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Problematic smartphone use, depression symptoms, and fear of missing out: Can reasons for smartphone use mediate the relationship? A longitudinal approach

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Highlights

- Depression and FOMO are longitudinally linked with PSU via emotional reasons for smartphone use.
- The relationship between depression and PSU is partly moderated by "escape from negative emotions."
- The relationship between FOMO and PSU is partly moderated by "search for positive emotions.".

Abstract

In the present longitudinal study, we investigated whether reasons for smartphone use, such as "search for positive emotions" and "escape from negative emotions," can mediate the relationship between depression symptoms, fear of missing out (FOMO), and problematic smartphone use (PSU). In total, 309 smartphone users from Germany (M_{age} = 28.88, SD_{age} = 12.53) completed the longitudinal study's online survey at two measurement time points (baseline, T1; 10-month follow-up, T2). "Escape from negative emotions" at T1 partly mediated the positive association between depression symptoms at T1 and PSU at T2. "Search for positive emotions" at T1 partly mediated the relationship between FOMO at T1 and PSU at T2. The present results showed that the relationship between psychopathological phenomena (depression symptoms, FOMO) and PSU could depend on reasons for smartphone use ("search for positive emotions," "escape from negative emotions"). This stresses the importance of motives underlying smartphone use. The knowledge gained supports the understanding of mechanisms that could contribute to the development of PSU.

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1. Introduction

Smartphone use has become a crucial part of daily life worldwide over the past 15 years. It enables accessible, fast, cost-effective communication, receiving news, organizing, and facilitating processes. Smartphone use can contribute to work processes (Bian et al., 2020) and education (Ubben et al., 2023). However, there is also evidence that smartphone use may become "problematic," which means that individuals show symptoms similar to substance-related dependencies such as withdrawal, craving, or failure to fulfill social or work-related tasks (Billieux et al., 2015). Billieux (2012) defined problematic smartphone use (PSU) as the incapacity to regulate one's smartphone use, leading to negative consequences. This behavior can cause lower work efficiency and productivity (Duke & Montag, 2017) and decrease life satisfaction and well-being (Fischer-Grote et al., 2020). Children and young people seem affected, leading to future concerns about psychological and economic well-being (Sohn et al., 2019). PSU is also associated with parental phubbing, which means that parents ignore children who are focused on their phones (Wang et al., 2023). Considering potential triggering factors, negative affectivity has been found to predict social media use and the development of PSU positively; moreover, it negatively predicted psychological well-being (Sanchez-Fernandes & Borda-Mas, 2023).

Despite its adverse effects, PSU has not yet been acknowledged as an official diagnosis in the International Classification of Diseases and Related Health Problems (ICD-11; World Health Organization, 2018). Thus, understanding the predisposing and triggering conditions of PSU is still necessary to offer adequate prevention and treatment options. Until now, research lacks evidence of effective therapeutic interventions to handle PSU (Liu et al., 2022). Available research has already shown that PSU is positively associated with certain psychopathological phenomena such as depression and anxiety symptoms (Elhai et al., 2017; Rozgonjuk et al., 2018) as well as fear of missing out (FOMO) (Wolniewicz et al., 2018). FOMO is the constant will to stay informed about other people's doings and the anxiety to miss rewarding experiences they might have (Przybylski et al., 2013). FOMO is positively connected with social connection (Roberts & David, 2019) but also with sleep deprivation, loss of productivity, and focus (Hayran & Anik, 2021). Younger people, singles, and those with greater social comparison inclinations are significantly affected (Eitan & Gazit, 2024). Nevertheless, whether and how far the above factors are mediated by further variables, such as reasons for smartphone use, has not been investigated.

Smartphones may be used for various reasons, such as social media, news reading, or social influence (Busch et al., 2021). Other reasons might be from a willingness to cope with daily living and technological affinity (Seifert & Schelling, 2015) to alleviating boredom, habituation, and feeling secure while away from familiar settings (Fullwood et al., 2007). Other studies have revealed that users are afraid of missing messages or have difficulties in self-regulation (Yang et al., 2021). Previous research has shown that more depressed people, people with higher FOMO and PSU, tend to escape from negative emotions while using their smartphones (Stirnberg et al., 2024). Similar results have been found by Kim and colleagues (2017).

Reasons for other problematic patterns of behavior, such as alcohol use, have been investigated a long time ago (Cooper et al., 1995). The authors found out that people consume alcohol mainly to regulate positive and negative emotions. These reasons have not been applied to PSU yet. Nonetheless, it might be expected that the development of PSU can be associated with reasons for smartphone use, such as "search for positive emotions" or "escape from negative emotions," as well as psychopathological phenomena such as depression symptoms and FOMO. These associations are further explored in this study better to understand the predisposing and triggering conditions of PSU.

2. Method

2.1. Research Design

In the present study, we investigate the potential mediating role of smartphone use and the reasons for the association between psychopathological phenomena such as depression symptoms and FOMO and PSU with a longitudinal design—two measurement points (T1 and T2) with a 10-month interval. The longitudinal design is chosen to understand experiences across time and to identify facilitators and inhibitors of PSU (Tuthill et al., 2020). Table 1 gives an overview of the four hypotheses. Recent cross-sectional studies have demonstrated a positive association between depressive symptoms and problematic smartphone use (Arrivillaga et al., 2023; Carter et al., 2024). Therefore, a positive relationship between PSU (T2) and depression symptoms (T1) is expected in the current study (Hypothesis 1a).

Table 1. Hypotheses and expected direction of correlation

	PSU (T2)
(1a) depression symptoms (T1)	r > .000
(1b) "escape from negative emotions" (T1)	r > .000
(1c) FOMO (T1)	r > .000
(1d) "Search for positive emotions" (T1)	r > .000

Notes. T1 = first measurement, T2 = second measurement, r = correlation coefficient

Hypothesis 1b states that PSU (T2) positively correlates with "escape from negative emotions" (T1). This hypothesis is based upon recent results from Arrivillaga and colleagues (2023), who found a positive association between PSU and higher impulse control dysregulation.

In a recent study, a positive link between PSU and FOMO has been found for a single-time measurement (Wang et al., 2023). In this study, we explore this correlation over a 10-month interval. Thus, PSU (T2) is hypothesized to positively correlate with FOMO (T1) (Hypothesis 1c). Lastly, it is hypothesized that PSU (T2) positively correlates with the "search for positive emotions" (T1) (Hypothesis 1d). This hypothesis is based upon existing research stating that PSU is predicted by reward responsiveness (Kwak & Kim, 2023) and is also associated with emotion dysregulation and psychological distress (Squires et al., 2021). Again, these results have not yet been investigated using longitudinal data.

The following two research questions are investigated in the present longitudinal study:

Research Question (RQ) 1: Can "escape from negative emotions" at T1 as a reason for smartphone use mediates the relationship between depression at T1 and problematic smartphone use at T2?

RQ2: Can "search for positive emotions" at T1 as a reason for smartphone use mediate the relationship between FOMO at T1 and problematic smartphone use at T2?

2.2. Participants, Procedure, and Ethical Considerations

The present study is characterized by a longitudinal design. Data was assessed in September 2021 (= T1) and June 2022 (= T2). At T1, individuals were invited by e-mail to participate in the first online survey. All of them were current or former students of a large university in the Ruhr region in Germany and had provided consent to be contacted for research purposes. They could participate voluntarily and were not compensated. The requirement to participate was possessing a smartphone and its daily use. At T2, participants who had finished the first survey were contacted again via e-mail to participate in the second online survey.

Both surveys were completed by 309 participants (78% women; M_{age} (SD_{age}) = 28.88 (12.53), range: 18-80). Frequency distribution by age group shows an asymmetric, right-skewed distribution. Two-thirds (67%) of the participants were students, 27% were employees, and 6% were unemployed or retired. The responsible Ethics Committee approved the implementation of the present study. All participants were instructed correctly and gave informed consent online. An a priori power analysis (G*Power program, version 3.1) was conducted, which showed that the sample size is sufficient for valid results (power > .80, α = .05, effect size f^2 = 0.15; cf., Mayr et al., 2007).

2.3. Measures

Depression symptoms. The German version (Nilges & Essau, 2015) of the depression subscale of the Depression Anxiety Stress Scales 21 (DASS-21; Lovibond & Lovibond, 1995) was used to assess depression symptoms with seven items (e.g., "I could not seem to experience any positive feeling at all"). Items were rated on a 4-point Likert-type scale (0 = did not apply to me at all, 3 = applied to me very much or most of the time). The current scale reliability at T1 was α = .90.

Reasons for smartphone use. Following Stirnberg et al. (2024), participants rated how often they use their smartphone to search for positive emotions and how often they use it to escape negative emotions ("How often do you use your smartphone to search for positive emotions?" ("How often do you use your smartphone to escape from negative emotions?") on a 5-point Likert-type scale (1 = very rarely, 5 = very often).

Problematic smartphone use. The short version of the Bergen Social Media Addiction Scale (BSMAS; original version: Andreassen et al., 2017; German language version: Brailovskaia et al., 2020) includes six items to assess addictive social media use. Following Brailovskaia et al. (2023), the term "social media" was replaced

by "smartphone" (e.g., "I spend a lot of time thinking about smartphones or planning how to use it") in the current study. Items were rated on a 5-point Likert-type scale (1 = very rarely, 5 = very often). The higher the sum score, the higher the level of problematic smartphone use. The current scale reliability at T2 was α = .85.

Fear of missing out. The level of FOMO was measured by the ten items of the Fear of Missing Out Scale (original version: Przybylski et al., 2013; German language version: Rozgonjuk et al., 2020). Items were rated on a 5-point Likert-type scale (1 = not at all true of me, 5 = extremely true of me) (e.g., "I fear others have more rewarding experiences than me"). High sum scores indicate a high level of FOMO. The current scale reliability at T1 was α = .84.

2.4. Data Analysis

SPSS 27 and the macro PROCESS version 3.5.3 (Hayes & Rockwood, 2020) were used for statistical analyses. First, descriptive statistics were run. Second, bivariate zero-order correlations between the variables were calculated to assess their relationship. Third, two mediation models (PROCESS: model 4) were calculated. In the first model, depression symptoms at T1 served as the predictor, the smartphone use reason "escape from negative emotions" at T1 served as the mediator, and PSU at T2 served as the outcome. In the second model, FOMO at T1 was used as the predictor, the smartphone used reason "search for positive emotions" at T1 as the mediator, and PSU at T2 as the outcome. Age and gender were included as covariates in both models. In both mediation models, the total effect (c) referred to the relationship between predictor and outcome, the path of the predictor to the mediator was referred to as a, and the path of a mediator to the outcome as b. The indirect effect (ab) was described by the combined effect of paths a and b. Path c' represented the direct effect of the predictor on outcome after including the mediator in the model. The bootstrapping procedure (sample of 10.000) assessed the mediation effect and provided percentile bootstrap confidence intervals (95% CI).

3. Results

3.1 Descriptive Analysis

The descriptive statistics of the investigated variables and their correlations are shown in Table 2. Depression symptoms at T1 were significantly positively correlated with PSU at T2 and with "escape from negative emotions" at T1. "Escape from negative emotions" at T1 was significantly positively correlated with PSU at T2. FOMO at T1 was significantly positively correlated with the "search for positive emotions" at T1 and PSU at T2. "Search for positive emotions" at T1 was significantly positively correlated with PSU at T2 (see Table 2).

Table 2. Descriptive statistics and correlations of the investigated variables.

	M (SD)	Min-Max	(1)	(2)	(3)	(4)	(5)
(1) Depression at T1	4.64 (4.61)	0-21	-	.477	.337	.298	.317
(2) Escape from negative emotions at T1	2.22 (1.20)	1-5		-	.543	.452	.596
(3) Search for positive emotions at T1	2.78 (1.04)	1-5			-	.415	.392
(4) FOMO at T1	24.42 (7.40)	10-45				-	.540
(5) Problematic smartphone use at T2	13.58 (5.09)	6-29					-

Notes. N = 309; M = mean, SD = standard deviation, Min = Minimum, Max = Maximum. All correlations were significant at the 0.001 level.

3.2. Findings of Mediation Analyses

The first mediation analysis showed that "escape from negative emotions" at T1 partly mediated the positive association between depression symptoms at T1 and PSU at T2. The primary relationship between depression symptoms at T1 and PSU at T2 was significant (total effect, c: p <.001). The link between depression symptoms at T1 and "escape from negative emotions" at T1 was also significant (path a: p <.001). The relationship between "escape from negative emotions" at T1 and PSU at T2 was also significant (path b: p < .001). The indirect effect (ab) was significant (b = .186, SE = .041 95% CI [.111, .269]). The relationship between depression symptoms at T1 and PSU at T2 was still significant after the inclusion of "escape from negative emotions" at T1 in the model (direct effect c': p = .035). However, the total effect was higher than the direct effect (see Figure 1).

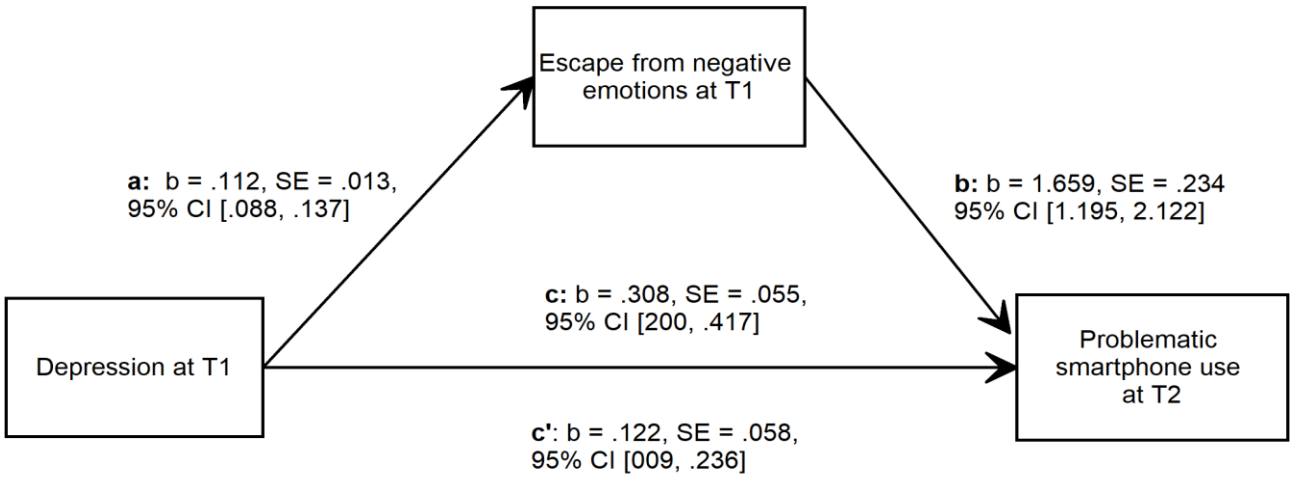

Figure 1. The mediation model includes depression at T1 (predictor), escape from negative emotions at T1 (mediator), and problematic smartphone use at T2 (outcome). ***Notes.*** *N = 309; c = total effect, c' = direct effect; b: standardized regression coefficient, SE: standard error, CI: confidence interval.*

According to the second mediation analysis, "search for positive emotions" at T1 partly mediated the relationship between FOMO at T1 and PSU at T2. The primary relationship between FOMO at T1 and PSU at T2 was significant (total effect, *c*: $p < .001$). The link between FOMO at T1 and "search for positive emotions" at T1 was also significant (path *a*: $p < .001$). The relationship between "search for positive emotions" at T1 and PSU at T2 was also significant (path *b*: $p = .001$). The indirect effect (*ab*) was also significant (*b* = .036, SE = .014, 95% CI [.012, .068]). The link between FOMO at T1 and PSU at T2 was significant after the inclusion of "search for positive emotions" at T1 in the model (direct effect *c*': $p < .001$). The total effect was higher than the direct effect (see Figure 2).

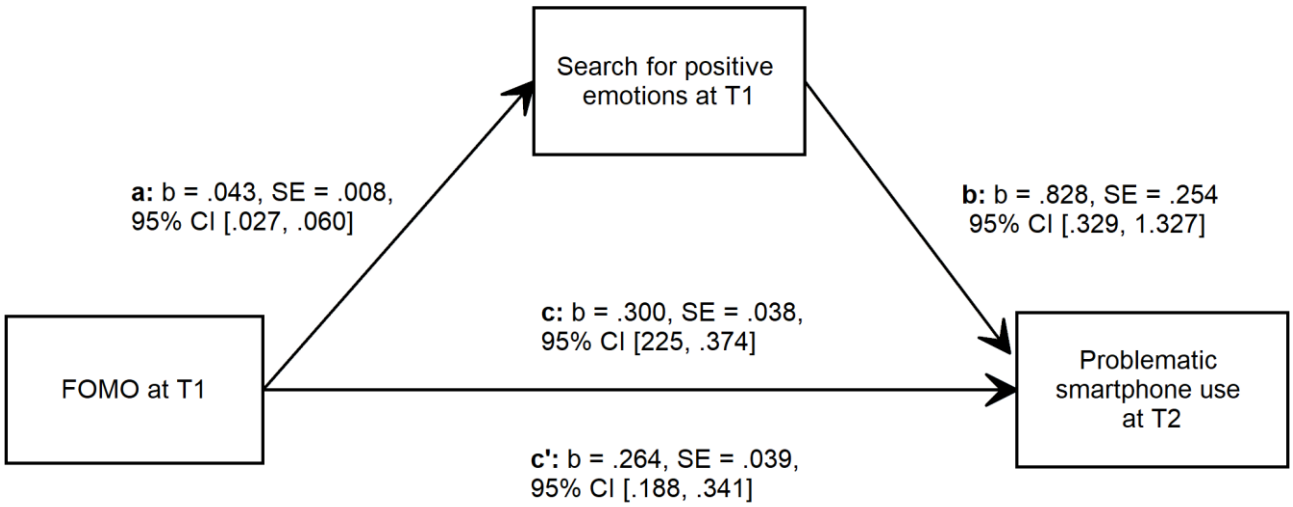

Figure 2. The mediation model includes FOMO at T1 (predictor), search for positive emotions at T1 (mediator), and problematic smartphone use at T2 (outcome). Notes. N = 309; c = total effect, c' = direct effect; b: standardized regression coefficient, SE: standard error, CI: confidence interval.

4. Discussion

Smartphone usage is omnipresent and on the rise. PSU has been shown to have an impact on people's mental health. This longitudinal study has focused on its links with psychopathological phenomena and reasons for smartphone use. People with difficulties regulating emotions are at higher risk of developing PSU (Horwood & Anglim, 2021; Squires et al., 2021). PSU is positively associated with mental health problems, alcohol consumption, impulsivity, and low academic performance (Grant et al., 2019). Little is known about potential antecedents apart from loneliness and deficits in self-regulation (Mahapatra, 2019).

4.1. Relationship between Depression Symptoms and Problematic Smartphone Use

The significantly positive correlation between depression symptoms (T1) and problematic smartphone use (T2) goes along with previous research (Cheng & Meng, 2021; Elhai et al., 2020) and can be explained by the maladaptive emotion regulation system in depressed people (Ho et al., 2014; Young et al., 2019). Participants who were more depressed at T1 showed more problematic smartphone use at T2. Hypothesis 1a can be confirmed.

The significantly positive relationship between "escape from negative emotions" (T1) and problematic smartphone use (T2) also goes along with the former results (Wei et al., 2021). It helps to understand the importance of smartphone use when considering the development and treatment of PSU. Participants who used their smartphone to "escape from negative emotions" at T1 showed more problematic smartphone use 10 months later. Hypothesis 1b has also been confirmed. In former research, a positive link between PSU and escapism has been found (Akyol et al., 2021), which is the result of the present study. In a recent study, it has been demonstrated that about half of one's smartphone use may be for emotion regulation (Shi et al., 2023).

The significantly positive link between FOMO (T1) and PSU (T2) means that people afraid of missing out tend to develop a more problematic smartphone use pattern 10 months later. This result confirms Hypothesis 1c. In a former study, FOMO was shown to predict PSU (Tugtekin et al., 2020). Other research confirmed the positive association between FOMO and PSU (Hudecek et al., 2023; Elhai et al., 2016).

A significantly positive correlation between the "search for positive emotions" at T1 and PSU (T2) has been found. Participants who used their smartphone to feel positive developed a more problematic smartphone use behavior 10 months later. This finding goes with operant conditioning (Skinner, 1971): Positive emotions make people feel better, a rewarding result of the individual's behavior. Thus, the behavior is shown more frequently. This finding is in accordance with former research, which has shown that people use their smartphones to get rewarded, validated, and pleasured (Mostyn et al., 2024). Hypothesis 1d is also confirmed.

4.2. Research Questions 1-2

The partly mediated positive association between depression symptoms (T1) and problematic smartphone use (T2) by the mediator variable "escape from negative emotions" as a reason for smartphone use means that even without the inclusion of the mediator variable, depression symptoms (T1) are positively linked with problematic smartphone use (T2). This goes along with existing research (Elhai et al., 2020; Jin et al., 2021; Pereira et al., 2020). Interestingly, in this study, the longitudinal link between depression symptoms (T1) and problematic smartphone use (T2) that is partly mediated by "escape from negative emotions" as a reason for smartphone use is shown.

Similarly, fear of missing out (T1) and problematic smartphone use (T2) stay positively correlated, whether "search for positive emotions" as a reason for smartphone use is included in the mediation model or not (partial mediation). Former research has shown the predictive effect of FOMO on problematic smartphone use (Gezgin, 2018). In the present study, this link remains positive if people use their smartphone to "search for positive emotions" as a reason for smartphone use. The mediator variable can explain some variance of the positive effect in the model. This contributes to the new finding that there seems to be a longitudinal association between FOMO and problematic smartphone use. This can help consider another potential risk factor for the development of PSU, especially for people who use their smartphone to "search for positive emotions."

4.3. Study Impact and Contribution

First, our results help to understand that depression symptoms might be considered a predominating risk factor for the development of PSU, mainly if people use their smartphones to escape from negative emotions. This determination can help to improve existing treatment plans for depression symptoms (for example, to investigate depressive people's reasons for smartphone use and use intensity) as well as to prevent further development of PSU. In this field, future research should also focus on protective factors within depressive people that make them more resistant to the development of PSU.

Second, we showed a longitudinal positive association between FOMO (T1) and problematic smartphone use (T2). This can help consider another potential risk factor for developing PSU, especially for people who use their smartphones to "search for positive emotions." Consequently, our study underlines that it is essential to include the investigation of FOMO and reasons for smartphone use when assessing and diagnosing PSU. This contributes to the former research of Ryding and Kuss (2020) on the assessment of PSU. Third, despite the partial mediation effects, the importance of assessing reasons for smartphone use at an early stage (T1) is

stressed by this study to better understand the potential development of PSU (T2). This goes along with previous research (Stirnberg et al., 2024).

4.3. Limitations

Despite the study's novel and practically relevant features, some limitations should be considered when interpreting the present findings. Since all four Hypotheses (1a-d) have been investigated by correlation analysis, the results cannot be interpreted causally. Further experimental research is needed. Since we conducted a longitudinal design, confounding intrapersonal variables might have arisen over time and are difficult to control (Streeter et al., 2017). It is doubtful whether results can be generalized since two-thirds of our participants were students and three-quarters were female. In an upcoming study, it is desirable to assess other age groups and realize a more balanced gender ratio. Data were collected in Germany only. Expanding this study to different countries to examine similarities and differences would be interesting. Despite the anonymous online setting, people might have answered in a socially desirable manner, especially regarding questions about mental health (Henderson et al., 2012). It would also be essential to assess people who are already affected by a psychological disorder to see whether there are differences between those two groups. In this study, it has not been differentiated between participants with psychological disorders and those without. Due to the response format of a self-report, answers might have been influenced by the same-source bias (Conway & Lance, 2010). We tried to minimize its effect with adequate study length and proper measurements. Future research could include other means of assessment, such as interviews or behavior observations.

5. Conclusion & Practical Implications

In conclusion, PSU is associated with specific antecedents such as depressive symptoms, FOMO, and emotionally regulating reasons for smartphone use over 10 months. The present results are in line with the findings of other studies that focused on problematic substance use, e.g., alcohol (Hammerton et al., 2023; Riordan et al., 2023) or problematic media consumption (e.g., gaming). The present results can help detect the development of psychopathological phenomena early and offer adequate prevention and treatment options. This seems necessary in times of rising costs in economic and health systems due to psychological disorders. Our results highlight the importance of future research on this topic, including probable experimental designs, clinical trials, and suitable prevention and treatment programs. What is more, the practical implications of our study include raising awareness of the potential risks of smartphone overuse and the need for early school-implemented education on "healthy" smartphone use. Csibi et al. (2021) demonstrated that preschool children and young adults are at risk for developing PSU. Future research could pursue a pathway to a potential sweet spot of smartphone use associated with certain intrapersonal features such as personality traits and mental health status.

Statement of Researchers

Researchers' contribution rate statement:
Study design: JS, JM, LP, JB; Literature search: JS; Statistical analysis: JS; Writing- original draft: JS; Data collection: JM, JB; Data preparation: JS, JB; Writing- editing & review: JM, LP, JB.

Conflict statement:
My co-authors and I do not have any interests that might be interpreted as influencing the research. On behalf of all authors, I state there is no conflict of interest.

Data Availability Statement:
The data supporting this study's findings are available on request from the corresponding author. However, the data are not publicly available due to privacy or ethical restrictions.

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Ethical Considerations:
All authors state their compliance with the Code of Ethics of the World Medical Association (Declaration of Helsinki). The study has received ethical approval from the responsible Ethics Committee of Ruhr University Bochum (Prof. Dr. Robert Kumsta), approval number 636. The rights of the human subjects participating in our research were protected.

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