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Examination of Self-Reported Subjective Assessment and Objective Measurement as Measurement Tool for Smartphone Overuse

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ABSTRACT
With increasing penetration of smartphone in our daily lives with higher rates, it becomes pertinent to have assessment tools which can appropriately take into consideration wide range of functions a smartphone can perform while making a diagnosis. This study evaluates and compares self-reported subjective assessment tools and objective measurements of smartphone usage. A total of 150 subjects participated in the survey where a google form which was circulated was to be filled, out of which data of 109 subjects was used in the analysis. This study included all healthy volunteers, 18 to 40 years of age from various different occupation, and should have inbuilt smartphone monitoring systems. Those subjects who used multiple gadgets were excluded from the study. Self-reported and objective usage hours and usage frequency, SAS-SV score were determined from the questionnaire. When self-reported questionnaire and objective measurements were compared it was found that, usage hours did not show any statistically significant difference (p=0.125) but usage frequency showed statistically significant difference (p=0.005). On comparing SAS-SV score and their self-interpretation on whether they are smart phone over users or not, showed major disparity. Correlation statistics showed that objective usage hours were moderately positively correlated with SAS-SV scores (r=0.436), weakly negatively correlated with age (r=-0.389) and weakly positively correlated with objective usage frequency(r=0.312). Above findings suggests that self-reported findings alone cannot be used to make a diagnosis and comparison regarding smartphone over use. And objective measurements can be explored more in order to determine the behavioural aspect of smartphone usage.
Keywords: *Smartphone overuse, self-reported subjective assessment, objective measurements*

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INTRODUCTION

Before invention of internet, phones were primarily used as a means of communication via calls or messages. With every passing year we witnessed great range in advancement of technology. Now it seems everyone and every possible device that we use are directly or indirectly connected to smartphones especially after covid-19 outbreak. The number of smartphone users has surpassed 3 billion worldwide. [1] This ubiquitous nature of smartphones call for researchers to dwell deeper into the research questions arising from this tremendous data available regarding smartphone use. After Covid-19 outbreak, smartphones became mainstay of our daily lives especially when people were forced to be at their homes for isolation and be quarantined after exposure to the virus. They continued their education and professional lives through smartphones and laptops. Hence, smartphone usage became more of a necessity. Whether necessity or habitual, this overdependence on smartphones eventually leads to many unfavorable clinical (sleep, ocular and musculoskeletal disorders), psychological (distraction, mood modification, loss of interest) and social (superficial approach to learning, isolation) outcomes. [2] Therefore, monitoring smartphone usage becomes pertinent in order to prevent any harmful outcome. A systematic review done by Bethany Harris and team [3] on problematic mobile phone and smartphone use scale, examined 78 existing subjective scales developed over last 13 years only. Majority of these questionnaires are developed on following constructs as main factors of diagnosis scales: [4] daily life disturbances, disregards for harmful consequences, preoccupation, withdrawal, tolerance, virtual world orientation.

Most of the scales use proxy measures of usage (e.g., the Smartphone Addiction Scale; SAS) [5], using high-scores to correlate smartphone usage with negative outcomes [6] [7] to provide evidence of behavioural addiction. But these subjective scales face various limitations. Firstly, majority of scales reported only internal consistency as a means of establishing reliability of scale but lacked establishing

validity of the intended construct. Secondly, most of the scales have simply borrowed the item criteria from assessment scales of more established substance or behavioural addiction like gaming or internet addiction. [8] Another most widely used method in real-time monitoring is ambulatory assessment (AA), which encompasses an active form of monitoring, for example, ecological momentary assessment (EMA) and experience sampling, which involve momentary self-reports through electronic diaries, in addition to pen and paper diaries and beepers, respectively. [9] Another method includes self-reported questionnaires where subjects are asked to fill the details of their type and duration of usage based on how they perceive their own usage. These subjective tools face bias as these depend explicitly on respondent's input which can be biased by social desirability and hence affect the validity of response rate and measurements. [10] Moreover, these tools are poor at reporting rapid and pervasive checking behaviour asthey are part of the deeper level of the cognitive aspect of the behaviour.

Passive objective monitoring provides with the data unobtrusively, eliminating the bias of active data entry by the respondent and allowing data collection for longer period of time. [11] [10] More generally, recent reviews evaluating passive monitoring have demonstrated how real-time measurement can facilitate assessment of dependent variables more accurately and in a less intrusive manner in comparison to self-report measures. [12] The upper hand this measurement tool gets on self-report measurement is that it provides higher temporal resolution in comparison to self-reports, allowing fluctuations in smartphone behaviour to be detected. Hence, allowing accurate monitoring of proxies of mental health such as behavioural patterns. [13] This study does not attempt to operationalize different methods of measurement for smartphone use but provide the comparison between psychometric methods of measurement and objective measurement, whether they can measure the distinct behavioural changes in smartphone users. And also determines how the usage varies among different demographic parameters of the population. The need for this study is that, if we reject the null hypothesis, we may want to reconsider the constructs of the psychometric measurements so that it can depict the behavioural pattern of the smartphone use more distinctively. This in turn is necessary, as we cannot simply cancel out the use of psychometric measurements as a tool of assessment from the epidemiological researches.

MATERIAL AND METHODS

Procedure: A google form was developed in order to determine the amount and type of smartphone usage. The form was divided into 4 parts.

First part included brief explanation of the study followed by clause seeking consent of the respective participants and assuring the confidentiality of the collected data.

Second part consisted of questions regarding self-reported smartphone usage. This part determined their perspective of their smartphone usage and whether they consider themselves as Smartphone overusers or not.

Third part consisted of Smartphone Addiction scale-Short Version questionnaire developed and validated by Kwon M et al [6] Smartphone addiction scale-Short Version (SAS-SV) is a scale for smartphone addiction that consisted of 6 factors and 10 items with a six-point Likert scale (1: ''strongly disagree'' and 6:''strongly agree'') based on self-reporting. The six factors were daily-life disturbance, positive anticipation, withdrawal, cyberspace- oriented relationship, overuse, and tolerance.

Last part included the questions which determined their smartphone usage on the basis of the objective findings of their respective screen monitoring systems. Objective findings were measured through the inbuilt system of their smartphones to exclude the bias due to hawthrone effect by installing any smartphone application exclusively to measure their usage.

Outcome measures that were determined using self-reported questions and objective findings were as follows:

1.Smartphone usage hours- Average number of hours that were used per day by the subject in last week.

2.Smartphone usage frequency- Number of time the screen of smartphone was activated in order to use it.

3.Purpose for which smartphone was used mostly- A list of different purposes was prepared, out of which subject had to choose top 5 reasons for which the smartphone was used most of the time.

This form was circulated in various social groups on whatsapp. Data from the individual form was sorted in excel spreadsheet for further statistical analysis.

Participants:

A total of 150 subjects participated in this study. Participants who had used smartphone for atleast one year were selected in the study and also those who had inbuilt screen monitoring system in their smartphones. Subjects who had use of multiple gadgets like laptop, tablet in their daily routine were exluded as they would have been subjected to the cognitive clouding when the self-reproted smartphone usage was to be determined due to multiple screen exposure. Participants were aged from 18 years to 40 years so as to have inclusive population using smartphone with various different occupations. Incentives

were not provided to the subjects in any form. Ethical approval was sought from an Independent Ethical committee named ACEAS Independent Ethics Committee with protocol number 001/3121/2021. All participants provided with their consent in the first part of the questionnaire.

STATISTICAL ANALYSIS

Data was analysed using Microsoft excel 2007. Descriptive statistics were used to study the demographic characteristics of the subjects like age, gender and occupation. Wilcoxen sign rank test was used to compare the difference in the self-reported and objective findings of smartphone usage. Cross-tabulation was used to determine the statistical difference between Smartphone Addiction Scale-Short Version (SAS-SV) score and interpretation of subjects on their being smartphone over users or not. Spearman correlation test was used to find any correlation between objective usage hours with age, SAS-SV score and objective usage frequency. The statistical significance level, α, was chosen as 0.05.

RESULTS

A total of 150 subjects participated in this study. Out of which 20 subjects were excluded as they had use of multiple gadgets like laptop or tablet, 12 participants did not complete the questionnaire and 9 of them did not have inbuilt screen monitoring system in their smartphones. Participants were aged from 18 years to 40 years with the mean age of 23.97±5.17 years. Out of 109 subjects, 65 were female and 44 were male. 36.7% of the sample consisted of Physiotherapist, 49.5% were students and remaining belonged to private jobs, businessmen and teaching profession category.

In majority of cases, smartphones were most frequently used for social media purposes followed by communication, entertainment, academic and profession related work.

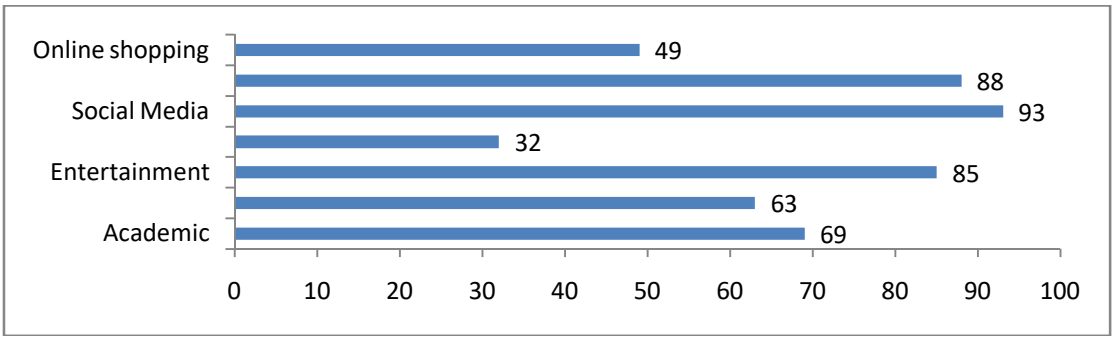

Figure 1: Purposes for smartphone usage

Table 1 shows findings of smartphone usage among different age group, gender and occupation. Age group of the sample was divided into 3 groups for convenience of understanding the pattern. Age group A consisting of subjects from age 18 to 25 years, group B from age 26 to 33 years and group C from age 34 to 40years. Occupations were categorised according to the occupation of subjects in the sample.

Sr.No.	Variable	Objective usage hours (Mean± SD)	Objective usage frequency (Mean± SD)
Age			
1	Group A (18-25 years)	4:54±2:39	65.82±47
2	Group B (26-33 years)	3:58±2:28	58.38±35
3	Group C (34-40 years)	3:06±1:45	29.17±22.89
Gender			
4	Male	4:51±2:30	74.34±52.21
5	Female	4:21±2:40	53.35±36.06
Occupation			
6	Businessmen	5:20±1:02	82±31.77
7	Physiotherapists	3:42±2:33	54.62±35.37
8	Private jobs	3:50±2:03	84.17±39.42
9	Students	5:17±2:46	65.61±51.87
10	Teaching Profession	3:57±1:47	43.33±19.14

Table 1: Smartphone usage among different age groups, gender and occupations

Table 2 shows frequency distribution of self-reported and objective smartphone usage (both usage hours and usage frequency) and result of Wilcoxen sign ranked test. Self- reported and objective usage hours did not show any statistical significance results with p-value=0.125 but self-reported and objective usage frequency did show statistically significant difference with p-value=0.005.

Table 2: Comparison of self-reported scale and objective findings

SMARTPHONE USAGE HOURS ASSIGNED RANKS	SR USAGE HOURS	OBJ USAGE HOURS	SMARTPHONE USAGE FREQUENCY ASSIGNED RANKS	SR FREQUENCY	OBJ FREQUENCY
Less than 1 hour-1	2(1.8)	3(2.8)	Less than 25 times-1	28(25.2)	11(10.5)
1-2 hours-2	11(9.8)	14(13.0)	25-50 times-2	44(39.6)	35(33.3)
2-3 hours-3	29(25.9)	18(16.7)	50-100 times-3	20(18.0)	41(39.0)
3-4 hours-4	23(20.5)	14(13.0)	100-150 times-4	9(8.1)	13(12.4)
More than 4 hours-5	47(42.0)	59(54.6)	More than 150 times-5	10(9.0)	5(4.8)
WILCOXEN SIGN RANKED TEST	Z-VALUE= -1.536		WILCOXEN SIGN RANKED TEST	Z-VALUE= -2.811	
	P-VALUE= 0.125			P-VALUE= 0.005	

According to the cut-off value for SAS-SV validated by Min Kwon and colleagues, score above 31 and 33 for boys and girls respectively were considered smartphone addict. Based on this finding, the sample was divided into two groups Non-Addicts (denoted as group 1) and Addicts (denoted as group 2). This was compared with the assumption of the individuals as smartphone over users or not asked in the 2nd part of the questionnaire is shown in table 3.

Table 3: Smartphone over users or not Vs SAS-SV score cross

			SASSVGROUP		Total
			1	2	
SPOVERUSER	No	Count	21	8	29
		Expected Count	12.8	16.2	29.0
	Yes	Count	27	53	80
		Expected Count	35.2	44.8	80.0
Total		Count	48	61	109
		Expected Count	48.0	61.0	109.0

Correlation test was run to determine presence of relationship between average smartphone usage hours found objectively and age, SAS-SV score and average smartphone usage frequency.

Table 4: Correlation statistics

			OBJHRS	AGE	SASSVSCORE	OBJFRE
Spearman's rho	OBJHRS	Correlation Coefficient	1.000	-.389**	.463**	.312**
		Sig. (2-tailed)	.	.000	.000	.001
		N	109	109	109	109
	OBJFRE	Correlation Coefficient	.312**	-.150	.246**	1.000
		Sig. (2-tailed)	.001	.120	.010	.
		N	109	109	109	109
**. Correlation is significant at the 0.01 level (2-tailed).						

Objective usage hours showed weak negative correlation with age and moderate positive correlation with SAS-SV score and weak positive correlation with objective usage frequency. Objective usage frequency showed weak positive correlation with SAS-SV score.

DISCUSSION

In this study which was done on the healthy population shows different pattern of smartphone usage with mean age of 23.97±5.17 years ranging from 18 years to 39 years old belonging to different occupational background. Also this study attempts to show how self- reported smartphone usage varies from the one measured objectively.

The purpose for which smartphone was used most frequently was social media followed by communication, entertainment, academic and professional related work. In this observation, number of subjects using their smartphones for the purpose of academic and profession related work is not much lesser than the ones using for social media and entertainment. This gives us the idea how the role of smartphone has changed from simple habitual use of switching among various social media application to something which is crucial segment like education and professional use especially after covid-19 outbreak. [14] This finding can be significant to the health policy makers who need to weigh the costs of continuing the daily routine of people while depending on the range and ease of application which smartphones provide with the effects that this dependence can bring upon them.

The pattern of usage among various demographic variables was determined. It was found that both usage hours and frequency decreased with increasing age. This was also demonstrated in the correlation study where usage hours were weakly negatively correlated (r= -0.389) with age. Usage pattern also differed between gender with male usage hours and frequency (4:51±2:30 and 74.34±52.21 respectively) more as compared to females' (4:21±2:40 and 53.35±36.06 respectively). This finding is different from the

findings of other studies done which showed female usage is more than their male counterparts. [15] [16] This can be due to unequal gender distribution of the sample. The findings among various occupations show the type of usage they might have due to their respective work requirement. Students who may indulge in their smartphone primarily for the online education and social media uses have higher usage hours and moderate usage frequency showing higher passive use of the phone. Private Job employees showed relatively lower usage hours but higher usage frequency which shows their repeated checking behaviour. Businessmen who had higher usage hours and usage frequency showed their increased indulgence in the smartphone. On the other side of spectrum, subjects working as physiotherapists and in teaching profession have relatively lower usage hours and usage frequency indicating their physical amount of work and lesser indulgence into smartphone. One future aspect to this finding can be that the usage hours and frequency can be dissected more for the applications used to provide us with a clearer picture of the pattern of smartphone usage. If usage hours are higher, this may have impact of subjects' musculoskeletal system as to hold the smartphone for prolonged time for their use. [17] And if usage frequency is higher, this signifies the repeated checking of the subject which is rooted in the compulsive behaviour [18]. These findings holds greater significance as the type of usage may be helpful in determining the management of smartphone overuse.

Next self-reported questionnaire and objective findings were compared. According to the test, subjects could report their usage time comparably to their objective measurements. This finding is in agreement with the finding of David A. Ellis [19] which states that "objectively measured time spent on a device may correlate with some self-report scale or duration estimates but the relationship appears patchy." But they could not judge their phone checking frequency comparable to the objective measurements. This could be because of the reason that usage frequency mostly comprises of rapid checking behaviour of the subject. Since self-report assessments predominantly evaluate conscious measures, it is likely that that the cognitive and automatic processes that are related to problematic smartphone use (e.g., compulsivity) cannot be captured via these tools. In particular, frequent short smartphone use is hard to estimate retrospectively, and may result in distorted perception by the user. Antti Oulasvirta in their study found that users themselves do not necessarily describe this habit formation as problematic. [20] And hence it is quite normal to underestimate or overestimate the usage frequency.

Another finding of the study was to compare the judgement of the subject whether they are smartphone over users or not with the result of SAS-SV scale. 27.59% of subjects who did not considered themselves as smartphone over users were categorised as addicts according to their SAS-SV scores. And 33.75% of subjects who considered themselves as smartphone over users fell in the category of non-addicts. This disparity in the finding can be due to difference in the perception of subjects on which they consider themselves as smartphone over users and also on the constructs on which the subjective scale measures the behavioural pattern of the smartphone use. Self-report measurement fails to reflect the real state of subjects. Regardless the reason for this disparity, error in self-reports can cause difficulty in diagnosis and treatment.

Correlation statistics found moderate correlation between objective usage hours and SAS-SV score ($r=0.463$), and weak correlation between objective usage hours and age ($r=-0.389$) and objective usage frequency ($r=0.312$). Objective usage frequency had statistically significant but weak correlation with SAS-SV only ($r=0.246$). Kristoffer Geyer and colleagues [21], Boase & Ling ([22] had similar finding but they stated that though the self-reported scales are weak to moderately correlated with objective measurements but this is still rudimentary when operationalizing the actual smartphone use. Moreover, even if the subjective scale does correlate with the actual behaviour, there is still reason to question the extent to which these measures constructs as expected. Because with the given range a smartphone can perform, subjective scale scores have little bearing on the person's overall experience with the smartphone. [23]

LIMITATIONS AND FUTURE SCOPE

The present study is not without limitations. Relatively unequal distribution of the demographic variables can hinder in generalizability of the findings. Further studies can include other subjective scales too in order to explore various types of constructs of psychometric scales to measure the overall behavioural pattern of smartphone usage. Moreover, we can also determine the frequently used applications to deduce the type of pattern of usage, whether it includes passive usage as in zoom meetings or watching movies or rapid checking and scrolling behaviour as in instagram or facebook.

CONCLUSION

Overall self-reported subjective questionnaires can be useful in determining the problematic smartphone usage especially when usage pattern over the period of time is longer. But it cannot cover the overall

experience of the subject when smartphones provide wide variety of range of its usability. Further, psychometric scales can be developed in manner that it is inclusive of both positive and negative outcomes of the smartphone usage because not always smartphone overuse is problematic. This further would improve the sensitivity of the diagnosis and hence improve the management strategies. Passive objective measurement provides with huge scope in assessment and conceptualisation of smartphone overuse with its ability to provide precise and ecologically valid data over longer period of time. This measurement tool should be incorporated in clinical assessment and research more often.

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