Article

The Mediating Role of Rumination and Sleep Quality between Social Media Usage and Loneliness among Emerging Adults

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Abstract: This study investigates the relationships among social media usage, loneliness, rumination, and sleep quality in college students in India. A sample of 200 participants aged 18–25 were recruited for this study. Participants were selected through convenience or purposive sampling. Online platforms such as Facebook, WhatsApp, Instagram, Telegram, and LinkedIn, along with Google Forms, were used for recruitment. The results revealed a significant positive correlation between social media usage, loneliness, rumination, and sleep quality. Mediation analysis revealed partial mediation of sleep quality and rumination between social media usage and loneliness. It also revealed that social media usage, rumination and sleep quality were also significant predictors of loneliness. Total mediation was also significant, emphasizing the overall impact of social media on loneliness through sleep quality and rumination. The need to create interventions promoting healthy social media engagement, such as digital detox programs, mindfulness training, and social skills development, and addressing underlying psychological needs was highlighted in the current study.

Keywords: Social media; Loneliness; Rumination; Sleep quality; Emerging adults; Psychosocial wellbeing

1. Introduction

The leading edge of technology has significantly altered the way we socialize and communicate, which has made real-time virtual social interactions possible [1]. Additionally, many facets of people's social life were severely impacted by the onset of the COVID-19 pandemic, ensuing lockdown and social distancing [2]. Large-scale lockdowns resulted in massive social disengagement, compelling many people to endure social alienation and detachment [3]. Although, prior to pandemic, the ever changing and evolving context of emerging adults, a term used to describe individuals in their late teens and early twenties who are transitioning into adulthood, has been significantly marked by increased connectivity through social media networks, particularly the cohorts of the Y and Z generations. In 2021, 86% of global users of social media comprised emerging adults [4]. Therefore, as demonstrated by recent research, it is reasonably anticipated that with the rise of social media, emerging adults may turn to it to meet their developmental demands. Research suggests that in 2023, approximately 4.9 billion people worldwide used social media with India having the highest number (448.1 million) of Facebook users, spending an average of 141.6 minutes on social media each day [5] with a majority of 18- to 25-year-olds [6]. However, a critical question that now needs to be addressed is whether or not these virtual connections and interactions can reduce the feelings of loneliness and fulfil our need for interpersonal connectedness. Social media's pervasiveness has made it a crucial part of emerging adults' lives, influencing both their social interactions and mental health.

A phenomenon known as "problematic social media use" occurs when people use social media excessively and for extended periods of time, having detrimental physical and psychological impacts [7]. The evidence shows a strong positive correlation between problematic social media use and loneliness, among numerous other factors [8]. A research also showed that people experience loneliness when there exists a dissonance between the level of anticipated intimacy and the level of received intimacy from their social relationships [9]. Notably, loneliness is prevalent among young adults, as evidenced by a study conducted by Schizophrenia Research Foundation (SCARF) [10]. Likewise, a high prevalence of loneliness among young adults was reported during the first COVID-19 lockdown [11]. Such findings are concerning as in the year 2023, WHO declared loneliness to be a 'pressing global health threat' as loneliness can have detrimental effects on the psychological wellbeing of individuals, especially

emerging adults [12]. In the context of loneliness and sleep quality, through actigraphy, demonstrated that lonely people experience sleep fragmentation [13]. Moreover, it is also proposed that within the context of loneliness, several quantitative studies have recognized loneliness as a strong predictor of rumination in emerging adults [14]. A study has also demonstrated that loneliness among social media users is linked to rumination and social comparison [15].

Besides loneliness, the second mechanism under consideration in the context of social media usage is rumination, and how it interacts with loneliness and sleep quality. Rumination can be referred to as repetitive and perseverative patterns of thinking with an emphasis on the situations, causes, interpretations, and consequences of feelings, symptoms, difficulties, distressing events, and unfavourable characteristics of oneself [16]. According to the response style theory, rumination is a cognitive coping style which involves passive dwelling about one's emotions, resulting in increased depressive symptoms [17]. A study has also proposed that numerous theories posit that both negative and positive metacognitive beliefs, such as "my worrying is uncontrollable" and "rumination helps me solve problems", initiate and promote rumination [18]. It was also demonstrated that individuals susceptible to rumination were more likely to experience negative emotions after ruminating on thoughts while using social networking sites such as Facebook, and it is oftentimes observed in individuals with anxiety and depression related symptoms [19]. Moreover, increased ruminative thinking was linked to more problematic social networking site use by individuals with extremely severe internalizing symptoms [20]. In addition, there was found to be a positive correlation between social media use and loneliness, social comparison, and rumination [15]. These results align with the social comparison theory, which posits that individuals tend to compare themselves with individuals who are either inferior, similar, or superior to them [21]. One of the main reasons social media use is associated with rumination is that users frequently worry about their postings, pertinent situational factors, and the consequences of their posts regularly [22]. Moreover, the content individuals consume from social media with continuous exposure may contribute to ruminative thinking. According to a newspaper article, Indians, particularly those between the ages of 18 and 24, use social media platforms like Facebook, Instagram, YouTube, and Twitter as tools for networking and communication, spending about 2.4 hours a day on these platforms, suggesting a high reliance on these apps which expose them potentially unhealthy content, altering their behaviour, creating feelings of loneliness and inadequacy, and even putting users at risk of cyberbullying [23]. Recent research underscores a connection between elevated social media use and increased rumination, leading to heightened distress [24].

The third mechanism under consideration is sleep quality in the context of social media use and its interplay with rumination and loneliness. A 2023 research reported that those with adverse sleep quality were associated with greater degrees of loneliness and scored higher across all facets of problematic social networking site usage compared to those with appropriate sleep quality [25]. As per another study, many users are engaging in night-time social media use [26]. Engaging in visually stimulating activities may be detrimental to sleep quality. Chronic nocturnal exposure to light from portable devices at night can disrupt the body's internal clock, known as the circadian rhythm [27]. Research suggests that those who wake up to check their phones after falling asleep may be more susceptible to the adverse effects of blue light exposure. Roughly around 21% of the population stated that they awaken during the night to check their social media updates, which puts them at an even higher risk of experiencing sleep deprivation and insomnia [28]. In addition, it was found that approximately 70% of hospital employees and university used social media while in bed, with 15% of them using it for an hour or more each night, leading to adverse effects on sleep and mood [29].

The current study has contemporary relevance as social media has become an integral part of daily life in the digital age, particularly for emerging adults. Moreover, emerging adulthood is a distinct life stage characterized by significant transitions in education, work, and relationships. Additionally, loneliness is a complex emotional experience, and exploring its connection with social media, rumination, and sleep quality provides a more comprehensive understanding. This can form interventions that address the mental health of emerging adults from multiple angles, considering both online and offline factors. The significant gap noticed in this research area is that the existing literature has heavily focused on adolescents and teenagers in the context of social media usage. A cross-sectional study with high school students as the sample found that the average daily time spent on all smart devices was 7.5 hours and that 62.3% of the students reported sleeping with their phone switched on in the bedroom [30]. In the context of loneliness, the research has mainly focused on the elderly, and it is proposed that older individuals are more likely to experience loneliness as a result of not having regular contact with their families, having to stay home due to an increased need for healthcare services, impaired physical functioning or bereavement of loved ones [31]. Prior studies have linked social media usage separately to loneliness, rumination, and sleep quality, but few have examined rumination and sleep quality together as parallel mediators in that relationship. This gap is pronounced in India, where social media engagement among emerging adults is among the highest globally. The present study tests whether rumination and sleep quality jointly mediate the association between social media usage and loneliness in this population.

1.1 Research Question

Based on the literature review, the following research question was formulated:

To explore the relationship between social media usage, sleep quality, rumination and loneliness among emerging adults in India.

1.2 Conceptual Research Model

Based on the above research question and literature review, following conceptual research model was created.

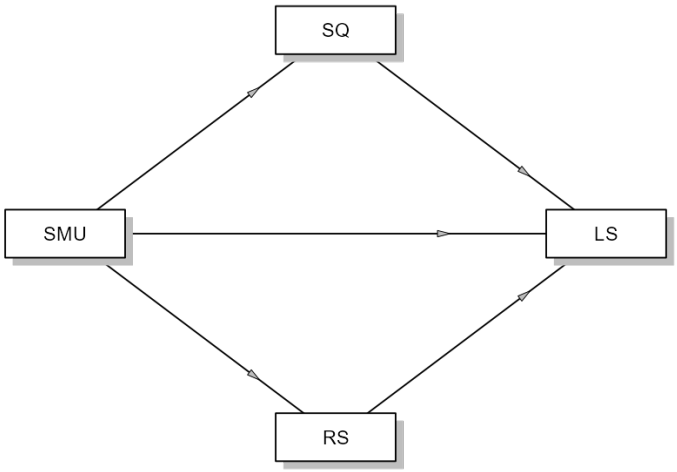


Figure 1. Conceptual Research Model

Note. SMU = social media usage; SQ = sleep quality; RS = rumination; LS = loneliness.

Based on the above conceptual model, following hypothesis were formulated:

H1: Social media usage would significantly predict loneliness

H2: Sleep quality and rumination would significantly predict loneliness

H3: Sleep quality would mediate the role between social media usage and loneliness

H4: Rumination would mediate the role between social media usage and loneliness

2. Methods

2.1 Sample

The participants in this quantitative correlational study comprised males, females, and other emerging adults aged 18–25 who are able to read and write English. The study excluded individuals ever diagnosed with a mental or psychiatric illness. The final sample size consisted of 200 participants from pan-India. A non-probability convenience and purposive sampling technique was selected because it offered an efficient, targeted method to access literate, digitally active college students across urban centers during the data collection window.

2.2 Measures

2.2.1 Social Networking Time Use Scale (SONTUS)

Social Networking Time Use Scale is a psychometric assessment with 29 items measuring the time an individual spends on social networking websites. The scale showcases high internal consistency reliability of 0.92 Cronbach's Alpha. Content and construct validity were established using expert validation and factor analysis respectively. Additionally, face validity was evaluated in a pilot study that demonstrated the scale to be highly readable and understandable. Likewise, predictive, convergent, and incremental validity was demonstrated through wellness and personality measures [32].

2.2.2 UCLA Loneliness Scale (Version 3)

UCLA Loneliness Scale (Version 3) is a psychometric tool including 20 items to assess loneliness among diverse populations including college students, elderly, teachers, and nurses. However, the scale does not have any specific norms. The tool has high reliability (coefficient alpha 0.89 - 0.94) and good test-retest reliability over 1 year (0.73 correlation). Lastly, the scale shows convergent and construct validity owing to its significant correlation with other assessments of loneliness, social support, health and wellness [33].

2.2.3 The Perseverative Thinking Questionnaire

The Perseverative Thinking Questionnaire [34] is a self-report measure of 15 items assessing repetitive negative thinking. The scale demonstrated excellent internal consistency (.92 to .95 Cronbach's alphas) and good test-retest reliability over a 4-week interval (r = .66 to .69). Convergent Validity was established through significant correlations between the PTQ total score and other assessments of Repetitive Negative Thinking (RNT), such as the RSQ, PSWQ, and Rumination Scale. Furthermore, predictive Validity is evidenced through a significant correlation with the IDS assessing present symptom levels of depression, highlighting good

predictive validity [34].

2.2.4 Pittsburgh Sleep Quality Index

The Pittsburgh Sleep Quality Index (PSQI) [35] is a self-report assessment of 19 items measuring sleep quality and disturbance over a one-month period. The scale demonstrated great internal consistency reliability (Cronbach's alpha - 0.80) across four populations. Besides this, it has strong construct validity, as indicated by moderate to high correlations between component and global scores. The PSQI's criterion validity was evidenced by its moderate to high correlations with assessments of sleep quality and problems. Furthermore, discriminant validity was displayed by the scale, highlighting its specificity to sleep-related variables [36].

2.3 Procedure

Data collection took place in India from May to June 2023. The participants were selected through online communication platforms such as Facebook, WhatsApp, Instagram, Telegram and LinkedIn and a link to a secure Google Form was shared. This online data collection approach was selected because it enabled the majority of people in different parts of India to be reached in an environment that is very digitalized. The strategy, however, also created a possible self-selection bias because of the inherent greater chance that individuals with higher social media network activity have of seeing and completing the survey.

A demographic sheet was viewed by the participants and informed consent was provided by asking participants to check a box at the bottom of the form, stating "I accept to participate in the study", as a mandatory requirement before completing the psychometric measures. The collected data was coded and analyzed with Jamovi software. Mediation analysis was chosen as the primary analytic approach, specifically a parallel mediation analysis, as opposed to simple linear regression. This path-analytic approach enables that the unique physiological path (sleep quality) and the unique cognitive path (rumination) from social media use to loneliness are simultaneously examined, while accounting for shared variance between the mediators without compromising Type 1 error.

3. Results

3.1 Results of Background Variables

Table 1 presents demographic variables namely gender, age and socio-economic status. The gender distribution among the sample, with 62 (31%) participants identifying as males and 138 (69%) participants identifying as females. The age distribution from 18–25 years among the sample with 18 (9.0%) participants being 18 years old, 5 (2.5%) participants being 19 years old, 18 (9.0%) participants being 20 years old, 34 (17.0%) participants being 21 years old, 43 (21.5%) participants being 22 years old, 39 (19.5%) participants being 23 years old, 21 (10.5%) participants being 24 years old, and 22 (11.0%) participants being 25 years old. The distribution of socioeconomic status among the sample with 5 (2.5%) participants from the lower class, 1 (0.5%) participant from the lower–middle class, 108 (54.0%) participants from the middle class, 19 (9.5%) participants from the upper–middle class, and 67 (33.5%) participants from the upper class. Group differences among gender, age and socioeconomic status were analyzed. However, there was a lack of statistically significant differences; hence, the tables were excluded.

Table 1. Demographic Variables

Variable	Count (n)	%
Gender		
Male	62	31.0
Female	138	69.0
Age (years)		
18	18	9.0
19	5	2.5
20	18	9.0
21	34	17.0
22	43	21.5
23	39	19.5
24	21	10.5
25	22	11.0
Socioeconomic status		
Lower class	5	2.5
Lower–middle class	1	0.5
Middle class	108	54.0
Upper–middle class	19	9.5
Upper class	67	33.5

3.2 Scale Validation

The authors applied confirmatory factor analysis (CFA) in the present study. As a result, Tables 2 and 3 show the reliability and validity measures.

3.2.1 Reliability Measures

Reliability analysis results from Table 2 indicate that Cronbach's alpha value ranges between 0.820 to 0.938, demonstrating that all the observed items are reliable and consistent.

Table 2. Reliability Analysis

Variable	Cronbach's α	CR	AVE
SMU	0.904	0.956	0.553
LS	0.896	0.957	0.584
RS	0.938	0.953	0.694
SQ	0.820	0.939	0.687

Note. SMU = social media usage; LS = loneliness; RS = rumination; SQ = sleep quality; CR = composite reliability; AVE = average variance extracted.

3.2.2 Validity Measures

The composite reliability (CR) scores must be greater than 0.7, which indicates a fair measure of internal consistency. Table 2 explains the value of composite reliability above 0.7 for all four constructs.

The average variance extracted (AVE) is a determinant of the convergent validity of the scale. Table 2 indicates that all four constructs demonstrated

satisfactory convergent validity with AVE scores exceeding the recommended threshold of 0.5. The value of discriminant validity must be greater than 0.5 to attain the construct validity. Table 3 indicates the value of discriminant validity above 0.5 for all four constructs. Thus, it can be said that the present study possesses a satisfactory measurement model.

Table 3. Discriminant Validity (Fornell–Larcker Criterion)

Construct	SMU	LS	RS	SQ
SMU	(0.744)			
LS	0.163	(0.764)		
RS	0.215	0.528	(0.833)	
SQ	0.201	0.457	0.487	(0.829)

Note. Values in parentheses on the diagonal are the square roots of the AVE; off-diagonal values are inter-construct correlations. SMU = social media usage; LS = loneliness; RS = rumination; SQ = sleep quality.

Taken together, the reliability and validity indices presented in Tables 2 and 3 confirm that the measurement model is statistically adequate and suitable for structural path analysis. All constructs meet or exceed the commonly accepted psychological thresholds of 0.70 for internal consistency (Cronbach's alpha and Composite Reliability) and 0.50 for convergent validity (Average Variance Extracted). Furthermore, the Fornell-Larcker criterion confirms that discriminant validity is established, ensuring that each psychological construct measures a distinct phenomenon in this model.

3.3 Mediation Analysis

The results of the simultaneous parallel mediation analysis are presented in Table 4. The model evaluates both the physiological path (sleep quality) and the cognitive path (rumination) linking social media usage (SMU) to loneliness (LS).

Table 4. Parallel Mediation Analysis

Type	Effect	Estimate	SE	95% CI lower[a]	95% CI upper[a]	β[b]	z	p
Indirect	SMU ⇒ SQ ⇒ LS	0.109	0.0481	0.0145	0.203	0.0482	2.26	0.024
	SMU ⇒ RS ⇒ LS	0.196	0.0672	0.0637	0.327	0.0867	2.91	0.004
Component	SMU ⇒ SQ	0.405	0.1430	0.1248	0.686	0.1964	2.83	0.005
	SQ ⇒ LS	0.268	0.0715	0.1281	0.408	0.2454	3.75	< 0.001
	SMU ⇒ RS	0.695	0.2047	0.2935	1.096	0.2334	3.39	< 0.001
	RS ⇒ LS	0.281	0.0500	0.1835	0.379	0.3715	5.63	< 0.001
Direct	SMU ⇒ LS	0.354	0.1324	0.0949	0.614	0.1572	2.68	0.007
Total	SMU ⇒ LS	0.659	0.1529	0.3590	0.958	0.2921	4.31	< 0.001

Note. SMU = social media usage; LS = loneliness; RS = rumination; SQ = sleep quality. [a] Confidence intervals computed with the standard (delta) method. [b] Betas are completely standardised effect sizes.

The structural model reveals that the direct effect of social media usage on loneliness is positive and statistically significant (β = 0.157, p = 0.007), confirming that higher digital consumption directly corresponds to increased feelings of isolation even when controlling for both mediators. While evaluating the indirect pathways, both proposed channels are statistically meaningful. The indirect effect of social media usage on loneliness through the mediation of sleep quality is significant and positive (β = 0.048, p = 0.024). Similarly, the parallel indirect effect through the cognitive mediation of rumination is also significant and positive (β = 0.087, p = 0.004).

The total overall effect of social media usage on loneliness (combines both the direct and combined indirect pathways) is statistically significant and positive (β = 0.2921, p < .001), emphasizing the comprehensive impact of digital habits on emerging adults' isolation. However, because the direct path from social media usage to loneliness remains statistically significant alongside the indirect paths, the data supports a model of partial mediation rather than full mediation. The modest standardized indirect effect sizes (β = 0.048 for sleep quality and β = 0.087 for rumination) indicate that while these internal cognitive and physiological mechanisms are empirically meaningful, they only partially account for the relationship, leaving a large portion of the variance in loneliness to be explained by alternate external or individual factors.

The underlying component paths within the structural model further clarify these relationships. The effect of social media usage on sleep quality is significant and positive (β = 0.1964, p = 0.005), and sleep quality subsequently predicts increased loneliness (β = 0.2454, p < .001). Concurrently, the path from social media usage to rumination is significant and positive (β = 0.2334, p < .001), with rumination acting as a highly significant predictor of increased loneliness (β = 0.372, p < .001).

3.4 Statistical Research Model

The following statistical research model shows the mediating effect of rumination and sleep quality between social media usage and loneliness.

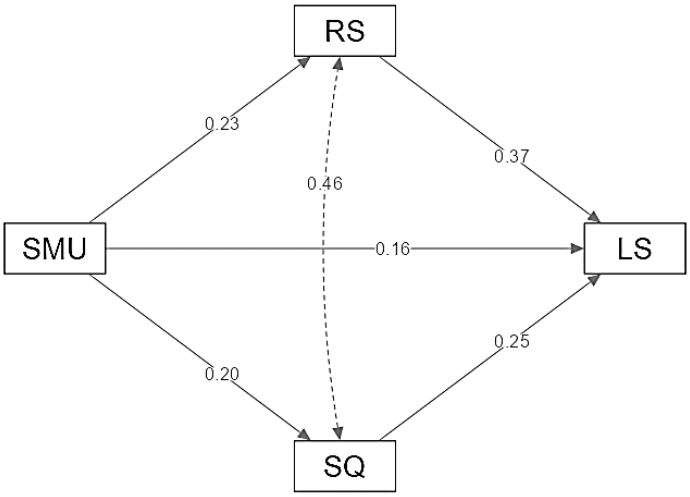


Figure 2. Statistical Research Model

Note. SMU = social media usage; SQ = sleep quality; RS = rumination; LS = loneliness. Values are standardised path coefficients; the dashed line indicates the residual covariance between the two mediators.

4. Discussion

The present study aimed to examine the social media-loneliness association with regard to the parallel role of sleep quality and rumination as mediators among emerging adults in India. The results of the empirical observations confirm the proposed pathways. First, there is a direct positive association between social media usage and loneliness, indicating that greater use of social media is associated with higher levels of loneliness. Secondly, sleep quality and rumination are important predictors of loneliness. Importantly, the parallel mediation analysis shows that the sleep quality and rumination each significantly mediate between social media use and loneliness. Because the direct path remains significant alongside the indirect paths, the data supports a model of partial mediation. This suggests that social media may directly contribute to increased isolation, but also that there is a dual relationship between repetitive thinking and sleep disruption and isolation. Such dynamics are well connected to the concepts of Arnett's Emerging Adulthood Theory and Erikson's Psychosocial Development Theory [37]. The late teens to early twenties period of life are a unique developmental phase of instability, self-focus, and identity experimentation, according to Arnett. In the context of these unstructured life transitions, emerging adults are very dependent on digital environments to satisfy their developmental needs for connection. This intensive digital exploration however regularly leads to the viewing of idealized versions of peers' lives, leading to Upward Social Comparisons [21].

It is the age period when, according to Erikson's theory, Intimacy vs. Isolation is a developmental crisis in which individuals actively pursue close interpersonal relationship and social support. A lack of true, physically present emotional connection in virtual interactions gives emerging adults a sense of relational dissonance and anonymity, contributing to the feelings of loneliness. An important result of this research is that rumination is a more parallel mediator than sleep quality. Given their hierarchical separation, it gives important psychological insights to this demographic. Although blue light and sleep fragmentation have a physical impact disrupting the circadian rhythm [13,27], the cognitive processing of the social media content seems to have a more immediate and strong effect on the internalization of distress. Emerging adults are more likely to have passive cognitive coping styles due to their heightened self-centeredness and vulnerability of identity. Highly active users engage in "social media rumination" which includes ruminating passively on their own social media content, loops of feedback, and self-perceived social inadequacies [17,22]. This internal cognitive rumination is a powerful driver of perceived loneliness, and the mental consequences of the digital environment on psychological well-being are more profound than the objective disruption of sleep alone.

Several research findings support the favourable correlation and effects of social media usage on loneliness, sleep quality, and rumination. A recent investigation illustrated that a 10% escalation in adverse social media experiences correlated with a 13% increase in feelings of loneliness [38]. In line with Hartung and Renner’s [9] definition of loneliness about expectation vs reality of the level of intimacy in social relationships, the current research suggests that because of increased online interactions individuals may experience a lack of intimacy in their social relationships owing to lack of physical presence which may result in feelings of anonymity and detachment. In the short term, this excessive social media use could offer comfort as an escape from reality, but over time, it compromises

people's connection to reality and reduces their sense of belonging in interpersonal interactions [39]. Conversely, the 'Uses and Gratification Theory' posits that people are driven to engage in a specific type of social media usage to fulfil their psychosocial needs [40]. Additionally, it is also suggested that engaging in addictive levels of social media usage is linked to increased inclinations toward rumination [41]. Likewise, Social Comparison Theory by Festinger [21] postulates that increased social media engagement could cause heightened exposure to upward social comparison, subsequently culminating in heightened rumination [42]. Furthermore, research indicates that people consume online content to cope and distract themselves from environmental stressors [43,44], aligning with the response style theory, which views rumination as a coping style, theorizing that individuals may dwell on the social media content instead of the immediate environmental stressor. Concerning sleep, research involving young adults of the United States revealed that using social media within half-hour before bedtime is linked with elevated sleep disturbances [45]. A study found that excessive social media use and certain sleep habits differently impact sleep problems and that Fear of Missing Out (FOMO) indirectly predicts sleep problems in two groups of young adults [46]. Additionally, it was discovered that 63.39% of Indian medical students had poor sleep quality owing to social media addiction [47]. Correspondingly, in another research it was demonstrated that, in young adults, there is a greater prevalence of anxiety and related symptoms, which are linked with mental stress, poor sleep quality, and dysfunctional sleep hygiene [48].

The results of this study are subject to a number of methodological limitations. First, the study design is purely cross-sectional: at one point in time. A causal directionality cannot be definitely determined and a reverse-causal directionality is not ruled out since the data on social media use, sleep quality, rumination and loneliness were all collected at the same time. Longitudinal or cross-lagged panel designs should be used by future researchers to follow the psychological and physiological trajectories and pathways across long developmental timelines. Second, self-report psychometric scales were used to assess all variables. This is subjective and liable to recall errors and social desirability biases in particular with regard to the estimated number of screens per day on the SONTUS scale. Future research would benefit from the use of digital screen time tracking and physiological sleep measures (actigraphy or polysomnography) to further enhance objective accuracy. Lastly, the study used non-probability convenience and purposive sampling framework of 200 literate people, limiting the generalizability of the findings. Within urban collegiate settings, there is a disproportionate representation of females (69%) and a disproportionate representation of middle and upper socio-economic classes (87.5%). Future empirical studies need to use the stratified random sampling technique to obtain a more socio-economically, geographically, and educationally heterogeneous group of emerging adults in rural and non-collegiate context in India.

5. Conclusion

Overall, this study sheds light on the intricate interplay between social media use, feelings of loneliness, rumination, and sleep quality in Indian college students. The results show that there is a significant positive correlation between the use of social media and these psychological variables, indicating the considerable influence of social media on mental health. The findings of the study indicate that social media can provide social connections yet overuse of social media can increase loneliness and rumination while contributing to poorer sleep quality. The findings emphasize the need for developing interventions that can foster healthy social media use behaviors and target the emotional needs of people. These are complex dynamics that can be understood to help guide interventions that support the mental health of this population today in an increasingly digital world.

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Conflicts of Interest: The authors declare no conflicts of interest.

Ethics Statement and Informed Consent Statement: The study was approved by the CHRIST (Deemed to be University) Delhi NCR Institutional Ethics Committee (IRB No. 1162322223013) and was conducted in accordance with ethical standards. Informed consent was obtained from all participants online: before completing the questionnaires, each participant was required to tick a box stating "I accept to participate in the study".

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Data Availability Statement: The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Both authors contributed to the conception and design of the study. Koteshwar Ramesh Rakesh carried out material preparation and data collection and wrote the first draft of the manuscript. Ananya Singhal performed the data analysis. Both authors edited and approved the final manuscript.

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