Loneliness and problematic social networking sites use in young adults with poor vs. good sleep quality: The moderating role of gender

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ABSTRACT

Despite the evidence of a relationship between loneliness, problematic social networking sites use (PSNSU), and sleep quality, associations between specific PSNSU symptoms and loneliness in individuals with poor vs. good sleep quality and possible gender differences have yet to be understood. We examined the relationships between loneliness and PSNSU symptoms (i.e., preference for online social interaction – POSI, mood regulation, deficient self-regulation, and negative outcomes), and possible moderating effects of gender for individuals with poor vs. good sleep quality. Seven hundred and sixty-three young adults completed an online survey including self-report measures of sleep quality, loneliness, and PSNSU symptoms. Individuals with poor sleep quality reported higher levels of loneliness and greater scores on all PSNSU domains than those with good sleep quality. Slope analyses revealed that in men vs. women with poor sleep quality, greater deficient self-regulation of social networking sites use was associated with lower levels of loneliness. Conversely, in men vs. women with good sleep quality, greater POSI was associated with higher levels of loneliness. Our findings showed that individuals with poor sleep quality are characterized by higher levels of loneliness and more severe PSNSU symptoms that may be the result of sleep disturbance-related metabolic, neural, and hormonal processes. Moreover, our results highlight gender differences for individuals with poor vs. good sleep quality which may help clarify the nature of the association between loneliness and PSNSU.

1. Introduction

The increasing popularity of Social Networking Sites (SNS) across global society has been paralleled by increasing concerns regarding Problematic Social Networking Sites Use (PSNSU), a multifaceted condition characterized by impaired control over SNS-related behaviors resulting in continued use despite negative consequences (Griffiths, 2013; Musetti et al., 2021). Despite the absence of a consensus on its clinical characterization, PSNSU can be conceptualized on the basis of multiple approaches: i) Five of the nine DSM-5 diagnostic criteria (i.e., preoccupation or obsession, withdrawal, tolerance, loss of control, loss of interest, continued overuse, deceiving, escape of negative feelings, functional impairment) for disorders due to addictive behaviors met within a year; ii) severity of functional impairment; iii) specific psychological mechanisms; iv) time spent online (Musetti, Manari, Billieux, Starcevic, & Schimmenti, 2022; Wegmann, Billieux, & Brand, 2022). Of note, it has been also proposed that Caplan's model of generalized

pathological internet use (Caplan, 2002, 2010) may provide a conceptual basis for understanding the PSNSU. In this context, PSNSU has been described as characterized by some specific symptoms, such as Preference for Online Social Interaction (POSI), using the SNS for mood regulation, cognitive preoccupation related to the use of the internet, compulsive use, and negative outcomes (Caplan, 2010; Casale & Fioravanti, 2015, 2017; Marino et al., 2017; Moretta & Buodo, 2018; Musetti, Grazia, et al., 2022; Ryan et al., 2014). Specifically, using SNS to regulate mood and POSI are associated with difficulties in regulating SNS use, which, in turn, predicts negative outcomes of SNS usage in daily life (Assunção & Matos, 2017; Moretta & Buodo, 2018). Importantly, using SNS for mood regulation appears to have a greater impact than POSI on negative outcomes of PSNSU (Moretta & Buodo, 2018). Thus, PSNSU has been interpreted as emerging from the need to compensate for low social competencies (Wegmann & Brand, 2019) and/or to cope with negative affect in the absence of effective emotion regulation strategies (Hormes et al., 2014; Wegmann & Brand, 2016).

Noteworthy, despite the consequences of negative outcomes triggered by PSNSU, the overall understanding of their underlying mechanisms as possible intervention targets remains far from complete.

Among the negative outcomes of PSNSU, a reduction in sleep quality (i.e., the satisfaction of one's overall sleep experience) and subsequently poor mental health outcomes have been largely documented (Gupta & Sharma, 2021; Kokka et al., 2021; Tandon et al., 2020). Specifically, in university students, high subjective distress and aversive mood states including anger, contempt, disgust, guilt, fear, and nervousness have been associated with sleep disturbance via fear of missing out, the desire to stay continually connected with what others are doing (Li, Griffiths, Mei, & Niu, 2020). Moreover, pre-sleep worry and fear of missing out could be linked to sleep disturbance in adolescents (Scott & Woods, 2018). Importantly, worse school performance linked to PSNSU may result from poor sleep habits in youth (Vernon et al., 2015). Overall, these findings highlighted that subjective distress and fear of missing out can be two of the main processes related to poor sleep quality. Another potential mechanism leading to poor sleep quality in PSNSU could be blue light emitted through technological devices used before bedtime leading to suppression of melatonin. Suppressing this hormone is the basis of neuropsychological arousal and thus, alterations in circadian rhythm affecting sleep latency and duration (Chang et al., 2015). Of note, reduced mood regulation capacities have been proposed as a primary mediator in explaining the relationship between negative affect, problematic use of the internet, and sleep-related symptoms (Guerrini Usubini et al., 2022). In addition, Musetti, Gori, et al., (2022) found that psychological stress and emotion dysregulation sequentially mediated the positive association between problematic online pornography use and insomnia. However, no study to our knowledge has yet investigated whether using PSNSU for mood regulation, a feature of PSNSU, would specifically characterize individuals with poor vs. good sleep quality and who seek alternative emotion regulation strategies.

One of the unpleasant subjective feelings that received considerable attention among researchers studying PSNSU is loneliness (i.e., the subjective feeling of social isolation resulting from a discrepancy between desired and actual social relationships; Moretta & Buodo, 2020; O'Day & Heimberg, 2021; Perlman & Peplau, 1981). Specifically, it has been suggested that in modern society the use of SNS increases loneliness and isolation. The reasons for this may be found in the displacement hypothesis which argues that people displace offline relationships with online ones. However, online communication lacks the quality of face-to-face human relationships and in turn, may lead to loneliness (Kraut et al., 1998; Turkle, 2011). Moreover, the model of compensatory internet use posits that negative life situations and feelings (e.g., loneliness) can give rise to a motivation to use SNS to alleviate negative affect. In this scenario, high loneliness levels might be a vulnerability factor leading to PSNSU (Kardefelt-Winther, 2014). At the same time, others argued that the use of SNS may reduce loneliness by enhancing existing relationships and favoring new ones (Gross, 2004; Valkenburg & Peter, 2007). A recent theoretical model posits that the relationship between loneliness and SNS use is bidirectional and dynamic with loneliness increasing when using SNS as a way to escape offline social relationships and decreasing when using SNS as a way to expand one's social network/strengthen existing relationships (Nowland et al., 2018).

Of note, loneliness has been also correlated with lower to poor sleep quality. A systematic review and *meta*-analysis found loneliness to be medium-sized (cross-sectionally) related to impaired sleep quality and insomnia symptoms (Griffin, Williams, Ravyts, Mladen, & Rybarczyk, 2020) supporting the hypothesis that loneliness might be one possible factor leading to poor sleep quality. Interestingly, a recent review (Alonzo et al., 2021) reported longitudinal evidence suggesting poor sleep quality and frequent sleep disturbances as mediators of the association between poor mental health outcomes and PSNSU. Furthermore, a study investigating the effects of a 1-week vacation from SNS found that limiting SNS use has benefits for both wellbeing and sleep quality, with changes in sleep quality being responsible for the relationship

between limiting SNS use and wellbeing (Graham et al., 2021). Given the negative relationship of sleep quality with both loneliness and PSNSU, it can be hypothesized that individuals with poor sleep quality are characterized by specific PSNSU symptoms related to loneliness, a key factor in the onset of depression and other common mental health problems (Mann et al., 2022). However, despite the evidence of a relationship between mental health, PSNSU, and sleep quality, to the best of our knowledge studies investigating whether specific PSNSU symptoms are related to loneliness, in individuals with poor vs. good sleep quality are lacking.

As for gender differences, previous research has shown that loneliness seems to be higher among men, compared with women (Barreto et al., 2021). However, this finding is contrary to those from some other studies, where loneliness level was reported to be higher among women than among men (Nicolaisen & Thorsen, 2014). These inconsistencies among studies may occur largely because gender differences in loneliness seem to be environmentally (e.g., social norms, cultural influences) rather than genetically determined (Boomsma et al., 2005). In this sense, changes in life patterns regarding the use of SNS might have an important role in determining gender differences in loneliness. In turn, gender differences in PSNSU can help to understand gender differences in loneliness. Indeed, it has been argued that women are socialized to develop a larger/more active social network that may works as protective factor from loneliness (Barreto et al., 2021). At the same time, it has been shown that given to gender stereotypes, men are more reluctant than women to express feeling lonely (Borys & Perlman, 1985). It can be hypothesized that men can use SNS for compensating their restricted social capital. However, at the same time engaging in SNS surfing may be perceived by women as a mean of further enlarging social connections leading to POSI. In turn, POSI may exacerbate social avoidance and reinforce SNS-mediated relationships, a cognitive symptom of PSNSU (Casale, Tella, & Fioravanti, 2013; Lee & Stapinski, 2012). In the context of PSNSU, it has been recently shown that men and women are characterized by different core symptoms, i.e., salience and conflict, respectively (Wang et al., 2022). Specifically, in men, cognitive salience of SNS use (i.e., preoccupation with SNS use and engaged in to the neglect of everything else; Griffiths, 2005) would progress into tolerance behaviors. Conversely, in women the conflict caused by excessive SNS use (i.e., negative outcomes caused by excessive SNS use including the compromising of relationships, occupation, and/or education; Griffiths, 2005) would be related to less control in using SNS (Wang et al., 2022). This finding may suggest that deficient self-regulation (in men) and negative outcomes of using SNS (in women) may have negative consequences on users' social capital leading to loneliness feelings. A systematic review studying current trends in the literature on problematic internet use showed that men are more susceptible to the generalized form of problematic internet use. On the other hand, women seem to be at more risk than men on PSNSU symptoms or severity (Baloğlu, Şahin, & Arpaci, 2020). However, reasons underlying gender-related specific pattern of use remain to be clarified. Importantly, a recent *meta*-analysis found that there was no moderation effect for gender on the relationship between PSNSU and mental health (Shannon, Bush, Villeneuve, Hellemans, & Guimond, 2022). The authors argued as a possible explanation that studies included in the *meta*-analysis did not specify if they assessed biological sex and they suggested further research to provide more specific results for sex and genders allowing future *meta*-analyses to summarize this information more accurately. However, despite the importance of studying gender differences for their potential insights into the etiological and pathogenetic mechanisms of maladaptive behaviors and mental disorders and to improve preventive programs for both women and men, little is known about how men and women differ in the pattern of relationships between loneliness and PSNSU domains.

In light of these considerations, the present study aimed at examining relations between loneliness and PSNSU symptoms (i.e., POSI, mood regulation, deficient self-regulation, and negative outcomes), and possible moderating effects of gender for individuals with poor vs. good

sleep quality. We hypothesized that (a) individuals with poor sleep quality would show higher levels of loneliness, greater POSI, higher use of SNS for mood regulation, as well as greater cognitive preoccupation and compulsive use, and negative outcomes of using SNS as compared with individuals with good sleep quality; (b) only in individuals with poor sleep quality, loneliness would be associated with higher SNS use-related problems; (c) as for gender differences in the relationship between loneliness, PSNSU domains and sleep quality, no a priori hypothesis was formulated given the presence of previous contrasting results.

2. Method

2.1. Procedure and participants

The study is part of a larger research project titled "Resilience and the COVID-19: how to react to perceived stress. Effects on sleep quality and diurnal behavior/thoughts" from which several articles were published with different objectives and methods (e.g., BLINDED FOR REVIEW). Data were collected from December 2020 to January 2021. Potential participants were contacted informally via advertisement on SNS and asked for participation in an online survey. To be eligible for inclusion in the study, participants were required to be at least 18 years old and to be SNS users. Those who met the inclusion criteria and agreed to participate were asked to provide their informed consent forms. After the informed consent, the survey started with a section on demographic information. The following sections included self-report measures of loneliness, sleep quality, and PSNSU domains (i.e., preference for online social interaction, using SNS for mood regulation, cognitive preoccupation about the use of SNS, compulsive use, and negative outcomes). Uncompleted questionnaires ($n = 45$) were excluded from the data analysis. Individuals did not receive any compensation for participation.

A total sample of 763 young adults participated in this study and, based on their Pittsburgh Sleep Quality Index (Buysse et al., 1989), 631 participants were classified as individuals with good sleep quality (PSQI total scores ≤ 5) and 132 as individuals with poor sleep quality (PSQI total scores > 5; more details on participants are reported in Table 1). As reported in Table 1, PSQI scores among individuals with poor sleep quality were significantly higher than among those with good sleep quality. No statistically significant differences between groups were found for age, education, marital and employment status. However, groups differed in terms of gender distribution.

The present study was carried out with the adequate understanding and written consent of the participants in accordance with the Declaration of Helsinki. The study was approved by the local Ethics Committee (prot. n. 12106).

2.2. Measures

2.2.1. Loneliness

The UCLA Loneliness Scale-version 3 (UCLA LS3; Russell, 1996; Italian version by Boffo et al., 2012) is a self-report measure of global loneliness. It includes 20 items rated on a 4-point scale. Higher scores indicate a higher level of loneliness. In our sample, the UCLA LS3 Cronbach's alpha was good ($\alpha = 0.89$).

2.2.2. Sleep quality

The Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989; Italian version by Curcio et al., 2013) was used to assess sleep quality. The PSQI assesses individuals' sleep patterns and several forms of sleep impairment in the past month. It includes 18 items rated on a 4-point scale. The PSQI allows to derive scores for 7 components of sleep (subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction). A global PSQI score is obtained by summing the 7 component scores (range = 0–21). Lower scores indicate better sleep quality whereas

Table 1

Descriptive statistics and t-tests between assessed variables in individuals with poor vs. good sleep quality.

		N of cases (%)/Mean (SD)		
		Individuals with poor sleep quality n = 132	Individuals with good sleep quality n = 631	p-value
Gender	Female	$N = 57$ (43%)	$N = 335$ (53%)	0.04 $^{\chi 2}$ test
	Male	$N = 75$ (57%)	$N = 296$ (47%)	
Age		28.70 (7.25)	28.08 (7.04)	0.36 $^{t-}$ test
Education	Primary	$N = 0$ (0%)	$N = 0$ (0%)	0.08 $^{\chi 2}$ test
	Secondary	$N = 12$ (9%)	$N = 31$ (5%)	
	High	$N = 78$ (59%)	$N = 417$ (66%)	
	Bachelor	$N = 20$ (15%)	$N = 84$ (13%)	
	Master Degree	$N = 22$ (17%)	$N = 89$ (14%)	
	Specialization/ PhD	$N = 0$ (0%)	$N = 10$ (2%)	
Marital status	Single	$N = 71$ (54%)	$N = 357$ (57%)	0.56 $^{\chi 2}$ test
	Married	$N = 60$ (46%)	$N = 262$ (42%)	
	Separated/ divorced	$N = 1$ (1%)	$N = 9$ (1%)	
	Widowed	$N = 0$ (0%)	$N = 3$ (1%)	
Employment status	Student	$N = 36$ (27%)	$N = 180$ (29%)	0.77 $^{\chi 2}$ test
	Student worker	$N = 25$ (19%)	$N = 91$ (14%)	
	Employee	$N = 40$ (30%)	$N = 264$ (42%)	
	Self-employee	$N = 21$ (16%)	$N = 61$ (10%)	
	Unemployed	$N = 6$ (5%)	$N = 20$ (3%)	
	Retiree	$N = 0$ (0%)	$N = 0$ (0%)	
	Other	$N = 4$ (3%)	$N = 15$ (2%)	
Global PSQI		7.13 (1.30)	2.67 (1.44)	<.001^{F} test
Loneliness		46.36 (10.07)	42.78 (9.50)	<.001^{F} test
PSNSU	POSI	6.15 (4.32)	5.35 (3.70)	.03^{F} test
	Mood regulation	10.63 (5.64)	8.63 (5.00)	<.001^{F} test
	Cognitive preoccupation	7.17 (4.34)	6.11 (3.65)	.003^{F} test
	Compulsive use	9.26 (5.97)	7.38 (4.92)	<.001^{F} test
	Negative outcomes	5.73 (3.71)	4.90 (3.34)	<.01^{F} test

Legend. PSQI stands for Pittsburgh sleep quality index; POSI stands for preference for online social interaction.

scores higher than 5 are associated with poor sleep quality (Buysse et al., 1989). In our sample, the PSQI Cronbach's alpha was acceptable ($\alpha = 0.60$).

2.2.3. Problematic social networking sites use

To assess the domains of the PSNSU, such as POSI, mood regulation, deficient self-regulation (i.e., cognitive preoccupation + compulsive use), and negative outcomes, participants were asked to complete the Italian version (Fioravanti et al., 2013) of the Generalized Problematic Internet Use Scale 2 (GPIUS2; Caplan, 2010) adapted to the SNS context by replacing the word "Internet" with the word "social networking sites". This tool includes 15 items rated on an 8-point scale. The scale includes five subscales reflecting the domains of PSNSU (Marino, Vieno, Altoè, & Spada, 2017; Moretta, Buodo, Demetrovics, & Potenza, 2022). Higher scores on the scale indicate higher levels of PSNSU. In our sample, the Cronbach's alpha for the total and each subscale was good (total: $\alpha = 0.91$; POSI: $\alpha = 0.80$; mood regulation: $\alpha = 0.79$; cognitive preoccupation: $\alpha = 0.74$; compulsive use: $\alpha = 0.87$; negative outcomes: $\alpha = 0.79$).

2.3. Statistical analysis

All analyses were performed using R software (R Development Core Team, 2016).

Descriptive statistics were examined and Pearson correlations were calculated between the study variables. Potential differences between loneliness correlations in the two groups (Tables 2a and 2b) were tested by transforming the correlations into z-scores using Fisher's r-to-z transformation (Ramseyer, 1979; R package: psych; Revelle, 2015). Gender differences in main study variables for individuals with good and poor sleep quality are reported as supplementary material (Table A1).

A Multivariate Analysis of Variance (MANOVA; R package: stats) was conducted to identify differences in loneliness and PSNSU domains between individuals with poor vs. good sleep quality (hypothesis a).

To study the relative contributions of PSNSU domains (i.e., POSI, mood regulation, deficient self-regulation, and negative outcomes) to loneliness levels (hypothesis b), and the possible moderating effect of gender (hypothesis c) for individuals with poor sleep quality vs. those with good sleep quality, respectively, two separate multiple regression analyses were employed (R package: stats). For the regression analyses, participants who reported non-binary gender self-identification were excluded because of the small number in our sample ($n = 1$). The maximum likelihood method was employed to analyze the contribution of statistical predictors in explaining loneliness levels. Multicollinearity was monitored by examining the variance inflation factor (VIF). In both groups the VIF measure indicated that multicollinearity was not a concern (all VIFs ≤ 10.00). Before running multiple regression analyses, continuous variables were centered and scaled. Residual plots were employed to evaluate the normality and homogeneity of the variance. In both groups, the scatterplot of the standardized residuals showed that the data met the assumptions of homogeneity of variance and linearity.

3. 3.Results

3.1. Group differences in loneliness and PSNSU domains

Descriptive statistics are reported in Table 1. Groups differed in loneliness and all PSNSU domains, with individuals with poor sleep quality reporting higher levels of loneliness, greater POSI, higher use of SNS for mood regulation, as well as greater cognitive preoccupation and compulsive use, and negative outcomes (hypothesis a). As shown in Table 2, Pearson correlations revealed statistically significant positive associations between loneliness and all PSNSU domains in both groups. Of note, no differences between individuals with poor and good sleep quality were found in the positive correlations between loneliness and POSI ($z = 0.89$, $p = 0.37$), mood regulation ($z = 0.64$, p = 0.52), cognitive preoccupation ($z = 0.43$, $p = 0.67$), compulsive use ($z = 0.11$, $p = 0.91$), and negative outcomes ($z = 1.28$, $p = 0.20$).

3.2. Individuals with poor sleep quality

To test the relative contributions of PSNSU symptoms to loneliness

levels (hypothesis b), and the potential moderating effect of gender (hypothesis c), a multiple regression analysis was employed. Only negative outcomes (B = 1.15, 95%CI [0.53 1.78], β = 0.43, $p < 0.001$) and the interaction between gender and deficient self-regulation of SNS use (i.e., compulsive SNS use and a cognitive preoccupation with the SNS; B = -0.71, 95%CI [-1.32–0.10], β = -0.52, $p = 0.02$) were statistically significant predictors of loneliness in individuals with poor sleep quality. The adjusted R^2 of the model was 0.19. Specifically, post-hoc slope analysis revealed that the regression slope of deficient self-regulation of SNS use differed significantly from zero in predicting loneliness only for men (B = -0.42, 95%CI [-0.744–0.087]). As shown in Fig. 1, in men vs. women with poor sleep quality, greater deficient self-regulation of SNS use was associated with lower levels of loneliness.

3.3. Individuals with good sleep quality

In individuals with good sleep quality, multiple regression analysis indicated that only POSI (B = 0.58, 95%CI [0.34 0.82], β = 0.23, $p < 0.001$) and the interaction between gender and POSI (B = 0.54, 95%CI [0.05 1.02], β = 0.15, $p = 0.03$) were statistically significant predictors of loneliness. The adjusted R^2 of the model was 0.11. Specifically, post-hoc slope analysis revealed that the regression slope of POSI differed significantly from zero in predicting loneliness only for men (B = 0.82, 95%CI [0.49 1.15]). As shown in Fig. 2, in men vs. women with good sleep quality, greater POSI was associated with higher levels of loneliness.

4. Discussion

The present study represents the first attempt to assess relations between loneliness and PSNSU symptoms, and the possible moderating effects of gender for individuals with poor vs. good sleep quality.

In line with our first hypothesis (a), individuals with poor sleep quality were characterized by higher levels of loneliness and more severe PSNSU symptoms. Our finding on higher levels of loneliness in individuals with poor vs. good sleep quality is strongly consistent with findings of two recent *meta*-analyses including previous studies on loneliness and health outcomes (Park et al., 2020) and loneliness and sleep disturbance (Griffin, Williams, Ravyts, Mladen, & Rybarczyk, 2020), respectively. Specifically, it has been found a medium-sized effect for the cross-sectional association between loneliness and sleep disturbance, both in terms of lower sleep quality and higher insomnia symptoms (Griffin, Williams, Ravyts, Mladen, & Rybarczyk, 2020). Since the present study was cross-sectional, it does not allow discussion of the results in terms of cause-effect relationships. However, it is noteworthy that poor sleep quality has been argued to be a mechanism through which loneliness influences health (Cacioppo & Hawkley, 2003). Considering our findings on more severe PSNSU symptoms in individuals with poor vs. good sleep quality, it could be hypothesized that in individuals with poor vs. good sleep quality, sleep disturbance-related metabolic, neural, and hormonal processes would favor both unpleasant subjective feelings (e.g., loneliness) and maladaptive
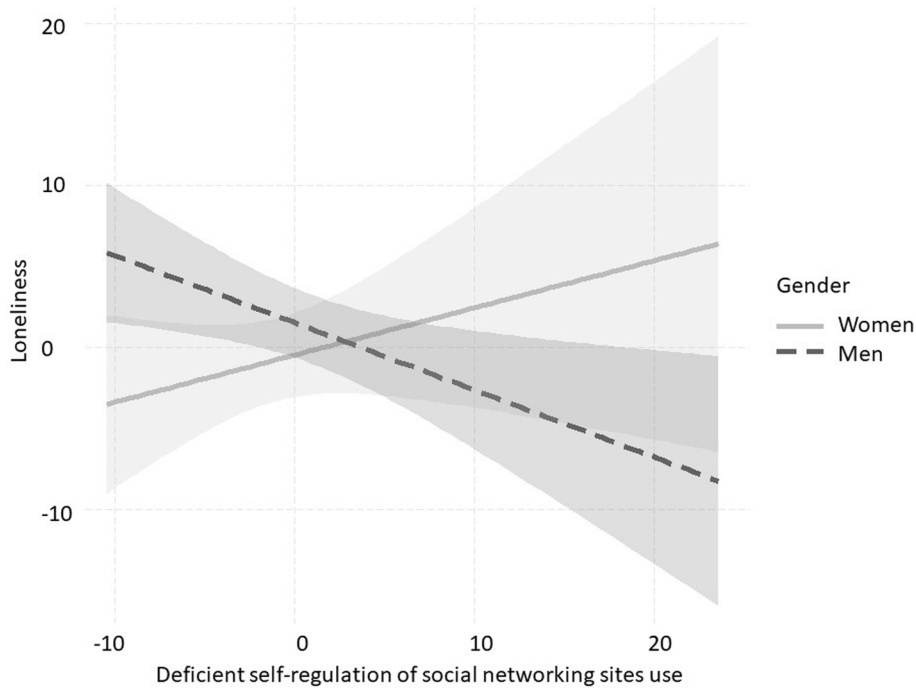
Table 2

Intercorrelations between main study variables for (a.) individuals with good and (b.) poor sleep quality.

	Individuals with good sleep quality n= 631					
	1.	2.	3.	4.	5.	6.
1. Loneliness	1	0.31***	0.16***	0.23***	0.21***	0.28***
2. POSI	0.23**	1	0.38***	0.50***	0.44***	0.60***
3. Mood regulation	0.22*	0.38***	1	0.61***	0.59***	0.41***
4. Cognitive preoccupation	0.19*	0.47***	0.68***	1	0.76***	0.64***
5. Compulsive use	0.22**	0.30***	0.66***	0.77***	1	0.63***
6. Negative outcomes	0.39***	0.52***	0.44***	0.67***	0.58***	1
	Individuals with poor sleep quality n = 132					

Legend. POSI stands for preference for online social interaction; *** stands for *p* value < 0.001; ** stands for *p* value < 0.01; * stands for *p* value < 0.05.

Fig. 1. The moderating effect of gender on the relationship between deficient self-regulation of SNS use (i.e., compulsive SNS use and a cognitive preoccupation with the SNS) and loneliness in individuals with poor sleep quality.
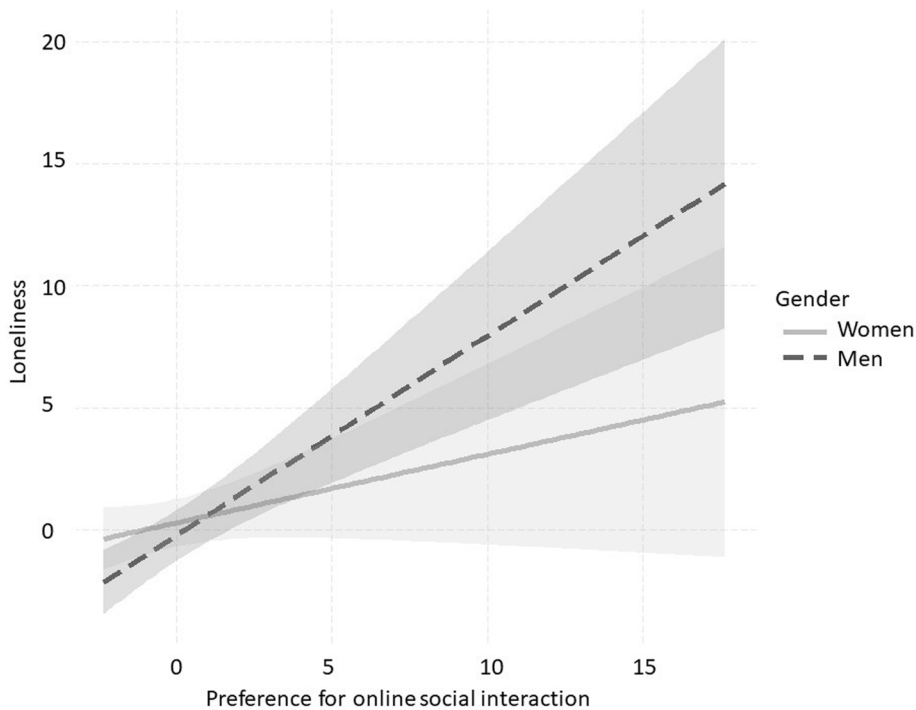

Fig. 2. The moderating effect of gender on the relationship between POSI and loneliness in individuals with good sleep quality.

behaviors (e.g., PSNSU; Cacioppo & Hawkley, 2003). On the other hand, loneliness filings in individuals with poor sleep quality might be a vulnerability factor, leading to problems in controlling one's use of SNS. Further longitudinal studies are needed to better characterize the relationship between sleep quality, loneliness, and PSNSU symptoms.

Interestingly, although the Pearson correlations suggested no differences between groups in the positive associations between loneliness and PSNSU symptoms, when we examined the relative contributions of

PSNSU to loneliness levels (hypothesis b), and the possible moderating effect of gender for individuals with poor vs. good sleep quality (hypothesis c), we found that only in individuals with poor sleep quality higher levels of loneliness were associated with more negative outcomes of using SNS, regardless of gender. Of note, continued use despite a clear risk of negative consequences for valued activities or relationships is the more clinically significant symptom of PSNSU (Kuss & Griffiths, 2017). Our findings seem to be in accordance with the displacement hypothesis

([Kraut et al., 1998](#)) and suggest that in individuals with poor sleep quality, loneliness may be increased by a maladaptive use of social technologies, leading to negative consequences on the individual's life. This assumption seems also to be in accordance with the predictions of the I-PACE model, a framework for the affective-cognitive factor interactions involved in addictive behaviors and Internet-related problematic behaviors ([Brand et al., 2019](#)). Following model predictions, progression of the PSNSU symptoms would be associated with the lack of offline social interactions and increased subjective feelings to be lonely. From a clinical perspective, the current finding suggests that this pattern of relationship between loneliness and negative consequences of using SNS could serve as a viable target for preventive intervention in individuals with poor sleep quality. For instance, improvement of emotion regulation ([Guerrini Usubini et al., 2022](#)) and maladaptive social cognition ([Masi et al., 2011](#)) should be considered in formulating future effective prevention programs. A recent *meta*-analysis showed addressing abnormal social cognition to be an effective intervention for the reduction of loneliness symptoms ([Masi et al., 2011](#)), which may be also considered for preventing the dysfunctional association between loneliness and PSNSU in individuals with poor sleep quality.

Importantly, findings revealed two different patterns of associations between loneliness, PSNSU symptoms, and gender characterizing individuals with poor vs. good sleep quality. Specifically, in men with poor sleep quality lower levels of loneliness were associated with higher deficient self-regulation of SNS use. Rather, in men with good sleep quality, higher levels of loneliness were associated with preferring online social interaction. These two patterns of associations fit with the reward-driven hypothesis described by [Wegmann & Brand (2019)](#) and the displacement hypothesis ([Kraut et al., 1998; Turkle, 2011](#)) social compensation, respectively. In men with poor sleep quality who are also characterized by more PSNSU symptoms, higher social competencies can be linked to higher reward expectancies toward SNS use. Here, SNS could be used to foster the extensive offline social network. Following the [Wegmann and Brand (2019)](#) view, individuals who are socially integrated into real life and are motivated by egocentrism experience higher SNS-related positive reinforcement processes (*reward-driven motivations*) leading to the development of PSNSU. Further studies which investigate gender differences in positive reinforcement processes leading to PSNSU are needed to identify possible gender-related risk factors of PSNSU. On the other hand, in men with good sleep quality, lonely individuals could be motivated by the interpersonal advantages offered by online social interaction. This result is in accordance with previous studies showing that people experiencing high loneliness prefer online over face-to-face communication ([Caplan, 2003; Kim et al., 2009; Morahan-Martin & Schumacher, 2003](#)) as they feel more in control of their online interactions ([Valkenburg & Peter, 2007](#)). The fact that we found these two patterns of associations between men with poor vs. good sleep quality also seems to highlight two possible roles of SNS: one maladaptive, characterized by deficient-self-regulation of SNS use via reward-driven motivations, and another, whereby preferring online social interaction could compensate for high loneliness levels without SNS use-related negative outcome. This last finding may suggest a potential adaptive role of using SNS in these individuals. Future studies should further explore maladaptive and possible adaptive roles of SNS in specific contexts and person's characteristics.

Our findings should be interpreted in light of some limitations. First, although this is the first study that tested the relations between loneliness, PSNSU symptoms, and sleep quality, it was implemented using a cross-sectional design. This makes it impossible to infer cause-effect relationships between variables. Longitudinal studies are needed to test the causal relations between the variables. Second, only self-report data were collected. Future studies including objective measures of SNS use and negative outcomes would improve the validity of the measure. Third, we did not assess specific domains of loneliness (i.e., social and emotional loneliness; attitudes toward aloneness, voluntary aloneness, etc.). Further studies aimed at further contributing to the discussion about relations between loneliness, PSNSU, and sleep quality should include this aspect. Fourth, we did not collect measures of psychopathology (e.g., affective symptoms). Future research should consider the presence of psychopathology to control its possible effect on the variables included in the study. Fifth, despite the feasibility of the model of generalized pathological Internet use ([Caplan, 2010](#)) in the context of PSNSU has been largely supported ([Casale & Fioravanti, 2015; Moretta & Buodo, 2018; Svicher, Fioravanti, & Casale, 2021; Moretta, Buodo, Demetrovics, & Potenza, 2022](#)) a consensus on the conceptualization of PSNSU has not been reached yet ([Besser, Loerbroks, Bischof, Bischof, & Rumpf, 2019; Brand, Rumpf, King, Potenza, & Wegmann, 2020](#)). Future studies can enlarge the present findings by studying gender differences in the relationships between other possible core symptoms of PSNSU (e. g., salience), loneliness, and sleep quality. Sixth, our groups differed in gender distributions. Further research, including equal gender distributions should be undertaken to confirm our findings. Last, although the present study did not control for COVID-19 pandemic-related factors, data collection was carried out during the Italian COVID-19-pandemic-related outbreak recovery period.

Of note, only a low proportion of the variance in loneliness was explained by the variables included in the two regression models, suggesting that PSNSU symptoms and the mediating role of gender might not be the main factors influencing loneliness levels in individuals with poor and good sleep quality. Future research is needed to explore other variables (e.g., psychological distress) that may have a role in the relationship between loneliness levels, sleep quality, and PSNSU symptoms (e.g., [Seidler et al., 2022](#)).

Notwithstanding these limitations, the study offers novel insights into understanding the relationships between loneliness, PSNSU, and sleep quality. In particular, the present study showed that individuals with poor sleep quality are characterized by higher levels of loneliness and more severe PSNSU symptoms that may be the result of sleep disturbance-related metabolic, neural, and hormonal processes. Moreover, in men with poor sleep quality lower levels of loneliness are related to higher deficient self-regulation of SNS that may underlie possible reward-driven motivations. Rather, in men with good sleep quality, higher levels of loneliness are related to the preference for online social interaction which may reflect the processes of social compensation.

Role of Funding Sources

CRediT authorship contribution statement

Tania Moretta: Conceptualization, Methodology, Data curation, Visualization, Formal analysis, Validation, Writing - original draft. **Christian Franceschini:** Conceptualization, Methodology, Supervision, Validation, Writing – review & editing. **Alessandro Musetti:** Conceptualization, Methodology, Supervision, Validation, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix A. Supplementary material

Supplementary data to this article can be found online at [https://doi.](#)

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