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Impact of Smartphone Addiction on Gross-Hand Dexterity in Young Adults

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ABSTRACT:Background*:Smartphone has become an integral part of everyday life for educational and recreational purpose. A smartphone is used for playing games, internet surfing, watching movies, communicating, etc. This has lead to increased severity and prevalence of smartphone addiction among teenagers, adolescents, and young adults. Evidence points to various pathophysiological changes in upper extremity due to repetitive and continuous usage of smartphone for longer durations.Thus, this study aims to compare the effect of smartphone addiction on gross-hand dexterity in young adults.*
Materials and methods:*160 young adults within the age group of 18-35 years were asked to fill the Smartphone Addiction Scale (SAS). Based on the scores calculated, they were classified as having mild, moderate and severe smartphone addiction. 20 subjects for each group (n=20) were randomly selected and were assessed for gross-hand dexterity using the Minnesota Manual Dexterity Test on dominant as well as the non-dominant side (N=60). The subtests used were Placing test, Turning test and One-hand turning and placing test.****Results:****Datawas analyzed using GraphPad Instat3 software. On comparing the group means, it was observed that the severely addicted group took the longest time to complete the tests, followed by mildly addicted group and then moderately addicted group. However, the difference in means was not statistically significant.For the placing test [Group means (in seconds):severe(181.00+19.593) >mild (177.85+16.878)>moderately (175.40+16.627)], the p-value was 0.7005 on dominant side and 0.0550 on the non-dominant side[Group means:severe(200.50+22.360)> mild(191.45+14.848)> moderate (184.80+ 22.353)]. The p-value was 0.1543 for the turning test[Group means:severe (155.25+21.584) > mild (146.70+19.377)> moderate (144.20+19.339)]. For one-hand turning and placing test, the p-value was 0.0890 on dominant side[Group means on dominant side: severe (218.00+23.231) > mild (206.500+24.958) ~ moderate (206.25+17.168)] and 0.1568 on non-dominant side[Group means on the non-dominant side: severe (244.15+26.664) >mildly (235.35+19.885)>moderately (229.20+25.757)].****Conclusion:****The current study indicates that the group means of severely addicted individuals is more than mildly and moderately addicted groups, however, the difference between the group means is not statistically significant.*
KEYWORDS: *smartphone addiction, gross-hand dexterity, hand functions, hand dexterity.*

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I. INTRODUCTION

Addiction is considered by WHO (WHO Expert Committee - 1964) as dependence, as the continuous use of something for the sake of relief, comfort, or stimulation, which often causes cravings in its absence[1]. Smartphone addiction is a type of behavioral addiction.Thegrowing technological advancement has lead to digitalization where people want everything to be done at one click. Google has replaced the need for referring to books. Our lives have become techno-savvy. Smartphone has replaced the need forvarious objects such as an alarm clock or watch, a printed calendar, a phone diary, television and newspaper to a certain extent, need for stepping out of the house for shopping, etc. It has become a rapid platform for the exchange of information. All these factors have led to an increased prevalence of smartphone addiction among young adults [2].

Previous studies suggest that a link between smartphone addiction and affection of various musculoskeletal tissues of the upper extremity exists. Distally, there is affection of 1st Carpometacarpal joint (trapeziometacarpal joint)[3]; Myofascial pain syndrome of 1stinterossei, thenar muscles and extensor digitoriumcommunis[4]; De Quervain's tenosynovitis[5]; Extensor pollicislongus tenosynovitis[5]; inflammation of median nerve within the carpal tunnel[6];reduced ulnar nerve conductivity[7]; Cubittal tunnel syndrome at the elbow; etc. Proximally, sustained faulty neck posturei.e forward head with increased upper thoracic and lower cervical flexion and increased upper cervical extension during prolonged smartphone use leads to 'Text Neck Syndrome'[8].These pathophysiological changes may lead to an altered length-tension relationship of muscles of the upper quadrant[9], thereby affecting the strength of proximal as well distal muscles. This may affect proximal stability and distal mobility of upper extremity. Thus, the purpose of this study was to assess and compare gross-hand dexterity in young adults with mild, moderate and severe smartphone addiction.

II. MATERIALS AND METHODS

Institutional review board approval was taken before initiating the study. Informed written consent was taken from all the participants. The study was conducted at the Research lab of K.J.Somaiya College of Physiotherapy. It was a cross-sectional, comparative study. 160 Young adultswithin the age group of 18-35 years and using a smartphonefilled the Smartphone Addiction Scale (SAS). Subjects with any neurological injury, any recent musculoskeletal injury of the upper extremity, musical instrument players and those who performed any fine-hand motor work were excluded from the study. SAS is a 33items questionnaire with the scoring of each question on a 6-point Likert scale. Based on the scores calculated, subjects were classified as having mild (SAS Score:33-66), moderate (SAS Score:67-132) and severe (SAS Score:133-198) smartphone addiction. 20 Subjects for each of the 3 groups (mildly addicted group:n=20, moderately addicted group: n=20 and severely addicted group: n=20, N=60) were randomly selected to assess for gross-hand dexterity using the Minnesota Manual Dexterity Test.Demographics of study groups have been summarized in Table 1.The subtests of Minnesota Manual Dexterity Test used were: Placing test, Turning test and One-hand turning and placing test. Placing test and One-hand turning&placing test are unilateral gross-hand dexterity tests which were assessed on the dominant and non-dominant side. Turning test is a bimanual test. Minnesota manual dexterity board was kept on a table with a height of 28-36 inches and at about 1-inch distance from the edge of the table. Subjects had to stand at the center of the board and were not allowed to walk during the performance of the tests. The time taken to complete the trials was recorded using a stopwatch. 3 trials were taken for each testwith a 30-second rest pause between each trial. The summation of the time taken to complete each of the 3 trials (in seconds) was used as the final score.

Table Ⅰ: Demographicsof study groups.

Addiction Grade	Mild addiction (n=20)	Moderate addiction (n=20)	Severe addiction (n=20)
Gender(M/F)(in percentage)	10/90	15/85	25/75
Mean age (years)+SD	24 ±4.3164	21.45 ±1.2763	23.95±4.7955

III. RESULTS

The datathus collected of 60 subjects, was statistically analyzed using GraphPad Instat3 software. Parametric test i.e. One-way Analysis of Variance test was used for the comparison of data between mild, moderate and severe smartphone addiction groups for the data which passed the normality tests. Non-parametric test i.e.Kruskal-Wallis test was used for the data which did not pass the normality test.These tests were performed at a 5% significance level.The results have been summarized in Table 2.For the placing test on the dominant side, the mean time taken to complete the test for the severely (181.00+19.593) addicted group was most, followed by mildly (177.85+16.878) addicted group and thenmoderately (175.40+16.627) addicted group. The non-dominant side followed the same sequence of affection i.e severe(200.50+22.360)> mild(191.45+14.848)> moderate (184.80+ 22.353).This suggests that increased usage of smartphone affects gross-hand dexterity of both, dominant as well as non-dominant hand, however, it is statistically insignificant (p-value=0.7005) for dominant side and not quite significant (p-value=0.0550) for the non-dominant side.For the turning test, the ability to perform bimanual activities with rapidity and ease was most affected in the severely addicted group, followed by mildly addicted group and then, moderately affected group i.e. severe (155.25+21.584) > mild (146.70+19.377)> moderate (144.20+19.339). However, this difference in means is not statistically significant (p-value=0.1543).Forone-hand turning and placing test on the dominant side, as the severity of addiction increased, the affection of gross-hand dexterity increased i.e severe (218.00+23.231) > mild (206.500+24.958) ~ moderate (206.25+17.168). However, this difference in means was not quitesignificant statistically (p-value=0.0890). The same test on non-dominant side showed that the severely(244.15+26.664) addicted group took the most time, followed by mildly (235.35+19.885) addicted and then by moderately(229.20+25.757) addicted group. However, the difference in means was not statistically significant (p-value=0.1568).Thus,to generalize, on comparing the means of 3 groups, the severely addicted group took the longest time to complete the dexterity tests as compared to mildly and moderately addicted groups.

Table : RESULTS OF DEXTERITY TESTS

Tests	Mean of groups±SD (in seconds)	p-value	Statistical test used	Level of significance
Placing test (dominant)	Severe(181±19.593) > Mild(177.85±16.878) > Moderate(175.40±16.627)	0.7005	Kruskal-Wallis test	Not significant
Placing test (non-dominant)	Severe(200.50±22.360)> Mild(191.45±14.848)> Moderate(184±22.353)	0.0550	One-way analysis of Variance	Not quite significant
Turning test	Severe(155.25±21.584)> Mild(146.70±19.377)> Moderate(144.20±15.347)	0.1543	Kruskal-Wallis test	Not significant
One-hand turning and placing test (dominant)	Severe(218.00±23.231)> Mild (206.50±24.958)~ Moderate(206.25±17.168)	0.0890	Kruskal-Wallis test	Not quite significant
One-hand turning and placing test (non-dominant)	Severe(244.15±26.664)> Mild(235.35±19.885)> Moderate(229.20±25.757)	0.1568	One-way analysis of Variance	Not significant

IV. DISCUSSION

The results obtained show that the severely addicted group took the longest time to complete the dexterity tests as compared to mildly and moderately addicted groups.The above results are in accordance to various other studies and can be attributed to:Thepostureattained by a maximum of smartphone users is that of a forward head with increased lower cervical and upper thoracic flexionand increased upper cervical extension[8]. Maintaining such faulty posture for prolonged periods of time increases the static load on the cervical spine and its tissues. The cervical spine is rich in various pain-sensitive tissues and nociceptors which on stimulation may lead to pain[9]. Muscles react to pain by a protective spasm. This may lead to an altered length-tension relationship of muscles of the upper quadrant[9], which may affect the strength and endurance of muscles of neck and shoulder girdle. Cervical proprioception is also found to be affected in young adults with smartphone addiction[10]. A strong and stable proximal musculature is essential for good distal mobility. Thus, there may be an affection of arm-hand and eye-hand-finger coordination due to the affection of the cervical spine.Cumulative trauma disorders to various structures of hand, wrist, and forearm may lead to continuous microtrauma of various musculoskeletal tissues[4]. Such prolonged, repetitive, low-amplitude dynamic loading of tissues during typing and scrolling over a period of time may cause tendinitis, tenosynovitis, synovitis, and osteoarthritis. This continuous wear and tear may lead to inflammation, which may cause protective spasm of muscles altering the length-tension relationship of muscles and thus affecting the strength and endurance of muscles. Thus, there may be reduced grip strength and endurance. Inflammation of muscles or tendons causes compression of the median nerve and ulnar nerve within the carpal tunnel at the wrist and cubital tunnel at the elbow, respectively. Such neuropraxia may lead to the slowness of nerve conductivity[7] over a period of time, leading to weakness and lack of coordination of muscles of thumb and fingers. Collectively, all these factors would affect the manipulative ability of the hand.Research conducted by Dr.Hyung Suk Seo, South Korea showed that smartphone-addicted individuals have increased levels of inhibitory neurotransmitter Gamma-aminobutyric acid (GABA) and decreased levels of the excitatory neurotransmitter glutamate in the anterior cingulate cortex, thus altering the GABA: Glutamate ratio in the brain[12]. This leads to increased inhibitory brain signals. GABA has shown to reduce motor activity by suppressing the supplementary motor area. This may affect the reaction time of individuals and thus, affect gross-hand dexterity. A study conducted by Yuanming Hu, Xiajing Long, HanqingLyu, Yangyang Zhou and Jianxiag Chen in 2017, shows that there are structural alterations in White Matter Integrity in young adults with Smartphone Dependence[13]. The regions affected were superior longitudinal fasciculus, superior corona radiata, anterior and posterior limbs of the internal capsule, external capsule, sagittal stratum, fornix/striaterminalis, cerebral peduncles, superior and middle cerebellar peduncles, medial lemniscus and pontine crossing tract[13]. This may result in impaired proprioception, reduced sense of discriminative touch, sensorimotor deficits, sustained negative effect on memory, attention, thinking, emotions, cognitive and executive functioning[13]. Also, there is a sub-axonal injury of the white matter of corpus callosum connecting the anterior cingulate cortex i.e cingulate bundle fibers[14]superimposed by increased GABA: Glutamate ratiowhich may affect the interhemispheric transfer of information, thus affecting bimanual activities. This may a reason for poor performance on Turning test in severely addicted individuals.

Learning of a novel motor activity takes time. It has to follow 3 stages of motor learning i.e.Cognitive, Associative and Autonomous. The reason for subjects in the mild group taking longer than the moderately addicted group in all tests may be attributed to reduced usage and still being in the cognitive phase of learning and thus transfer of learning takes longer time in them.

V. CONCLUSION

Thus, although there is an affection of gross-hand dexterity in severely addicted individuals as compared to mildly and moderately addicted groups, the difference of the group means is not statistically significant. The author of the present study suggests carrying out a similar study with a larger sample size, in order to obtain a clinically significant result.

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