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Effect of prolonged smartphone usage on median nerve and hand grip strength among female medical students in Umm Al-Qura University

Ali A. Thabet [1,2], Anwar A. Ebid [1,2], Kadrya H. Battecha [1,2], Hayam Mahmoud [1,2], Raghad A. Baakhdhar[1], Husna A. Saleh[1], Mawadh H. Almaimani[1], Renad A. Alghamdi[1]

[1]*Department of Physical Therapy, College of Applied Medical sciences, Umm Al-Qura University, Makkah, Kingdom of Saudi Arabia (KSA).*

[2]*Faculty of physical therapy, Cairo University, Giza, Egypt.*

ABSTRACT

Background: In the past ten years, there has been a considerable rise in the usage of smartphones, and it has been noted that students use mobile phones for prolonged hours and thus they may commonly experience hand pain. Prolonged usage of smartphones may lead to daily-life disturbances including neck and wrist disorders, such as carpal tunnel syndrome & grip weakness .

Purpose: To explore the effect of prolonged smartphone usage on hand grip strength and median nerve conduction velocity, and the association between smartphone usage duration and hand-grip strength and nerve conduction velocity among female medical students in Umm Al-Qura University.

Methods: A 70 female subjects from umm Al-Qura University (UQU), their ages ranged from 19-25 years, volunteered to participate in the study. Data was conducted using a pre-experiment scale of smart phone addiction scale – short version (SAS-SV) questionnaire for collecting demographic data about the participants determining the smartphone usage. Participants were briefly examined for hand-grip strength measurement was performed using a hand-held dynamometer and median nerve conduction velocity measurement was performed using electromyography studies through one assessment session

Data analysis: By using descriptive statistics for demographic data of the participants. The student t-test to compare between mean groups and bivariate correlation to assess the relationship between smartphone usage and hand-grip strength and median nerve conduction velocity, with P-value below 0.05 was assumed to be significant. All data were entered and analyzed through statistical package for social sciences SPSS version 16

Results: There was significant difference (P-value < 0.05) in the hand grip and median nerve conduction velocity between addiction and non-addiction group with a low strength significant (r = 0.33, p = 0.005) inverse relationship between smartphone usage duration and hand-grip strength and a non-significant relationship between smartphone usage duration and median nerve conduction velocity with little or no correlation (r = 0.08, p = 0.524).

Conclusion: Prolonged use of smartphones was related to weaker hand-grip in medical female students of UQU who use smartphones for more than 4 hours, while there was a normal value of median nerve conduction velocity in both smartphones addicted and non-addicted students.

Corresponding Author e-mail: khbattecha@uqu.editor.sa

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INTRODUCTION

In the previous ten years, there has been a fast expansion in the utilization of smartphones and today, they are important in practically every aspect of human life [1,2]. Regardless of age group, income level, gender, or location. It is important for communication, so that it has become something essential that people cannot do without it, including internet browsing, accessing email, global positioning system (GPS) navigation, capturing high quality photos, touchscreen, large displays and gaming [2,3]. The persistent decline in the cost of these gadgets propose that the utilization of cell phones will likewise Increment [4]. Even this, a smartphone has negative effects on people, including depression, difficulty doing daily tasks, and social, physical, psychological disorder [5,6].

In South Korea, as per the report of Korea correspondences commission, the advanced mobile phone has been assessed to be more than 20 million [7]. In Saudi Arabia, the number of mobile phone connection in 2021 was equal to 112.7% of the entire population, and a percentage of 95.7% of people Accessing the Internet [8]. The prevalence and ownership of smartphones is associated with the fact that younger people are more receptive to new technology or have a stronger intuitive understanding of it comparing to older adults. In spite of the fact that smartphones are no longer regarded as "new technology," there are some clear distinctions between the types of people who are more likely to own a smartphone for themselves [9]. Moreover, younger individuals use social media platforms accessed via hand-held smartphones more frequently than older adults, and they also appear to have more problematic use of social media [10]. For instance, in 2019, 56% of Americans of 65 years of age or older owned smartphones comparing to a greater percent of 96% of People in the age of 18 to 29. Ages between 18-29 years old use social media around 90% more compared to 40% usage of people of 35 years old and over [9]. The age group of 20-34 years received the highest score on the problematic smartphone usage scale, followed by those aged 3-11 years and those aged 35-50 years, while the age group of 11 to 19 and individuals over 50 has the lowest scores [11]. Due to their rapid resource availability and ability to promote better decision-making at the point-of-care, smartphone features hold considerable promise for medical education applications [12-15]. The average use of smartphones differs accordingly in different studies, as one study conducted among university students suggests that an average of 3.5 hours/day of smartphone usage spent on texting, emailing, scheduling, and browsing the internet. While another study reported 7.35 hours/day as an average of smartphone usage among university students [16]. According to the National Information Society Agency (2011), a daily usage of the smartphone greater than 5 hours/day is a criterion indicative of addiction [17]. While according to a study conducted in south India using the SAS-SV scale, 46% of the participants were using smartphones for 4-6 hours in a day [18]. The results of a study established in Turkey aimed on understanding the use of smartphones usage purposes and patterns among university students, have reported that university students have been using smartphones for more than 4 years [19]. Although smartphones are designed to be used with both hands, young people prefer to use them one-handed [20]. While using one hand, pressing keys mostly involves moving the thumb, with the rest of the hand being used for grabbing [21]. Despite its advantages, overuse may have a number of physical and psychological side effects [22]. According to several research, excessive smartphone use is linked to depressed symptoms, issues with memory and concentration, alterations in eating habits, and poor sleep quality [23–26]. Earlier research demonstrated that several physical fitness markers are inversely related to the risk of type 2 diabetes, hypertension, and all-cause mortality and are directly related to changes in cardiovascular health [27-30]. All these studies looked at the relationship between mobile phone usage and physical fitness and found that heavy mobile phone use was associated with insufficient physical fitness. Users of smartphones run the risk of contracting a number of repetitive strain injury (RSI-type conditions) [31,32]. Dry eyes, computer vision issues, carpal tunnel syndrome, and weakening in the thumb and wrist can all be complications and side effects of excessive smartphone use [33]. The nerves, muscles, and tendons in the fingers, hands, wrists, arms, elbows, shoulders, and neck can become injured as a result of repetitive movements, poor posture, and excessive use of mobile devices for texting or playing games without taking breaks [31,32]. If untreated, these injuries may result in long-term damage. With excessive use of a mobile phone for texting, joints can also suffer injury in the form of arthritis or subluxation in addition to soft tissues [34]. In addition, it has been suggested that excessive Long-term smartphone use is linked to poor physical health & fitness since poor sleep quality and infrequent meals are risk factors for low physical fitness [35]. Several physiotherapy groups as well as mobile phone operators throughout the world have recognized these issues [36]. When using cellphones for an extended period of time, flexion and extension movements over the wrist and fingers become more repetitive, which leads to weakening in the thumb and wrist and this repetitive movement considered as one of the main causes of carpal tunnel syndrome [21,37,38]. With time, these issues would reduce the hand's usefulness and could cause issues like a poor quality of life [39]. The median nerve is responsible for controlling the flexor-pronator muscles in the forearm and the majority of the musculature in the radial area of the hand, including the flexion of the hand, wrist, and digital phalanx of the fingers [40]. it may be get damaged & impacted by the constant hand and thumb positioning used when holding a smartphone for an extended period of time [21,38]. The muscles innervated by the median nerve, which are responsible for gripping and pinching actions, may eventually become weak as a result of the injured median nerve. There are a few studies in the Middle East looking at the relationship between smartphone addiction/overuse and at least the hand-grip or pinch-grip strength. [41].A previous study reported that when comparing two groups of young adults who use smartphone excessively(high and low users) with a control group of people who don't use smartphones found that high-frequency smartphones users had an enlarged median nerve, more pain in the thumb, decreased pinch strength, and impaired hand functions compared to low frequency smartphone users[37].Conversely, an observational study carried out in Dr. D.Y.Patil college of physiotherapy, showed that there was no difference between smartphone addicts and non-addicts hand-grip strength [42]. Also, another cross-sectional study carried out in Cairo university among adults, showed that there is no effect on median nerve conduction velocity [41]. Therefore, our aim of this study was to explore the effect of prolonged smartphone usage on hand grip strength and median nerve conduction velocity, and the association between smartphone usage duration and hand-grip strength and nerve conduction velocity among female medical students in Umm Al-Qura University.

METHODOLOGY

Design

An exploratory cross-sectional design, with an internet-based questionnaire, to collect self-reported measures of daily mobile hand-held device use, at female medical field Umm Al-Qura University, Saudi Arabia.

Participants

Participants were subjected to assessment after they signed consent forms, which were approved by the Biomedical research ethics committee at Umm Al-Qura university.

The inclusion Criteria, the participants were female students from medical field in umm Al-Qura University, with age ranged from 18-25 years old, BMI ranged from 18-25, average years of usage at least 4 years and, average hours of usage at least 1h/ day or more, achieved at least 14 or more score in the SAS-SV scale.

The exclusion criteria female students with history of wrist-related disorders, neurological disorders, and other health problems, also, those who play sports including Tennis & basketball.

The participants were invited to assess the grip strength & median nerve conduction velocity by using hand dynamometer & EMG, in one session for 20 minutes.

A 138 university female students were enrolled in this study. Of the 138 students, 70 was included according to inclusion & exclusion criteria.

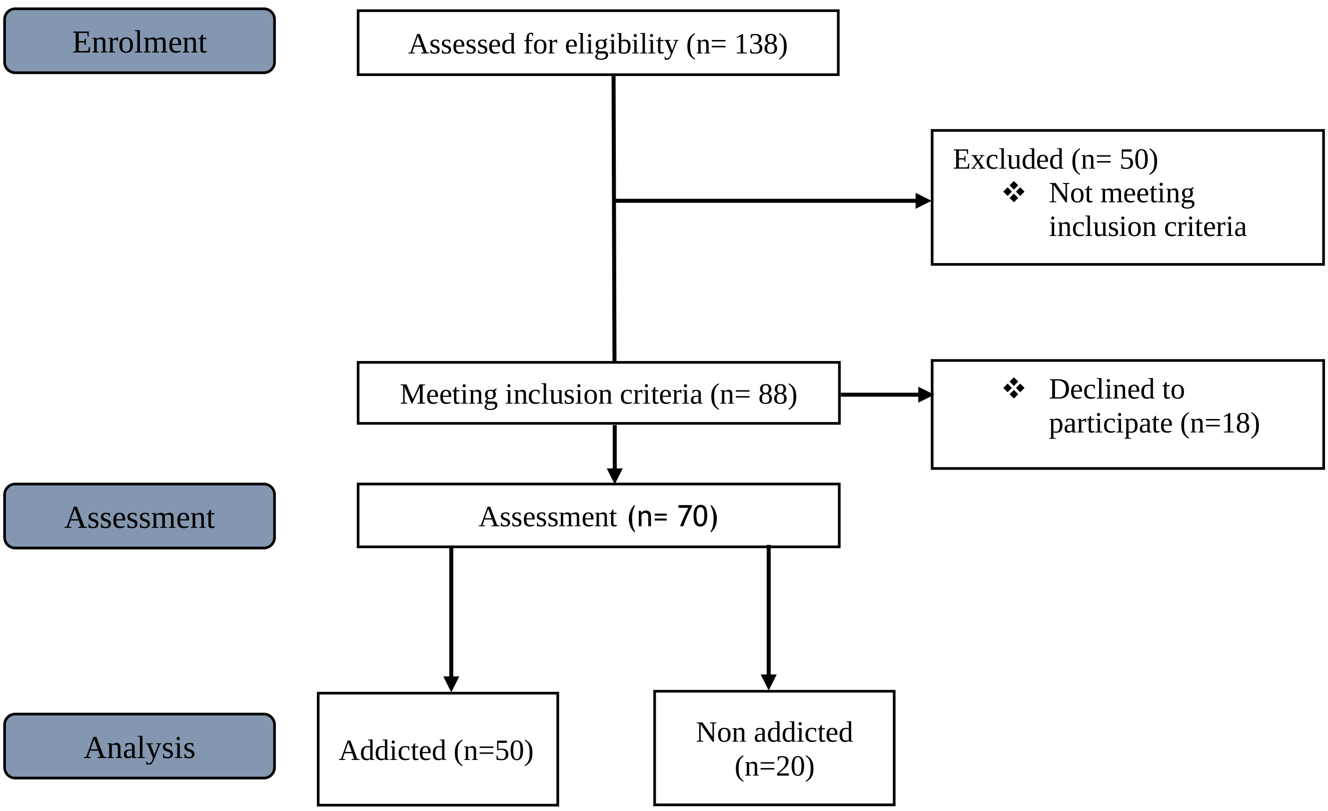

Figure 1 flow chart: eligibility criteria for participants' selection

Tools

Questionnaire

Online Questionnaires were given to students and provided by the aims of the study. The questionnaire includes open and close ended questions. It is containing an introduction giving an overview of the study and general questions covering participant information which are the age, height, weight, the average use, years of usage, it also contains the SAS-SV scale to know the addicted students, which was translated into Arabic language by a translator, the SAS-SV was used to calculate the addiction score. It consists of 10 questions that are based on a self- reporting system with a Likert scale of 6 points (1: strongly disagree, 2: disagree, 3: weakly disagree, 4: weakly agree, 5: agree, 6: strongly agree) [43]. They were also asked to report if they had any history of wrist-related injuries.

Informed consent was given to each participant for signing, after taking a full explanation of the aim and procedure of the study.

Handheld dynamometer (Jamar Hydraulic Hand Dynamometer Owner's Manual)

Jamar hand dynamometer offers different features in routine screening as well as evaluating Hand trauma and diseases. It accommodates to various hand size to fit an individual hand grasp. The handle can adjust to five grip positions from 1 3/8" to 3 3/8", in half inch increments. It displays grip force in both kilograms and pounds up to 90 kilograms or 200 pounds. [41]

EMG (electromyography (SIERRA Summit EMG/NCV/EP)

The Sierra Summit is the outcome of Cadwell's 40 years of study and development. Regarding the neurodiagnostic technology, this device has capabilities in EMG, nerve conduction velocity, evoked potentials, ultrasonography and chemodenervation. It consists of test fixtures and electrodes, as well as industrial cables with locking aluminum connectors, electrode connectors rated for 100k+ connections, and aluminum knobs and buttons rated for 100k+ uses [43].

Procedure

Ethical clearance was approved by director of biomedical ethics committee at UQU with Approval No. (HAPO-02-K-012-2022-11-1355). A 70 female students were selected based on inclusion criteria according to SAS-SV scale. Anthropometric measurements were obtained by questionnaire including height, weight and BMI

Hand Grip.

It was assessed for each participant using hand-held dynamometer (Jamar Hydraulic Hand Dynamometer Owner's Manual). The subject was seated with their shoulder adducted and elbow extended while arm and hand in neutral position. The subject was asked to squeeze the dynamometer by placement of the fingers in flexion at the proximal and distal interphalangeal joints. The grip strength was assessed for both dominant and non-dominant hand. Data was noted and filled in excel spreadsheet. Comparison was done between the two dominant and non-dominant hand.

Nerve Conduction Velocity.

It was assessed using EMG (electromyography (SIERRA Summit EMG/NCV/EP)) with bare arm and forearm skin. Three electrodes recording the responses to the electrical stimulus, two for measuring, and one for withdrawing, used to record the median nerve conduction velocity, as well as amplitude and latency of the nerve, in high-users of smartphone. Placing the cathode (-ve electrode) on abductor pollicis brevis, and the anode (+ve electrode) on the tip of the thumb, and the ground electrode on the dorsum of hand , then begin giving the stimulus at the wrist between palmaris longus and flexor carpi radials showed in, a mark was then made at the stimulating-point , next another stimulus was giving at elbow-joint medial to the biceps tendon , another mark was made at this stimulating-point showed. Lastly, the distance between the two points was measured in (inch) using a meter as.

Outcome variables

The hand grip strength was assessed using hand-held dynamometer and recorded in (kg)

Median nerve conduction velocity was measured using Electromyography studies (EMG)

Data Analysis

The descriptive statistics for the mean and standard deviation included the height, weight, age and BMI of the participants. Differences between the addiction and non- addiction mean groups were assessed using the student t-test, the relationship between smartphone usage and hand-grip strength and median nerve conduction velocity was assessed by using bivariate correlation. P-value below 0.05 was assumed to be significant. All data were entered and analyzed through statistical package for social sciences SPSS version 16.

RESULTS

Demographic characteristics

As shown in tables (1) the demographic characteristics of 70 participants in both groups are represented with non-significant differences were found between both groups regarding the age and BMI

Table 1. Demographic and clinical characteristics of participants at baseline.

Character	Addiction group	Non-addiction group	P-Value
	Mean ± SD	Mean ± SD	
Age (years)	21.12 ± 1.06	21.40 ± 1.05	0.32*
BMI (kg/m2	21.42 ± 2.12	21.13 ± 1.98	0.59*

* Non-significance SD: standard deviation

Unpaired T-test

As shown in tables (2) Unpaired T-test was performed to examine hand grip strength between the addiction and non-addiction groups, and results revealed that there was significant difference (P-value < 0.05) in the hand grip between both group with the non-addiction group has more hand grip strength than addiction group.

Unpaired T-test was performed to examine median nerve conduction velocity between the addiction and non- addiction groups, and results revealed that there was significant difference (P-value < 0.05) in the median nerve conduction velocity between both group with the non-addiction group has more median nerve conduction velocity than addiction group but still median nerve conduction velocity of addiction group in normal range

Table 2: Mean values of Hand grip strength and Median nerve conduction velocity in both groups

Variable	Addiction group	Non-addiction group	P-Value
	Mean ± SD	Mean ± SD	
Hand grip strength (kg)	12.44 ± 5.34	15.75 ± 5.40	0.02**
Median nerve conduction velocity (m/s)	63.04 ± 4.55	65.35 ± 4.60	0.04**

** Significance SD: standard deviation

Correlation analysis

As shown in tables (3) Correlation analysis that revealed a significant inverse relationship (negative correlation) between smartphone usage duration and hand grip strength with low strength correlation (r = 0.33, p = 0.005) that mean with increase of Smartphone usage duration there is decrease in hand grip strength

While there is a non-significant relationship between smartphone usage duration and median nerve conduction velocity with little or no correlation (r = 0.08, p = 0.524)

Table 3. Correlation analysis between smartphone usage duration and hand-grip strength, Median nerve conduction velocity

Variable	Smartphone usage duration (hours)	
	r	P-Value
Hand grip strength (kg)	- 0.33	0.005**
Median nerve conduction velocity (m/s)	-0.08	0.524*

** Significance * Non-significance

DISCUSSION

The aim of this study was to explore the effect of prolonged smartphone usage on hand grip strength and median nerve conduction velocity, and the association between smartphone usage duration and hand-grip strength and nerve conduction velocity among female medical students in Umm Al-Qura University. Our study found that there was significant difference (P-value < 0.05) in hand grip strength between both addictive and non- addictive groups, with higher hand grip strength in the non-additive group, also it revealed a significant inverse relationship between smartphone usage duration and hand grip strength, that mean with an increase in smartphone usage duration, there was a decrease in the hand grip strength. Also, our results showed that there was significant difference (P-value < 0.05) in the median nerve conduction velocity between both addictive and non-addictive groups, although the median nerve conduction velocity of addiction group was in normal range, and there was a non-significant relationship between smartphone usage duration and median nerve conduction velocity. Interpretation of different hand-grip strength values in our study between the addictive and non-additive smartphone users corresponds with a study conducted at LAHORE university that found more than 4 hours of smartphone usage will increase the risk of hand-grip weakness [44]. This was in line with another previous study that examined the effects of eight weeks long period of smartphone usage on hand-grip strength, forward neck translocation, and neck flexion angle. According to the study conducted at LAHORE university, cell phones have a direct impact on the cervical spine's flexing ratio as well as the forward head posture. And as a result, this will lead to significant musculoskeletal abnormalities and greater MSK movement rates that could eventually lead to fatigue. [44] [45]. There's an inverse relationship between smartphones usage duration and hand-grip strength, which can be explained by the damage occurring to the median nerve, and this damage was believed to be associated with prolonged usage of smartphones [37]. Muscles of the forearm as the flexor and the pronator, as well as most of the hand radial portion musculature, including thumb abduction, wrist flexion, finger flexion, are all innervated and controlled by the median nerve. [40]. The median nerve can be affected by the position of the hand as well as position of the thumb, that are adjusted during prolonged usage of smartphone [21]. The median nerve may also be damaged by repetitive wrist flexion and extension as well as frequent thumb use [38]. Eventually, the muscles innervated by the median nerve, which are those responsible for hand-grip action, may become weak as a result of the damaged median nerve [46]. When high-frequency smartphone users were compared to low-frequency smartphone users, numerous studies worldwide found that hand function was impaired and that there were numerous musculoskeletal issues [41]. Our study results agree with an observational study evaluated the hand-grip and pinch-grip strength between children who used smartphones frequently and those who used them less frequently. that found the greater frequency smartphone users had decreased hand-grip and pinch-grip strength [47]. Our study results also, agree with an observational study showed that a prolonged average daily usage of smartphone was contributed to both weaker hand-grip and pinch-grip strength [48]. The results of the current study are consistent with previous study that investigated the grip-strength and function in smartphone users and reported that the increase of smartphone addiction, was followed with a standard decrease in hand-grip strength as well as hand functionality [49]. Our study results also, agree with a study explored the effect of smartphone usage on the median nerve, that found the increase in the rate of smartphone usage have an adverse impact on median nerve, as it may lead to Carpel Tunnel Syndrome [50]. Our study results agree with a cross-sectional study found that the prolonged use of smartphones and hand-grasp strength has a significant negative correlation [51]. As well as our study results agree with the results of study that evaluated for early detection of musculoskeletal hand disorders and nerve entrapment in smartphone users, has found a latency and slow conduction velocity in both sensory and motor fibers of the median nerve among smartphone high-users [52]. The result of our study is consistent with this previous study that assessed the effect of smartphone use on hand-grasp strength among undergraduate students and concluded that students who use smartphones more than 4 hours, had a low value of hand-grip strength [44]. Another study investigated variation of median nerve affection due to electronic device overuse in students and reported that they had positive clinical tests indicative of carpel tunnel syndrome (CTS) [53].

Conversely, our study results disagree with cross-sectional study at king Saud university that found no significant difference in hand-grip strength between user and non-user of smartphones [54].

LIMITATION AND RECOMMENDATION

This study is not exempt of limitations; firstly, the sample sizes for the study is limited. Secondly our participant were only female students in the medical field. Thirdly data on common daily routines and hobbies that can influence hand function weren't gathered and the usage and frequency of other gadgets, such as tablets and tablet pencils, were also not recorded. Finally, regular attendance at a gym and engaging in strenuous exercise, such as weightlifting, may have an impact on the occurrence of this condition. We recommend for further research with big number of students of different Colleagues specialties in prospective longitudinal studies investigate the impact of prolonged use of smartphone on different hand muscles.

CONCLUSION

There is an inverse association between prolonged use of smartphones with hand-grip strength with less hand-grip strength in medical female students of UQU who use smartphones for more than 4 hours, there were also difference in median nerve conduction velocity between smartphones addicted and non-addicted but still in normal range.

Compliance with ethical standards

All procedures performed in study were in accordance with the ethical standards of the institutional and/or national research committee

Ethical approval

This study protocol reviewed and received approval from the "Biomedical Ethics Committee at Umm Al Qura University, Makkah, Saudi Arabia with approval number (HAPO-02-K-012-2022-11-1355).

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None

Conflict of Interest

The authors declare that they have no conflicts of interest

Informed consent

All participants signed an informed consent form before engaging in the study.

Author contributions

All authors contribute in concept and design of the study, Acquisition of data and data analysis, critical revision of the manuscript and final approval of the version to be submitted

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