scientific reports

Check for updates

OPEN

Prevalence and predictors of problematic smartphone use in a sample of Spanish undergraduate students

Enrique Ramón-Arbués[1,2]✉, Emmanuel Echániz-Serrano[2,3], José Manuel Granada-López[2,3], Pedro José Satústegui-Dordá[2,3], María Teresa Fernández-Rodrigo[2,3] & Lucía Sagarra-Romero[1]

The aim of this study was to determine the prevalence and predictors of problematic smartphone use (PSU) in a sample of young Spanish university students. A descriptive cross-sectional study was conducted in a sample of university students. An online questionnaire collected data on socio-demographic characteristics, health-related behaviours, loneliness, life satisfaction and smartphone use. PSU was assessed using the Smartphone Addiction Scale-Short Version. Logistic regression analysis was used to examine predictors of PSU. 545 students (52.5% female) participated in the study. PSU was present in 33.8% of participants. PSU was associated with duration of device use (OR = 1.39; 95%CI 1.22–1.58), smartphone use before sleep (OR = 3.31; 95%CI 1.32–8.30), preferred use for entertainment purposes (OR = 5.03; 95%CI 1.32–19.17), smoking (OR = 1.75; 95%CI 1.07–2.87), alcohol consumption (OR = 1.60; 95%CI 1.30–1.98) and loneliness (OR = 1.20; 95%CI 1.03–1.40). In contrast, high physical activity was a protective factor for PSU (OR = 0.55; 95%CI 0.31–0.98). Prevalence of PSU is high among Spanish university students. Loneliness, smartphone use habits and certain health-related behaviours are predictors of PSU. Our findings highlight the need to formulate policies and institutional guidelines that promoted a balanced use of technology.

Keywords College students, Young adults, Predictors, Smartphone, Problematic smartphone use

We are in the Information Age, where wireless communications and the Internet have catalysed a revolution in communication and entertainment. Two decades ago, the use of smartphones began and today these devices have become one of the most popular in the world. Smartphones offer a wide range of functionalities that facilitate various activities, whether professional, educational, communication or entertainment. As a result, they have become indispensable tools in the daily lives of many people[1] and represent one of the fastest growing sectors in the technology industry. It is estimated that around 5.9 billion people will own a smartphone by 2025[2]. However, in extreme cases, some people may find it difficult to control their smartphone use[3].

Theoretical frameworks

The question of whether excessive and uncontrolled smartphone use should be considered a behavioural addiction remains a subject of debate[4]. A proportion of researchers posit that the presence of diagnostic criteria, including tolerance, salience, withdrawal, modification, conflict, and relapse, should be a fundamental consideration[5,6]. These characteristics of use have the potential to engender significant disruptions to individuals' lives, as well as adaptive disorders, including the development of interpersonal and social problems[7], physical, emotional and sleep problems[8], or negligent use of the mobile phone, which may encompass neglect of responsibilities, use of the device in dangerous situations, or excessive financial expenditure, among others[4]. Conversely, alternative perspectives contend that a more appropriate classification would be maladaptive or problematic smartphone use (PSU), as the consequences do not reach the level of severity characteristic of addiction[9], or because the causal relationship is not clear, whether the problem is related to the device itself or the functionalities it offers[10]. In any event, the two terms may be considered synonymous, as demonstrated by the utilisation of highly

[1]Faculty of Health Sciences, Universidad San Jorge, Autovía A-23, Km 299, Villanueva de Gállego, 50830 Zaragoza, Spain. [2]SAPIENF Research Group, University of Zaragoza, C/Pedro Cerbuna 12, Zaragoza 50009, Spain. [3]Faculty of Health Sciences, Department of Physiatry and Nursing, University of Zaragoza, C/Domingo Miral s/n, 50009 Zaragoza, Spain. ✉email: eramon@usj.es

analogous terminology to define both smartphone addiction and PSU. Smartphone addiction has been defined as a maladaptive dependence on and/or obsessive-compulsive use of the smartphone device[11], inability to adequately regulate smartphone use to the point of experiencing adverse consequences[12], or a state of immersion in uncontrollable smartphone use[13], among others. PSU has been defined in a similar manner as 'excessive or uncontrolled smartphone use'[14].

Beyond the terminology used, the literature has linked the smartphone addiction/PSU to various health problems, both physical[15], social[16,17] and mental[18], leading to a deterioration in the quality of life[19].

A range of theoretical frameworks have been proposed to facilitate comprehension of the developmental processes associated with smartphone addiction or PSU. Social influence theory posits that social influence factors predict a user's behaviour in virtual environments and, in this case, are influenced by three social processes: 'conformity (normative influence of others' expectations), internalisation (congruence of one's goals with those of others) and identification (conception of oneself in terms of defining group traits)'[20]. This theory could assist in elucidating the phenomenon of smartphone addiction/PSU among impressionable youth, who demonstrate an increased susceptibility to peer influence. This susceptibility leads to the adoption of behaviours that are deemed trendy or cool by their peers and which ultimately result in addictive smartphone behaviours. In the context of PSU, the prevailing group norms, the tendency towards conformity, and the role of imitation in shaping individual behaviour are particularly pronounced in environments characterised by extensive connectivity. The pressure to respond immediately, the search for validation through digital interactions (e.g. likes and comments), and the fear of social exclusion have been shown to reinforce the need to maintain a constant presence on mobile platforms. Furthermore, the modelling of hyperconnected lifestyles by influential figures, such as celebrities or opinion leaders, serves to promote the internalisation of such lifestyles as desirable.

Fishbein and Ajzen's theory of reasoned action[21] hypothesises that an individual's behaviour is determined by their intention to behave in a certain way, which is influenced by both their own attitudes and the prevailing social context. Consequently, attitudes towards smartphones have been identified as significant predictors of addictive behaviour[22]. The present theoretical framework focuses on the intrapersonal reasons why an individual may become addicted, and the positive attitudes of the individual may provide positive reinforcement for the perpetuation of excessive smartphone use. In accordance with the principles of the theory of reasoned action, an individual's behavioural beliefs – for instance, the perception that smartphones offer emotional relief, entertainment, or enhanced social image – give rise to a positive assessment of their consequences. This, in turn, serves to reinforce a favourable attitude towards their use. Concurrently, normative beliefs – such as the anticipation of perpetual accessibility by the social environment, and the motivation to satisfy these expectations – serve to consolidate the subjective norm that subsequently propels the intention to utilise the technology. This rational process can result in patterns of compulsive use.

Another relevant theory, the theory of uses and gratifications, helps to understand the reasons why people choose media and content to satisfy specific needs and gain personal gratifications, as well as the individual differences that motivate people to use particular types of mass media. This theory posits that smartphone addiction can be conceptualised as the consequence of individuals actively seeking to satisfy a range of psychological, social and emotional needs through the utilisation of the device. Users turn to their smartphones for social gratification (maintaining interpersonal relationships), emotional gratification (relieving stress or boredom), informational gratification (accessing relevant content), entertainment gratification (consuming digital leisure content) and identity gratification (constructing and projecting the self on social media). When these gratifications are experienced immediately and constantly, a pattern of repetitive use is reinforced that can lead to dependence. However, it has been suggested that the uses and gratifications theory does not provide an adequate explanation for the phenomenon of why some individuals' increased smartphone use leads to addiction and problematic use, while others use smartphones productively[23,24].

In recent times, frameworks such as the I-PACE (Interaction of Person-Affect-Cognition-Execution) model or the Compensatory Internet Use model have been increasingly cited in PSU research. It is hypothesised that these models can offer a more nuanced explanation of why certain individuals develop problematic patterns of use despite similar levels of exposure. The I-PACE model posits that addictions are the result of the interaction of individual, psychological and cognitive factors[25]. The model suggests that vulnerability to addiction may be influenced by genetic predisposition, personality traits, emotional imbalances and the way people process information and respond to stimuli related to addictive behaviour[26]. In this context, individuals exhibiting traits such as impulsivity, low self-esteem or high sensitivity to rejection have been observed to utilise their smartphones as a means of evading negative emotional states, including anxiety, boredom and stress. This emotional use is reinforced by dysfunctional cognitive beliefs, such as the conviction that the smartphone is indispensable for maintaining feelings of connection and validation. When these factors are combined with deficits in self-control and behavioural inhibition, the result is a decrease in self-regulation and the development of a pattern of compulsive use.

The Compensatory Internet Use model proposes that problematic smartphone use may represent a coping mechanism for individuals experiencing negative emotions or encountering challenges in their real-life social interactions[27]. It proposes that individuals may utilise their smartphones to alleviate negative emotions or compensate for a perceived lack of social connection. In essence, the smartphone becomes a tool employed to evade or manage challenging circumstances[28,29].

Prevalence and factors related to problematic smartphone use

There is a growing body of knowledge dedicated to studying the prevalence of PSU in different populations[30]. These studies indicate an unstoppable upward trend of PSU in virtually all contexts, but with a variable dimension depending on geographical, socio-cultural and technological access factors[31]. In Spain, it is estimated that approximately 42.26 million Spanish citizens use smartphones, representing a penetration rate of over 88%

of the country's total population. This outcome is indicative of the increasing ubiquity of mobile devices as the predominant medium for accessing digital services, facilitating communication, and consuming content, irrespective of age or social class[32]. Jenaro et al.[33] and López-Fernández[34] found PSU prevalences of 7.99% and 12.5% in the population over 18 years of age in 2007 and 2015, respectively. More recently, specifically in 2023, Correa-Iriarte et al.[35] reported a PSU prevalence of 37.2%, confirming this upward trend.

From this perspective, identifying populations and risk profiles for the development of PSU becomes a public health priority. Youth is a developmental stage associated with greater vulnerability to problematic and addictive behaviours that can persist into adulthood and contribute to the development of chronic health problems in the future[36]. Several factors put young adults at risk of PSU. Unlike previous generations, today's youth have grown up in a digital environment with massive exposure to smartphones. In addition, youth are characterized by greater impulsivity[37], lower risk perception[38] and, sometimes, ineffective coping strategies[39], all of which are factors associated with the development of behavioural addictions and problematic behaviours such as PSU. In fact, PSU has previously been linked to some health risk behaviours such as excessive alcohol consumption[40] or poor diet. Thus, some authors have observed that problematic smartphone users tend to skip meals more frequently, increase snacking, eat faster, and consume fewer vegetables, milk, and yogurt[41,42]. The relationship between smoking and PSU remains unclear. Several studies found no correlation between the two phenomena[43,44], others an increased risk of PSU in smokers[45,46], and a separate study has proposed a potential association between the decline in youth smoking and the rise in mobile phone usage. This suggests the possibility that smartphones may function as a displacement behaviour for smoking[47]. Furthermore, a considerable number of personal and socio-demographic factors, academic concerns, and smartphone usage patterns have been associated with the PSU. Some authors indicate a negative relationship between smartphone addiction and life satisfaction among university students[48]. The risk of smartphone addiction is positively correlated with perceived stress and negatively associated with academic performance, which could have an impact on life satisfaction[49]. Research on the relationship between loneliness and smartphone addiction among students has yielded equivocal results. A number of studies have identified a substantial positive correlation between loneliness and PSU, particularly among female subjects[50,51]. However, other studies have not observed a similar correlation.

A substantial number of socio-demographic variables have been the focus of prior studies. The relationship between PSU, age and gender is not without controversy, with divergent results reported in the literature[52,53]. Furthermore, family social support (i.e. conflicting parental roles or living away from home) has been identified as a significant predictor of PSU[54]. Conversely, participation in alternative sporting activities appears to exhibit an inverse association[55].

PSU among university students is associated with various usage patterns. Studies have found that excessive daily use, particularly 4 h or more, significantly increases addiction risk[56]. Social media use and meeting new friends are strong predictors of addiction, while academic use and news consumption may reduce risk[57].

In any case, the findings concerning the factors associated with PSU are, in general, not very stable and appear to be strongly influenced by the geographical context in which each study is conducted. This absence of evidence highlights the necessity for specific monitoring of the factors associated with PSU in each respective society and culture. Further research on PSU in the young adult population can help health and education authorities to understand the problem and allocate appropriate resources for its treatment and prevention. Furthermore, knowledge of the factors associated with PSU may help to design education and awareness programs that are more appropriate for this specific group and ultimately improve their current and future quality of life. Therefore, the aim of this study was to determine the prevalence and predictors of problematic smartphone use in a sample of young Spanish university students.

Methods

Design

The study consisted of a cross-sectional online survey carried out at the University of San Jorge of Zaragoza during the second semester of the academic year 2023-24. The anonymised data were collected through online surveys using Microsoft forms. The study was conducted and reported in accordance with relevant guidelines and regulations. The study was approved by the Clinical Research Ethics Committee of Aragon (H-2017-0323).

Participants and recruitment

Participants were students from the Universidad San Jorge in Aragon, Spain. All undergraduates enrolled in any degree programme at the institution were eligible to participate (approximately 3,900 at the time). Students were informed about the study through institutional newsletters, posters and the university's social media pages. The survey was open from 8 January 2024 until 31 May 2024. The survey was preceded by an explanatory text about the characteristics of the research (including objectives, risks/benefits and anonymous data processing). In addition, all participants had to give their informed consent before starting the survey.

In total, 563 students completed the survey. The data of 18 of the participants were excluded from the research because they contained obviously erroneous information. In the end, the data of 545 students were included in the research.

Data collection

In order to identify the predictors of PSU, the variables most frequently associated in previous literature on the subject and mentioned in the Introduction section were gathered. Therefore, a data collection process was initiated, encompassing a range of demographic variables (age, gender, field of study and housing status), health-related behaviours (smoking, alcohol consumption, physical activity, diet quality), loneliness, life satisfaction and smartphone use. The field of study has been analysed on the basis of whether or not the participants have a healthcare degree. This approach is predicated on the hypothesis that healthcare students may be more

susceptible to PSU than their non-healthcare peers. This is attributable to their elevated emotional requirements, which arise from their practice in real-life contexts, dealing with illness and death, and other factors[58,59]. Social and family support has previously been associated with the PSU[60,61]. In the present study, the assessment of this variable was carried out indirectly through the analysis of the living arrangement. There is a substantial corpus of literature indicating that young people living outside the family home perceive reduced social support[62,63]. A categorisation of living arrangements was thus conducted, yielding three distinct options: living with family, with peers (including student hostels), or alone.

Alcohol consumption was assessed using the CAGE questionnaire, validated in the Spanish population by Rodríguez-Martos et al.[64]. The CAGE consists of 4 dichotomous response items (yes/no). Each affirmative item adds a point to the score, indicating that there are problems with alcohol if 2 or more questions are answered in the affirmative. The sensitivity is 65–100% and the specificity 88–100%[65].

Physical activity was assessed using the International Physical Activity Questionnaire-Short form (IPAQ-SF). This instrument assesses the frequency, intensity and duration of physical activity during the previous 7 days. Participants were then categorised according to their level of physical activity[66], namely low, moderate and high levels of physical activity. The IPAQ-SF has been validated in the Spanish university student population and has adequate clinimetric properties[67].

Participants' diet quality was assessed using the Spanish Healthy Eating Index (SHEI)[68]. The SHEI was adapted from the Healthy Eating Index of Kennedy et al.[69] and modified for the Spanish context according to the recommendations of the Spanish Society of Community Nutrition. This questionnaire consists of 10 items scored from 0 to 10. The total score ranges from 0 to 100 and categorises the participants' diet as healthy (> 80 points), in need of modification (50–80 points) and inadequate (< 50 points).

The Three Items Loneliness Scale (TILS) was used to analyse the participants' feelings of loneliness. The TILS was created using the three items of the Revised UCLA Loneliness Scale[70] with the highest loadings on the loneliness factor. These questions measure three dimensions of loneliness: relational connectedness, social connectedness and self-perceived isolation. The scores for each individual question can be added together to give you a possible range of scores from 3 to 9. Researchers have categorised people with scores of 3–5 as 'not lonely' and people with scores of 6–9 as 'lonely'[71]. This questionnaire showed adequate psychometric properties in the validation study in the Spanish population[72].

The Satisfaction With Life Scale (SWLS)[73] was used to assess participants' life satisfaction. The SWLS consists of five statements on a 7-point scale: 1 - strongly disagree, 2 - disagree, 3 - rather disagree, 4 - neither agree nor disagree, 5 - rather agree, 6 - agree, 7 - agree. The total score (range 5 to 35 points) indicates the level of satisfaction with one's life. The higher the score, the higher the level of life satisfaction. The total score (range 5 to 35 points) indicates the level of satisfaction with one's life. The higher the score, the greater the feeling of life satisfaction. It is also possible to categorise subjects according to the 20-point threshold (dissatisfied - SWLS < 20 points, neutral - SWLS 20 points, satisfied - SWLS > 20 points). The results of the validation study of the Spanish version of the SWLS indicate that it is a valid and reliable tool for analysing life satisfaction in the Spanish context[74].

Finally, we measured problematic smartphone use (PSU) using the Smartphone Addiction Scale-Short Version (SAS-SV)[75]. This is a 10-item self-report scale, and each item is rated on a 6-point Likert scale ranging from 1 to 6 (1 = strongly disagree; 6 = strongly agree). The total score ranges from 10 to 60 and is obtained by summing the 10 items. The higher the SAS-SV score, the greater the problem associated with smartphone use. In this study, a cut-off score of 31 for men and 33 for women was used to classify PSU[76]. The Spanish version of this questionnaire has shown excellent reliability ($\alpha = 0.88$)[34]. In addition, we assessed the characteristics of smartphone use among our participants through three multiple-choice questions: (i) In general, how many hours per day do you use your smartphone? (ii) For which tasks do you prefer to use your smartphone? and (iii) Do you use your smartphone before going to sleep?

Data analysis

The characteristics of the sample were summarised using mean and standard deviation for continuous variables and frequencies and percentages for nominal data. The Kolmogorov-Smirnov test was utilised to assess the normality of the distribution of each variable. In the present study, it was determined that the SHEI score was the only variable to satisfy the criteria for normality. Bivariate analysis was performed using Chi-square, Mann-Whitney U or t-Student test, as appropriate. Furthermore, a binary logistic regression analysis (enter method) was performed in order to ascertain the predictors of PSU (a cut-off score on the SAS-SV of 31 for men and 33 for women was used). The model incorporated a range of categorical variables, including gender, living arrangements (with family, with mates or alone), academic disciplines (health sciences vs. other fields), physical activity levels (low, medium or high), smoking (yes vs. no), regular smartphone use before sleep (yes vs. no), and the smartphone's primary use (tasks related to work/studies vs. other uses, including social networks, online entertainment, etc.). Furthermore, the quantitative variables age, hours of smartphone use per day, and the scores of the CAGE, SHEI, TILS and SWLS questionnaires were entered into the model. Multicollinearity among independent variables was checked using tolerance and variance inflation factor. The assumptions of the logistic regression model Hosmer-Lemeshow goodness of fit statistics was checked and satisfied. Statistical analysis of the data was performed using the SPSS statistical package for Windows (version 28, Chicago, IL, USA), with a significance level of $p < 0.05$.

Results

Sample characteristics and differences by smartphone use

The mean age of the participants in this study was 22.14 ± 5.22 years (median = 20; minimum 18 and maximum 53), with an almost equal gender distribution (47.5% males vs. 52.5% females). Most of the participants lived at

home (60.6%) and were studying health (60.4%). No statistically significant differences were observed for any of these variables according to whether they belonged to the group of problematic smartphone users. Table 1. There is a significant prevalence of health risk behaviours such as smoking (24.4%), poor diet (11.6%), low physical activity (44.4%) and hazardous alcohol consumption (22.8%). In addition, with the exception of smoking, these behaviours were more likely to be found among problematic smartphone users ($p < 0.01$). Participants with controlled smartphone use showed better scores on the loneliness and life satisfaction scales. However, this trend was only statistically confirmed for loneliness ($p < 0.01$). Table 1.

Smartphone use

33.8% of participants reported PSU. The average daily time spent on the smartphone by the participants was 4.64 ± 1.70 h. Many of the smartphone users regularly used the smartphone before going to bed (85.7%) and the main use they made of the device was for activities unrelated to work/study such as online entertainment,

Variable	Non-PSU *n* = 361 (66.2%)	PSU *n* = 184 (33.8%)	Total *N* = 545 (100%)	*p*-value
Gender				
Males	171 (47.4%)	88 (47.8%)	259 (47.5%)	0.928[a]
Females	190 (52.6%)	96 (52.2%)	286 (52.5%)	
Age. Mean ± SD	22.31 ± 5.31	21.82 ± 5.06	22.14 ± 5.22	0.154[b]
Living arrangement				
Family	226 (62.6%)	104 (56.5%)	330 (60.6%)	0.221[a]
Mates (including student hostels)	124 (34.3%)	70 (38.0%)	194 (35.6%)	
Alone	11 (3.0%)	10 (5.4%)	21 (3.9%)	
Faculty				
Health sciences	220 (60.9%)	109 (59.2%)	329 (60.4%)	0.712[a]
Non-health sciences	141 (39.1%)	75 (40.8%)	216 (39.6%)	
Physical activity level				
Low	142 (39.3%)	100 (54.3%)	242 (44.4%)	0.001[a]
Medium	101 (28.0%)	47 (25.5%)	148 (27.2%)	
High	118 (32.7%)	37 (20.1%)	155 (28.4%)	
Smoking				
Smoker	89 (24.7%)	44 (23.9%)	133 (24.4%)	0.916[a]
Non-smoker	272 (75.3%)	140 (76.1%)	412 (75.6%)	
Alcohol consumption				
CAGE scores. Mean ± SD	0.56 ± 0.84	1.03 ± 1.05	0.72 ± 0.94	0.001[b]
No-risk consumption (CAGE 0–1 points)	297 (82.3%)	124 (67.4%)	421 (77.2%)	0.001[a]
Risky/harmful consumption (CAGE 2–3 points)	64 (17.7%)	60 (32.6%)	124 (22.8%)	
Diet quality				
SHEI scores. Mean ± SD	67.51 ± 12.79	63.35 ± 12.23	66.11 ± 12.75	0.001[c]
Inadequate nutrition (SHEI < 51 points)	32 (8.9%)	31 (16.8%)	63 (11.6%)	0.001[a]
Diet requiring changes (SHEI 51–80 points)	277 (76.7%)	141 (76.6%)	418 (76.7%)	
Healthy eating (SHEI > 80 points)	52 (14.4%)	12 (6.5%)	64 (11.7%)	
Smartphone use				
Hours of smartphone use per day	4.32 ± 1.67	5.27 ± 1.58	4.64 ± 1.70	0.001[b]
Preferential use of the Smartphone				
Tasks related to work/studies	38 (10.5%)	3 (1.6%)	41 (7.5%)	0.001[a]
Other (Social networks, online entertainment, etc.)	323 (89.5%)	181 (98.4%)	504 (92.5%)	
Regular use of smartphone before sleep (Vs Non-use)	290 (80.3%)	177 (96.2%)	467 (85.7%)	0.001[a]
Loneliness				
TILS scores. Mean ± SD	3.89 ± 1.31	4.24 ± 1.40	4.01 ± 1.35	0.001[b]
Not lonely (TILS 3–5 points)	306 (84.8%)	146 (79.3%)	452 (82.9%)	0.119[a]
Lonely (TILS 6–9 points)	55 (15.2%)	38 (20.7%)	93 (17.1%)	
Satisfaction with life				
SWLS scores. Mean ± SD	25.36 ± 6.88	24.96 ± 6.27	25.22 ± 6.67	0.247[b]
Dissatisfied (SWLS < 19 points)	59 (16.3%)	32 (17.4%)	91 (16.7%)	0.144[a]
Neutral (SWLS 20 points)	11 (3.0%)	12 (6.5%)	23 (4.2%)	
Satisfied (SWLS > 20 points)	291 (80.6%)	140 (76.1%)	431 (79.1%)	

Table 1. Characteristics of the sample. [a]Chi-square test; [b]U Mann-Whitney test; [c]t-Student test.

browsing social networks, or gaming, among others (92.5%). It should be noted that the participants included in the PSU group showed more marked tendencies towards these behaviours ($p < 0.01$). Table 1.

The mean score of the SAS-SV in the sample was 27.91 ± 10.23, and the items with the highest scores (less control over smartphone use) were the #2 ("Having a hard time concentrating in class, while doing assignments, or while working due to smartphone use"), #4 ("Won't be able to stand not having a smartphone") y #9 ("Using my smartphone longer than I had intended") that would correspond to symptoms of "daily-life disturbance (academic disruption)", "withdrawal", and "overuse (tolerance)", respectively. Table 2.

Predictors of PSU

Binary logistic regression analysis suggests that high physical activity was inversely associated with PSU (OR = 0.55; 95%CI 0.31–0.98). Conversely, smoking (OR = 1.75; 95%CI 1.07–2.87) and higher alcohol consumption (OR = 1.60; 95%CI 1.30–1.98) were associated with the presence of PSU.

Factors related to device use were significantly associated with PSU. For example, each additional hour spent using a smartphone per day increased the odds of experiencing PSU by 39% (OR = 1.39; 95%CI 1.22–1.58). Similarly, participants who reported regular smartphone use before bed were three times more likely to suffer from PSU than their peers who did not (OR = 3.31; 95%CI 1.32–8.30). And those who used their device mainly for entertainment and fun were five times more likely to suffer from PSU (OR = 5.03; 95%CI 1.32–19.17). Finally, PSU was directly related to feelings of loneliness. For example, each additional point on the TILS scale increased the odds of being a problematic smartphone user by 20% (OR = 1.20; 95%CI 1.03–1.40). The predictive capacity of this logistic regression model was 26% (Nagelkerke R2 = 0.26). Table 3.

Discussion

The aim of this study was to determine the prevalence and predictors of PSU in a sample of young Spanish university students. The prevalence of PSU in this study was 33.8%. This result is in line with that reported in more recent studies. In Spain, studies using the SAS-SV scale have shown an upward trend in the prevalence of PSU, with prevalences of 7.9%[33] and 12.5%[34] being reported in the last two decades. While in a recent study from 2023, 37.2% of participants were classified as smartphone addicts[35]. The trend in Europe is similar. Prevalence rates of 21.5% have been reported in Belgium[34], 16.5% in Switzerland[77], but more recently values of 34.6% have been reported in Turkey[78], which are more in line with those obtained in this study. This upward trend may be related to the increased accessibility and dependence on mobile technology in the daily lives of young university students. Smartphones are increasingly used not only for recreational activities such as social networking and gaming, but also for academic activities such as searching for information, communicating with peers and teachers, and accessing online learning platforms[79]. This duality in smartphone use may contribute to the increased prevalence of PSU among college students. In addition, the COVID-19 pandemic may have exacerbated PSU due to increased time at home and reliance on technology for education, work, and socialising. During the pandemic, many people turned to their mobile devices to stay entertained and connected socially and academically, leading to significant increases in screen time and, in some cases, addictive behaviours. One study found that smartphone use among college students increased significantly during the pandemic, leading to negative mental health outcomes and addictive behaviours[80].

In our sample, three main symptoms related to smartphone use stood out: "daily-life disturbance (academic disruption)", "withdrawal" and "overuse (tolerance)". The inability to stop using the smartphone or to tolerate not having one are classic symptoms indicative of a psychological dependence[81]. These behaviours reflect a compulsive need to be constantly connected, which can have a negative impact on mental health and general well-being[82]. "Academic disruption" includes difficulty concentrating in class, completing assignments or working due to smartphone use. A meta-analysis found that mobile phone use is negatively correlated with academic performance, suggesting that time spent on smartphones may displace the time students spend studying and participating in academic activities[83]. Furthermore, recent studies suggest that PSU is positively correlated with deficits in cognitive tasks, executive function and memory impairment[84,85]. These findings highlight the

Item	Strongly disagree	Disagree	Weakly disagree	Weakly agree	Agree	Strongly agree	Item score (mean ± SD)	Total score (mean ± SD)
Item 1. Missing planned work	200 (36.7%)	135 (24.8%)	50 (9.2%)	90 (16.5%)	43 (7.9%)	27 (5.0%)	2.49 ± 1.54	27.91 ± 10.23
Item 2. Difficulty with concentration or performing tasks	61 (11.2%)	75 (13.8%)	67 (12.3%)	147 (27.0%)	136 (25.0%)	59 (10.8%)	3.73 ± 1.51	
Item 3. Presence of musculoskeletal pain	204 (37.4%)	110 (20.2%)	76 (13.9%)	63 (11.6%)	69 (12.7%)	23 (4.2%)	2.54 ± 1.58	
Item 4. Won't be able to stand not having a smartphone	95 (17.4%)	143 (26.2%)	80 (14.7%)	97 (17.8%)	75 (13.8%)	55 (10.1%)	3.14 ± 1.60	
Item 5. Impatience and restlessness	133 (24.4%)	151 (27.7%)	86 (15.8%)	99 (18.2%)	37 (6.8%)	39 (7.2%)	2.77 ± 1.51	
Item 6. Always thinking about the smartphone.	204 (37.4%)	171 (31.4%)	62 (11.4%)	69 (12.7%)	24 (4.4%)	15 (2.8%)	2.23 ± 1.33	
Item 7. purpose of continuing its use	246 (45.1%)	134 (24.6%)	70 (12.8%)	56 (10.3%)	21 (3.9%)	18 (3.3%)	2.13 ± 1.36	
Item 8. Constant checking (fear of missing out)	132 (24.2%)	147 (27.0%)	102 (18.7%)	94 (17.2%)	40 (7.3%)	30 (5.5%)	2.73 ± 1.46	
Item 9. Longer use than anticipated	52 (9.5%)	86 (15.8%)	81 (14.9%)	142 (26.1%)	122 (22.4%)	62 (11.4%)	3.70 ± 1.49	
Item 10. Perceived overuse by outsiders	198 (36.3%)	138 (25.3%)	71 (13.0%)	68 (12.5%)	53 (9.7%)	17 (3.1%)	2.43 ± 1.47	

Table 2. Participants' responses to SAS-SV.

	OR	95% confidence interval
Age (1-point increase)	1.03	(0.98–1.08)
Females (Vs males = 1)	0.80	(0.53–1.23)
Living arrangement (with family = 1)		
With mates (including student hostels)	1.18	(0.76–1.83)
Alone	2.63	(0.86–8.01)
Health sciences studies (Vs others = 1)	0.85	(0.56–1.31)
Physical activity (medium = 1)		
Low	1.19	(0.73–1.93)
High	**0.55**	**(0.31–0.98)**
Smoker (Vs non-smoker = 1)	**1.75**	**(1.07–2.87)**
CAGE score (1-point increase)	**1.60**	**(1.30–1.98)**
SHEI score (1-point increase)	0.99	(0.97–1.00)
Hours of smartphone use per day (1-hour increase)	**1.39**	**(1.22–1.58)**
Preferential use of the Smartphone (tasks related to work/studies = 1)		
Other (Social networks, online entertainment, etc.)	**5.03**	**(1.32–19.17)**
Using the Smartphone before sleeping (Vs non-using = 1)	**3.31**	**(1.32–8.30)**
TILS score (1-point increase)	**1.20**	**(1.03–1.40)**
SWLS score (1-point increase)	0.99	(0.96–1.03)

Table 3. Predictors of PSU. Binary logistic regression analysis*. *p-value of the model = 0.001; Nagelkerke $R^2 = 0.26$. Significant values are in bold.

importance of addressing problematic smartphone use among university students, not only for its immediate impact on academic performance, but also for its long-term effects on mental health and well-being.

In our sample, predictors of PSU were smartphone-related behaviours, certain health-impairing behaviours and loneliness. High levels of physical activity were inversely associated with PSU. This finding is consistent with previous studies showing that regular physical activity can reduce the risk of technology addiction and improve overall well-being[55,86]. Physical activity may act as a distraction mechanism and provide a healthy alternative to excessive smartphone use, which may explain this inverse relationship. In addition, physical activity is associated with the release of endorphins and improved mood, which may reduce the need to turn to the smartphone as a form of emotional escape[87].

Smoking and heavy alcohol consumption were positively associated with the presence of PSU. These findings are consistent with research suggesting that both smokers and alcohol users may be more likely to engage in addictive behaviours, including problematic smartphone use[88,89]. Nicotine and alcohol can affect the brain's reward circuits, which may increase susceptibility to other forms of addiction[90]. In addition, smoking and drinking can reduce self-control and increase impulsivity, which could lead to excessive smartphone use. These behaviours may be related to attempts to manage stress and negative emotions by seeking immediate gratification through smartphone use.

In terms of factors related to device use, daily time of use, regular use before sleep, and preferential use for entertainment activities were associated with the likelihood of experiencing PSU. These findings are consistent with studies that have identified excessive smartphone use[18], especially before sleep, as a significant risk factor for PSU[76,91]. Smartphone use before sleep may interfere with sleep quality and increase dependence on the device, while use for entertainment may reflect a search for immediate gratification and a lack of other recreational activities[91]. This finding is consistent with previous research in this field. Consequently, a persistent dedication to the utilisation of the device may be indicative of PSU, irrespective of the temporal or frequency parameters of its use. The preferential use of the smartphone to interact on social media may be indicative of problematic symptoms, including anxiety, depression, low self-esteem, social isolation and the need for approval[92]. The persistent tendency to engage in self-comparison, the pursuit of external validation through likes and comments, and the distorted perception of reality can all contribute to the development of PSU. In a similar vein, online games, particularly those that offer frequent rewards, have the potential to result in compulsive and addictive patterns of use[93].

Finally, loneliness was directly related to PSU, with each additional point on the TILS scale increasing the likelihood of being a problematic user. Loneliness has been identified as a risk factor for several addictions, including problematic smartphone use[94,95]. The existing literature suggests a bidirectional relationship between PSU and loneliness. On the one hand, people with social anxiety and poor communication skills may prefer to communicate their thoughts and feelings through online messaging rather than verbal communication, leading to excessive smartphone use[96]. On the other hand, people who overuse their devices miss out on opportunities for face-to-face interaction, resulting in a loss of social skills and increased loneliness[17].

Interpretation of results from theoretical frameworks

The findings of this study offer empirical validation for numerous theoretical models that have previously been proposed to explain problematic smartphone use (PSU). Furthermore, they unveil intricacies that facilitate the refinement of these models' application within university populations.

From the perspective of Social Influence Theory, the association between PSU and smartphone use for entertainment purposes, as well as the high percentage of use before bedtime, suggests that normative pressures and digital validation play a central role. The propensity to persistently maintain connectivity and accessibility may be indicative of a tendency to conform to the expectations of one's peer group, as well as a trepidation of social exclusion. This phenomenon aligns with the processes of identification and internalisation elucidated within the theoretical framework.

The present findings are also consistent with Fishbein and Ajzen's theory of reasoned action, particularly with regard to the influence of perceived attitudes and norms on behavioural intentions. The robust correlation between PSU and entertainment-oriented use suggests that students hold favourable attitudes towards smartphone-mediated gratifications. Moreover, the pervasive societal expectation of perpetual availability, as evidenced by nocturnal utilisation, underscores the pivotal role of normative beliefs in perpetuating compulsive patterns. These findings provide validation for the hypothesis that behaviour can be guided by rational intentions that are shaped by personal evaluations and social pressures.

In relation to Uses and Gratifications Theory, the data confirm that smartphones are primarily utilised to satisfy emotional and entertainment needs. The significant association between PSU and loneliness suggests that students may use the device to compensate for emotional or social deficiencies. This lends further support to the notion that the emergence of PSU is concomitant with the smartphone's rise to become the predominant source of gratification.

The I-PACE model provides a more comprehensive explanation for this variability. The correlation between PSU and factors such as loneliness, alcohol consumption, and tobacco use indicates underlying emotional and behavioural vulnerabilities. The interaction of these factors with traits such as impulsivity and low self-control, which are prevalent among young adults, is a significant factor in the development of problematic smartphone use. The presence of dysfunctional cognitive beliefs, such as the perceived indispensability of the smartphone for feelings of connection or validation, serves to reinforce compulsive use. The model's emphasis on the dynamic interaction between personal traits, affective states, and executive control is supported by the predictive power of variables such as daily usage duration and night-time usage. To summarise, the findings of this study provide substantiation for the pertinence of the theoretical frameworks under discussion, and indicate that PSU is a multifactorial phenomenon that necessitates integrative approaches for prevention and intervention. This interpretation facilitates the contextualisation of the study within extant literature, thereby providing a robust foundation for future research and the development of public health strategies targeting university populations.

To the best of our knowledge, this is a pioneering study on the prevalence of PSU and the identification of its predictors in a large sample of Spanish university students. Our findings have important implications for public health and education. The increase in time spent using smartphones, especially in non-academic activities, is associated with unhealthy lifestyles and feelings of loneliness. In the long term, this can lead to both physical and mental health problems. This underlines the need to implement prevention and awareness-raising strategies involving policymakers and educational authorities. Incorporating into the academic curriculum programmes on the responsible use of technology, the risks of PSU and strategies to manage smartphone time in favour of physical activity or promoting times and spaces for young people to socialise can be useful strategies.

The present study has several limitations that should be considered when interpreting the results. Firstly, its cross-sectional design limits the ability to draw causal inferences, especially regarding the direction of the association between PSU, health-related behaviours and loneliness. A second limitation is the fact that all participants were students from the same institution, which may limit the generalisability of the present findings to other risk groups. Indeed, the emergence of pressures and opportunities for problematic smartphone-related behaviour may be influenced by a combination of institutional, cultural and academic factors. It is imperative to consider the potential impact of university policies pertaining to technology use, the provision of designated digital literacy and support services, and the implementation of cultural norms concerning smartphone usage within academic settings on the development of students' PSU. Thirdly, given that this study is based on a self-administered online questionnaire, there is a possibility that it may be subject to social desirability and self-report biases. In particular, it is not possible to rule out the hypothesis that participants responded in a way that perceived themselves favourably to others, rather than accurately reflecting their true attitudes and behaviours. Finally, although the socio-demographic characteristics of the sample fit the profile of Spanish university students, and although logistic regression analysis revealed significant associations, the predictive power of the models was modest. This suggests that other unaccounted for factors may contribute significantly to PSU. In this regard, it is important to note that certain factors not considered in this study may have a significant impact on the results. These include study mode (full-time or part-time), participants' employment status, and specific personality traits such as impulsivity, fear of missing out, and social anxiety. These factors have previously been associated with PSU and could potentially qualify our results. Individuals who are impulsive have been shown to act without thinking about the consequences, and as a result, tend to use mobile phones impulsively and excessively, without considering the negative effects this may have on their health[97]. The phenomenon of FOMO has been shown to motivate individuals to constantly use their mobile devices in order to remain informed and avoid feelings of exclusion[98]. Finally, in terms of social anxiety, some people may use the phone as a way to avoid face-to-face social interactions, or to seek validation and approval through social networks, which can lead to compulsive and problematic use[99]. Further research with a longitudinal approach and a larger number of variables is recommended to alleviate these limitations.

Conclusions

This study has shown that the prevalence of PSU among young Spanish university students is high. The most prominent symptoms of psychological dependence on smartphones found in our sample were 'daily-life disturbance (academic disruption)', 'withdrawal' and 'overuse (tolerance)'. Predictors of PSU included smartphone-related behaviours, health behaviours and loneliness. Physical activity was inversely associated with PSU, while smoking and alcohol consumption were positively associated. These findings highlight the need to address PSU among college students, not only for its immediate effects on academic performance, but also for its long-term implications for mental health and overall well-being.

Data availability

The data that support the findings of this study are available from the corresponding author upon request.

Received: 25 October 2024; Accepted: 12 November 2025
Published online: 27 November 2025

References

1. Ratan, Z. A., Parrish, A. M., Alotaibi, M. S. & Hosseinzadeh, H. Prevalence of smartphone addiction and its association with Sociodemographic, physical and mental Well-Being: A Cross-Sectional study among the young adults of Bangladesh. *Int. J. Environ. Res. Public. Health*. **19**, 16583 (2022).
2. N'da, K., Ge, J., Ji-Fan Ren, S. & Wang, J. What matters for international consumers' choice preferences for smartphones: evidence from a cross-border ecommerce platform. *PloS One*. **18**, e0285551 (2023).
3. Abuhamdah, S. M. A. & Naser, A. Y. Smart phone addiction and its mental health risks among university students in jordan: a cross-sectional study. *BMC Psychiatry*. **23**, 812 (2023).
4. Loleska, S. & Pop-Jordanova, N. Is smartphone addiction in the younger population a public health problem? *Pril Makedon Akad. Na Nauk. Umet Oddelenie Za Med. Nauki*. **42**, 29–36 (2021).
5. Jameel, S., Shahnawaz, M. G. & Griffiths, M. D. Smartphone addiction in students: A qualitative examination of the components model of addiction using face-to-face interviews. *J. Behav. Addict*. **8**, 780–793 (2019).
6. James, R. J. E., Dixon, G., Dragomir, M. G., Thirlwell, E. & Hitcham, L. Understanding the construction of 'behavior' in smartphone addiction: A scoping review. *Addict. Behav.* **137**, 107503 (2023).
7. Yang, S. Y. et al. Does smartphone addiction, social media addiction, and/or internet game addiction affect adolescents' interpersonal interactions? *Healthc. Basel Switz.* **10**, 963 (2022).
8. Luo, J., Xu, J., Lin, Y. & Chen, Q. Understanding the complex network of anxiety, depression, sleep problems, and smartphone addiction among college Art students using network analysis. *Front. Psychiatry*. **16**, 1533757 (2025).
9. Panova, T. & Carbonell, X. Is smartphone addiction really an addiction? *J. Behav. Addict.* **7**, 252–259 (2018).
10. Körmendi, A., Brutóczki, Z., Végh, B. P. & Székely, R. Smartphone use can be addictive? A case report. *J. Behav. Addict.* **5**, 548–552 (2016).
11. Yuchang, J., Cuicui, S., Junxiu, A. & Junyi, L. Attachment styles and smartphone addiction in Chinese college students: the mediating roles of dysfunctional attitudes and Self-Esteem. *Int. J. Ment Health Addict.* **15**, 1122–1134 (2017).
12. Kwan, H. C. & Leung, M. T. The structural model in parenting style, attachment style, Self-regulation and Self-esteem for smartphone addiction. *IAFOR J. Psychol. Behav. Sci* **3**, (2017).
13. Kim, H. J., Min, J. Y., Min, K. B., Lee, T. J. & Yoo, S. Relationship among family environment, self-control, friendship quality, and adolescents' smartphone addiction in South korea: findings from nationwide data. *PloS One*. **13**, e0190896 (2018).
14. Kim, J. H. Psychological issues and problematic use of smartphone: adhd's moderating role in the associations among loneliness, need for social assurance, need for immediate connection, and problematic use of smartphone. *Comput. Hum. Behav.* **80**, 390–398 (2018).
15. Söylemez, E. et al. Excessive smartphone use increases self-reported auditory and vestibular symptoms. *Wien Klin. Wochenschr*. **135,** 520-526 (2024).
16. Cilligol Karabey, S., Palanci, A. & Turan, Z. How does smartphone addiction affect the lives of adolescents socially and academically? A systematic review study. *Psychol. Health Med.* **29**, 631–654 (2024).
17. Tateno, M. et al. Internet Addiction, smartphone Addiction, and Hikikomori trait in Japanese young adult: social isolation and social network. *Front. Psychiatry*. **10**, 455 (2019).
18. Kil, N., Kim, J., McDaniel, J. T., Kim, J. & Kensinger, K. Examining associations between smartphone use, smartphone addiction, and mental health outcomes: A cross-sectional study of college students. *Health Promot Perspect.* **11**, 36–44 (2021).
19. Masaeli, N. & Billieux, J. Is problematic internet and smartphone use related to poorer quality of life? A systematic review of available evidence and assessment strategies. *Curr. Addict. Rep.* **9**, 235–250 (2022).
20. Chen, C. Y. Smartphone addiction: psychological and social factors predict the use and abuse of a social mobile application. *Inf. Commun. Soc.* **23,** 454-467 (2020).
21. Ajzen, I., & Fishbein, M. Understanding attitudes and predicting social behavior. *Prentice-Hall,* Englewood Cliffs (1980).
22. Cocoradă, E., Maican, C. I., Cazan, A. M. & Maican, M. A. Assessing the smartphone addiction risk and its associations with personality traits among adolescents. *Child. Youth Serv. Rev.* **93**, 345–354 (2018).
23. Oulasvirta, A., Rattenbury, T., Ma, L. & Raita, E. Habits make smartphone use more pervasive. *Pers. Ubiquitous Comput.* **16**, 105–114 (2012).
24. van Deursen, A. J. A. M., Bolle, C. L., Hegner, S. M. & Kommers, P. A. M. Modeling habitual and addictive smartphone behavior: the role of smartphone usage types, emotional intelligence, social stress, self-regulation, age, and gender. *Comput. Hum. Behav.* **45**, 411–420 (2015).
25. Mehmood, A. et al. Exploration of psychological mechanism of smartphone addiction among international students of China by selecting the framework of the I-PACE model. *Front. Psychol.* **12**, 758610 (2021).
26. Zhou, B., Mui, L. G., Li, J., Yang, Y. & Hu, J. A model for risk factors harms and of smartphone addiction among nursing students: A scoping review. *Nurse Educ. Pract.* **75**, 103874 (2024).
27. Lin, L. et al. The influence of interpersonal sensitivity on smartphone addiction: A moderated mediation model. *Front. Psychol.* **12**, 670223 (2021).
28. Zhong, G. et al. The relationship between social support and smartphone addiction: the mediating role of negative emotions and self-control. *BMC Psychiatry*. **25**, 167 (2025).
29. Kardefelt-Winther, D. A conceptual and methodological critique of internet addiction research: towards a model of compensatory internet use. *Comput. Hum. Behav.* **31**, 351–354 (2014).
30. Ratan, Z. A., Parrish, A. M., Zaman, S. B., Alotaibi, M. S. & Hosseinzadeh, H. Smartphone addiction and associated health outcomes in adult populations: A systematic review. *Int. J. Environ. Res. Public. Health*. **18**, 12257 (2021).

31. Lu, X., An, X. & Chen, S. Trends and influencing factors in problematic smartphone use prevalence (2012–2022): A systematic review and Meta-Analysis. *Cyberpsychology Behav. Soc. Netw.* **27,** 616-634 (2024).
32. Esteller, E. La cifra sigue subiendo: esto es lo ya gastamos los españoles al comprarnos un smartphone en 2025. *Pro Android - Mejores aplicaciones, juegos, tutoriales y reviews* (2025). https://www.proandroid.com/la-cifra-sigue-subiendo-esto-es-lo-ya-gastamos-los-espanoles-al-comprarnos-un-smartphone-en-2025/
33. Jenaro, C., Flores, N., Gómez-Vela, M., González-Gil, F. & Caballo, C. Problematic internet and cell-phone use: Psychological, behavioral, and health correlates. *Addict. Res. Theory*. **15**, 309–320 (2007).
34. Lopez-Fernandez, O. Short version of the smartphone addiction scale adapted to Spanish and french: towards a cross-cultural research in problematic mobile phone use. *Addict. Behav.* **64**, 275–280 (2017).
35. Correa-Iriarte, S., Hidalgo-Fuentes, S. & Martí-Vilar, M. Relationship between problematic smartphone Use, sleep quality and bedtime procrastination: A mediation analysis. *Behav. Sci. Basel Switz.* **13**, 839 (2023).
36. LePine, S. E. et al. Exploring definitions of 'Addiction' in adolescents and young adults and correlation with substance use behaviors. *Int. J. Environ. Res. Public. Health*. **19**, 8075 (2022).
37. Dali, G. et al. The role of impulsivity in the relationship between affect and alcohol consumption in young adults. *Alcohol Clin. Exp. Res.* **47**, 2161–2168 (2023).
38. Kollmann, J., Kocken, P. L., Syurina, E. V. & Hilverda, F. The role of risk perception and affective response in the COVID-19 preventive behaviours of young adults: a mixed methods study of university students in the Netherlands. *BMJ Open.* **12**, e056288 (2022).
39. Nieto, M. et al. Differences in coping strategies between young and older adults: the role of executive functions. *Int. J. Aging Hum. Dev.* **90**, 28–49 (2020).
40. Choi, S. W. et al. Comparison of risk and protective factors associated with smartphone addiction and internet addiction. *J. Behav. Addict.* **4**, 308-314 (2015).
41. Kim, Y., Lee, N. & Lim, Y. Gender differences in the association of smartphone addiction with food group consumption among Korean adolescents. *Public. Health*. **145**, 132–135 (2017).
42. Manzoor, A. et al. Smartphone Addiction/ overuse and its effect on dietary behavior and lifestyle -A systematic review. *EAS J. Nutr. Food Sci.* **2**, 289–297 (2020).
43. Alhazmi, A. A., Alzahrani, S. H., Baig, M., Salawati, E. M. & Alkatheri, A. Prevalence and factors associated with smartphone addiction among medical students at King Abdulaziz University, Jeddah. *Pak J. Med. Sci*. **34**, 984–988 (2018).
44. Matar Boumosleh, J. & Jaalouk, D. Depression, anxiety, and smartphone addiction in university students- A cross sectional study. *PloS One*. **12**, e0182239 (2017).
45. Luk, T. T. et al. Short version of the smartphone addiction scale in Chinese adults: psychometric properties, sociodemographic, and health behavioral correlates. *J. Behav. Addict.* **7**, 1157–1165 (2018).
46. Okasha, T. et al. Prevalence of smartphone addiction and its correlates in a sample of Egyptian university students. *Int. J. Soc. Psychiatry*. **68**, 1580–1588 (2022).
47. Cassidy, S. Using social identity to explore the link between a decline in adolescent smoking and an increase in mobile phone use. *Health Educ.* **106**, 238–250 (2006).
48. Kula, H., Ayhan, C., Soyer, F. & Kaçay, Z. The relationship between smartphone addiction and life satisfaction: faculty of sport sciences students. *Int. J. Psychol. Educ. Stud.* **7**, 86–95 (2020).
49. Samaha, M. & Hawi, N. S. Relationships among smartphone addiction, stress, academic performance, and satisfaction with life. *Comput. Hum. Behav.* **57**, 321–325 (2016).
50. Amalya, I. D., Rizqi, A. & Fadjri, F. A. The relationship between smartphone addiction and loneliness among students: *Proc. ICECRS* 8, (2020).
51. Kara, N. S., Çetin, M. Ç., Dönmez, A., Kara, M. & Genç, H. I. A study on the relationship between the levels of loneliness and smartphone addiction of students who are studying at the faculty of sports science. *Asian J. Educ. Train.* **6**, 213–218 (2020).
52. Khalily, M. T., Loona, M. I., Bhatti, M. M., Ahmad, I. & Saleem, T. Smartphone addiction and its associated factors among students in twin cities of Pakistan. *JPMA J. Pak Med. Assoc.* **70**, 1357–1362 (2020).
53. Wu, Y. Y. & Chou, W. H. Smartphone addiction, gender and interpersonal attachment: A cross-sectional analytical survey in Taiwan. *Digit. Health*. **9**, 20552076231177134 (2023).
54. Kim, Y., Dhammasaccakarn, W., Laeheem, K. & Rinthaisong, I. The impact of family functioning factors on smartphone addiction and phubbing among Muslim adolescents in Thailand. *Child. Basel Switz.* **11**, 522 (2024).
55. Pirwani, N. & Szabo, A. Could physical activity alleviate smartphone addiction in university students? A systematic literature review. *Prev. Med. Rep.* **42**, 102744 (2024).
56. Nikolic, A. et al. Smartphone addiction, sleep quality, depression, anxiety, and stress among medical students. *Front. Public. Health*. **11**, 1252371 (2023).
57. Lee, H., Kim, J. W. & Choi, T. Y. Risk factors for smartphone addiction in Korean adolescents: smartphone use patterns. *J. Korean Med. Sci.* **32**, 1674–1679 (2017).
58. Osorio-Molina, C. et al. Smartphone addiction, risk factors and its adverse effects in nursing students: A systematic review and meta-analysis. *Nurse Educ. Today*. **98**, 104741 (2021).
59. Sönmez, M., Gürlek Kısacık, Ö. & Eraydın, C. Correlation between smartphone addiction and loneliness levels in nursing students. *Perspect. Psychiatr Care*. **57**, 82–87 (2021).
60. Abu Khait, A. et al. The association between proneness to smartphone addiction and social anxiety among school students and the mediating role of social support: A call to advance Jordanian adolescents' mental health. *J. Am. Psychiatr Nurses Assoc.* **31**, 183–196 (2025).
61. Ding, Y. et al. The associations between smartphone addiction and self-esteem, self-control, and social support among Chinese adolescents: A meta-analysis. *Front. Psychol.* **13**, 1029323 (2022).
62. Thériault, É. R., Walsh, A., MacIntyre, P. & O'Brien PhD, C. Self-efficacy in health among university students: the role of social support and place. *J. Am. Coll. Health J. ACH*. **71**, 2510–2517 (2023).
63. Wu, H., Wu, S., Wu, H., Xia, Q. & Li, N. Living arrangements and Health-Related quality of life in Chinese adolescents who migrate from rural to urban schools: mediating effect of social support. *Int. J. Environ. Res. Public. Health*. **14**, 1249 (2017).
64. Rodríguez-Martos, A., Navarro, R., Vecino, C. & Pérez, R. Validación de Los cuestionarios KFA (CBA) y CAGE Para El diagnóstico Del alcoholismo. *Droga-Alcohol* **11**, 132–139 (1986).
65. Morales-Rueda, A. & Rubio-Valladolid, G. Diagnóstico y Tratamiento de Los problemas relacionados Con El alcohol En atención primaria. *MEDIFAM*. **7**, 211–225 (1997).
66. The IPAQ group. IPAQ scoring protocol - International Physical Activity Questionnaire. https://sites.google.com/site/theipaq/scoring-protocol
67. Rodríguez-Muñoz, S., Corella, C., Abarca-Sos, A. & Zaragoza, J. Validation of three short physical activity questionnaires with accelerometers among university students in Spain. *J. Sports Med. Phys. Fit.* **57**, 1660–1668 (2017).
68. Norte Navarro, A. I. & Ortiz Moncada, R. [Spanish diet quality according to the healthy eating index]. *Nutr. Hosp.* **26**, 330–336 (2011).
69. Kennedy, E. T., Ohls, J., Carlson, S. & Fleming, K. The healthy eating index: design and applications. *J. Am. Diet. Assoc.* **95**, 1103–1108 (1995).
70. Russell, D., Peplau, L. A. & Ferguson, M. L. Developing a measure of loneliness. *J. Pers. Assess.* **42**, 290–294 (1978).

71. Nielsen, T., Friderichsen, I. S. & Rayce, S. B. Classification of loneliness using the T-ILS: is it as simple as it seems? *Scand. J. Psychol.* **62**, 104–115 (2021).
72. Trucharte, A. et al. Three-item loneliness scale: psychometric properties and normative data of the Spanish version. *Curr. Psychol.* **42**, 7466–7474 (2023).
73. Diener, E., Emmons, R. A., Larsen, R. J. & Griffin, S. The satisfaction with life scale. *J. Pers. Assess.* **49**, 71–75 (1985).
74. Vázquez, C., Duque, A. & Hervás, G. Satisfaction with life scale in a representative sample of Spanish adults: validation and normative data. *Span. J. Psychol.* **16**, E82 (2013).
75. Kwon, M., Kim, D. J., Cho, H. & Yang, S. The smartphone addiction scale: development and validation of a short version for adolescents. *PloS One*. **8**, e83558 (2013).
76. Liu, H., Zhou, Z., Zhu, E., Huang, L. & Zhang, M. Smartphone addiction and its associated factors among freshmen medical students in china: a cross-sectional study. *BMC Psychiatry*. **22**, 308 (2022).
77. Haug, S. et al. Smartphone use and smartphone addiction among young people in Switzerland. *J. Behav. Addict.* **4**, 299–307 (2015).
78. Ozcan, B. & Acimis, N. M. Sleep quality in Pamukkale university students and its relationship with smartphone addiction. *Pak J. Med. Sci.* **37**, 206–211 (2021).
79. Middle East Technical University, Ataş, A. H., Çelik, B. & Middle East Technical University / Van Yuzuncu Yil University & Smartphone use of university students: Patterns, Purposes, and situations. *Malays Online J. Educ. Technol.* **7**, 54–70 (2019).
80. Saadeh, H. et al. Smartphone use among university students during COVID-19 quarantine: an ethical trigger. *Front. Public. Health*. **9**, 600134 (2021).
81. Uhl, G. R., Koob, G. F. & Cable, J. The neurobiology of addiction. *Ann. N Y Acad. Sci.* **1451**, 5–28 (2019).
82. Guo, Z. et al. Network analysis of the relationships between problematic smartphone use and anxiety, and depression in a sample of Chinese college students. *Front. Psychiatry*. **14**, 1097301 (2023).
83. Kates, A. W., Wu, H. & Coryn, C. L. The effects of mobile phone use on academic performance: A meta-analysis. *Comput. Educ.* **127**, 107–112 (2018).
84. Fabio, R. A., Stracuzzi, A. & Lo Faro, R. Problematic smartphone use leads to behavioral and cognitive Self-Control deficits. *Int. J. Environ. Res. Public. Health*. **19**, 7445 (2022).
85. Lim, J. The effect of adult smartphone addiction on memory impairment: focusing on the mediating effect of executive function deficiencies. *J. Digit. Converg.* **16**, 299–308 (2018).
86. Kim, J. & Lee, K. The association between physical activity and smartphone addiction in Korean adolescents: the 16th Korea youth risk behavior Web-Based Survey, 2020. *Healthc. Basel Switz.* **10**, 702 (2022).
87. Pujari, V. Moving to improve mental Health - The role of exercise in cognitive function: A narrative review. *J. Pharm. Bioallied Sci.* **16**, S26–S30 (2024).
88. Liu, H. et al. Prevalence of smartphone addiction and its effects on subhealth and insomnia: a cross-sectional study among medical students. *BMC Psychiatry*. **22**, 305 (2022).
89. Mei, S. et al. Internet addiction in college students and its relationship with cigarette smoking and alcohol use in Northeast China. *Asia-Pac Psychiatry Off J. Pac. Rim Coll. Psychiatr* **9**, (2017).
90. Hendrickson, L. M., Guildford, M. J. & Tapper, A. R. Neuronal nicotinic acetylcholine receptors: common molecular substrates of nicotine and alcohol dependence. *Front. Psychiatry*. **4**, 29 (2013).
91. Li, L., Wang, L. & Wang, X. Effect of smartphone use before bedtime on smartphone addiction behaviors among Chinese college students. *Front. Psychol.* **13**, 1023245 (2022).
92. Eichenberg, C., Schneider, R. & Rumpl, H. Social media addiction: associations with attachment style, mental distress, and personality. *BMC Psychiatry*. **24**, 278 (2024).
93. Makas, S. & Koç, M. The mediating effect of emotional schemas in the relationship between online gaming addiction and life satisfaction. *Sci. Rep.* **15**, 430 (2025).
94. Karaoglan Yilmaz, F. G., Avci, U. & Yilmaz, R. The role of loneliness and aggression on smartphone addiction among university students. *Curr. Psychol. N B NJ*. **19,** 1–9 (2022).
95. Peng, Y. et al. Depression and loneliness as mediators between social support and mobile phone addiction. *Psychiatr Danub*. **34**, 475–482 (2022).
96. Annoni, A. M., Petrocchi, S., Camerini, A. L. & Marciano, L. The relationship between social Anxiety, smartphone Use, dispositional Trust, and problematic smartphone use: A moderated mediation model. *Int. J. Environ. Res. Public. Health*. **18**, 2452 (2021).
97. Lane, H. Y., Chang, C. J., Huang, C. L. & Chang, Y. H. An investigation into smartphone addiction with personality and sleep quality among university students. *Int. J. Environ. Res. Public. Health*. **18**, 7588 (2021).
98. Akinci, H. & Durmuş, A. Does smartphone addiction impact happiness? Exploring the mediating roles of belongingness and fear of missing out: a cross-sectional survey from Turkey. *Psychol. Health Med.* **30**, 1137–1157 (2025).
99. Lai, X. et al. Risk and protective factors associated with smartphone addiction and phubbing behavior among college students in China. *Psychol. Rep.* **126**, 2172–2190 (2023).

Author contributions

Conceptualization, Enrique Ramón-Arbués and Lucía Sagarra-Romero; Data curation, Emmanuel Echániz-Serrano and Pedro José Satústegui-Dordá; Formal analysis, María Teresa Fernández-Rodrigo and José Manuel Granada-López; Investigation, Enrique Ramón-Arbués, Pedro José Satústegui-Dordá and Emmanuel Echániz-Serrano; Methodology, María Teresa Fernández-Rodrigo, Lucía Sagarra-Romero and José Manuel Granada-López; Project administration, Enrique Ramón-Arbués and Lucía Sagarra-Romero; Resources, Emmanuel Echániz-Serrano; Supervision, Enrique Ramón-Arbués and Lucía Sagarra-Romero; Validation, Enrique Ramón-Arbués, Emmanuel Echániz-Serrano and María Teresa Fernández-Rodrigo; Visualization, José Manuel Granada-Lopez and Enrique Ramón-Arbués; Writing – original draft, Pedro José Satústegui-Dordá; Writing – review & editing, Lucía Sagarra-Romero.

Funding

This work was financed by the Government of Aragón (Spain). Research Reference Team SAPIENF B53_23R (University of Zaragoza).

Declarations

Competing interests

The authors declare no competing interests.

Transparency declaration

The authors affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

Additional information

Correspondence and requests for materials should be addressed to E.R.-A.

Reprints and permissions information is available at www.nature.com/reprints.

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.