and not being able to control smartphone usage time (5).

CITATION
Altiparmak A, Arpaci MF, Aydin M, et al. Investigation of the Effects of Smartphone Use on the Dominant Thumb and Wrist of University Students. Med Records. 2023;5(3):523-31. DOI:1037990/medr.1309585

Received: 05.06.2023 **Accepted:** 30.06.2023 **Published:** 12.07.2023
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Since smartphones are used excessively and unconsciously, they negatively affect individuals' mental and physical health in recent times. Mental problems such as anxiety, depression, lack of attention, decreased social interaction and academic achievement, and problems in business life are observed (5,6).

As a result of unconscious and excessive use, musculoskeletal disorders originate in the head, neck, back, and hands. However, it causes numbness, loss of strength in the hands, and structural disorders in the fingers. Due to the obsession with controlling the smartphone, people experience concentration impairment and distraction, which causes accidents (3,7,8).

Smartphones offer online communication opportunities, making them an important communication tool among university students (9). However, the increase in students' smartphone usage time decreases their course concentration and negatively affects their course success. This increased usage time causes a decrease in their ability to pay attention, coordinate, problems solving, and quickly reaction (10-13).

It is also often necessary to measure proprioception to determine the cause of the resulting movement or balance problems or the effects of an intervention (14). Proprioception is defined as awareness of the mechanical and volumetric state of the body and its musculoskeletal parts. Proprioception is also critical for learning, planning, executing, and correcting motor actions (15,16). Besides, each person has a different degree of proprioception awareness. The sense of perception of hand movements is based on multi-sensory information, including touch and muscle proprioception. Proprioception disorders cause muscle coordination disorders that cause people injuries (14-16).

In this study, we investigated the addiction level of the smartphones of university student's effect on the range of motion (ROM) of the dominant hand, wrist, thumb, and the effect of proprioception alteration.

MATERIAL AND METHOD

100 volunteer university student were included in the study. The participant's average age was between 18-25, and informed consent forms were taken from the participants. Ethical approval of Malatya Turgut Özal University Non-Invasive Clinical Research Ethics Committee was obtained (2022/78).

The participants who did not have any deformity or congenital deformity in the wrist or hand were included in the study. Individuals who had wrist trauma or surgery were not included in the study. To eliminate the margin of error, 3 measurements were taken from the participants, and the average value was recorded.

Various measurements were taken from the participants' dominance and non-dominance hand. Goniometer measured the ROM while they were sitting position with placing their forearm on the table.

The most appropriate 20° of thumb flexion ROM used in daily life was determined in proprioceptive evaluation. Besides the thumb abduction, ROM was measured at the most appropriate 40° used daily, with eyes open and closed .

Ulnar and radial deviation joint movement measurement of the pivot point of the goniometer was placed in the 3rd carpometacarpal joint. The fixed arm was placed parallel to the midplane of the radius and ulna. Then the mobile arm is followed the third metacarpal bone during the motion (17).

The grip strength was measured by the "Baseline Hydraulic Hand Dynamometer." The measurements were performed while sitting and standing. In the first measurement, the shoulder was in adduction, the elbow was in 90 flexions, the forearm was in a neutral position, the wrist was measured at 0-30˚, the extension, and the ulnar deviation was calculated at 0-15˚. In the second measurement position, the shoulder was adduction while standing, the elbow was in extension, and the forearm was in the neutral position (18).

Smartphone Addiction Scale-Short Form (SAS-SF) was developed to measure individuals' smartphone addiction risk. The scale consists of 10 parts, and 6 of the query is evaluated with a Likert grade scale. The scale questions consisting of 10 items are graded with a 6-point Likert scale. Validity and reliability studies of the scale were conducted for university students. Scale scores range from 10 to 60. As the test score increases, people's smartphone addiction increases (19).

Patient Rated Wrist and Hand Evaluation (PRWHE) scale consists of 15 queries. It was performed to measure daily life disability and pain due to wrist problems by professional surgeries on wrist surgery. As the total score in the PRWHE questionnaire approaches 0, the level of pain and disability decreases, while as it approaches 100, pain and disability increase (20).

Statistical Analysis

The analysis of the data included in the research was carried out with the SPSS25 (Statistical Program in Social Sciences) program. Normal distribution was checked with the Kolmogorov Smirnow Test (21). The significance level (p) was taken as 0.05 for the comparison tests. Since the variables did not have a normal distribution ($p>0.05$), the analysis was continued with non-parametric test methods. Spearman rank correlation coefficient was used since the variables included in the study showed normal distribution. The Cronbach α coefficient was used to determine the reliability analysis of the scales.

RESULTS

Demographic Information

Demographic information of the participants is given in Table 1.

Table 1. Demographic information of the participants

Variable	Groups	Frequency	Percent
Gender	Male	41	41.0
	Female	59	59.0
Age	17-19 age	50	50.0
	20 age and over	50	50.0
Marital status	Single	98	98.0
	Married	2	2.0
Dominance hand	Right	90	90.0
	Left	10	10.0
How many years have you been using a smartphone?	1-5 year	32	32.0
	5-7 year	34	34.0
	8 year and over	34	34.0
Do you have a psychiatric disorder?	No	95	95.0
	Yes	5	5.0
Do you have any physical disorders?	No	97	97.0
	Yes	3	3.0
Have you had a hand operation?	No	98	98.0
	Yes	2	2.0
Do you use glasses or contact lenses?	No	49	49.0
	Yes	51	51.0
Mothers of the student's educational status	Illiterate	9	9.0
	Primary school	48	48.0
	High school	28	28.0
	University	13	13.0
	Graduate	2	2.0
Fathers of the student's educational status	Illiterate	3	3.0
	Primary school	21	21.0
	High school	38	38.0
	University	33	33.0
	Graduate	5	5.0
The tool used to access the Internet	Mobile phone	94	94.0
	Tablet	2	2.0
	Computer	4	4.0
Daily smartphone usage time	Less than 1 hour	3	3.0
	1-2 hour	10	10.0
	3-4 hour	45	45.0
	4-5 hour	29	29.0
	More than 6 hour	13	13.0
Number of cell phone checks per day	Less than 10 times	5	5.0
	11-20 times	24	24.0
	21-30 times	21	21.0
	31-40 times	27	27.0
	More than 40 times	23	23.0
The market value of the used mobile phone	2000 TL and below	19	19.0
	2001-5000	46	46.0
	5001-10000	23	23.0
	10001 TL and above	12	12.0
Most used phone time	08.00-12.00 hours	1	1.0
	12.00-18.00 hours	19	19.0
	18.00-24.00 hours	69	69.0
	24.00-08.00 hours	11	11.0
Total		**100**	**100.0**

Definitive stats of scale scores

The mean scores of the scale scores, the standard deviation values, the intervals of variation of the scale scores, and the Cronbach α reliability coefficients were calculated for the participants (Table 2).

It was determined that the ABI-SF Index ranged between 12 and 59, the average was 30.2±10.73, and the Cronbach's alpha value scale total correlation coefficient was 0.907. Besides the PRWHE Index ranged from 1 to 88, the mean was 27.98±20.45, and the Cronbach's alpha value scale total correlation coefficient was 0.913 (Table 2).

Examining the parameters of investigation

Evaluations of the relationship between the tests and grip strength

The participants included in the study were tested to determine whether there is a relationship between smartphone usage time, SAS-SF index, PRWHE Index, and hand grip strength. There was a statistically significant weak positive correlation between SAS-SF and PRWHE pain (p=0.007). It was determined that there was no statistically significant relationship between the right and left grip strength of MFUT and SAS-SF (Table 3).

Table 2. Descriptive statistics and reliability values of scale scores

Scale	Mean±sd	Median (Min-Max)	Cronbach alfa
SAS-SF	30.2±10.73	31(12-59)	0.907
PRWHE Index of pain	10.12±7.34	9(0-30)	0.913
PRWHE Index of function	9.53±9.73	7(0-39)	
PRWHE Index of daily activities	8.47±6.72	7(0-27)	
PRWHE Index	27.98±20.45	25.5(1-88)	

sd: standart deviation, SAS-SF: smartphone addiction scale-short form, PRWHE: patient rated wrist and hand evaluation

Table 3. The relationship between Mobile phone usage time, SAS-SF index, PRWHE İndex, and hand grip strength

Indexes	Value	Right hand SGS	Right hand CGS	Left hand SGS	Left hand CGS
MFUT	r	-0.065	-0.032	-0.028	0.036
	p	0.521	0.751	0.783	0.723
SAS-SF	r	-0.003	-0.079	-0.013	-0.070
	p	0.979	0.434	0.899	0.491
PRWHE	r	-0.142	-0.115	-0.136	-0.153
	p	0.162	0.258	0.180	0.132

r: sperm rank correlation coefficient, *p<0.05, SGS: standing grip strength, CGS: grip strength sitting in a chair, MFUT: mobile phone usage time, SAS-SF: smartphone addiction scale-short form, PRWHE: patient rated wrist and hand evaluation

Evaluations of the relationship between the tests and the ROM of wrist

The participants' wrist flexion, extension, radial deviation, and ulnar deviation values were analyzed. There was a negative, weak, statistically significant relationship between SAS-SF scale and right-left hand of the radial deviation. In addition there was a weak positive correlation determined between SAS-SF and left wrist extension (p<0.05) (Table 4).

Evaluations of the relationship between the tests and the ROM of thumbs

The correlation of the ROM of the thumb with the duration of smartphone use, the SAS-SF index and the PRWHE Index value were analyzed (Table 5). A positive, weak, statistically significant correlation was found between SAS-SF and the right thumb flexion and thumb abduction movement (p<0.05). There was a positive weak statistical significance that was determined between the PRWHE index and the flexion of the right thumb (p<0.05) (Table 5).

Table 4. Evaluations of the relationship between the tests and the ROM of wrist

Scales	Values	Extension of the right hand	Flexion of the right hand	Radial deviation of the right hand	Ulnar deviation of the right hand	Extension of the left hand	Flexion of the left hand	Radial deviation of the left hand	Ulnar deviation of the left hand
MFUT	r	0.128	-0.197	-0.069	0.152	-0.016	-0.175	0.167	0.081
	p	0.205	0.051	0.492	0.131	0.872	0.082	0.096	0.426
SAS-SF	r	0.121	-0.008	-0.261	0.014	**0.284**	0.141	-0.225	-0.001
	p	0.231	0.940	**0.009***	0.891	**0.004***	0.161	**0.025***	0.992
PRWHE	r	0.050	0.082	-0.154	-0.162	0.052	0.172	-0.150	-0.145
	p	0.624	0.424	0.131	0.111	0.609	0.091	0.141	0.154

r: sperm rank correlation coefficient, *p<0.05, SGS: standing grip strength, CGS: grip strength sitting in a chair, MFUT: mobile phone usage time, SAS-SF: smartphone addiction scale-short form, PRWHE: patient rated wrist and hand evaluation

Table 5. Evaluations of the relationship between the tests and the ROM of thumbs

Scales	Values	The flexion of the right thumb	The abduction of the right thumb	The flexion of the left thumb	The abduction of the left thumb
MFUT	R	-0.145	-0.149	-0.096	0.110
	P	0.150	0.138	0.341	0.277
SAS-SF	R	**0.240**	**0.244**	0.077	-0.053
	P	**0.016***	**0.015***	0.448	0.600
PRWHE	R	0.277	0.010	-0.009	-0.067
	P	**0.006***	0.921	0.927	0.513

r: sperm rank correlation coefficient, *p<0.05, SGS: standing grip strength, CGS: grip strength sitting in a chair, MFUT: mobile phone usage time, SAS-SF: smartphone addiction scale-short form, PRWHE: patient rated wrist and hand evaluation

Evaluations of the relationship between the tests and the proprioception of thumbs

The correlation of the eyes open proprioception of thumb and eyes closed proprioception of thumb with the duration of smartphone use, the SAS-SF index, and the PRWHE Index values were analyzed. In addition, the thumb proprioception correlation among themselves was analyzed (Table 6).

A positive, weak, statistically significant correlation was found between the duration of smartphone use and the eyes open proprioceptive value determined with the right thumb abduction ROM (p<0.05) (Table 6).

The eyes open right thumb flexion proprioception was correlated with, the eyes closed right thumb flexion, the eyes closed and opened right thumb abduction, the eyes closed left thumb flexion, and the eyes opened left thumb abduction (Table 6).

The eyes closed right thumb flexion proprioception was correlated with, the eyes closed and opened right thumb abduction, the eyes closed left thumb flexion, and the eyes opened and closed left thumb abduction (Table 6).

The eyes opened right thumb abduction proprioception correlated with, the eyes closed right thumb abduction and opened left thumb flexion. The eyes closed right thumb abduction proprioception was correlated with the eyes closed left thumb flexion (Table 6).

The eyes opened and closed left thumb flexion, and abduction proprioception were correlated with left thumb proprioception movements except the left flexion eyes opened proprioception and left abduction eyes closed proprioception (Table 6).

Table 6. Evaluations of the relationship between the parameters and the proprioception of thumbs

Parameters	Values	The prop. of right thumb FLX-EO	The prop. of right thumb FLX-EC	The prop. of the right thumb. ABD-EO	The prop. of the right thumb ABD-EC	The prop. of left thumb FLX-EO	The prop. of left thumb FLX-EC	The prop. of the left thumb. ABD-EO	The prop. of left thumb ABD-EC
MFUT	R	-0.025	0.035	0.221	0.062	-0.047	-0.109	-0.028	0.055
	P	0.808	0.727	0.027*	0.540	0.641	0.280	0.786	0.586
SAS-SF	R	0.002	-0.110	-0.002	-0.042	-0.227	-0.110	0.013	0.074
	P	0.986	0.275	0.981	0.681	0.023	0.274	0.902	0.464
PRWHE	R	-0.055	-0.070	-0.094	-0.026	0.023	-0.003	-0.069	0.069
	P	0.589	0.495	0.356	0.799	0.821	0.974	0.501	0.497
The prop. of right thumb FLX-EO	R		0.592	0.243	0.219	0.132	0.276	0.201	0.001*
	P		**0.001***	**0.015***	**0.029***	0.191	**0.006***	**0.044***	0.997
The prop. of right thumb FLX-EC	R			0.247	0.229	0.148	0.402	0.232	0.231
	P			**0.013***	**0.022***	0.142	**0.001***	**0.020***	**0.021***
The prop. of the right thumb. ABD-EO	R				0.552	0.248	0.165	0.104	0.079
	P				**0.001***	**0.013***	0.101	0.301	0.435
The prop. of the right thumb. ABD-EC	R					0.163	0.310	0.179	0.226
	P					0.104	0.002	0.075	0.023
The prop. of left thumb FLX-EO	R						0.543	0.274	0.195
	P						**0.001***	**0.006***	0.052
The prop. of left thumb FLX-EC	R							0.291	0.209
	P							**0.003***	**0.037***
The prop. of the left thumb. ABD-EO	R								0.319
	P								**0.001***

r: sperm rank correlation coefficient, *p<0.05, SGS: standing grip strength, CGS: grip strength sitting in a chair, MFUT: mobile phone usage time, SAS-SF: smartphone addiction scale-short form, PRWHE: patient rated wrist and hand evaluation
EO: eyes open, EC: eyes closed FLX: flexions ABD: abduction

DISCUSSION

Excessive use of smartphones for purposes other than their intended purpose may adversely affect people's physiological, psychological and social development. Excessive use of smartphones, especially by young users, causes smartphone addiction (22). In the study by Noyan et al., the students' SAS-SF mean scores were 26.17±9.64 (19). In the study of Kwon et al., this average is 25.7 (3). In our study, the mean score of the students in SAS-SF scores was found to be 30.2±10.73. The fact that the scores on this scale are close and have similar values showed that the results given in the studies in which this scale was conducted with different student groups were at the same values.

It has been determined that the frequency of smartphone use in individuals in the 18-34 age group in Turkey has reached 81% (23). Barthwal et al. found that 62.1% of students use smartphones for more than 3 hours (24). In two similar studies conducted by Jilisha et al., and Güneş et al., in which the average daily cell phone usage time was examined, the rate of use of three hours or more was found to be 71% and 73% (25,26). In the study of Noyan et al., it is seen that people are interested in their smartphones for 3-4 hours (32.9%) at most (19). In our study, similar to the results of Noyan et al., it was determined that students use their smartphones for a maximum of 3-4 hours (45%) per day.

Jilisha et al., Güneş et al., in their study, similarly found that students usually check their phones first when they get up in the morning (25,26). As a result of Sarıkaya's research on associate degree students, it is pointed out that as the frequency of checking their smartphone increases, nomophobia increases (27). In his study, Yılmaz concluded that 42.6% of students check their phones 41 times a day or more (28). In the study by Noyan et al., 38.7% of the students checked their smartphones 40 or more times; It was observed that 23.6% of them checked 20 times a day or less (19). In our study, 27% of the students checked 31-40 times, 24% 11-20 times, 23% 40 times a day, and more; It was determined that 5% of them checked their smartphones ten times or less. As a result of this situation, we think that nomophobic behaviors increase in those who check their phones 40 or more times a day.

As a result of Sarıkaya's research on associate degree students, it was determined that the nomophobia levels of students with a smartphone experience of 4-5 years and more than five years were significantly higher than those with less than one year of smartphone experience (27). As a result of their studies, Gezgin et al. and Yıldırım et al. similarly state that the level of nomophobia increases as the smartphone experience increases (29,30). In our study, when we look at the years of use of smartphones, it was determined that 34% of those who use smartphones for 5-7 years and eight years or more. The fact that the SAS-SF data is high during this period shows that the long-term use of the phone by the students increases the level of addiction.

Gay et al. developed a motion-tracking system for wrist joint position sense measurement and evaluated passive and active joint position sense for flexion and extension movements in 80 healthy individuals. They found that flexion and extension error averages 4.9° in passive and 5.9° in active movement (31).

Patterson et al. evaluated the wrist joint position sense with the goniometer they developed and found that the error amount in neutral and extension varied between 0° and 3° (32).

In our study, joint position sense was evaluated for thumb abduction and flexion movements with eyes open and eyes closed. As a result of our research found a significant relationship between the students' smartphone usage time and the right-hand thumb abduction movement and eye-open proprioceptive value. Here, the increase in ECTS is associated with abduction movement, especially in the dominant right thumb. Because the proprioception values in the right and left thumb flexion and abduction movements are correlated in the measurements with eyes open and eyes closed, we think that the right and left thumbs are affected in a parallel direction, influence not only peripheral but also central.

Smartphone users also experience pain, numbness, muscle weakness, and limitation of movement in other parts of the body, including the neck, shoulder, elbow, arm, wrist, hand, thumb, and finger. Kim et al. As a result of ultrasound evaluation, it was reported that excessive smartphone use causes thumb pain and reduces finger grip strength and hand functions (33). In the study of Eapen et al., it was determined that hand muscles are used excessively due to holding mobile devices in hand for a long time, and myofascial pain syndrome in hand may develop as a result (34). In their study, Gustafsson et al. found that numbness developed in the hands and fingers due to texting on the phone (35). Berolo et al., in their study on university students and staff, found that pain developed in the right thumb due to mobile device use (36). Inal et al., in their study, determined that the repeated use of smartphones for messaging may cause Dequervein tenosynovitis by damaging the extensor pollicis longus tendon of the thumb in addition to the tendons in the first compartment of the wrist (37). Our study was similar to the studies in the literature, and it was determined that there was a significant relationship between the students' smartphone usage time and PRWHE pain, right thumb flexion and abduction, and radial deviation values of both wrists, and it did not affect grip strength.

Choi et al., in their study on 315 students using smartphones, determined that as the duration of use of the devices increased, the problems related to the musculoskeletal system grew, and they found that the pain was also associated with the period of use of these devices (38). Turgay et al. found that students with pain in the hands/wrists at any time during the last 12 months had higher mean scores in SAS-SF than those who did not (39). In our study, there was a weak positive correlation between ABI-SF and right thumb flexion and abduction movement; There was a weak positive and statistically significant correlation between ECTS and proprioceptive value measured with right-hand thumb abduction movement with eyes open. This shows that the flexion and abduction movements of the thumb increase in direct proportion with the increase in addiction, and the increase in the duration of smartphone use also increases the error rate in thumb proprioception, that is, the sensitivity error.

CONCLUSION

In conclusion, we determined that the excessive usage of smartphones affects the ROM of thumb flexion and abduction, the ROM of wrist radial deviation, and the proprioception of thumb abduction and does not effects the hand grip strength. The findings of our research will be a source for future studies.

Financial disclosures: *The authors declared that this study has received no financial support.*

Conflict of Interest: *The authors have no conflicts of interest to declare.*

Ethical approval: *Ethical approval of Malatya Turgut Özal University Non-Invasive Clinical Research Ethics Committee was obtained (2022/78).*

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