

The relationship between smartphone usage duration (using smartphone's ability to monitor screen time) with hand-grip and pinch-grip strength among young people. An observational study

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Research article

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Abstract

Background

The use of smartphones has become widely popular especially among young people for multiple purposes other than communication including gaming and internet browsing. The weakness of the hand and wrist is one of the main complications associated with the increase of use of smartphones. This weakness occurs due to the repetitive flexion and extension of the wrist, thumb and fingers which eventually could lead to a major musculoskeletal pathology. Little is known about the relationship between smartphone usage duration (using the phones ability to monitor screen time) and hand-grip, pinch-grip strength. Therefore, the study was aimed to investigate the association between smartphone usage duration and hand-grip, pinch-grip strength among young people.

Methods

100 young males volunteered to participate in the study. Participants were briefly examined for height and weight using a portable stadiometer and a digital scale. Hand-grip, pinch-grip strength measurement was performed using a hand-held dynamometer. Smartphones usage duration was obtained from the daily average screen time reported in the last seven days.

Results

Mean daily usage of smartphone among the participants was 7.8 ± 2.2 . There was a significant inverse relationship between smartphone usage duration and hand-grip strength ($r=-.22, p=.03$) and pinch-grip strength ($r=-.28, p=.004$).

Conclusion

Prolonged use of smartphones is related to weaker hand-grip and pinch-grip. This may lead to future musculoskeletal pathologies such as carpal tunnel syndrome. Young people should be aware of the dangers of smartphones overuse.

Background

The use of smartphones has become a necessity for everyone in their daily life. Smartphones have been recently used not only for communication but also for gaming, socializing and internet browsing especially by the younger population. In the last few years, there has been a constant increase in the number of people using smartphones. In 2020, the number of smartphone users globally has projected to 3.5 billion, which is more by 9.3% than in 2019 ¹. Also, it has been suggested by many surveys that younger adults are the ones who represent the majority of smartphone users globally ². This increase in smartphone usage led to addiction behavior to these devices especially by 50% of teens, as survey reports suggested ³.

Despite the structure and design of smartphones which allow the use of both hands, the use of single-handed is more preferred by young people⁴. The use of single-hand mainly relies on thumb movement to reach for the keys and interaction, whereas, the rest of the hand is used for grasping⁵. It was reported that the average duration of smartphone usage among university students was >3.5 hours/day, which was also accompanied by pain at the base of the thumb⁶.

Complications and adverse effects of the excessive usage of smartphones may include dry eyes, computer vision problems, neck and shoulder problems, De Quervain's tenosynovitis and weakness of the thumb and wrist⁷. The weakness of the thumb and wrist is due to repetitive movement of flexion and extension over the wrist and fingers, which is increased with more duration spent over smartphones, eventually causing pain and fatigue^{5,8}. Further, this repetitive flexion and extension of the wrist are also known as one of the leading causes of carpal tunnel syndrome⁹. These complications would limit the functionality of the hand over time and may lead to psychological problems such as poor quality of life¹⁰.

The number of studies which investigated the association between smartphone addiction/overuse and at least the hand-grip strength or pinch-grip strength are limited. A study compared hand-grip and pinch-grip strength between high-frequency smartphone users and low-frequency smartphone users among children¹¹. The study reported that the higher frequency smartphone users had reduced hand and pinch-grip strength in comparison to the lower frequency smartphone users. Another study reported no difference in pinch-grip strength between high frequency and low-frequency smartphone users among young adults¹². These former two studies utilized smartphone addiction scale- (short form) to group the participants based on the scoring of the scale. Most smartphones have a weekly record of the duration of usage in units of time. To the best of knowledge, no study was found which investigated the association between smartphone usage (in units of time) and hand-grip, pinch-grip strength. To address this gap in the literature, the aim of the current study was to investigate the association between smartphone usage (in units of time) and hand-grip, pinch-grip strength among young people. It was hypothesized that both hand-grip and pinch-grip will be inversely associated with smartphone usage duration.

Methods

Participants

100 participants from Riyadh region, Saudi Arabia volunteered to participate in the study. Participants were approached in different and multiple locations for a single measurement. Inclusion criteria included the use of a smartphone with the ability to report the duration of usage weekly, between 18–30 years old. Exclusion criteria included individuals with neuromuscular disorders, surgical history of median nerve release, tendon lesion of the thumb or hand, previous fracture of the hand or wrist, and any previous history of hand or wrist injury. According to the sample analysis performed using G*power software

(version 3.1), a priori test for correlation showed that the minimum sample required to achieve the power of $(1 - \beta \text{ error probability}) = 0.85$ was 93 with the effect size (d) = 0.3.

Procedure

Participants were invited verbally to volunteer to the study, or were approached on the spot (e.g. coffee shops, lounging areas) and were given information about the study. Upon acceptance to participate, informed consent was provided for signing, then the assessment sheet was filled by the investigator. Anthropometric measurement was obtained with minimal clothing. Height was measured using a portable Stadiometer to the nearest 0.5 cm (Holtain Ltd, Crosswell, UK). Weight was obtained via standing on a portable electronic zeroed scale (Wedderburn, Southampton, UK). Then, measurement of hand-grip and pinch grip was performed, each for three times. Finally, the smartphone was checked for the weekly average screen duration (see Fig. 1).

Outcome variables

Hand-grip (handheld) Jamar dynamometer (Sammons Preston Rolyan, Bolingbrook, IL, USA) was adjusted for the size of the hand of every participant via adjusting the handle of the grip to allow placement of the fingers at approximately 90° of flexion at the proximal and distal interphalangeal joints. Participants were requested to perform the test with their dominant hand. As recommended by the American Society of Hand Therapists¹³, the hand-grip measurement was performed while each participant was seated in an upright position, shoulder slightly abducted, elbow in flexion at 90°, and wrist in a neutral position. Participants were instructed to squeeze the handle as much as possible for three times, each time the squeeze lasted for 5 seconds and 30-seconds rest period was given between each time. Then, the average of the three trials in (kg) was recorded

Pinch-grip dynamometer (Baseline, Fabrication Enterprises Inc., Irvington, NY, USA) position was similar to the position of hand-grip measurement. The same hand was used for doing the pinch-grip measurement. The gauge was placed between the tip of the thumb's pad and the radial side of the middle phalanx of the index finger. Similarly, to the measurement of hand-grip, participants were instructed to pinch the gauge as much as possible for three times, with 5-second duration for each, and 30-seconds rest period between each time. Again, the average of three trials in (kg) was recorded.

Smartphone usage duration was checked via asking the participant to check the screen time on the smartphone (which is an option available for all smartphones) for the average daily use in the past week. The average duration for smartphone screen time is calculated and the average duration of smartphone daily usage for a week is reported in hours.

Statistical analysis

Statistical analysis was performed using statistical package for social sciences (SPSS) (version 27, Chicago, IL, USA). Normality of the variables was tested using the Kolmogorov-Smirnov test. Normally distributed variables were presented as mean and standard deviation, and non-normally distributed

variables were presented as median and interquartile range. Log transformation was performed on one single variable (Pinch-grip strength). To assess the relationship between smartphone usage and hand-grip pinch-grip strength (after log transformation), bivariate correlation using Pearson product-moment correlation analysis. Partial correlation correcting for weight and body mass index (BMI) as confounding variables was conducted to assess the same relationship between the main outcome variables of the study. The level of significance was set at $\leq .05$.

Results

The demographic characteristics and the main outcome variables of 100 participants are presented in Table 1. The average daily usage of smartphone among the participants was 7.8 ± 2.2 .

Table 1
characteristics and main outcome variables of n = 100 participants.

Variable	value
Age (years)	21 (19–23)
Height (m)	1.67 ± 0.1
Weight (kg)	76.9 ± 16.7
BMI (kg/m^2)	27.4 ± 4.8
<i>Outcome variables</i>	
Hand-grip strength (kg)	34 ± 7.8
Pinch-grip strength (kg)	6.7 (6–8.3)
Smartphone usage duration (hours)	7.8 ± 2.2
Values are presented as means \pm standard deviation, or median (25th to 75th percentile values) as appropriate. BMI, body mass index.	

Correlation analysis

Correlation analysis revealed that there was a significant inverse relationship between smartphone usage duration and hand-grip strength and pinch-grip strength (Table 2). The more young people use their smartphones, the weaker their hand-grip and pinch-grip strength. Further analysis revealed that there was a significant correlation between weight, and BMI with hand-grip strength ($r = 0.22, p = .03$; $r = 0.27, p = .007$ respectively). Thus, further correlation analysis was conducted with weight and BMI as a confounding variable. This analysis revealed that there was still a significant inverse relationship between smartphone usage duration and hand-grip strength (correcting for weight and BMI) (Table 2).

Table 2
Correlation analysis between smartphone usage duration and hand-grip, pinch-grip strength

Variable	Smartphone usage duration (hours)		Smartphone usage duration (hours) With weight and BMI as confounding variables	
	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>
Hand-grip strength (kg)	-0.22	.03	-0.22	.03
Pinch-grip strength (kg)	-0.28	.004	-0.27	.008

Discussion

The current study explored the association between smartphone usage duration and hand-grip, pinch-grip strength among young people. As expected, there was an inverse association between the aforementioned variables. After using weight and BMI as a confounding factor, the inverse association remained significant. The results indicate that longer duration of average daily smartphone usage was related to weaker hand-grip and pinch-grip strength.

Many studies reported reduced hand function as well as multiple musculoskeletal problems when high-frequency smartphone users compared against low-frequency smartphone users. A study compared median and ulnar nerve conduction velocity, forward head angle, neck pain, and hand-grip between two adolescents groups based on the duration of smartphone usage (group A which use smartphone < 4 hours/day vs group B which use smartphone > 4 hours/day)¹⁴. The results showed that group B with a higher frequency of smartphone usage had weaker ulnar nerve conduction velocity, higher neck pain (on visual analogue scale), reduced forward head angle movement, whereas, no difference was found in hand-grip strength or median nerve conduction velocity. The methodology of grouping in the former study was not reported, as it is unknown how the duration of smartphone usage was determined. Although group B had lower hand-grip strength than group A, the difference between the two groups was not significant¹⁴. Another study compared between two young adults groups over smartphones overuse (high, low) based on smartphone addiction scale with a non-smartphone users group as a control group, in which it was found that high-frequency smartphone users had enlarged median nerve, more pain at the thumb, decreased pinch strength and hand functions in comparison to low-frequency smartphone users⁸. With regards to the reduction of hand and pinch strength and overall hand performance among children, similar results were reported among high-frequency smartphone users¹¹. Majority of the former studies reported adverse effects of smartphone overuse over the hands, neck, median and ulnar nerve integrity. The question is whether these effects can be corrected or reduced with treatment or not.

Longitudinal studies investigating the effects of management to reduce the effect of smartphone overuse are limited. A study among 100 young adults investigated the effect of exercise training program and

postural correction on hand-grip strength, pinch-grip strength, upper extremity disability ¹⁵. The study reported significant improvement in hand-grip strength, pinch-grip strength after a 12-week exercise program. The result of this study may indicate that increased smartphone usage is linked to the weakness of the hand-grip and pinch-grip, hence, with training, these variables improved. The current study reported this association between smartphone usage duration and hand-grip and pinch-grip strength.

The inverse association between smartphones usage duration and hand-grip pinch-grip strength can be explained due to the median nerve damage (enlargement) which was found to be associated with prolonged use of smartphones ⁸. The median nerve controls the flexor-pronator muscles in the forearm and most of the musculature present in the radial portion of the hand which include the abduction of the thumb, flexion of the hand and wrist, flexion of the digital phalanx of fingers ¹⁶. The position of the hand and the thumb which is adapted while holding the smartphone for a prolonged duration may affect the median nerve ⁵. Additionally, the repetitive flexion and extension of the wrist and excessive use of the thumb may also damage the median nerve ⁹. Eventually, the damaged median nerve may lead to weakness of the muscles innervated by the median nerve, in which these muscles are the ones responsible for hand-grip and pinch-grip action.

To the best of knowledge, this is the first study that utilized the technology provided by the smartphones which enable the users to monitor their daily average use of the smartphone in the form of weekly reports. This method of direct measurement of smartphone usage duration has been used before to examine the relationship between screen time over smartphone and sleep quality ¹⁷. Although screen time can involve the duration of just merely looking at the screen, simple browsing over the phone will at least require the use of the thumb and the use of the palm to hold the smartphone (e.g. scrolling up and down over a page). Unlike filling a scale such as smartphone addiction scale, the method used in the current study allow participants to self-monitor their daily average smartphones activity weekly without the need of filling scales. This may also give an advantage of less time consumption for the health care professionals to advise targeted individuals about reducing their smartphones usage.

Clinically, this study adds to the literature and fill the gap in the knowledge about the relationship between smartphone usage duration and hand-grip, and pinch-grip strength. This would help health care professionals to establish preventive strategies or educational strategies to overcome the adverse effects of prolonged use of smartphones, especially at the younger ages. Further, the novelty in this study that using smartphone own monitoring system to detect the duration of the use of the phone may give a less time-consuming “more objective” option to use it instead of smartphone addiction scale. This can be utilized during physical assessment performed by health care professionals, especially with hand and wrist pathologies.

There are some limitations to the study. Due to the cross-sectional design of the study, causality between variables should not be assumed. The study was gender-biased and conducted only on males due to cultural reasons. Therefore, the generalizability of the data is limited to males in the same age categories.

This warrant further research involving a female investigator and other age categories. Involvement of other daily tasks such as using keyboards on laptops may also influence hand-grip and pinch-grip strength. Thus, future research should also investigate other activities which involve the use of thumb and digitals of the hand during screening.

In conclusion, the current study demonstrated the inverse association between prolonged use of smartphones (using the smartphone own characteristics to monitor the screen time) with hand-grip and pinch-grip strength. The result indicates that longer use of smartphones was associated with weaker hand-grip and weaker pinch-grip. Young individuals should be aware of the negative impact of smartphones overuse on their hand functions.

Abbreviations

SPSS, statistical package for social sciences

BMI, Body mass index

Declarations

Ethics approval and consent to participate

All participant signed informed consent before participation. Ethical approval was obtained from the research ethics committee at Prince Sattam bin Abdulaziz University.

Consent for publication

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Availability of data materials

All data generated or analyzed during this study are included in supplementary information files.

Competing interest

The author declares no conflict of interest.

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Authors' contribution

AO designed the study, supervised the testing and measurements, analyzed the data, and wrote the final draft of the paper.

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Figures

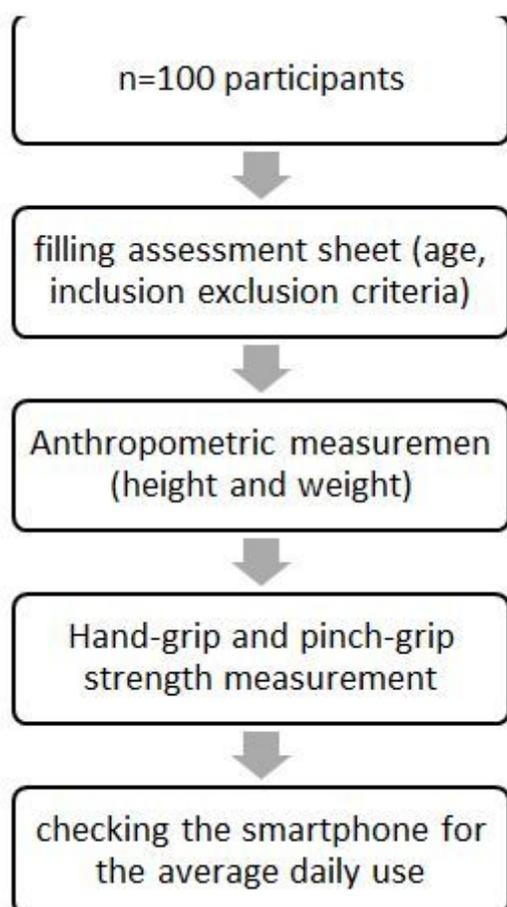


Figure 1

flow diagram of the procedures of the study

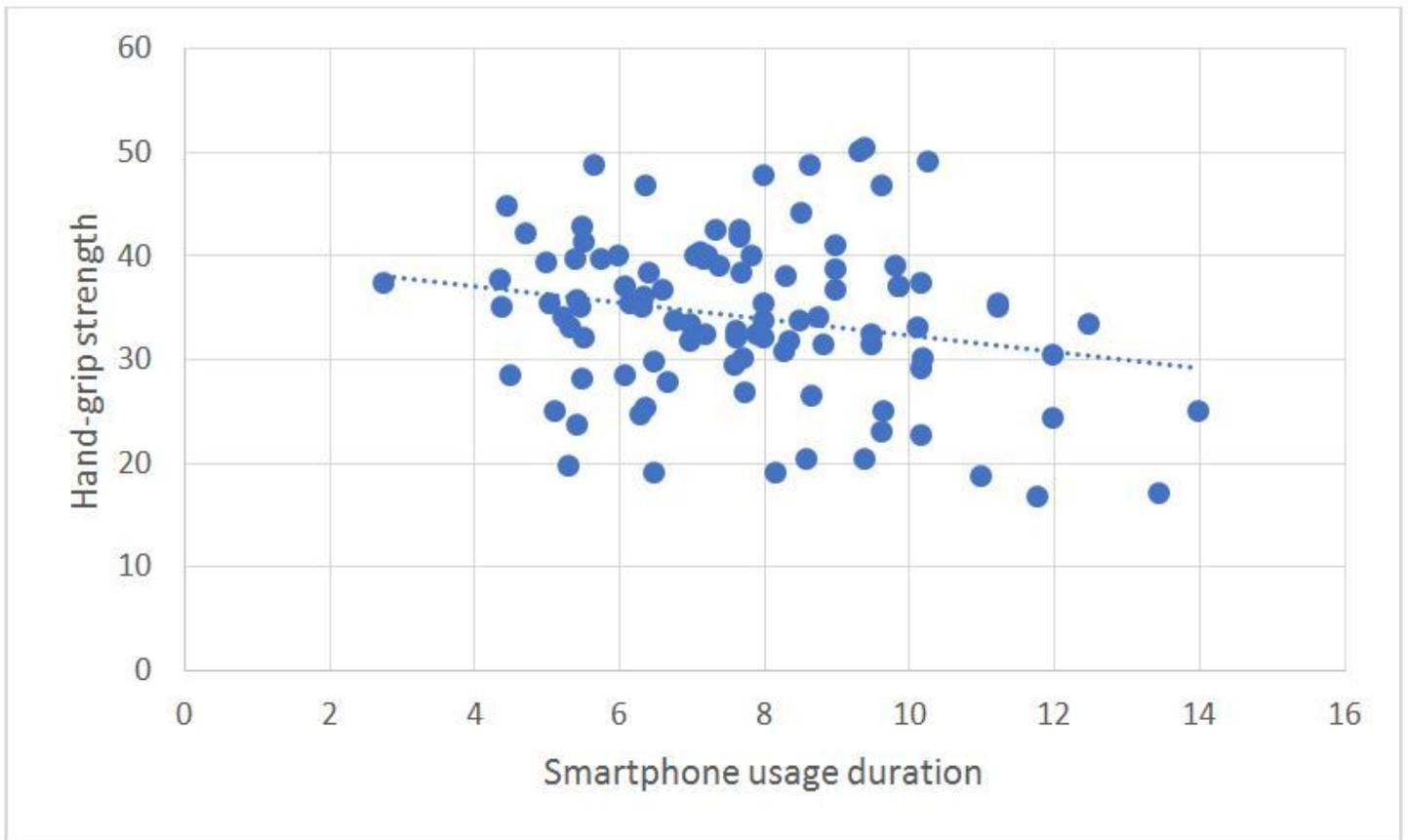


Figure 2

Relationship between smartphone usage and hand-grip strength.

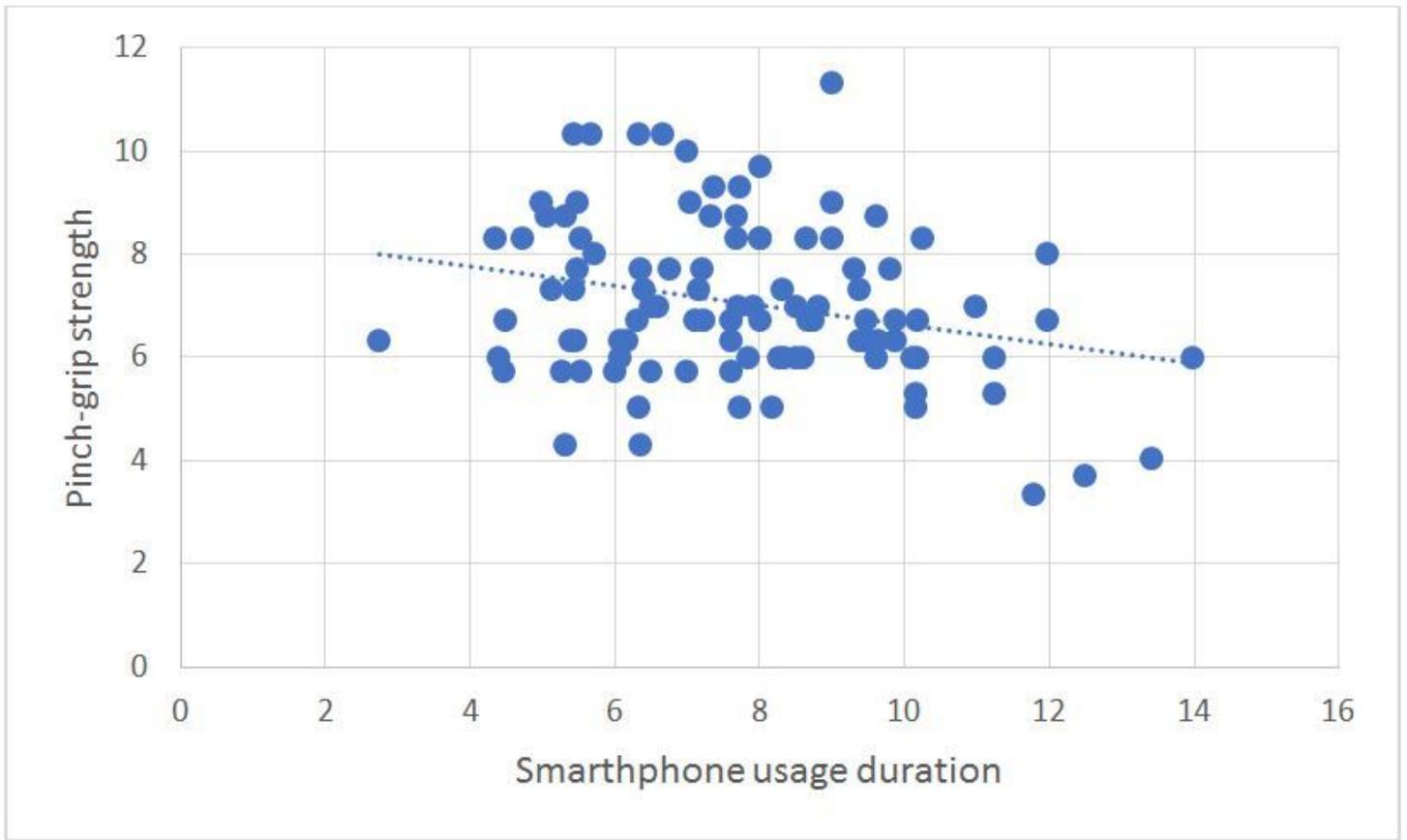


Figure 3

Relationship between smartphone usage duration and pinch-grip strength.

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