

DAILY EXCESSIVE USE OF SMARTPHONE, LEADS TO EXAGGERATED HAND SYMPTOMS AMONG UNIVERSITY STUDENTS AS CHECKED BY BOSTON CARPAL TUNNEL QUESTIONNAIRE: A CROSS-SECTIONAL STUDY

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ABSTRACT

Introduction: The usage of smartphone (SP) has dramatically increased among young University students for their daily work and social media connect. It affects hand functions, and the present study was aimed at checking for chronicity of SP use and its effect on hand function.

Methods: Using a cross-sectional study design N=150 university students in the age group of 18-35 years were involved, after taking informed consent. They were using smartphone chronically (>12 months minimum). Hand functions were checked using Smartphone addiction scale (SAS) and Boston Carpal Tunnel Questionnaire (BCTQ). To check the effect of chronicity the participants were grouped based on daily usage (3-6hrs; 6-9hrs &>9hrs per day of SP use), and usage over a period of months (12-60 months; 60-120 months &>120 months of SP use). One - way ANOVA was used to check significant difference taking p=0.05 as the level of significance.

Results: For all participants Mean values were SAS = 22.63 ± 4.075, BCTQ FSS = 11.41 ± 3.784, BCTQ SSS= 15.053 ± 4.32. Significant differences were seen in daily usage of SP on BCTQ FSS (p=0.00097 & f ratio=5.73) and BCTQ SSS (p=0.032 & f ratio=2.99). ANOVA for SAS was significant (p<0.05) for daily usage groups but not for usage over a period of months.

Conclusion: Excessive daily usage of smartphone for more than 3 hours, chronically leads to hand symptoms among University students, and it is addictive as seen here, however chronicity of use over months in non-addictive. It has implications during daily extended uses like working on SP for official work and gaming.

KEYWORDS: Smartphone, hand symptoms, Smartphone addiction scale, Boston carpal tunnel questionnaire.

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Access this Article online	Journal Information
Quick Response code  DOI: 10.16965/ijpr.2020.146	International Journal of Physiotherapy and Research ISSN (E) 2321-1822 ISSN (P) 2321-8975 https://www.ijmhr.org/ijpr.html DOI-Prefix: https://dx.doi.org/10.16965/ijpr 
	Article Information
	Received: 18 Jun 2020 Peer Review: 19 Jun 2020 Revised: None
	Accepted: 07 Jul 2020 Published (O): 11 Aug 2020 Published (P): 11 Aug 2020

INTRODUCTION

Human hand is a master tool[1], that has led to much of the developments what we see today in term of art, science and technology[3,4].

Hand has been associated with communication from the beginning of evolution in the form of non-verbal communications - gestures and

signs[2]. However, during the course of evolution many developments and inventions in the field of communication has changed its role[3]. A similar advanced development 'the smart phone' (SP) poses significant challenge for the hand in terms of its chronic usage on a daily basis. SP use has been found to cause

thickening of the median nerve and flexor pollicis longus tendon[4-9].

Problematic prolonged SP use has been reported in the literature. It leads to poor social, psychological and academic outcomes[5]. Roberts et al., (2014) stated that smartphone users spent most time on texting, e-mail & social media site like Facebook, Whatsapp etc. [6] Day by day, number of smartphone users are increasing, they are found with associated factors like neck pain, headache, irritability, anxiety, lack of concentration, straining of eyes, insomnia, memory problems and depression [7,12]. Excess use of smartphone can cause physical disease and discomforts, pain in the hand and wrist, blurred vision, headache; these all problems can affect the daily life routine[8].

There are many assessment scales of addiction for smartphone use, in this study Smartphone Addiction Survey Short Version (SAS SV)[11], and Boston Carpal Tunnel Questionnaire (BCTQ), [10], have been used to check SP addiction and affected hand functions. SP use either with both hands or with single hand - produces flexion of the hand at wrist and metacarpal joints and there is repeated movements of tendons in flexed position, it may affect the carpal tunnel and its structures.

Purpose of the study: The effects of chronicity (of daily use and months of use) of use of SP in case of young people and hand symptoms were studied to check the effect of chronic SP use on hand functions. Measures used for this were SAS SV and BCTQ.

Null Hypothesis - Chronicity of SP use daily hourly and over a period of months does not result in a significant effect on hand function as seen by BCTQ.

MATERIALS AND METHODS

Research Design: It was a cross-sectional study.

Sample size: The sample comprised of N=150 individuals, consisting of both male and female. The sample age range is between 18yr- 35yr

Inclusion criteria: Individual using Smartphone chronically (more than 3 hours in a day) for >12 months. This duration (>12 months) has been defined as the chronicity of the SP use in the study.

Exclusion criteria: Any history with other joint inflammatory disorder or bone disorder. Any history of who have undergone any orthopaedic surgical procedures. Any history of who are undergoing physiotherapy for pain in neck, shoulder, elbow and hand. Pain in neck, shoulder, elbow and hand because of any trauma.

Assessment Measures: Participants were divided in to following categories based on chronicity of SP use %

a- on the basis of months of usage where the 3 groups were (12-60 months; 60-120 months & >120 months of SP use)

b- on the basis of hours of daily usage where the 3 groups are (3-6hrs; 6-9hrs & >9hrs per day of SP use)

Following assessment measure were used in this study

I. Smartphone Addiction Scale- Short Version

II. Boston Carpal Tunnel Syndrome Questionnaire

Ø Symptom Severity Scale

Ø Functional Status Scale

Demographic Information Sheet: It consisted of general and personal information statements assessing the demographic variables including the information about Name, age, gender, occupation, hand dominance, contact no, years of having smartphone, hours of using smartphones in a day, and the way of holding Smartphone Smartphone Addiction Scale- Short Version(SAS-SV)[11].

Smartphone addiction scale- short version is a scale used to identify the Smartphone addiction which consists of 10 items with a six point Likert scale i.e, 1: strongly disagree and 6: strongly agree, based on self-reporting. A Cronbach's alpha correlation coefficient of 0.91 has been obtained for the SAS-SV [11].

Boston Carpal Tunnel Syndrome Questionnaire[10]: The Boston Questionnaire is a self-applied and evaluates the severity of the symptoms and the functional status of the patients. The symptoms severity scale (SSS) evaluates symptoms regarding severity, frequency, time and kind. The functional status scale (FSS) how the syndrome affects daily life. In SSS, there are 11 questions with 5 points

i.e, 1: no symptoms and 5: severe symptoms whereas In FSS, it consist of 8 Questions with 5 points i.e, 1: no symptoms and 5: severe symptoms

Procedure: Ethical approval was given by Non-teaching credit course committee of Amity Institute of Physiotherapy to undertake this study. Written informed consent form was signed by all the participants for the permission for collection of data. After taking the permission by signing the consent form, data was taken. The participants were assured about the full confidentiality of the information they provided. The purpose of the research was explained. The participants were given the required demographic information, SP addiction scale-short version, and the Boston carpal tunnel syndrome questionnaire formats to complete. The questions were administered after brief instructions to the participants. Approximately 10-15 min was taken to administer this questionnaire. After completion, the questionnaires were taken back from the participants and were thanked for the cooperation.

Statistical Methods: All the data was compiled in a master chart & analysed using Microsoft excel data pack. Descriptive statistics (Mean±SD) was checked for the variables. One-way ANOVA was used to check the effect of chronicity of use on hand function. P-value <0.05 was taken a level of significance.

Table 2: SP addiction scale ANOVA table of sum of squares depicting the fratioand p value when participants are grouped as per the duration of chronic usage in months.

S.No.	Source of variation	df	Sum of squares	Mean sum of squares	f-ratio	P value
1	Between the classes	2	3.93	1.96	1.84	0.16
2	Within the classes	147	156.65	1.06		
3	Total	149	160.58			

Checking differences for SAS Scores based on chronicity of use of smartphone among the university student on the basis of months of usage where the groups are (12-60 months; 60-120 months & >120 months of SP use).

Table 3: ANOVA table of sum of squares using BCTSQ FSS data depicting fratio and p value, participants grouped as per the duration of chronic usage in months.

S.No.	Source of variation	df	Sum of squares	Mean sum of squares	f-ratio	P value
1	Between the classes	2	0.185	0.09	0.45	0.64
2	Within the classes	147	30.36	0.2		
3	Total	149	30.55			

Checking differences for FSS score based on Chronicity of use of smartphone among the university student on the basis of months of usage where the groups are (12-60 months; 60-120 months & >120 months of SP use).

RESULTS AND DISCUSSION

Descriptive results are seen in table 1. Differences for chronicity are seen in tables 2%4. Differences for daily excessive usage are seen in tables 5%7.

Table 1: Descriptive statistics for the involved participants.

Variable	MEAN±SD
AGE	22.62 ± 0.33278
M:F	04:11
Smartphone addiction scale-SAS	22.63 ± 4.075
Boston carpal tunnel syndrome questionnaire –FSS	11.41 ± 3.784
Boston carpal tunnel syndrome questionnaire – SSS	15.053 ± 4.32

Descriptive data for N=150 for age, M:F ratio and baseline values for Smart phone addiction scale (SAS) and Boston carpal tunnel syndrome questionnaire (FSS and SSS) scores.

Communication has evolved in humans from a set of gestures involving hands, face and body language [1,2]. Vocalization once discovered lead to the development of articulated speech [2]. There may be common neuronal pathways for verbal and non-verbal communications. Hand gestures still play a role in the communication process. SP combines voice and hand actions for communication in a unique way, thus it reunites the pathways and leads to prolonged activity durations with adaptive changes [16]. This may cause addiction and excessive use.

Table 4: ANOVA table of sum of squares using BCTSQ SSS data depicting f ratio and p value, participants grouped as per the duration of chronic usage in months.

S.No.	Source of variation	df	Sum of squares	Mean sum of squares	f-ratio	P value
1	Between the classes	2	182.04	91.02	0.92718	0.397969
2	Within the classes	147	14430.94	98.16		
3	Total	149	14612.99			

Checking differences for SSS score based on Chronicity of use of smartphone among the university student on the basis of months of usage where the 3 groups are (12-60 months; 60-120 months & >120 months of SP use).

Table 5: SP addiction scale ANOVA table of sum of squares depicting the f ratio and p value when participants are grouped as per the duration of daily usage in hrs.

S.No.	Source of variation	df	Sum of squares	Mean sum of squares	f-ratio	P value
1	Between the classes	3	24.69	8.23	8.84	0.00002 (Highly significant)
2	Within the classes	146	135.89	0.93		
3	Total	149	160.58			

Checking differences for SAS score of groups, based on use of smartphone per day among the university student on the basis of hours of daily usage where the 3 groups are (3-6hrs; 6-9hrs & >9hrs per day of SP use).

Table 6: ANOVA table of sum of squares using BCTSQ FSS data depicting f ratio and p value (highly significant), participants grouped as per the duration of daily usage in hrs.

S.No.	Source of variation	df	Sum of squares	Mean sum of squares	f-ratio	p-value
1	Between the classes	3	3.21	1.07	5.73	0.00097
2	Within the classes	146	27.32	0.18		
3	Total	149	30.54			

Checking differences for FSS score, based on use of smartphone per day among the university student on the basis of hours of daily usage where the 3 groups are (3-6hrs; 6-9hrs & >9hrs per day of SP use).

Table 7: ANOVA table of sum of squares using BCTSQ SSS data depicting f ratio and p value (Significant, participants grouped as per the duration of daily usage in hrs.

S.No.	Source of variation.	df	Sum of squares.	Mean sum of squares.	f-ratio.	P-value.
1	Between the classes	3	1.490679	0.49	2.99	0.032
2	Within the classes	146	24.2068	0.16		
3	Total	149	25.69748			

Checking differences for use of smartphone per day among the university student on the basis of hours of daily usage where the groups are (3-6hrs; 6-9hrs & >9hrs per day of SP use).

As the results show, that individuals of all ages use SP for excessive time. The data seen in present study also suggests that individuals are addicted to SP which affects their hand functions. In addition to it, the deterioration of functions and the symptoms are arising early, when we use Smartphone daily for more than 3 hours. (ANOVA for FSS- $F=5.73$; $p=0.00098$; ANOVA for SSS- $F=2.99$; $p=0.032$) (Tables 6 & 7)

The development of communication started with initial gesturing and vocalization syntax and words with meanings of expression came in to existence later [2].

This has led to written syntax in the form of symbols and pictures. With the inventions of pen and paper- literature with prose and poetry developed leading to executive functions and development of *the artistic hand*. Thus, expressions by hand have been a sign of intellect from millions of years. Intermediary inventions like type writer etc increased the role and dexterity of hand in writing. However, with the advent of computers hands have faced a machine faster than the fingers and exceeded the cognitive limits. Smartphone is also a communicating device that is advanced technology and adds higher

demands on the hands. SP has evolved from the dial phone – it has changed in shape and size and at present it is a gizmo involving different technologies. Its use involves various grips and pinches and different postures of the hand. Overuse may lead to symptoms in the hand and limitation of hand functions. These shall be noted during assessment for hand functions and symptoms in clinical practice.

Consequently, when the use of SP increases day by day, there is increase in symptoms and it also affects the hand function as checked on various scales like SAS, FSS and SSS. Overall addiction to a smartphone leads to symptoms in the hand and also affects the hand function according to the FSS and SSS scale. But in the present study the usage in the form of months has not given a significant result thus it is unclear how chronic use affects hand functions.

So, with this result, we found that as the usage of smartphone is increased for longer time daily, more symptoms may arise in hand and also affect the day to day activities, mobile phone usage is known to produce many symptoms [14]. Moreover, the participants in our study are of different age groups and both genders, most of them are college students and job workers who have a habit of using SP for more than 3 hours per day. In this study, we also defined the SP use level according to a SP addiction scale shorter version which contains 10 questions. Significant differences in addiction is seen for excessive daily use, however, significant differences in addiction scale with chronicity over months are not seen thus the chronic use increases without addiction. There are studies that have discussed age and gender differences for SP addiction [15].

The SP addiction scale-short version led us to evaluate all kinds of SP use such as texting, internet browsing, emailing etc. Previous studies have been demonstrated that prolong use of SP leads to the symptoms in the hand and also affects the hand function, social connect was a drive that could lead to addiction of SP when there is inadequate family and peer support [7,17]. The participants in this study don't have any previous history of trauma and injury of hands. SP users typically adapt their thumb and hand posture to constraints of the phone

design layout that may impact their performance, in addition excessive movement of the thumb and wrist occurs when an individual uses a SP, and placing thumb and wrist in these static postures will likely to increase the load on the wrist joints and associated structures like ligaments and tendons.

Chronic use of SP- Interpreting its challenge:

Due to overuse of the smartphone, as the hand posture is in flexed position and is accentuated day by day by chronic use. It initiates symptoms in the hand. Thickening of flexor pollicis longus tendon and median nerve are two mechanisms confirmed that lead to hand function deterioration [9]. It was found in present study that individuals who are using SP for more than 3 hours in a day tends to have more symptoms while doing household chores, writing, carrying of grocery bags etc. Some of the participants, who were using SP for extreme durations were having numbness also in their hands while doing working. Repetitive use of flexor mechanisms in Smartphone usage in bad posture can cause overuse injury also. Excessive work with the thumb and hand results in painful thumb known as text thumb. Pain while activity also found in the users who were doing texting for prolong hours and also presence of gaming hobby was found in chronic users (>10hrs/day). Overall, pain while movement among SP user seems to increase with greater use of the device. However, we did not find any statistically significant difference in hand functions on the basis of the chronicity (in months), smart phone addiction and symptoms. In addition to SAS, we found increased pain, symptoms and effects of hand functions on the basis of duration of SP use for more than 3 hours per day. (Figure-1) Individuals should be aware of the danger from overuse of the SP on a daily basis.

There may be various other possible mechanisms associated with the deterioration of hand function with daily overuse of the SP like muscle spasm. However, palmar fascia tightens due to the continuous flexion for the grasping and typing function of the smartphone. Shortened positioning of the thenar and hypotheneal eminence and the underlying muscles leads to the inefficient muscle action. Repeated adduction, abduction and opposition of the thumb leads to

Fig. 1: Linear increase in average SAS score of participants when grouped according to hourly daily use.

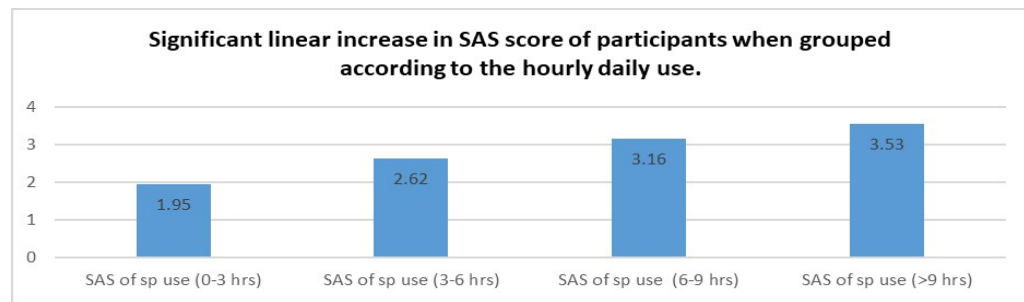
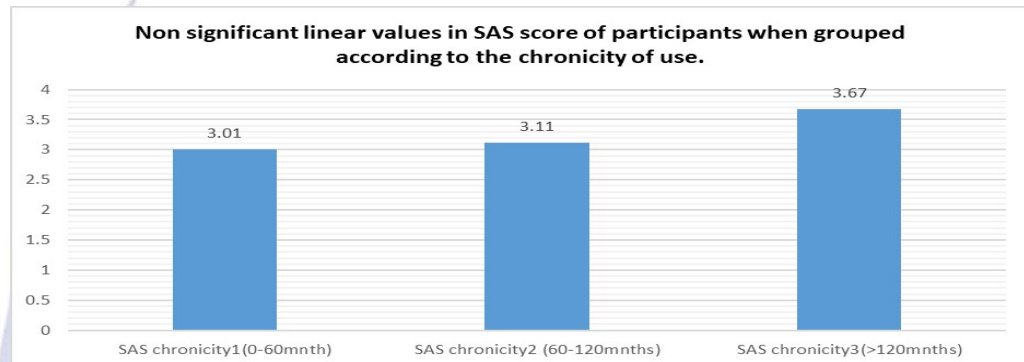


Fig. 2: Non-Linear values in average SAS score of participants when grouped according to the chronicity of use.



overuse syndrome for the tendons of the respective muscles. Blackberry thumb is one clinical entity described in the literature. It has been seen and reported that impulsive and chronic onslaught of the overuse of SP leads to demands which are not normal for the hand, even though hand has evolved for the rapid dextrous work, leading to musculoskeletal symptoms [13].

Such significant changes are not seen when participants are grouped according to the chronicity of use as seen in Figure-2.

Meanwhile there is one more aspect of hand development which is handedness. Handedness – right handed, left handed or ambidextrous are various aspects currently evolving but right handedness is claimed to be unique characteristic of human hand as can be seen in Corballis C. M. – 2003 [2].

Exercises and tips to relieve hand symptoms with excessive use of SP - Many simple exercises for the hands involving free active range of motion exercises and stretches mainly to the flexor compartment of the hand – thenar and hypothenar muscles can help to relieve the hand symptoms. Ergonomic aids for SP use are also popular in the present trends, where holders may be used to grasp the phone rather than the hand.

Future of SP use and hand functions - different designs for the SPs that are ergonomic and need less flexion for grasping and less flexion on the tendons and muscles may be better for hand health. General clinical assessment of hand

functions and symptoms may include questions for daily use of SP and from how many months. SP based games and appliances that requires prolonged continuous use may be more addictive in nature [18].

Situations like lockdown may increase daily use of SP significantly and populations may watch for hand symptoms and shift to more ergonomic devices when extended daily use is warranted.

CONCLUSION

In the study the daily SP usage with increased hand symptoms and addiction is seen. Thus, daily SP use in hourly basis with > 3 hrs of minimum daily use is seen affecting the hand functions using BCTQ. Also in individuals of hand symptoms strategies to relieve hands from SP usage on a daily basis may be incorporated.

ABBREVIATIONS

SP- Smartphone

SAS - Smartphone addiction scale

BCTQ - Boston Carpal Tunnel Questionnaire

SSS - Symptoms severity scale

FSS - Functional status scale

ACKNOWLEDGEMENTS

We would like to acknowledge the participants for their time and contributions.

Conflicts of interest: None

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How to cite this article: Mayank Shukla, Sakshi Jain, Meenakshi Rajput. DAILY EXCESSIVE USE OF SMARTPHONE, LEADS TO EXAGGERATED HAND SYMPTOMS AMONG UNIVERSITY STUDENTS AS CHECKED BY BOSTON CARPAL TUNNEL QUESTIONNAIRE: A CROSS-SECTIONAL STUDY. *Int J Physiother Res* 2020;8(4):3547-3553. **DOI:** 10.16965/ijpr.2020.146