

# Smartphone addiction among university students in Riyadh, Saudi Arabia

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## ABSTRACT

**الأهداف:** استكشاف معدل انتشار إدمان الهواتف الذكية بين طلاب الجامعات في السعودية، ومعرفة العوامل المرتبطة بهذا الإدمان.

**الطريقة:** أُجريت دراسة مقطعية على عينة من طلاب جامعة الملك سعود بين شهري سبتمبر 2014 ومارس 2015، وذلك عبر إرسال استبيان إلكتروني يحتوي على مقياس مقنن اسمه (مقياس الاستعمال المشكل للهواتف الجواله).

**النتائج:** أظهرت الدراسة أن 27.2% من عينة الدراسة البالغ عددهم 2367 طالباً وطالبة، يقضون أكثر من 8 ساعات يومياً في استعمال هواتفهم الذكية، و75% يستعملون 4 تطبيقات على الأقل يومياً، غالباً لأجل التواصل الاجتماعي ومتابعة الأخبار. ونتيجة لهذا الاستعمال قل كلا من ساعات النوم والإحساس بالحياة لدى 43% منهم، كما سلك 30% منهم أنماطاً حياتية غير صحية مثل تناول الوجبات السريعة، وزيادة الوزن، وقلة ممارسة الرياضة. بينما انحدر الإنجاز الأكاديمي لدى 25% منهم. وأظهرت الدراسة علاقة موجبة ومهمة إحصائياً، بين درجة مقياس الاستعمال المشكل للهواتف الجواله والعوامل التالية: النمط السلبي للحياة وضعف الإنجاز الأكاديمي و عدد الساعات اليومية للاستعمال وسنة الدراسة وعدد التطبيقات المستخدمة. وكان متوسط قيم مقياس الاستعمال المشكل للهواتف الجواله لدى عينة الدراسة هو 60.8، والوسيط هو 60.

**الخاتمة:** هناك خطر داهم لحصول إدمان الهواتف الذكية لدى طلاب الجامعات في السعودية، والذي يرتبط بعواقب وخيمة على النوم، والعادات الغذائية، وممارسة الرياضة، والأداء الأكاديمي.

**Objectives:** To investigate the prevalence and correlates of smartphone addiction among university students in Saudi Arabia.

**Methods:** This cross-sectional study was conducted in King Saud University, Riyadh, Kingdom of Saudi Arabia between September 2014 and March 2015. An electronic self administered questionnaire and the problematic use of mobile phones (PUMP) Scale were used.

**Results:** Out of 2367 study subjects, 27.2% stated that they spent more than 8 hours per day using their smartphones. Seventy-five percent used at least 4 applications per day, primarily for social networking and watching news. As a consequence of using the smartphones, at least 43% had decrease sleeping hours, and experienced a lack of energy the next day, 30% had a more unhealthy lifestyle (ate more fast food, gained weight, and exercised less), and 25% reported that their academic achievement been adversely affected. There are statistically significant positive relationships among the 4 study variables, consequences of smartphone use (negative lifestyle, poor academic achievement), number of hours per day spent using smartphones, years of study, and number of applications used, and the outcome variable score on the PUMP. The mean values of the PUMP scale were 60.8 with a median of 60.

**Conclusion:** University students in Saudi Arabia are at risk of addiction to smartphones; a phenomenon that is associated with negative effects on sleep, levels of energy, eating habits, weight, exercise, and academic performance.

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The smartphone, in English, is defined as a mobile phone that performs many of the functions of a computer. As such, it typically has a touch screen interface, Internet access, and an operating system capable of running downloaded applications.<sup>1</sup> While recently the words smartphone, mobile phone, and cell phone have come to be used interchangeably, 2 decades ago, mobile phones and cell phones were used primarily for making and receiving calls and for SMS messaging. Smartphones have increasingly become a major part of our lives due to their numerous benefits, such as easy accessibility to information, social connectivity, workplace applications, convenience, mobility, size, and so forth. Moreover, smartphones now play a critical role in the health field as both health professionals and their patients seek to promote the good health of the patient.<sup>2</sup> However, in recent years, there has also been increasing concern on the negative consequences of smartphone use. Before the widespread use of smartphones, a study in Saudi Arabia linked the use of mobile phones with numerous health hazards, including headaches (21.6%), sleep disturbances (4.%), tension (3.9%), fatigue (3%), and dizziness (2.4%).<sup>3</sup> Later, another Saudi Arabian study<sup>4</sup> found that 44.4% of the medical student participants attributed their headaches, decreased concentration, memory loss, hearing loss, and fatigue to the use of their mobile phones. A review of studies related to drivers' use of cell phones found that a 4-fold increase in the risk of property damage only crashes and injury crashes was associated with phone use. This increased risk was similar for males and females, younger and older drivers, and hands-free and hand-held phones.<sup>5</sup> Although addiction is a term arguably overused in society, the conceptualization of addiction remains controversial even among experts in the field.<sup>6</sup> However, the recent edition of the Diagnostic and Statistical Manual of Mental Disorders, Fifth-Edition (DSM-5) has officially recognized the first behavioral addiction disorder (gambling disorder) and includes it within the revised chapter of "Substance-Related and Addictive Disorders".<sup>7</sup> Internet Gaming Disorder is identified in Section III of the DSM-5 as a condition warranting more clinical research and experience before being considered for inclusion in the main book as a formal disorder.<sup>7</sup> Although it was

suggested as early as 1982,<sup>8</sup> before the widespread use of mobile phones, that pathological use of technology may exist in the form of techno-dependence, in recent years, there has been increasing concern regarding problematic mobile phone use, and accordingly, it has been publicized extensively as an emerging social problem. Even though behavioral addiction does not involve the use of a chemical substance, the similarities between the cardinal features of substance use disorders and behavioral addiction disorders such as smartphone addiction are striking. In general terms, both may be described as disorders involving a loss of control over a compulsive, time- and resource-consuming behavior, which persists despite adverse consequences, characterized by a continued escalation of the behavior, or withdrawal symptoms when engagement in the behavior is reduced.<sup>6</sup> A recent review of the literature indicates a conceptual vagueness on the concepts of abuse and addiction in relation to smartphones and a wide disparity in the adoption of diagnostic criteria. However, there are numerous instruments for the assessment of these concepts. As a result, the estimated prevalence ranges from 0-38%, depending on the scale used and the characteristics of the population studied.<sup>9</sup> A meta-analysis of 6 studies aimed to assess smartphone addiction in Indian adolescents revealed characteristic features of emerging smartphone abuse. These features included a preoccupation with using their smartphones throughout the day; the inability to restrict smartphone use despite knowing the harmful effects of its use; a severe craving, accompanied by anxiety and restlessness, to use the phone when they are not using it; and the tendency to sleep with the phone nearby accompanied by the need to repeatedly wake up and check the phone. However, other DSM criteria for addiction were not addressed.<sup>10</sup> There are few studies that address the addictive phenomenon regarding smartphone users based on the DSM-5 criteria. There is ample evidence that addictive behaviors and substance abuse begins during adolescence and young adulthood,<sup>11</sup> which makes university students a good representative population. To date, only 4 studies have been conducted in Saudi Arabia regarding cell phone use, 3 of which focused on physical and cognitive complications associated with the use of mobile phones.<sup>3,4,12</sup> The fourth study examined the risky behaviors during the use of smartphones among 120 female medical students, but it did not address the prevalence of addiction among this cohort.<sup>13</sup> The aim of this study is to investigate the prevalence of the addictive phenomenon related to smartphone use among university students in Saudi Arabia using a

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validated scale based on DSM-5 criteria and to identify the potential associated factors and consequences of the addiction phenomenon among this population.

**Methods. Participants.** The current study was conducted among university students attending King Saud University (KSU), Riyadh, Saudi Arabia. The study included both male and female students from all KSU colleges. Out of the targeted 10,000 study subjects, 2367 (24%) responded to our study. More than 50% of the respondents were in the age group of 20-24 years, and 43.6% were male. The study obtained all required ethical approvals from the institutional review board at the Faculty of Medicine, KSU, Riyadh, Saudi Arabia.

**Measures.** We developed a self-administered questionnaire specifically for the purpose of this study that included 3 major sections: socio-demographic information, addiction risk facts, and consequences of smartphone use. For example, under the section of pattern of current use of smartphones, one of the questions was: on average how many hours you spend on your smartphone on a daily basis? The addiction phenomenon was evaluated by a validated Arabic version of the problematic use of mobile phones (PUMP) scale. The PUMP scale is a 20-item questionnaire that assesses mobile phone use based on the DSM-5 criteria for substance use disorder.<sup>6</sup> The PUMP scale demonstrates a single factor structure, with excellent internal consistency. It also displays convergent validity when compared to existing measures of smartphone dependency and self-reported feelings of addiction to the smartphone.<sup>6</sup> The respondents answered each PUMP scale question on a Likert-type scale-strongly disagree, disagree, neutral, agree, or strongly agree-where strongly disagree corresponds to one and strongly agree corresponds to 5. For example, the first item of the PUMP scale is: when I decrease the amount of time spent using my cell phone, I feel less satisfied. The PUMP score is calculated by summing up the scores for the individual questions such that higher scores indicate higher levels of addiction. The PUMP scale was translated and validated in Arabic by the same authors. The PUMP original English version was first translated into Arabic by 2 linguistic specialists, fluent in both English and Arabic. Then, another linguistic specialist, fluent in both English and Arabic, carried out back translation into English. During each stage, the translated or back-translated versions and the original scale were compared and any differences were discussed and resolved to get one final version. The content of the study questionnaire as well as the Arabic version of the PUMP scale were validated by experts

in addition, technology, and psychiatry to ensure the relevance and applicability of the various questions. The survey, including the study questionnaire and the Arabic PUMP scale, was piloted using a small number of college students (n=20) and then repeated 2 weeks after for reliability. Based on the feedback, the wording of some questions was modified before being widely distributed.

**Procedure.** This cross-sectional observational study was conducted between September 2014 and March 2015. Assuming a minimum correlation of 0.20 between score of problematic use of mobile phone and score of consequences of use of smart phone, with 0.05 level of significance and with power of 90%, 258 subjects are required from each of the colleges of KSU. Hence, approximately 2500 subjects from different colleges constituted the sample size of this study. After obtaining all required ethical approvals for the study, we contacted the department of student administrative affairs to procure the electronic mailing list for 10,000 random samples of the 60,000 university students attending KSU, anticipating 25% response (n=2500). We sent 2 successive e-mails in which we explained our study objectives to the individuals on the list. Each E-mail included a link to the study survey. Participants were required to sign an electronic informed consent form before participating in the study.

**Statistical analysis.** The data were analyzed using the IBM SPSS Statistics for Windows version 21.0 (IBM Corp, Armonk, NY, USA). Descriptive statistics (mean, standard deviation, frequencies, and percentages) were used to describe the quantitative and categorical variables. Student's t-test for independent samples and one way analysis of variance to compare the mean scores of the PUMP across the categorical study variables with 2 and 3 categories, followed by post hoc Tukey test were also employed. Karl-Pearson's correlation coefficient was used to observe the linear relationship between the total score of the PUMP scale and the quantitative study variables. Stepwise regression analysis was used to identify the variables that were independently related to the total score on the PUMP scale. A *p*-value of <0.05 and 95% confidence intervals were used to report the statistical significance and the precision of the results.

**Results.** Most the participants (92.7%) were Saudi nationals, and 2091 (83%) were single. Of 2367 subjects, 252 subjects responded positively with respect to substance use habits, such as smoking cigarettes, or shisha, consuming alcohol, and so forth, whereas 35.7% (n=845) of the study subjects reported that their family members used these substances. The study

subjects represented all of the university's colleges, including 24.8% from preparatory college, 13.5% from business administration, 8.3% from medicine, and 8.9% from the arts. A higher proportion of the study subjects (87.7%) were pursuing a bachelor's degree, and 29.5% were in their first academic year (Table 1). Before using smartphones, the academic grades of the subjects, as reported by the respondents, were fair (1.1%), good (8%), very good (28.1%), and excellent (62.7%). However, after initiating smartphone use, they reported that their academic achievement was fair (1.7%), good (11.6%), very good (35.4%) and excellent (51.2%).

**Table 1** - Distribution of socio-demographic characteristics of university student in Saudi Arabia (n=2367).

Variables	n (%)
<i>Age groups (in years)</i>	
≤19	617 (26.1)
20-24	1396 (59.0)
≥25	354 (15.0)
Gender (male)	1031 (43.6)
<i>Marital status</i>	
Single	2091 (88.3)
Married	259 (10.9)
Divorced or widowed	17 (0.8)
Nationality (Saudi)	2194 (92.7)
<i>Habits (n=252)*</i>	
Cigarettes	164 (65.1)
Shisha	138 (54.8)
Alcohol	9 (3.6)
Cannabis	4 (1.6)
Stimulants	2 (0.8)
Benzodiazepines (Roche, Xanax)	4 (1.6)
Opioids (Heroin, Tramadol)	1 (0.4)
Qat	5 (2.0)
Others	4 (1.6)
<i>College</i>	
Business administration	318 (13.5)
Medicine	196 (8.3)
Arts	210 (8.9)
Computer & Information Sciences	147 (6.2)
Education	208 (8.8)
Engineering	142 (6.0)
Science	181 (7.6)
Preparatory	588 (24.8)
Languages and translation	65 (2.7)
Law & Political Science	81 (3.4)
Others	228 (9.6)
<i>Academic degree</i>	
Bachelor's degree	2077 (87.7)
Master's degree	250 (10.6)
PhD	40 (1.7)
<i>Year of study</i>	
1 <sup>st</sup>	698 (29.5)
2 <sup>nd</sup>	491 (20.7)
3 <sup>rd</sup>	493 (20.8)
4 <sup>th</sup>	369 (15.6)
5 <sup>th</sup>	189 (8.0)
6 <sup>th</sup>	51 (2.2)
7 <sup>th</sup>	76 (3.2)

\* Multiple responses

Of the study subjects, 82.1% indicated that they had been using a smartphone for 3 or more years. The most common applications being used were Whatsapp (41%), Twitter (18.5%), Instagram (12.5%), Snapchat (7.1%), and others (20.1%). The purposes for using the applications included social networking (94.7%), news watching (70.7%), performing academic tasks (57.1%), and engaging in educational searches (52.4%). With respect to the assessment of the consequences of the use of smartphones, approximately 28.8% of the study subjects agree, and 15.3% strongly agreed that their sleep hours had decreased since they began using their smartphones; 29.5% agreed and 13.9% strongly agree and felt that they lacked energy the next day; 17.3% and 12.4% were eating fast food more so than before using their smartphones; 17.6% and 11.9% indicated that they had gained weight; 16.1% and 7.3% reported that their academic achievement had been adversely affected; and 19.9% and 12.5% were engaging in less exercise compared with before their smartphone use. There is a highly statistically significant positive correlation between the consequences of the use of smartphones and the total scores on the PUMP such that the responses on a 5-point scale increase as the total scores on the PUMP increase (Tables 2 & 3). For 2367 subjects, the 20-item PUMP, which was assessed on a 5-point scale, yielded a mean±standard deviation of 60.8±14.9, median score of 60, an interquartile range of 20, and with a minimum of 20 and maximum of 100. There is a highly statistically significant positive correlation between the scores on the PUMP scale and the scores regarding the consequences of the use of smartphones

**Table 2** - Distribution of variables related to the use of smartphones among Saudi University students.

Variables	n (%)
<i>Duration of smartphone use (years)</i>	
≤1	47 (2.0)
1-3	377 (15.9)
>3	1943 (82.1)
No. of hours spent using smartphone (mean±SD)	6.65 ± 4.3
No. of applications (mean±SD)	5.26 ± 2.3
<i>Purpose of using the applications (n=2366)*</i>	
Watching news	1673 (70.7)
Social networking	2241 (94.7)
Academic performance tasks	1352 (57.1)
Games	997 (42.1)
Athletic	633 (26.8)
Educational	1240 (52.4)
Religious	831 (35.1)
Scientific	1063 (44.9)
Other purpose	159 (6.7)

\*Multiple responses



**Table 3** - Distribution of responses towards consequences of smart phone use and its correlation with PUMP scale score among Saudi university students.

Consequences smart phone use	Strongly disagree	Disagree	Fair	Agree	Strongly agree	Correlation with total PUMP score
I feel that my sleeping hours decreased	244 (10.3)	580 (24.5)	500 (21.1)	682 (28.8)	361 (15.3)	0.379
I feel lack of activity the next day	216 (9.1)	565 (23.9)	559 (23.6)	698 (29.5)	329 (13.9)	0.504
I eat more fast food than before	445 (18.8)	704 (29.7)	514 (21.7)	410 (17.3)	294 (12.4)	0.450
I noticed an increase in my weight	568 (24.0)	694 (29.3)	407 (17.2)	417 (17.6)	281 (11.9)	0.349
Adversely affected my academic achievement	526 (22.2)	698 (29.5)	588 (24.8)	382 (16.1)	173 (7.3)	0.474
I exercise less than before	424 (17.9)	564 (23.8)	614 (25.9)	470 (19.9)	295 (12.5)	0.381

Statistically significant positive correlation (Spearman rank correlation coefficient). PUMP - problematic use of mobile phones

**Table 4** - Correlation and comparison of total score for problematic use of smartphone with other study variables among Saudi university students.

Variables	Total score of problematic use of smartphone <sup>†</sup>	t-value / F-value	P-value
Age	0.023		0.27
Score of consequences from use of smartphone	0.598		<0.0001
Number of hours spent using smartphone	0.311		<0.0001
Number of applications	0.126	1.49	<0.0001
<b>Gender</b>			0.14
Male	61.4 (15.5)		
Female	60.4 (14.47)		
<b>Marital status</b>		-0.41	0.68
Single	60.8 (15.0)		
Married	61.2 (14.1)		
<b>Nationality</b>		-0.44	0.66
Saudi	60.8 (14.9)		
Non-Saudi	61.3 (15.4)		
<b>Academic degree</b>		-1.60	0.11
Bachelor's degree	60.7 (15.0)		
Master's or PhD	62.1 (14.5)		
<b>Year of study</b>		2.28	0.045
1 <sup>st</sup>	60.5 (15.2)		
2 <sup>nd</sup>	61.3 (14.5)		
3 <sup>rd</sup>	61.5 (15.0)		
4 <sup>th</sup>	59.9 (14.6)		
5 <sup>th</sup>	58.8 (14.7)		
6 <sup>th</sup> & 7 <sup>th</sup>	63.7 (16.0)*		
<b>Duration of smartphone use (years)</b>		2.37	0.09
<1	57.7 (18.9)		
1-3	62.0 (14.3)		
>3	0.7 (15.0)		

\*Significantly higher than fourth and fifth year, but not different from first, second, and third years (by Tukey's test), <sup>†</sup>Karl-Pearson's correlation coefficient

( $r=0.598$ ,  $p<0.0001$ ), which indicates that the scores for the consequences of the use of the smartphone increase, the scores on the PUMP scale also increase. A similar trend of positive correlation was observed regarding the number of hours spent using the smartphone ( $r=0.311$ ,  $p<0.0001$ ). Also a positive correlation was observed between number of applications and the scores of PUMP scale ( $r=0.126$ ,  $p<0.0001$ ). Additionally,

the mean score of the PUMP scale is statistically significantly different across the academic years for the study subjects ( $F=2.28$ ,  $p=0.045$ ), in which the mean score of sixth and seventh year subjects is significantly higher than the subjects from the fourth and fifth year. The other variables (age, gender, marital status, nationality, and academic degree) are not statistically significantly related to the scores on the PUMP scale

**Table 5** - Independent variables related to the total score of problematic use of smart phones using stepwise multiple regression analysis among Saudi university students.

Model	Unstandardized coefficients		Standardized coefficients	t-test	P-values	95.0% confidence interval for Beta	
	Beta	Std. Error				Lower Bound	Upper Bound
(Constant)	32.608	0.817		39.896	<0.0001	31.006	34.211
Score of consequences regarding smartphone use	1.650	0.046	0.598	36.211	<0.0001	1.560	1.739
(Constant)	29.014	0.826		35.135	<0.0001	27.394	30.633
Score of consequences regarding smartphone use	1.556	0.044	0.563	35.130	<0.0001	1.469	1.642
How many hours per day spent using smartphone	0.782	0.056	0.226	14.068	<0.0001	0.673	0.891
(Constant)	24.546	1.197		20.503	<0.0001	22.199	26.894
Score of consequences regarding smartphone use	1.557	0.044	0.564	35.351	<0.0001	1.471	1.643
How many hours per day spent using smartphone	0.821	0.056	0.237	14.714	<0.0001	0.712	0.931
Years of study	3.723	0.726	0.082	5.129	<0.0001	2.300	5.147
(Constant)	23.088	1.305		17.692	<0.0001	20.529	25.646
Score of consequences regarding smartphone use	1.556	0.044	0.564	35.373	<0.0001	1.470	1.642
How many hours per day spent using smartphone	0.779	0.058	0.225	13.500	<0.0001	0.666	0.893
Years of study	3.918	0.728	0.086	5.380	<0.0001	2.490	5.346
Number of applications	0.293	0.105	0.046	2.789	0.005	0.087	0.498

(Table 4). The stepwise multiple regression analysis reveals a statistically significant positive relationship between the 4 study variables, consequences of the use of smartphones, number of hours spent per day using smartphones, year of study, and number of applications used, and the outcome variable score on the problematic use of mobile phones. The final model with these 4 variables is highly statistically significant ( $F=418.68$ ,  $p<0.001$ ). The R-squared value of 0.415 indicates that approximately 41.5% of the changes in scores on the PUMP scale are explained by these 4 variables. The R-squared change from model one to model 4 is also statistically significant. Furthermore, the positive regression coefficients of these 4 study variables are statistically significant. The other variables (age, gender, marital status, grade, and duration of smartphone use) are not statistically significantly related to the scores on the PUMP scale (Table 5).

**Discussion.** The present study may be the first wide-scale regional study in which the phenomenon of smartphone addiction is explored. Most participants are single Saudi nationals between 20 and 24 years of

age who have been using their smartphones for more than 3 years. In our study, gender was not statistically significantly related to the scores on the PUMP. This is in contrast to a Korean study conducted among college students that found females to be more addicted to their smartphones than males. Moreover, anxiety levels and neurotic personality traits were found to increase with addiction severity levels.<sup>14</sup> However, a study of nomophobia (the fear of being out of smartphone contact) and smartphone dependence among Indian medical students found that this disorder is equally prevalent among the study group irrespective of gender.<sup>15</sup> Only 252 subjects (10.6%) responded positively to the question regarding their substance use, a finding that may be explained by cultural sensitivity to the question. This small number makes it difficult to detect a statistically significant correlation between substance use and scores on the PUMP scale. Most of those who answered the substance abuse question admitted to smoking cigarettes (65.1%), or shisha (54.8%). These results were 4 times more likely in a 5-year old cohort study in KSU students.<sup>16</sup> This increase can be explained by the rapid recent increase in smoking prevalence

in Saudi Arabia,<sup>17</sup> but it could also be attributed to methodological issues. Regarding the number of hours spent per day using their smartphones, 61% of our study participants reported that they spend at least 5 hours per day using their smartphones, whereas 27.2% spend more than 8 hours per day. Three-quarters of the participants use at least 4 applications per day, mainly for social networking and watching news. Moreover, as the number of applications used increased, the mean values on the PUMP increased. In one Korean study, the investigators used an objective comprehensive smartphone use logging system over more than 800 days of usage logs and found different application category preferences between addicts and non-addicts wherein social and communication applications have a shorter usage time and a higher daily usage frequency than do game applications. A comparison between addict and non-addict use patterns for daily and hourly use found that with respect to daily use, it is only on Sundays when the difference in use patterns is high. An hourly analysis reveals that addicted users' usage occurs primarily at night, whereas non-addicted users' usage occurs primarily in the afternoon.<sup>18</sup> Another study indicated that social network use is a stronger predictor of smartphone addiction than game usage.<sup>19</sup> However, a Chinese study<sup>20</sup> on the role of motives in smartphone addiction from the functionalist perspective, found that perceived enjoyment, mood regulation, pastime, and conformity positively affect smartphone addiction, whereas information seeking and social relationships have no significant effects on such addiction.

Our study finds a highly statistically significant positive correlation between a negative lifestyle and poor academic achievement that could be attributed to the use of smartphones, according to the total scores on the PUMP. As a consequence of using their smartphones, at least 43% of the respondents agreed that their sleeping hours had decreased since they began using their smartphones and that they experienced a lack of energy. A study conducted among Turkish university students associated depression, anxiety, poor sleep quality, and daytime dysfunction with smartphone overuse.<sup>21</sup> Similar findings were found in local and international studies.<sup>3,4,6,13,22</sup> Moreover, at least 30% of our study participants agreed that they had a less healthy lifestyle since they began using their smartphones (more fast food, increased bodyweight, and less exercise). Health complications, including obesity, caused by the excessive use of smartphones are recognized consequences.<sup>23</sup> Therefore, an exercise

rehabilitation program was proposed as a potential treatment for smartphone addiction in addition to the classical treatments for addiction, such as cognitive behavioral therapy, motivational programs, and mindfulness-based therapies.<sup>24</sup> Approximately 25% of our study participants found that their academic achievement had been adversely affected since they started using their smartphones. A similar trend was found in a local study.<sup>13</sup> In a USA study,<sup>25</sup> after controlling for other established predictors, increased smartphone use was associated with decreased academic performance. A Korean study found that the higher the addiction level, the lower was the level of self-regulated learning. Additionally, a low level of flow was detected when learners who were studying were constantly interrupted by non-relevant applications on their phones, indicating that the student users do not have sufficient control over their smartphone use and study habits.<sup>26</sup> Another study<sup>27</sup> found that undergraduate college students with an external locus of control, in comparison with those with an internal locus of control, have less control over their smartphone use, namely, they are more likely to use their phones at bedtime, in class, and while studying, and are consequently more vulnerable to the negative outcomes associated with excessive smartphone use, such as poor sleep quality, lower academic performance, and a reduced degree of subjective well-being.<sup>27</sup> Problematic smartphone use has generally been considered a behavioral addiction that shares many features with the more established addictions such as drug addictions. However, evidence supporting it as an addictive behavior is scarce.<sup>28</sup> Moreover, there is a wide disparity in the adoption of diagnostic criteria and the numerous instruments applied to assess these concepts. Thus, the estimated prevalence ranges from 0-38%, depending on the scale used and the characteristics of the population studied.<sup>9</sup> Because, to date, no gold standard measure, namely, accepted formal diagnostic criteria, exists for problematic smartphone use, there are no cut-off that can be applied to the PUMP scale to define addiction based on the scale.<sup>6</sup> While the maximum score on the PUMP scale is 100 and the minimum is 20, in our study, the mean value of the PUMP scale was 60.8 and a median score of 60 with an interquartile range of 20. These data may point to a higher prevalence of addiction phenomenon in this cohort. A mixed method study that included systematic-review and meta-analysis found that the smartphone addiction magnitude in India ranged from 39-44%.<sup>10</sup> In a British study among adolescents aged between 11 and 18 years in which the

mobile phone problem use scale (MPPUS) was used, the prevalence of problematic users among the students was found to be 10%.<sup>29</sup> In a Spanish study<sup>30</sup> that applied the same scale, a problematic use prevalence rate of 14.8% among adolescents was detected. A study among German medical residents revealed that 40% of the participants met the ICD-10 substance dependence criteria, 27.1% of the subjects scored 2 or more on the CAGE questionnaire, and 23.4% of the subjects self-rated themselves as addicted to their smartphones.<sup>31</sup> The current study surveys a relatively large number of students and employs a well-validated tool to examine addiction phenomena, and thus contributes to the knowledge on smartphone addiction among university students in Saudi Arabia.

**Study limitations.** The study's cross-sectional design and different life styles and demands between pre-university and university academic stages precludes the detection of any causal association. We cannot avoid the possibility of reporting bias from self-reported data. This is a single center study with a low response rate, the generalizability of the current findings may be negatively affected. Lack of a standard measure of smartphone addiction against which to base estimates of prevalence in the current sample is another limitation.

In conclusion, this study showed that university students in Saudi Arabia are at risk of addiction to smartphone use, which is associated with negative effects on sleep, energy level, eating habits, weight, exercise, and academic performance. The findings from this present study suggest the need for larger multi-center studies that include broader populations to explore the addictive potential of smartphone use to avoid possible negative outcomes.

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