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ORIGINAL ARTICLE

Morningness-Eveningness and Problematic Online Activities

Adrien Rigó[1] · István Tóth-Király[2] · Anna Magi[1] · Andrea Eisinger[1] · Mark D. Griffiths[3] · Zsolt Demetrovics[1,4]

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Abstract
Online activities and problematic online behaviors have recently emerged as important research topics. However, only a few studies have explored the possible associations between these behaviors and morningness-eveningness. The authors examined whether eveningness predicts these distinct problematic online behaviors differently and directly or via mediators. The associations between eveningness and three different problematic online behaviors (problematic Internet use, problematic online gaming, and problematic social media use) were explored among a large sample of Hungarian young adults ($N = 1729$, 57.2% female, $M_{age} = 22.01$, $SD_{age} = 1.97$) by using a self-report survey. Depression and the time spent engaging in online activities were assessed as possible mediators. The effects of age and sex were controlled for. Using structural equation modeling, the results supported the association between eveningness and the higher risk for all three problematic online behaviors and highlighted that these associations were mediated by depressive mood and time spent on the activities. In addition, eveningness also predicted PIU directly. Eveningness is a risk factor for problematic online behaviors not only because of the higher amount of time spent on the activities but also because of the worse mood associated with eveningness. The results highlight that it is important to examine the different types of online activity separately and explore the role of diverse risk factors, among them morningness-eveningness.

Keywords Morningness-eveningness · Problematic Internet use · Problematic online gaming · Problematic social media use · Depressive mood · Time engagement

✉ Adrien Rigó
rigo.adrien@ppk.elte.hu

[1] Institute of Psychology, ELTE Eötvös Loránd University, Izabella Utca 46, Budapest 1064, Hungary

[2] Substantive-Methodological Synergy Research Laboratory, Department of Psychology, Concordia University, Montreal, Canada

[3] International Gaming Research Unit, Psychology Department, Nottingham Trent University, Nottingham, UK

[4] Centre of Excellence in Responsible Gaming, University of Gibraltar, Gibraltar, Gibraltar

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In recent years, online activities, particularly online gaming and social media use, and their problematic manifestations have emerged as important topics of research (Blachnio et al., 2015; Laconi et al., 2018; Sussman et al., 2018) and public health concerns. *Problematic Internet use* (PIU) has become a global social issue, as its prevalence, particularly among adolescents, is steadily increasing worldwide (Al-Khani et al., 2021; Laconi et al., 2018; Mihara et al., 2016; Spada, 2014). There is no single definition of PIU, but many scholars view PIU as an umbrella term that integrates the unhealthy use of many online activities. For instance, according to recent reviews focusing on conceptualization and measurement, PIU refers to all Internet-related behaviors that are potentially addictive (Fineberg et al., 2018; Moretta et al., 2022). Problematic online gaming, gambling, shopping, pornography viewing, email checking, instant messaging, and social media use can all be examples (or subtypes) of PIU.

The topic of *problematic online gaming* (POG) and gaming disorder has also been extensively studied in the empirical literature, given that online gaming is one of the most popular online activities worldwide (Konrad, 2017; Montiel et al., 2021). After intensive scientific discussion, and based on its negative consequences and functional impairments identified in both empirical and clinical studies, gaming disorder was officially introduced to the eleventh revision of the International Classification of Diseases (ICD-11) in 2019 (Brand et al., 2020, 2019a, 2019b; Griffiths, 2022; King et al., 2019; Rumpf et al., 2018). Finally, a recent emerging online activity, *social media use*, has been playing an increasingly pivotal role in the lives of transitional age youth, leading to increased research on problematic social media use (PSMU). Because *Facebook* was the first popular social networking site, most research has focused on the characteristics of *Facebook* users and misusers (Blachnio et al., 2015; Orosz et al., 2016). However, other platforms (*Snapchat, Instagram, WhatsApp, Twitter, YouTube*, etc.) have become prevalent in recent years.

While POG and PSMU refer to overuse/problematic use in a specific activity domain of the Internet, PIU refers to individuals' more general online overuse (Brand et al., 2014; Davis, 2001) that is not captured by either POG or PSMU due to their specificity, warranting the scientific investigation of all three variables (Király et al., 2014). This idea has been confirmed by the empirical knowledge that has accumulated in recent years. To describe and characterize PIU, a comprehensive model is needed that conceptualizes higher-order mechanisms shared by different subtypes of PIU. At the same time, it is also important to understand the main differences between PIU subtypes which can related to the specific application, content, or other characteristics (Moretta et al., 2022).

Accumulated empirical knowledge has encouraged professionals to try to interpret PIU and its diverse correlates in complex models. Arguably the most complex of the recent models is the Interaction of Person-Affect-Cognition-Execution (I-PACE) model (Brand et al., 2019a, 2019b). This model proposes that PIU is the result of the interaction of psychological and neurobiological predisposing variables (e.g., impulsivity, depression), moderating variables (e.g., self-regulatory capacities, personality characteristics), and mediating variables (e.g., reduced inhibitory control) (Brand et al., 2019a, 2019b; Moretta et al., 2022). The model also draws attention to the fact that, beyond the general/common mechanisms, different predisposing factors can be identified in different types of addictive behaviors (or PIU subtypes).

The presence of theoretically meaningful associations between depression and problematic behaviors (i.e., PIU, POG, PSMU) has also been supported by the theory of compensatory Internet use (Kardefelt-Winther, 2014). This model proposes that problematic online behaviors might arise as a reaction to negative feelings, and individuals might "overuse" these activities with the purpose of generating compensatory positive emotions. Put

differently, people might use the Internet, and its different functions and applications, in an excessive way in order to escape from their negative emotions (e.g., depressive mood states). These theoretical propositions have all been supported by both cross-sectional studies (Liang et al., 2016; Mamun & Griffiths, 2019; Sussman et al., 2018) and longitudinal studies (e.g., Liang et al., 2016; Tóth-Király et al., 2021) highlighting the positive associations between depressive mood and various problematic online behaviors. For these reasons, the present authors explicitly considered depressive mood as a potential predictor of problematic online behaviors.

Apart from depressive mood, most studies emphasize that "time spent on the activity" contributes substantially to the development of these problematic behaviors, although the relationship is context-dependent (Griffiths, 2010). Indeed, the associations between problematic online behaviors and time spent on these activities tend to differ depending on the activity being focused on (Bőthe et al., 2021; Chak & Leung, 2004; Chen et al., 2020; Király et al., 2017; Tóth-Király et al., 2017). However, excessive online activity use, in and of itself, does not necessarily mean addiction. Therefore, it is not just the amount of time spent on these activities that are relevant, but, more importantly, the negative impact of the behavior on other areas of life. Studies have mainly concentrated on the duration of online activities, and only a few studies have focused on the temporal pattern of use (i.e., which period of the day or week the person does these activities) as a potentially relevant predictor (Griffiths et al., 2014; Laconi et al., 2018; Mihara et al., 2016; Triberti et al., 2018).

Problematic Online Activities and Morningness-Eveningness

Relatively little attention has been paid to a specific timing-related, chronobiological individual characteristic, namely, morningness-eveningness, even though the association between eveningness and other potentially risky, addictive behaviors (such as cigarette smoking, alcohol consumption, and drug use) is well-documented in the literature (Adan, 1994; Gau et al., 2007; Prat & Adan, 2011; Randler, 2008; Randler et al., 2016; Urbán et al., 2011). Morningness-eveningness is a personality trait that is related to a number of factors listed in the I-PACE model. It can be relevant not only because of the time spent engaging in (and the timing of) these online activities but also because several personality characteristics that are associated with eveningness (e.g., higher sensation seeking, impulsivity, higher emotional instability, higher risk for depressive mood, higher reward-sensitivity) have also proved to be risk factors for problematic online activities (Caci et al., 2005; DeYoung et al., 2007; Hasler et al., 2013; Jankowski, 2016; Simor et al., 2018; Tsaousis, 2010).

Few studies have explored the possible association between circadian preference and problematic online activities. Regarding PIU, evening-oriented individuals appear to be more prone to developing PIU even after controlling for Big Five personality characteristics, age, and gender based on a Turkish university sample (Randler et al., 2014). Researchers propose that greater emotional problems, more significant problems with the timing of sleep, and more Internet use in the evening hours can be responsible for the association (Alimoradi et al., 2019). Another study highlighted that the strength of the association between eveningness and compulsive Internet use severity was moderated by maternal protection and care among Taiwanese adolescents (Lin & Gau, 2013). Only one study examined the possible associations between circadian preference and POG (Vollmer et al., 2014)

and reported a similar result: eveningness was associated with POG even after controlling for age, gender, and Big Five personality characteristics.

In the field of *Facebook* use, a study by Blachnio et al. (2015) found that evening-oriented individuals use *Facebook* more intensively and are more involved in it than morning-oriented individuals. Considering the possible underlying mechanisms, individual/personality characteristics associated with eveningness (such as sociability, extraversion, sensation seeking, impulsivity, and thinking style) are proposed to be responsible for more intensive *Facebook* use (Blachnio et al., 2015). Compared to morning types (and in some cases to neither types as well), evening type university students expressed more positive attitudes towards *Facebook* and its different functions (e.g., maintaining existing relationships, passing the time, use for entertainment)(Ross et al., 2009) and used 12 of 16 *Facebook* features (photos, links, chat, etc.) more frequently (Horzum & Demirhan, 2017). Like Blachnio et al., the present authors posited that personality features associated with both eveningness and heavy *Facebook* use (e.g., extraversion, higher neuroticism, and lower conscientiousness) could be essential mediators, but none of the previous studies assessed and controlled the aforementioned characteristics. Similar results have been reported while investigating the relationship between eveningness, problematic mobile phone use, and smartphone dependence. More specifically, eveningness was significantly associated with problematic mobile phone use even after controlling for depressive symptoms (Toda et al., 2015) and in another study after controlling for the most influential personality predictor, low conscientiousness (Demirhan et al., 2016).

Based on the current data and models available, it is likely that there are complex interactions between morningness-eveningness and PIU (and subtypes of PIU), but more research is needed to delineate these. For instance, it is not known whether eveningness only acts directly, only through mediators, or through both (directly and indirectly).

The Goal of the Present Study

The present study explored the associations between morningness-eveningness and three problematic online behaviors (problematic Internet use, problematic online gaming, and problematic social media use) in a large sample of adolescents and young adults. The present study tested whether eveningness predicts problematic online behaviors directly or indirectly via mediators. Two possible mediators (depressive mood and time spent on these activities) were chosen based on the previous studies proposing that depressive mood and time spent engaged in the activities could be relevant mediators, even though their mediation effect has not been tested. Based on the aforementioned model, many other mediator/moderator variables could have been relevant to investigate. However, in the present study, as a first step, the present authors wanted to include variables that have well-documented relationships with both morningness-eveningness and PIU in the empirical literature. The study controlled for age and sex as these demographic characteristics have shown an association with morningness-eveningness; being a younger age (Roenneberg et al., 2004) and being male (Randler, 2007) predict higher eveningness. Finally, simultaneously focusing on three problematic behaviors allowed us to explore whether different patterns of associations can be identified between the different problematic online behavior and eveningness.

Methods

Participants and Procedure

The present study was part of a larger cross-sectional research project, "The Psychological and Genetic Factors of Addictive Behaviors (PGA) Study." The samples used for the present analyses were those in which circadian preference was also measured. Voluntary participants were recruited at college and university dormitories. Participants in these dormitories were systematically contacted by research assistants and were asked to complete self-report surveys. More details about the sampling and recruitment procedure are provided elsewhere (Kotyuk et al., 2018). The resulting sample size was 1729 in the present study (57.2% female), aged between 18 and 37 years (M_{age} = 22.01 years, SD_{age} = 1.97) (Table 1).

Measures

Problematic Internet Use

The six-item version of the Problematic Internet Use Questionnaire (PIUQ) (Demetrovics et al., 2016; Koronczai et al., 2011) was administered to assess problematic Internet use along the dimensions of obsession, neglect, and control disorder. Participants rated items (e.g., How often do you neglect household chores to spend more time online?) on a five-point scale (1 = never; 5 = always). Prior studies (Demetrovics et al., 2016; Koronczai et al., 2011) have supported this scale's factor structure and scale-score reliability. The PIUQ does not give any cut-off points because it is not a diagnostic questionnaire.

Problematic Online Gaming

The 12-item Problematic Online Gaming Questionnaire (Demetrovics et al., 2012; Pápay et al., 2013) was used to assess the six dimensions of problematic online gaming use (i.e., preoccupation, overuse, immersion, social isolation, interpersonal conflicts, and withdrawal). The "overuse" scale does not measure the amount of time spent on the activity but asks how much a person feels that they are spending more time than they should have been. Items (e.g., How often are you so immersed in gaming that you forget to eat? How often do the people around you complain that you are gaming too much?) were rated on a five-point scale (1 = never; 5 = always). Evidence supporting its psychometric properties has been reported elsewhere (Demetrovics et al., 2012; Pápay et al., 2013).

Problematic Social Media Use

The six-item Bergen Social Media Addiction Scale (Andreassen et al., 2012; Bányai et al., 2017) was used to assess problematic social media use in the preceding 12 months based on the addiction components model (Griffiths, 2005), including salience, tolerance, mood modification, withdrawal, relapse, and conflict. Participants responded to items (e.g., How often do you feel an urge to use social media more and more?) on a five-point scale (1 = never; 5 = always). Bányai et al. (Bányai et al., 2017) supported this measure's factorial validity and scale-score reliability. There is no consensus in the literature regarding the cut-off points of the scale (Stănculescu, 2022). However, it was not a problem in the present

Table 1 Demographic and online activity-related characteristics of the recruited sample ($N = 1729$)

Social-economic status	
Among the best	4 (0.2%)
Substantially higher than average	134 (7.8%)
Somewhat higher than average	547 (31.7%)
Average	782 (45.3%)
Somewhat below average	228 (13.2%)
Substantially below average	30 (1.7%)
Among the worst	1 (0.1%)
Highest education of the father	
Primary school or lower	54 (3.2%)
Vocational school	530 (30.9%)
High school	419 (24.4%)
Unfinished college or university	52 (3%)
College or university	603 (35.2%)
Highest education of the mother	
Primary school or lower	49 (2.8%)
Vocational school	249 (14.5%)
High school	591 (34.4%)
Unfinished college or university	41 (2.4%)
College or university	771 (44.8%)
Internet use	
None	4 (0.2%)
Less than 1 h	17 (1%)
1–2 h	163 (9.5%)
3–4 h	555 (32.2%)
5–6 h	491 (28.5%)
7–8 h	195 (11.3%)
More than 8 h	297 (17.2%)
Online gaming	
None	1186 (69.1%)
Less than 1 h	218 (12.7%)
1–2 h	189 (11%)
3–4 h	90 (5.2%)
5–6 h	15 (0.9%)
7–8 h	4 (0.2%)
More than 8 h	14 (0.8%)
Social media use	
None	28 (1.6%)
Less than 1 h	240 (13.9%)
1–2 h	521 (30.2%)
3–4 h	457 (26.5%)
5–6 h	248 (14.4%)
7–8 h	83 (4.8%)
More than 8 h	150 (8.7%)

Note. Missing data are not included in the table and in the summation of percentages

analyses, as the authors wanted to know the strength of the relationship between the variables. Therefore, pathological, at-risk, and non-risk groups were not identified—the total score was used.

Time Spent Engaging in Online Activities

For all three problematic activities, participants were asked to estimate the average amount of time they spent on these activities on an average day in the preceding month (Table 1), and the name of this variable was termed 'time engagement'. Participants responded on a seven-point ordinal scale (1 = none; 2 = less than 1 h; 3 = 1–2 h; 4 = 3–4 h; 5 = 5–6 h; 6 = 7–8 h; 7 = more than 8 h). As no clearly recommended instrument was found in the literature measuring the amount of time spent on the Internet (and on other more specific online activities), the present study used this self-report method. Although this approach is not without bias, it is common practice in research (Alshakhsi et al., 2022).

Morningness-Eveningness

The five-item reduced Horne-Östberg Morningness-Eveningness Questionnaire (Adan & Almirall, 1991; Urbán et al., 2011) was administered to assess the preference for rising time, peak time, retiring time, morning freshness, and self-evaluation of circadian preference. Participants responded to items (e.g., At approximately what time of day do you usually feel your best?) on a five-point scale with higher scores referring to the preference of late rising time, late peak time, and late retirement time. The factorial and construct validity of the scale have been reported by Urbán et al. (2011).

Depressive Symptoms

Depressive mood and the level of depressive symptoms were assessed with the 10-item Center of Epidemiological Studies Scale (Radloff, 1977). Participants responded to items (e.g., During the past week…. I was bothered by things that usually don't bother me. I felt that everything I did was an effort) on a four-point scale (1 = rarely or never; 4 = most of the time). The CES-D-10 is a reliable and valid measure of depression in a volunteer sample. No remarkable evidence of invariance and item discrimination bias has been identified across gender, age, race, language, and ethnic groups. The one-factor structure and the scale's construct validity have been supported (Björgvinsson et al., 2013; El-Den et al., 2018; Mohebbi et al., 2018).

Statistical Analysis

Statistical analyses were conducted using Mplus 8.2 (Muthén & Muthén, 1998) while relying on the weighted least squares mean- and variance-adjusted estimator more suitable to the ordinal nature of Likert scales used in this study (Finney & DiStefano, 2013). The small amount of missing data (0 to 5.67%, $M = 1.85\%$, $SD = 2.21\%$) was handled with default algorithms implemented in Mplus for the WLSMV estimation (Asparouhov & Muthén, 2010). A preliminary measurement model was estimated to verify the psychometric properties of the scales using a confirmatory factor analytic (CFA) approach, whereby scale items were loaded on their corresponding latent factors, and the factors were allowed to correlate with one another. One *a priori* correlated uniqueness was included in this model

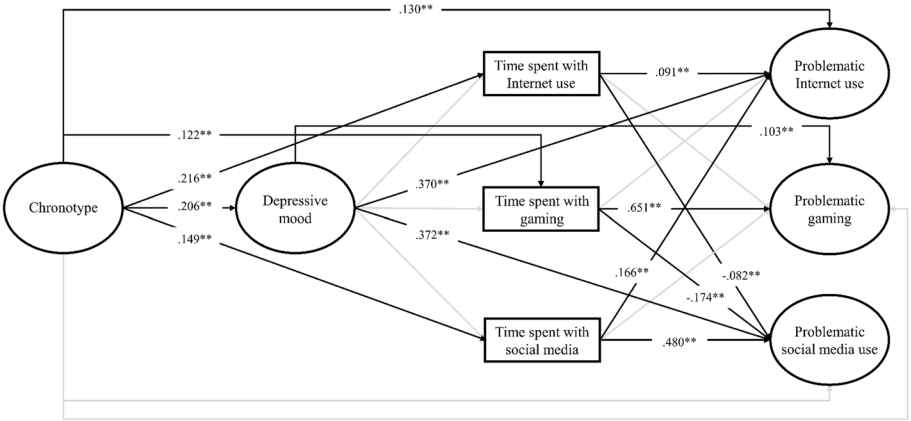

Fig. 1 Standardized parameter estimates from the examined model. Note. *$p < .05$; **$p < .01$; Ovals reflect latent variables, while rectangles reflect manifest variables. Directional arrows represent predictive paths. The measurement part of the model whereby the observed items are used to define latent variables and correlations between the variables is not shown to maximize clarity. Control variables are not included on the figure for the sake of clarity. Among the control variables, being male predicted problematic gaming ($\beta = -.218$, $p < .001$) and time spent on gaming ($\beta = -.413$, $p < .001$); being female predicted depressive mood ($\beta = .126$, $p < .001$) and time spent on social media ($\beta = .188$, $p < .001$); and age positively predicted time spent on internet use ($\beta = .111$, $p < .001$) and negatively predicted time spent on social media ($\beta = -.081$, $p < .001$). Other control variable effects were not statistically significant

to account for the negative-wording effect between two items belonging to the depressive mood factor (Marsh et al., 2010). The main analyses involved estimating the proposed model (see Fig. 1), in which the possible effect of age and sex was controlled. To test indirect associations between eveningness and problematic behaviors, following the recommendations by Preacher and Hayes (2008), a total of 5000 bootstrap replication samples were requested, and the indirect mediation effects were considered statistically significant if the 95% confidence intervals excluded the value of zero.

The models were interpreted following standard goodness-of-fit indices (Marsh et al., 2005): the comparative fit index (CFI; ≥ 0.95 excellent, ≥ 0.90 adequate), the Tucker–Lewis index (TLI; ≥ 0.95 excellent, ≥ 0.90 adequate), and the root-mean-square error of approximation (RMSEA; ≤ 0.06 adequate, ≤ 0.08 excellent) with its 90% confidence interval (90% CI). Finally, model-based omega (ω) composite reliability indices were calculated (McDonald, 1970).

Ethics

The study procedures were carried out following the Declaration of Helsinki and were approved by the Scientific and Research Ethics Committee of the Hungarian Medical Research Council. All participants were informed about the study, and all provided written informed consent. The heads of the participating high school and universities were informed beforehand, and parental consent was also obtained for those younger than 18 years of age (see Kotyuk et al. [2018] for more details).

Table 2 Descriptive statistics, scale-score reliability, and latent correlations between the examined variables

	Range	M	SD	α	1	2	3	4	5	6	7	8	9
1. Problematic Internet use†	1-5	1.95	0.63	.819	—								
2. Problematic gaming†	1-5	1.33	0.54	.915	.318**	—							
3. Problematic social media use†	1-5	1.60	0.63	.817	.755**	.002	—						
4. Eveningness†	1-5	3.32	0.65	.671	.247**	.188**	.078*	—					
5. Depressive mood†	0-3	0.98	0.48	.759	.419**	.077*	.416**	.188**	—				
6. Time spent on the internet	1-7	4.91	1.27	—	.241**	.235**	.141**	.230**	.063*	—			
7. Time spent on gaming	1-7	1.60	1.08	—	.089*	.754**	-.204**	.180**	-.014	.268**	—		
8. Time spent on social media	1-7	3.87	1.45	—	.272**	.003	.471**	.129**	.091**	.508**	.025	—	
9. Sex	0-1	—	—	—	.058	-.488**	.236**	-.141**	.099**	-.087**	-.424**	.182**	
10. Age	18-37	22.01	1.97	—	-.020	.031	-.037	.017	-.024	.120**	.015	-.104**	-.134**

Note. *$p < .05$; **$p < .01$; †, fully latent variables; *M*, mean; *SD*, standard deviation; α, Cronbach's alpha; time spent on the three online activities were assessed as 1 = none; 2 = less than 1 h; 3 = 1–2 h; 4 = 3–4 h; 5 = 5–6 h; 6 = 7–8 h; 7 = more than 8 h; sex was coded as 0 = male, 1 = female. Descriptive statistics and scale-score reliability is based on observed scores, whereas correlations are based on latent variables

Results

The fit of the preliminary measurement model was adequate ($\chi^2 = 4680.837$, df = 808, CFI = 0.932, TLI = 0.927, RMSEA = 0.053 [90% CI 0.051, 0.054]). Parameter estimates associated with this model are reported in the online supplements. These results demonstrated well-defined and reliable factors for problematic Internet use (λ = 0.555 to 0.834; ω = 0.890), problematic online gaming (λ = 0.828 to 0.922; ω = 0.974), problematic social media use (λ = 0.666 to 0.835; ω = 0.883), depressive mood (λ = -0.565 to 0.748; ω = 0.811), and morningness-eveningness (λ = 0.493 to 0.822; ω = 0.756). Descriptive statistics, scale-score reliabilities, and latent factor correlations are reported in Table 2. Correlations were small to moderate[1] in magnitude (Cohen, 1988). They were in line with expectations: eveningness positively correlated with problematic Internet use, problematic gaming, problematic social media use, depressive mood, and time spent engaging in all three online activities. Depressive mood positively correlated with all three problematic behaviors and time spent on the Internet and social media (but not time spent on gaming). Interestingly, the correlation was not statistically significant between problematic gaming and problematic social media use, nor between time spent gaming and time spent using social media. These results suggest that the two online behaviors should be considered distinct with little-to-no overlap between them.

The hypothesized path model had good fit ($\chi^2 = 5178.043$, df = 993, CFI = 0.933, TLI = 0.927, RMSEA = 0.049 [90% CI 0.048, 0.051]). Parameter estimates, which were small to moderate in magnitude, are reported in Table 3 (also see Fig. 1), showing a complex interplay between the variables. More specifically, problematic Internet use was positively predicted by time spent on the Internet and social media, depressive mood, and eveningness. Problematic gaming was predicted by time spent on gaming, being male, and depressive mood. Problematic social media use was positively predicted by time spent on social media, being female, and depressive mood, but was negatively predicted by time

[1] Correlation coefficients as effect sizes were evaluated according to thresholds established by Cohen (1988): correlations of $r = .10–.30$ were considered small, .30–.50 were considered medium, and over .50 were considered large.

Table 3 Parameter estimates from the path model

Predictor	Outcome	*b* (SE)	*β* (SE)
Time spent on the Internet	Problematic Internet use	.103 (.038)**	.091 (.034)**
Time spent on gaming	Problematic Internet use	.063 (.043)	.060 (.040)
Time spent on social media	Problematic Internet use	.186 (.038)**	.166 (.032)**
Sex	Problematic Internet use	.101 (.067)	.043 (.028)
Age	Problematic Internet use	− .001 (.013)	− .002 (.021)
Depressive mood	Problematic Internet use	.420 (.043)**	.370 (.032)**
Eveningness	Problematic Internet use	.151 (.034)**	.130 (.028)**
Time spent on the Internet	Problematic gaming	.054 (.062)	.035 (.040)
Time spent on gaming	Problematic gaming	.941 (.056)**	.651 (.024)**
Time spent on social media	Problematic gaming	− .005 (.053)	− .003 (.034)
Sex	Problematic gaming	− .709 (.085)**	− .218 (.026)**
Age	Problematic gaming	− .009 (.015)	− .011 (.019)
Depressive mood	Problematic gaming	.161 (.040)**	.103 (.026)**
Eveningness	Problematic gaming	.022 (.050)	.013 (.031)
Time spent on the Internet	Problematic social media use	− .103 (.045)*	− .082 (.036)*
Time spent on gaming	Problematic social media use	− .204 (.042)**	− .174 (.034)**
Time spent on social media	Problematic social media use	.606 (.047)**	.480 (.030)**
Sex	Problematic social media use	.095 (.073)	.036 (.028)
Age	Problematic social media use	.026 (.014)	.039 (.021)
Depressive mood	Problematic social media use	.472 (.046)**	.372 (.030)**
Eveningness	Problematic social media use	.001 (.043)	.001 (.033)
Depressive mood	Time spent on the Internet	.030 (.030)	.029 (.030)
Eveningness	Time spent on the Internet	.224 (.032)**	.216 (.029)**
Sex	Time spent on the Internet	− .093 (.057)	− .044 (.027)
Age	Time spent on the Internet	.058 (.011)**	.111 (.020)**
Depressive mood	Time spent on gaming	.003 (.034)	.003 (.031)
Eveningness	Time spent on gaming	.136 (.036)**	.122 (.032)**
Sex	Time spent on gaming	− .931 (.067)**	− .413 (.025)**
Age	Time spent on gaming	− .024 (.012)	− .043 (.022)
Depressive mood	Time spent on social media	.043 (.026)	.043 (.026)
Eveningness	Time spent on social media	.154 (.030)**	.149 (.029)**
Sex	Time spent on social media	.392 (.059)**	.188 (.027)**
Age	Time spent on social media	− .042 (.011)**	− .081 (.021)**
Eveningness	Depressive mood	.212 (.033)**	.206 (.031)**
Sex	Depressive mood	.262 (.054)**	.126 (.026)**
Age	Depressive mood	− .006 (.011)	− .011 (.021)

Note. *$p < .05$; **$p < .01$; *b*, unstandardized regression coefficient; *β*, standardized regression coefficient; *SE*, standard error; sex was coded as 0 = male, 1 = female

spent on the Internet and gaming. Time spent on the Internet was predicted by eveningness and being older, and time spent on gaming was predicted by eveningness and being male. In contrast, time spent on social media was predicted by eveningness, being female, and younger. Finally, the depressive mood was positively predicted by eveningness and being female.

Table 4 Standardized estimates of total, direct, and indirect effects with 95% bias-corrected bootstrapped confidence intervals

Paths	Total effect		Direct effect		Indirect effect	
	β	95% CI	*β*	95% CI	*β*	95% CI
EV PRIN	.260**	[.204, .316]	.130**	[.102, .174]	.130**	[.085, .185]
Via TI					.020*	[.007, .039]
Via TG					.007	[− .003, .018]
Via TS					.025**	[.013, .037]
Via DEP					.076**	[.052, .101]
Via DEP TI					.001	[.000, .002]
Via DEP TG					.000	[− .001, .001]
Via DEP TS					.001	[.000, .003]
EV PRGA	.122**	[.049, .181]	.013	[− .037, .081]	.113**	[.048, .142]
Via TI					.008	[− .009, .021]
Via TG					.079**	[.032, .118]
Via TS					.000	[− .010, .010]
Via DEP					.021**	[.010, .035]
Via DEP TI					.000	[.000, .001]
Via DEP TG					.000	[− .010, .010]
Via DEP TS					.000	[− .001, .000]
EV PSMU	.114**	[.052, .177]	.001	[− .064, .067]	.113**	[.075, .151]
Via TI					− .018*	[− .035, − .002]
Via TG					− .021**	[− .038, − .010]
Via TS					.071**	[.038, .095]
Via DEP					.077**	[.060, .112]
Via DEP TI					.000	[− .002, .000]
Via DEP TG					.000	[− .003, .002]
Via DEP TS					.004	[− .001, .009]

Note. *$p < .05$; **$p < .01$; *EV*, eveningness; *PRIN*, problematic Internet use; *PRGA*, problematic gaming; *PSMU*, problematic social media use; *TI*, time spent on the Internet; *TG*, time spent on gaming; *TS*, time spent on social media; *DEP*, depressive mood; *β*, standardized regression coefficient; *CI*, confidence interval; bias-corrected confidence intervals (based on 5000 samples) were estimated with the maximum likelihood estimator. Sex was coded as 0 = male, 1 = female

Mediation analyses (including direct and indirect effects) are reported in Table 4 and show that eveningness indirectly predicted the outcomes through various intervening variables. It predicted problematic Internet use via time spent on the Internet and social media and depressive mood. Eveningness also predicted problematic gaming via time spent on gaming and depressive mood. Eveningness predicted problematic social media use via time spent on gaming and Internet use (negatively) and social media (positively), as well as via depressive mood. Finally, the proportion of explained variance was 26.2% for problematic Internet use, 61.5% for problematic gaming, and 41.2% for problematic social media use.

Discussion

The present study explored the associations between eveningness and three problematic online behaviors, problematic Internet use (PIU), problematic online gaming (POG), and problematic social media use (PSMU), via the mediating variables of the time spent engaging in the online activities and depressive mood while also controlling for sex- and age-related effects.

The results of the present study showed that eveningness predicted all three problematic online behaviors, mostly indirectly via the increased time spent on the activities and via depressive mood. These results are in line with earlier studies suggesting that eveningness might indicate a higher risk for PIU (Lin & Gau, 2013; Randler et al., 2014), POG (Vollmer et al., 2014), and PSMU (Blachnio et al., 2015; Horzum & Demirhan, 2017). Evening-type individuals spend more time in front of screens (Kauderer & Randler, 2013; Urbán et al., 2011; Vollmer et al., 2012), which might be related to their daily rhythm and shorter sleep duration (Negriff et al., 2011). The results here suggest that the activity time is not solely responsible for the chronotype problematic behaviors association. In the present authors' model, depressive mood also mediated the effect of eveningness on the different problematic online behaviors. Many studies have highlighted that time spent online is an important predictor of problematic or addictive behaviors (Griffiths et al., 2014; Laconi et al., 2018; Mamun & Griffiths, 2019; Mihara et al., 2016; Moreno et al., 2015; Pornsakulvanich, 2018; Triberti et al., 2018), but it has also been emphasized that activity duration should be regarded as a component or an indicator of this phenomenon rather than its complete representation (Griffiths, 2010; Jasso-Medrano & López-Rosales, 2018; Marino et al., 2018; Moreno et al., 2015). Frequent use of the Internet and social networking sites can also lead to positive and functional outcomes (Marino et al., 2018; Primack & Escobar-Viera, 2017). Therefore, excessive use alone is not responsible for the negative outcomes of problematic/addictive behaviors or impaired well-being. Time spent on the activity in combination with different psychopathological characteristics (depression, suicidal ideation, obsessive–compulsive symptoms, hostility, paranoid ideation, phobic anxiety, somatization) (Jasso-Medrano & López-Rosales, 2018; Laconi et al., 2018) can be a more differentiating predictor.

Depressive mood in the present study, as in most of the previous studies (Bozoglan et al., 2014; Cerniglia et al., 2017; Chang et al., 2015; Laconi et al., 2017, 2018; Mamun & Griffiths, 2019; Sussman et al., 2018), emerged as a significant predictor of all types of problematic online behaviors. Depressive mood can drive individuals to use online activities (such as gaming or social media) and engage in Internet-related activities more frequently to relieve their mood problems (Kardefelt-Winther, 2014). At the same time, depressive mood can also impair individuals' ability to control their use, which might increase the risk

for PIU (Moreno et al., 2015). Large-scale representative studies have consistently demonstrated positive associations between problematic online activities and depressive mood (Primack & Escobar-Viera, 2017). These studies also suggest that depressive mood might be better understood as a predictor rather than an outcome (Moreno et al., 2015). However, researchers have emphasized the need for further longitudinal studies and more clinically-based research to help understand more deeply the complex interactions between depressive mood and problematic online behaviors (Primack & Escobar-Viera, 2017).

The result that depressive mood partially mediated the effect of eveningness on all three problematic online behaviors is not surprising because the associations between mood problems and eveningness are well-documented (Alvaro et al., 2014; Gulec et al., 2013; Hidalgo et al., 2009; Kim et al., 2010). It is proposed that irregular sleeping behaviors, higher social jetlag (Schneider et al., 2011), higher circadian misalignment (Hasler et al., 2010a, 2010b), temperamental characteristics (Ottoni et al., 2012; Park et al., 2015) and/or the typical function of the behavioral activation and behavioral inhibition systems (Hasler et al., 2010a, 2010b) might be responsible for the increased risk for depressive symptoms among evening individuals. The notion that depressive mood can mediate the effect of eveningness on health risk behaviors has been reported previously in the literature (Negriff et al., 2011). However, to date, it has not been tested in the field of problematic online behaviors.

While eveningness was an indirect predictor for POG and PSMU, it remained a significant direct predictor of PIU. Based on these findings, it can be concluded that other characteristics correlating with eveningness might be responsible for the association. As proposed earlier, personality characteristics (such as extraversion, neuroticism, sensation seeking, and conscientiousness) might have a contributory role in this association (Blachnio et al., 2015; Horzum & Demirhan, 2017; Randler et al., 2014). It is also possible that the difference lies in the nature of the problematic behaviors. When the characteristics of the three online activities are examined, on the one hand, Internet use is a broad phenomenon, including all the time spent online for many different purposes (e.g., surfing, chatting, entertainment, or learning). On the other hand, online gaming and social media use are more domain-specific Internet uses that may have particular characteristics (Mihara et al., 2016; Primack & Escobar-Viera, 2017) that "overwrite" the direct effect of eveningness.

The gender-related results (being male predicted problematic gaming while being female predicted time spent on social media) were consistent with earlier studies in that PSMU was more prevalent among women (Andreassen et al., 2016; Laconi et al., 2018; Mihara et al., 2016). This result might be explained by the fact that females prefer to engage in social activities on the Internet (Colley & Maltby, 2008; Marino et al., 2018). On the other hand, problematic online gaming is more prevalent among males than females (Andreassen et al., 2016; Laconi et al., 2018). Because females and males use the Internet for different purposes, they may have different risks for the subtypes of PIU and other Internet-related problematic behaviors (Moreno et al., 2015).

The present study's findings are consistent with the theory for PIU in general (Moretta et al., 2022), but it is important to identify common risk factors (in the present study, these were posited to be eveningness, depressed mood, and time spent online), for the different subtypes of PIU (e.g., POG, PSMU). Moreover, content may also be of importance. In the context of the latter, in the present study, gender appeared to be a variable that may be significant in understanding predictors of PIU subtypes.

Given that age showed a weak significant association with Internet use (positive) and social platform use (negative), it was important to control for its effect. However, specific hypotheses were not formulated because the present sample was considered to be somewhat

homogeneous in terms of age. Comparing the three problematic online behaviors, the direct predictive value of eveningness was highest in the case of PIU, while eveningness did not directly predict neither POG nor PSMU. On a more global level, the predictors of the three problematic online behaviors were not the same, which supports the notion that it is worth examining the different aspects of online activities separately. Finally, it has to be noted that no statistically significant association was found between POG and PSMU, nor between the times spent on these two activities, which might suggest that online gaming and social media use are distinct with little-to-no overlap between them.

In conclusion, the results of the present study supported the presence of associations between eveningness and the higher risk for problematic online behaviors and highlighted different characteristics (the time spent online and depressive mood) that could mediate the effect of eveningness. These results point out that eveningness could be a risk factor for problematic online behaviors not only because of the higher amount of time spent on the activities, but also because of worse mood associated with eveningness. In the prevention and treatment of problematic online behaviors, it would be essential to target eveningness and its correlates (depressive mood, elevated sensation seeking, regulatory difficulties, sleep difficulties according to eveningness) since in adolescence and young adulthood, the shift towards evenings can be a significant risk factor for the overuse or misuse of different types of online activities.

The knowledge that eveningness can be a risk factor for problematic online behaviors has important implications for the individuals concerned (e.g., in relation to strengthening self-regulation and understanding the complex interactions), for their family members (e.g., in relation to the need for stronger external control/regulation), and for institutions and public policy (e.g., in relation to education, offering opportunities that better fit the adolescents/young people's rhythm, prevention and interventions integrating time management and methods to restore circadian rhythms).

Limitations

The present study is not without its limitations. A cross-sectional design was used, which does not allow for causal inferences. A logical next step would be the application of longitudinal studies that would allow for more precise identification of the uni-directionality or bi-directionality between eveningness and problematic behaviors. Self-report surveys were administered, which could lead to distorted results due to potential biases (e.g., social desirability). To address this issue, more objective activity indicators (e.g., actual activity tracking, monitoring applications) might be needed that also respect an individual's privacy. The results should be replicated among more diverse, comprehensive, and representative adult samples for more generalizable conclusions. It is also important to note that problematic behaviors were assessed in the present study rather than addiction *per se*. Although the two concepts overlap, clinical evidence is needed for the latter (Bőthe et al., 2018; Ross et al., 2012). Other mediator and moderator variables might influence the associations between eveningness and problematic behaviors. As indicated in the theoretical framework of the introduction, eveningness is associated with a number of additional factors that may be relevant to PIU (e.g., impulsivity, emotion-regulation, sensation seeking), so it is important to include other such potential mediators in the model for future research.

Ethics

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000 (5). Informed consent was obtained from all patients for being included in the study.

Author Contribution All authors contributed to the study conception and design. Material preparation and data collection were performed by Anna Magi, Andrea Eisinger, and Zsolt Demetrovics; data analysis was performed by István Tóth-Király. The first draft of the manuscript was written by Adrien Rigó, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Declarations

Ethics Approval All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000 (5).

Informed Consent Informed consent was obtained from all patients being included in the study.

Conflict of Interest Adrien Rigó, István Tóth-Király, Anna Magi, Andrea Eisinger, and Zsolt Demetrovics declare no competing interests. MDG has received research funding from *Norsk Tipping* (the gambling operator owned by the Norwegian government). MDG has received funding for a number of research projects in the area of gambling education for young people, social responsibility in gambling, and gambling treatment from Gamble Aware (formerly the Responsibility in Gambling Trust), a charitable body which funds its research program based on donations from the gambling industry. MDG undertakes consultancy for various gambling companies in the area of social responsibility in gambling. The University of Gibraltar receives funding from the Gibraltar Gambling Care Foundation, an independent, not-for-profit charity.

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