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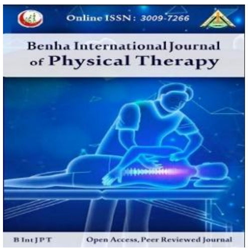

Original research

Smartphone Addiction and Isometric Rotator Cuff Muscles Strength Among Adults.

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Abstract

Background: Smartphones are essential in daily life, but excessive use may contribute to poor posture, affecting shoulder stability and rotator cuff muscle strength. **Purpose:** A cross section observational study was carried out to investigate how smartphone addiction affected the strength of rotator cuff muscles in adults. **Methods:** The study comprised 300 participants aged 18–30 (mean age 21.30 ± 2.75 years). The Smartphone Addiction Scale-Short Version (SAS-SV) was employed to assess smartphone addiction, and rotator cuff muscle strength was measured utilizing a hand-held dynamometer. **Results:** Spearman correlation testing indicated a weak negative non-significant association between SAS score and right Infraspinatus & Teres minor ($r = -0.093$, $p = 0.107$) and right Subscapularis ($r = -0.097$, $p = 0.095$), while a weak negative significant correlation was found with right Supraspinatus ($r = -0.162$, $p = 0.005$). For the left side, a weak negative significant correlation was detected with left Infraspinatus & Teres minor ($r = -0.119$, $p = 0.039$) and left Supraspinatus ($r = -0.172$, $p = 0.003$), whereas a weak negative non-significant correlation was noted with left Subscapularis ($r = -0.094$, $p = 0.104$). No significant changes were detected in Infraspinatus & Teres minor and Supraspinatus strength between both sides ($p > 0.05$), but right Subscapularis indicated a significant reduction in strength compared to the left side. **Conclusion:** There is a negative correlation between smartphone addiction and isometric rotator cuff muscles strength.

Key words: Rotator cuff, Dynamometer, Smartphone.

INTRODUCTION:

Smartphones have become essential in human life, serving as tools for interaction, surfing the internet, and playing games. Over the last ten years, people's use of smartphones, and the time people spend on their devices have risen significantly.[1] A study found that 79% of individuals aged 18 to 44 spent nearly all their time on their smartphones, with just two hours a day spent without using one.[2] According to the most recent results of a research conducted in the United States, 46% of smartphone users said they "cannot live without" their cell phone".[3]

Excessive smartphone use among the younger generation contributes to a more sedentary lifestyle, which in turn leads to a rise in various musculoskeletal problems.[4] Smartphone users tend to develop poor posture while using smartphones. This often involves a forward head position and rounded shoulders due to neck flexion and scapula abduction, as users hold their hands out to view the screen. Such posture can cause neck and shoulder fatigue and discomfort.[5]

Rounded shoulders, characterized by the forward tilting of the shoulders due to poor posture, significantly affect the strength and functionality of the rotator cuff muscles. This posture alters the resting length of the rotator cuff muscles, disrupting their length-tension relationship and reducing their ability to generate optimal force.[6,7]

Smartphones can aid people manage their tasks, keep in touch with friends and relatives, and be more accessible, but using them excessively can have negative impacts.[8] Concerns have recently been highlighted by research about smartphone users' necks and shoulders.[9] Furthermore, Yang et al. [10] established a correlation between the time spent on smartphones and musculoskeletal pain.

No previous study has found a link between smartphone addiction and isometric rotator cuff muscular strength, to the authors' knowledge. Thus, the main objective of this research was to ascertain the relation between smartphone addiction and isometric rotator cuff muscular strength.

METHODS

Participants

This is a cross-sectional study using an analytical observational design to see if there was a link between smartphone addiction and isometric rotator cuff muscle strength on the right and left sides in adults. In compliance with the ethical criteria of the 1964 Declaration of Helsinki, the study was also authorized by the ethics committee of Cairo University's Faculty of Physical Therapy (No.: P.T.REC/012/005294) and registered on the Clinical Trial. gov (NCT06633081). A total of 300 persons of both genders, were included in this study. The study involved healthy volunteers aged between 18 to 30 who required the use of a smartphone. Participants with any medical condition associated with shoulder pain, such as impingement, subacromial bursitis, rotator cuff injuries, or traumatic or degenerative supraspinatus tendonitis were excluded. Individuals presenting a positive Neer or Hawkins test, pain during shoulder elevation, tenderness at the rotator cuff tendon site, discomfort with resisted isometric shoulder abduction, or a history of pain in the C5 dermatome were also excluded. Additionally, anyone with a prior musculoskeletal injury or surgery that could impact the measurements was disqualified from participation.

Before the assessment, all selected participants signed a consent form to confirm their voluntary contribution in the study. The results of the assessment process were kept confidential throughout the study but were shared with the participants at its conclusion.

Procedures of the study:

Smartphone addiction assessment

The participants were assessed for smartphone addiction utilizing the Arabic version of the smartphone addiction scale (short version) [11]. The SAS-SV's Cronbach's alpha value of 0.91 indicated that it had excellent internal consistency. On a six-point Likert scale, which goes from 1 to 6 (extremely disagree to extremely agree), participants gave their answers. Based on ten self-reported items, the scale assesses six aspects: overuse, withdrawal, daily-life disturbance, tolerance, cyberspace-oriented relationships, and positive anticipation, for males, the threshold score for smartphone addiction was 31, while for females, it was 33. [12]

Isometric muscles strength assessment

The hand-held dynamometer (MMT 01165, Lafayette Manual Muscle Test System, Lafayette, IN, USA) was implemented to test the isometric rotator cuff muscular strength. In isometric muscle strength testing, this tool has shown intrarater reliability (ICC=0.67 to 0.99) and interrater reliability (ICC=0.67 to 0.96) in the moderate to excellent value. [13,14]

Measurement of isometric infraspinatus and teres minor muscle strength:

The participants sat with their arms in a neutral rotation, keeping their elbows and forearms at a 90-degree angle of flexion. The thumb was pointed upward, and the forearm was placed halfway between supination and pronation. The examiner placed the dynamometer a little above the ulnar styloid process, on the outside of the distal forearm, **Fig (1).** To perform an isometric test of the teres minor and infraspinatus muscles, the participants were told to externally rotate against the resistance of the dynamometer and hold the position for five seconds. [15] Three repetitions were conducted, and the mean measurement was taken.

Fig (1): Isometric measurement of infraspinatus and teres minor muscle strength.

Measurement of isometric supraspinatus muscle strength:

The participants sat with their elbows completely extended and their palms facing down, with their shoulders at roughly 90 degrees of abduction and 45 degrees of horizontal abduction. The dynamometer was situated by the examiner the lateral epicondyle of the humerous on the distal arm **Fig (2).** The participants were instructed to perform abduction against the dynamometer's resistance and held for 5 seconds to perform an isometric supraspinatus muscle test. [15] Three repetitions were conducted, and the mean measurement was taken.

Fig (2): isometric measurement of supraspinatus muscle strength.

Measurement of isometric subscapularis muscle strength:

The participants sat with their elbows flexed at 90 degrees and their arms positioned at about 90 degrees of forward flexion. The dynamometer was placed beneath the subject's hand by the examiner. The examiner put one fingertip from the hand wasn't gripping the dynamometer on the participant's olecranon to make sure the participant performs medial rotation moment instead of adduction moment **Fig (3).** To execute an isometric subscapularis muscle test, the participant was told to rotate internally against the resistance of the dynamometer and hold the position for five seconds. [15] After three repetitions, the mean measurement was taken.

Fig (3): Isometric measurement of subscapularis muscle strength.

Sample size calculation

The sample size was computed through the G*Power software (version 3.0.10). T-test linear bivariate regressions: one group was selected. The power of 0.80, (two tails) and alpha level of 0.05, the generated sample size is ***300*** subjects.

Statistical analysis

The measured variables were displayed utilizing descriptive statistics, which involved mean, standard deviation, minimum, maximum, and frequency. To ascertain the relationship between SAS-SV and isometric rotator cuff muscle strength, the Pearson Correlation Coefficient was utilized. To compare the strength of the right and left isometric rotator cuff muscles, a paired t test was applied. For statistical testing, the significance level was set at $p < 0.05$. The statistical software for social sciences (SPSS) version 25 for Windows was employed to conduct all statistical analyses.

RESULTS

Subject characteristics

Three hundred subjects with smartphone addiction took part in this research. Their mean age, weights. height and BMI were 21.30 ± 2.75 years, 64.81 ± 9.36 kg, 166.90 ± 8.15 cm and 23.19 ± 2.36 kg/m² respectively. The mean daily smartphone usage of study group was 7.06 ± 2.16 h/day, and the mean SAS-SV was 39.81 ± 5.68 **(Table 1).**

Table 1. Participant characteristics.

	Mean ± SD	Maximum	Minimum
Age (years)	21.30 ± 2.75	30	17
Weight (kg)	64.81 ± 9.36	92	42
Height (cm)	166.90 ± 8.15	188	149
BMI (kg/m²)	23.19 ± 2.36	31.50	15.40
Daily smartphone usage (h/day)	7.06 ± 2.16	20	5
SAS-SV	39.81 ± 5.68	60	33
	N	**%**	
Sex distribution			
Males	69	23	
Females	231	77	
Occupation distribution			
Faculty staff	8	2.7	
Student	191	63.7	
Internship	99	33	
Physiotherapist	2	7	

SD, Standard deviation

Relationship between SAS-SV and isometric rotator cuff muscles strength:

The association between SAS-SV and right isometric rotator cuff muscles strength was weak negative non-significant correlation with right Infraspinatus & Teres minor strength (r = -0.093, p = 0.107) and right Subscapularis (r = -0.097, p = 0.095) while was weak negative significant correlation with right Supraspinatus (r = -0.162, p = 0.005).

The correlation between SAS-SV and left isometric rotator cuff muscles strength was weak negative significant correlation with left Infraspinatus & Teres minor strength (r = -0.119, p = 0.039) and left Supraspinatus (r = -0.172, p = 0.003) while was weak negative non-significant correlation with left Subscapularis (r = -0.094, p = 0.104) **(Table 2).**

Table 2. Association between SAS-SV and isometric rotator cuff muscles strength:

Isometric rotator cuff muscles strength (kg)		SAS-SV r value	SAS-SV p value
Right side	**Infraspinatus & Teres minor**	-0.093	0.107
	Subscapularis	-0.097	0.095
	Supraspinatus	-0.162	0.005*
Left side	**Infraspinatus & Teres minor**	-0.119	0.039*
	Subscapularis	-0.094	0.104
	Supraspinatus	-0.172	0.003*

r value: Pearson correlation coefficient; p value: Probability value, * significant at p < 0.05.

Comparison of isometric rotator cuff muscles strength between right and left sides

Paired t-test shows no significant difference in Infraspinatus & Teres minor and Supraspinatus isometric strength between right and left sides (p > 0.05). A significant reduction in Subscapularis isometric strength of right side was detected compared with that of left side (p = 0.02). **(Table 3).**

Table 3. Comparison of isometric rotator cuff muscles strength between right and left sides.

Isometric rotator cuff muscles strength (kg)	Right Mean ± SD	Left Mean ± SD	MD	t-value	p-value
Infraspinatus & Teres minor	6.68 ± 1.71	6.69 ± 1.68	-0.01	-0.58	0.55
Subscapularis	5.98 ± 1.72	6.04 ± 1.73	-0.06	-2.29	0.02
Supraspinatus	7.23 ± 1.92	7.20 ± 1.91	0.03	1.00	0.32

SD, Standard deviation; MD, Mean difference; p-value, Probability value.

DISCUSSION

Numerous activities are carried out by smartphone users, including social media use, internet surfing, conversation, gaming, gambling, music listening, and others.[16] People may perform repetitive motions or stay in one position for extended periods of time while performing these duties, which could lead to a variety of musculoskeletal problems. [17] Persistent musculoskeletal pain has been linked to inadequate head and neck posture brought on by prolonged smartphone use. [10,18] Diseases of the musculoskeletal system that impact the hand, wrist, arm, neck, and forearm. The study aimed to determine whether smartphone addiction and the strength of the isometric rotator cuff muscles in subjects within the ages of 18 and 30 were correlated.

The current study's findings revealed a weak association between the SAS score and the isometric strength of the supraspinatus on both sides, as well as the isometric strength of the infraspinatus and teres minor on the left side. However, no significant association was detected between the SAS scoring and the isometric strength of the subscapularis on both sides or the infraspinatus and teres minor on the right side.

The study's result aligns with that of Yasa et al. [19] who found connection between reduced shoulder girdle muscle strength on the dominant side and the electromagnetic fields generated by smartphones. This may be due to that electromagnetic fields have the potential to influence various physiological processes, including the propagation of action potentials within nerve fibers. When nerve fibers are exposed to these fields, action potential transmission can be blocked or disrupted, leading to a reduction in muscle tone and strength in the neuromuscular system. [20,21] Electromagnetic fields may impact muscle function by altering acetylcholine (ACh) release from presynaptic terminals. A disruption in the presynaptic release mechanisms of ACh, possibly caused by electromagnetic exposure, could contribute to a decrease in muscle tone and strength. Neurotransmitter release is influenced by numerous ions and molecules, including calcium, calmodulin, synapsin I, ATP, and A kinase. [22]

Electromagnetic fields may also affect cholinergic receptors sensitivity at the motor endplate. Research has shown that a reduction in receptor sensitivity, or desensitization, can occur in response to electromagnetic exposure. There has been evidence of ACh receptor desensitization at the neuromuscular junction, with the induction of this process involving the phosphorylation of these receptors by enzymes such as A kinase, C kinase, and tyrosine kinase, along with cyclic AMP activity. [23,24] If a magnetic field disrupts any of these processes, it could impair muscle strength and tone.

Furthermore, changes in the excitability of the sarcolemma can significantly influence muscle tone and strength. Calcium (Ca) plays an essential role in muscle contraction, and any magnetic field-induced disruption in Ca handling during muscle contraction could alter muscle tone. Research has indicated that electromagnetic field exposures may impact ATP and big molecular enzymes such calmodulin, and myosin light chain kinase. These disruptions could collectively affect muscle contraction processes and contribute to changes in muscle tone and strength. [18,25]

Another explanation for this is that Prolonged smartphone use often leads to poor posture, such as a forward head position and rounded shoulders, due to neck flexion and scapula abduction. This posture strains the shoulder joint, especially the rotator cuff muscles, which are significant for shoulder stabilization and movement. The alignment of the thoracic spine, influenced by sitting posture, affects scapular orientation and the ability of the rotator cuff to generate force. [26]

In line with our results, Kebaetse et al, found that excessive scapular protraction during smartphone usage reduces rotator cuff strength by limiting the force of internal and external rotator muscles with 23% decrease in maximum rotator cuff activation and slouched postures can decrease muscle force during arm abduction by 16.2%. [27]

Many studies concluded that prolonged smartphones use also alters cervical spine curvature, leading to upper crossed syndrome, which causes muscle imbalances and rounded shoulders. These imbalances disrupt the muscles' length-tension relation, weakening stabilizers and increasing the risk of shoulder injuries, such as rotator cuff impingement and tendon degeneration. [28,29,30]

Limitation

The study was limited to a particular age range (18–30 years), which can affect how broadly the findings can be applied. When measuring the degree of smartphone addiction, the use of self-reported assessment, like the SAS-SV, can create bias and inaccuracy. Furthermore, the current study was conducted on people with various occupations that may contain multiple working demands that may impair rotator cuff strength and other factors that can be linked to smartphone addiction, including computer usage and fitness practices, were not assessed.

CONCLUSION

There is a negative correlation between smartphone addiction and isometric rotator cuff muscles strength.

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Conflict of Interests

The authors stated no potential conflicts of interest.

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