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ORIGINAL ARTICLE

Effect of Smartphone Addiction on Academic Performance; Mediation of Self-Regulation and Bedtime Procrastination

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ABSTRACT

This study examines the effect of smartphone addiction on the academic performance of medical students with the mediating role of self-regulation and bedtime procrastination. The framework of this study is based on social cognitive theory. Data was collected through an adopted questionnaire from the medical students at different institutes in Pakistan. A survey questionnaire was distributed among 300 students however 260 students participated and returned it. SmartPLS3 was used to analyze the data collected from respondents. Results showed that smartphone addiction is not negatively associated with academic performance. Similarly, smartphone addiction is not inversely associated with self-regulation. Furthermore, results showed a positive relationship between self-regulation and academic performance, a positive relationship between smartphone addiction and bedtime procrastination, and a negative relationship between bedtime procrastination and academic performance. Moreover, bedtime procrastination mediates the association between smartphone addiction and academic performance. Contrary to our expectations, self-regulation did not mediate the association between smartphone addiction and academic performance. Implications of research are discussed.

Keywords: Smartphone addiction, Academic performance, Self-regulation, Bedtime procrastination

INTRODUCTION

The advent of the smartphone has created its proliferation and assemble it an important part of life. WHO (2011) confirmed that cell phone use leads to health hazards and radiation from a cell phone is regarded as carcinogenic for human health. Frequency waves or electron beams through smartphones change the brain's electric impulses and result in many ill consequences on health for example deprivation of alertness, enlarged response time, sleep disruption, tiredness, anxiety, and attention difficulties, and these radiation damages brain zone related with learning, memory, and movement. One of the studies reported that among the entire population, 1.85 are smartphone users and this number is expected to reach 2.32 billion users by 2017, and by 2020 it is expected to be 2.87 billion (Marshall, Dunstan, & Bartik, 2020). Nowreen and Ahad (2018) found that smartphone addiction is common among medical students, and it leads to sleep deprivation. Poushter (2016) reported that the overall number of smartphone users is increasing day by day. Just like the entire world, smartphone users are also increasing in Pakistan. The latest study investigated the student time consumed on social websites utilizing their mobile phones and their outcome on academic performance at institutes. Students were asked to keep a logbook so they can keep a record of their communication done using smartphones. The result of this study showed that too much use of smartphones causes an 'addiction' that negatively affected the academic grades of university individuals (Giunchiglia et al., 2018). Zhang and Wu (2020) found that it is difficult for people suffering from smartphone addiction to manage their interruptions and stop using the phone before bed, resulting in high sleep delays, short sleep time, and poor sleep quality.

Previous literature has paid attention to the factors that cause smartphone addiction such as personality, demographics, and their effect on smartphone use while some studies determined how smartphone addiction affects social and personal aspects (Cha & Seo, 2018; Archana & Balaji, 2019). However, some researchers have established an association between smartphone addiction and academic performance among medical students (Oswal et al., 2020; Santhi & Rajesh, 2020). In Pakistan, all the past studies paid attention to the prevalence of smartphone addiction among adults and the impact of smartphone addiction on university student's satisfaction with classroom learning but no previous study specifically determined the effect of smartphone addiction on medical students regarding their academic performance (Khalily et al., 2018; Soomro, YousufZai & Hina 2019). Ahmed et al (2020) conducted a study regarding how smartphone functions affect university students learning and suggested that it should be studied with other behavioral and psychological variables in the future. Thus, based on the previous literature, this research is going to determine the effect of smartphone addiction on the academic performance of medical students with the addition of two mediators, one is self-regulation and the other one is bedtime procrastination. There is no previous study that specifically used these mediators to determine the effect of smartphone addiction on academic performance.

Literature Review and Hypothesis Development: Our study uses the foundation of social cognitive theory (Bandura, 1982). Social cognitive theory has three determinants including behavioral, personal, and environmental determinants. All three determinants are interlinked with each other. By demonstrating an association between smartphone addiction and academic performance levels, this study assists the association between behavioral (i.e., choice of activities, persistence) and the environmental (i.e. rewards, feedback) determinants of social cognitive theory. Similarly, by demonstrating an association between smartphone addiction and self-regulation, it supports the association of behavioral and personal (i.e., self-efficacy and values) determinants of social cognitive theory. This study demonstrates an association between self-regulation and academic performance, it supports the association of personal and environmental determinants of social cognitive theory. Hence, the research framework of this study is based on social cognitive theory. Several studies provided us with direction for our hypothesis. One of the most recent studies found that smartphone addiction leads to poor academic performance, poor physical health, and mental illness (Alotaibi et al., 2022). Simbolon and Daulay (2022) found that smartphone addiction is the main cause of academic procrastination among students. Hawi and Samaha (2016) suggested that students who are suffering from smartphone addiction have a negative impact on academic performance. Nayak (2018) described a negative association between smartphone addiction and academic performance. Mahapatra (2019) found that a lack of self-regulation leads to smartphone addiction. Previous studies identified self-regulation as an important factor to enhance academic performance (Ning & Downing, 2010; Zamora, Suarez & Ardura, 2016). Recent studies determined a positive association between smartphone addiction and bedtime procrastination. They found that individuals suffering from smartphone addiction have high bedtime procrastination as they spend most of their time using phones before bed (Geng, Gu,

Wang, & Zhang, 2021; Chung, An, & Suh, 2020). Chen (2019) established a positive relationship between bedtime procrastination and academic procrastination. The research model of the study is shown in figure 1.

Thus, we hypothesized:

H1: Smartphone addiction is negatively associated with academic performance.

H2: Smartphone addiction is inversely associated with self-regulation.

H3: Self-regulation is positively associated with academic performance.

H4: Self-regulation mediates the association between smartphone addiction and academic performance

H5: Smartphone addiction is positively associated with bedtime procrastination.

H6: Bedtime procrastination is negatively associated with academic performance.

H7: Bedtime procrastination mediates the association between smartphone addiction and student performance.

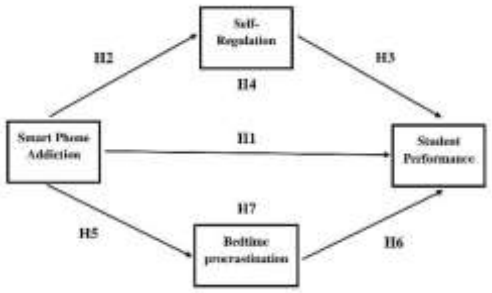

Figure 1: Theoretical Model of Study

METHODOLOGY

The current study is conducted in Pakistan, from October 2020 to January 2021. Data has been collected from the medical students (including M.B.B.S and Allied health sciences) of different institutes. A questionnaire was used as a research instrument. The questionnaire was made up of five separate sections, the first section represented the demographic information of participants, and the remaining three represented research instruments for each variable. The response for all scale items was recorded against a five-point Likert scale where 1= strongly disagree to 5= strongly agree. Students of both genders were included in the study. There is some other demographic information included such as age, education level, and department or field of the students. During the data collection, an option was given to participants to participate by choice, and a guarantee was given that their information will only be used for study purposes and that confidentiality will not be breached. In this study, smartphone addiction is used as an independent variable. SAS-SV scale consisting of ten items has been used to measure smartphone addiction (Kwon, Kim, Cho & Yang, 2013). Example items are "1: I miss planned work due to smartphone use. 2: I feel pain in the wrists or at the back of the neck while using a smartphone. 3: I won't be able to stand not having a smartphone. 4: I feel impatient and fretful when I am not holding my smartphone. In this study, academic performance has been used as a dependent variable. Academic performance has been measured by using an academic performance scale consisting of 7 items (Whelan, Islam, & Brooks, 2020). Example items are"1: I am obtaining personal career goals. 2: I am making progress in my career. 3: I need developing skills for future in my career". Self-regulation has been used as a mediator. Schwarzer et al. (1999) developed the scale of self-regulation consisting of 10 items. Example items are "1: It is difficult for me to suppress thoughts that interfere with what I need to do. 2: I can control my thoughts from distracting me from the task at hand. 3: When I worry about something, I cannot concentrate on an activity". Bedtime procrastination has been used as a mediator in this study. Kroese et al., (2014) designed this scale consisting of 9 items. Example items are "1: I go to bed later than intended. 2: I go to bed early if necessary. 3: I turn off the lights immediately at bedtime". By using scales (mentioned above) questionnaire was developed and sent to the students online (in the form of a Google form). Moreover, at the start of the questionnaire, a consent page was attached, which described the purpose of the study, and details regarding information of the participants would be used only for study purposes and confidentiality will remain intact. A questionnaire was distributed among 300 students however 260 students participated and returned it making the response rate 86%. The final sample size used in the study was 260.

Data Analysis: SmartPLS3 software was used to analyze data received from respondents.

RESULTS

Characteristics of the Sample: As described earlier, medical students from different major cities of Pakistan were selected as participants. In terms of gender distribution, our sample consists of 61% females and 39% males. Our sample is composed of medical students including MBBS and allied health sciences. So, in terms of department-wise distribution, 65% of participants belonged to the allied health sciences and 35% of participants belonged to MBBS. 79% of participants of the study were in the age group of 21 to 25year, 20% of participants were above 25year and 1% of participants were above 35year. In the context of education, 76% of participants were doing bachelor's, 31% were doing masters and 1% were doing PhD.

Measurement Model Assessment: We used samartPLS3 for data analysis. Assessment of the measurement model (outer model) gives us reliability and validity of variables. Assessment of the structural model (inner model) tells us about the relationship between these variables.

Analysis of the measurement model gives composite reliability (CR) and average variance extracted (AVE). CR is used to measure internal consistency reliability while AVE is used to measure convergent validity. See Table 1 regarding CR values of variables of the current study. Hair et al., (2009) stated that if CR values are greater than 0.70 then it confirms internal consistency reliability. To check convergent validity, AVE is calculated. See Table1 for AVE values of all the latent variables. Hair et al., (2009) stated that if AVE values are greater than 0.50 then convergent validity is established. To represent discriminant validity, Fornell & Larcker criterion (1981) is used. Table 1 represents that the square root of AVE for all variables is higher than the inter-construct correlations (Fornell & Larcker, 1981) so discriminant validity is established.

Table 1: Construct Validity and Discriminant Validity – Fornell and Lacker Criterion

Latent Variables	AVE	CR	AP	BP	SA	SR
AP	0.552	0.895	0.743			
BP	0.531	0.849	0.123	0.729		
SA	0.506	0.911	0.067	0.452	0.711	
SR	0.541	0.892	0.42	-0.103	-0.033	0.735

AVE: Average Variance Extracted; CR: Composite Reliability. Diagonal values are the representation of the AVE square root and off-diagonal values show inter-construct correlation

Table 2: Results of Hypothesis Testing and Structural Relationship

Hypothesis	Path	Original Sample	Standard Deviation	T Statistics	P Values	Hypothesis
H1	SA -> AP	0.006	0.069	0.085	0.932	Rejected
H2	SA -> SR	-0.033	0.073	0.453	0.650	Rejected
H3	SR -> AP	0.437	0.053	8.251	0.000	Supported
H5	SA -> BP	0.452	0.046	9.890	0.000	Supported
H6	BP -> AP	0.166	0.066	2.516	0.012	Supported

T-values for two tailed tests: *p < 0.01

SA= Smartphone addiction, AP= Academic performance, SR= Self-regulation, BP= Bedtime procrastination.

Structural Model Assessment: The structural model determines the association between variables as shown in table 2. H1 evaluates whether smartphone addiction (SA) has a significant impact on academic performance (AP). Results showed that SA doesn't have significant impact on AP (β=0.006, t = 0.0085, p = 0.932). Therefore, H1 is rejected. H2 evaluates whether SA has a significant impact on self-regulation (SR). Results showed that SA doesn't have significant impact on SR (β=-0.003, t = 0.453, p = 0.650). Hence, H2 is rejected. H3 evaluates whether self-regulation (SR) has a significant impact on academic performance (AP). Results showed that SR has significant impact on AP (β=0.437, t =8.251, p = 0.000). Hence, H3 is accepted. H5 evaluates whether smartphone (SA) has a significant impact on bedtime procrastination (BP). Results showed that SA has significant impact on BP (β=0.452, t =9.890, p = 0.000). Thus, H5 is accepted. H6 evaluates whether bedtime procrastination (BP) has significant impact on academic performance (AP) (β=0.166, t = 2.516, p = 0.012). Results showed that BP has a significant impact on AP. Consequently, H6 is accepted.

The structural model is evaluated by the r2 value. r2 values show the amount of effect on endogenous variables by exogenous variables related to it. Falker and Miller (1992) stated that the r2 value should be equal to or over 0.1. In this study, the endogenous variables AP, BP, and SR have the r2 value 0.204, 0.204, and 0.01 respectively (see table 3). Q2 value determines the predictive relevance of constructs. In our study, AP has a Q2 value of 0.103, BP has 0.101 and SR has 0.000. This shows a small size effect (see table3).

Table 3: Results of R2 and Q2

Endogenous Latent Variables	R2	Adjusted R2	Q2	Effect Size
AP	0.204	0.195	0.103	Small
BP	0.204	0.201	0.101	Small
SR	0.001	0.003	0.000	

AP= Academic performance, SR= Self-regulation, BP= Bedtime procrastination.

Mediation Analysis: Mediation analysis determines the association between smartphone addiction (SA) and academic performance (AP) in the presence of self-regulation (SR) and bedtime procrastination (BP) as mediators. To access mediation, we see the total effect, direct effect, and indirect effect. Table 4 shows the mediation effect of self-regulation (SR) on the linkage between smartphone addiction (SA) and academic performance (AP). Results showed that the total effect of SA on AP is insignificant (β=0.066, t =0.980, p=0.327). After including mediating variable (SR), the effect of SA on AP is still insignificant (β=, 0.006, t =0.870, p=0.931). The Indirect effect of SA on AP through SR is also found insignificant (β=-0.014, t =0.44, p=0.660). This shows that the relationship between SA and AP is not mediated by SR.

Table 5 shows the mediation effect of BP on the linkage between smartphone addiction (SA) and academic performance (AP). Results showed that after including mediating variable (BP) effect of SA on AP is still insignificant (β=0.022, t =0.236, p=0.814). However, the indirect effect of SA on AP through BP is significant (β=0.075, t = 2.370, p=0.018). This shows that the relationship between SA and AP is fully mediated by BP. This is called complete mediation.

Table 4: Mediation Analysis: SR as Mediator

Exogenous Variable	Total Effect			Direct Effect			Indirect Effect			Mediation
	β	T value	P value	β	T value	P value	β	T value	P value	
SA	0.066	0.98	0.327	0.006	0.87	0.931	-0.014	0.87	0.931	No Mediation

Mediating Variable: SR; Endogenous Variable: AP

Table 5: Mediation Analysis: BP as Mediator

Exogenous Variable	Total Effect			Direct Effect			Indirect Effect			Mediation
SA	β	T value	P value	β	T Value	P value	B	T value	P value	Complete Mediation
	0.096	1.173	0.241	0.022	0.236	0.814	0.075	2.37	0.018	

Mediating Variable: BP; Endogenous Variable: AP

DISCUSSION

Although there are many studies conducted on smartphone addiction, self-regulation, bedtime procrastination, and academic performance in past literature with different constructs. But relatively little attention is paid to the effect of smartphone addiction on the academic performance of medical students with the mediating role of self-regulation and bedtime procrastination. Our study determined the association between smartphone addiction and academic performance by using self-regulation and bedtime procrastination as mediators. This study did not find any significant negative relationship between smartphone addiction and academic performance (H1). Our findings are similar to one of the recent studies conducted by (Oswal et al., 2020). They stated that students have smartphone addiction, but their academic performance does not have any significant negative relationship with smartphone addiction. This is in contrast to one of the previous studies conducted that found that smartphone addiction negatively impacts academic success (Sert,Yilmaz, Kumsar & Aygin, 2019). In the literature, there are no conclusive findings regarding the relationship between smartphone addiction and academic performance. However, a major difference between previous studies where they found a negative impact of smartphone addiction on academic performance and this study is the unit of analysis. As those studies were conducted on college or university students. This study population is composed of medical students including MBBS and allied health sciences. One of the reasons behind our contrasting results is that our study population consists of highly intelligent and motivated individuals. Only those students who performed very well in their examinations and competitive entrance examinations get admission to medical, that's why despite having smartphone addiction they can manage their

study time and smartphone addiction does not have any significant negative relationship with their academic performance. Furthermore, the results of the study showed that smartphone addiction is not inversely associated with self-regulation (H2). The results of this study are consistent with one of the previous studies that determined self-regulation within the context of smartphone addiction (Kanthawongs, Jabutay & Upalanala, 2016). As we predicted that self-regulation shows attention and emotional regulation, and it would have an inverse relationship with smartphone addiction like high self-regulation would lead to lesser addiction or no addiction. The results of the current study did not confirm these predictions. This finding may be explained that self-regulation may not be a determinant of smartphone addictions for medical students. As per analysis results, self-regulation has a positive relationship with academic performance (H3). This shows self-regulation is an important contributor to academic performance. Students can enhance their academic performance by developing self-regulatory skills. Our results are consistent with one of the previous studies conducted (Zamora, Suarez & Ardura, 2018). The mediation of self-regulation among smartphone addiction and academic performance was tested in PLS-SEM3 by using the bootstrapping technique. The analysis showed that self-regulation does not significantly mediate the association between smartphone addiction and academic performance which means that self-regulation is not an important determinant that affects the association between smartphone addiction and academic performance. In other words, although medical students having high self-regulation are more likely to enhance academic performance, but self-regulation is not a powerful variable that affects the association between smartphone addiction and academic performance. Another explanation is that medical students with high self-regulation may use a smartphone only for study purposes and they perceive the smartphone as a tool to reach specific academic goals. Thus, their better inhibitory control during cell phone use does not lead to where smartphone addiction negatively impacts academic performance. Furthermore, results showed a positive relationship between smartphone addiction and bedtime procrastination (H5). Students suffering from smartphone addiction become unable to stop using cell phone in bed or manage distractions and this led to high bedtime procrastination and poor sleep quality. Our results are consistent with one of the previous studies, Chung, An & Suh (2020) found that delayed bedtime is mainly associated with smartphone use. Individuals belonging to the high bedtime procrastination group spend most of their time using smartphones approximately more than eight hours per day and three hours before bedtime, and usage of smartphones increases before bedtime. Furthermore, this study also found a negative association between bedtime procrastination and academic performance (H6). Previously, bedtime procrastination has not been studied in the context of academic performance. Bedtime procrastination is mostly studied in the context of sleep quality and other psychological variables (Chung, An, & Suh, 2020). However, the findings of this research are consistent with one of the studies which examined only one factor of academic performance i.e., academic procrastination. Academic procrastination has a strong positive relation with bedtime procrastination and goal disengagement played a role as a moderator between bedtime procrastination and academic procrastination (Chen, 2019). Results of this study showed that bedtime procrastination significantly mediates the relationship between smartphone addiction and academic performance which means that bedtime procrastination is an important determinant that affects the association between smartphone addiction and academic performance (H7). By demonstrating an association between smartphone addiction, bedtime procrastination, and academic performance levels, this study assists the association between individual behavior, personal factors, and the environment of social cognitive theory. In this way, social cognitive theory supports our result that smartphone addiction leads to bedtime procrastination, and bedtime procrastination leads to a negative impact on academic performance.

CONCLUSION

The current study determined the effect of smartphone addiction on the academic performance of medical students with the mediating role of self-regulation and bedtime procrastination. Results of the study showed that smartphone addiction is not negatively associated with academic performance. Furthermore, self-regulation is not inversely associated with academic performance. However, self-regulation has a positive relationship with academic performance. Moreover, the association between smartphone addiction and bedtime procrastination is also supported. The findings of the study also found a significant negative effect of bedtime procrastination on academic performance. Mediation analysis showed that self-regulation did not mediate between smartphone addiction and academic performance while bedtime procrastination completely mediates between smartphone addiction and academic performance.

Implications: The main finding of our study is the positive association between smartphone addiction and bedtime procrastination and the mediation of bedtime procrastination between smartphone addiction and academic performance. This indicates that smartphone use before sleep leads to high bedtime procrastination and also poor sleep quality. This gives useful information for planners and academicians to guide students about the harmful effects of smartphone addiction. These findings also provide an insight for the researchers who want to determine the quality of sleep among adolescents or for those who want to determine the interaction between humans and computers. Furthermore, our study indicates that self-regulation being a personal trait can lead to better academic performance, which reminds educators to focus on developing the self-regulatory skills of students. Study findings may help planners and policymakers produce guidelines for the productive and effective use of a smartphone.

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