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Enigma of social media use: complexities of social media addiction through the serial mediating effects of emotions and self-presentation

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Introduction: Excessive social media use, though considered unhealthy, is no longer formally categorized as an addiction or disorder, leading to a lack of consensus on this behavior. It raises concerns regarding the exclusion of Internet Addiction Disorder from the DSM-5-TR due to insufficient empirical evidence. This study investigates the serial mediating effects of positive and negative affect, fear of missing out, and offline and online self-presentation in the relationship between social media use and social media addiction.

Method: The study was conducted in Hong Kong with 385 participants (84.2% F, age range = 18−60) of an online survey. This study administered the Social Media Use Scale, Positive and Negative Affect Schedule, Fear of Missing Out Scale, Presentation of Online Self Scale, and Bergen Social Media Addiction Scale.

Results: The results indicate that social media use plays a significant role in predicting both positive and negative affect. The findings further reveal that positive and negative affect, fear of missing out, and offline and online self-presentation act as serial mediators in the relationship between social media use and social media addiction. In other words, these variables work together in a sequential manner to mediate the impact of social media use on addiction. Additionally, the study indicates that social media use and social media addiction are fully mediated by both positive and negative affect, fear of missing out, and offline and online self-presentation.

Discussion: Social media use can evoke both positive and negative affect. The longer individuals are immersed in social media, the more their positive affect intensifies, exacerbating FoMO and fostering inconsistent offline and online self-presentation. Conversely, extended social media engagement can heighten negative affect, leading to anxiety about others having more rewarding experiences and concurrently inducing apprehension characterized by FoMO. To prevent addiction, the development of educational tools such as SimCity video games, scenario-based learning activities, and virtual reality experiences focused on social media use and social media addiction can offer a valuable opportunity for pre-exposure to the related risks and challenges.

KEYWORDS

serial mediation, social media addiction, social media use, positive and negative affect, fear of missing out, offline and online self-presentation

1 Introduction

Social media provides users with opportunities to exchange information and opinions, explore interests, communicate with friends, and grow one's social network by connecting with a diverse group of people (Withington and Punch, 2019). Individuals use social media platforms, including collaborative projects, blogs, online communities for sharing content, social networking websites, virtual gaming worlds, and virtual social worlds (Kaplan and Haenlein, 2010), for diverse aims.

Social media use (SMU) has reached a staggering milestone, with approximately 5.17 billion individuals, almost 64% of the global population, actively engaging with these various platforms worldwide as of March 2024 (Shewale, 2024). This overview of the situation highlights the widespread adoption and pervasive influence of social media in today's interconnected society.

Over recent decades, social media has become an integral part of people's lives, particularly when they rely on technology to connect with others worldwide and access information at home and elsewhere, and the majority of research has focused on the negative factors of social media (e.g., Choi and Noh, 2019; El Abiddine et al., 2022). For example, studies have shown that more time spent using social media increases negative emotions (e.g., addiction, depression, loneliness, and anxiety) and fear of missing out (FoMO) (Houghton et al., 2018; Hunt et al., 2018; Shabahang et al., 2023), while increasing SMU has shown detrimental effects on the mental and physical well-being of both children and adults (Brown, 2021; Marengo et al., 2022).

By contrast, comparatively positive factors, especially SMU's generation of positive emotions among users, including satisfaction, pride, and a sense of belonging (McKinsey Health Institute, 2023; Ng and Indran, 2023; Ostic et al., 2021), have been underexamined. Such positive emotions can enhance users' self-disclosure as well as foster connection and enhance communication (Kim et al., 2014; Winstone et al., 2021). Notwithstanding these scarce findings, the potential beneficial impacts of SMU demand further examination.

Another important concept in this discussion is social media addiction (SMA), which is employed in this study to elucidate and characterize problematic SMU patterns across social networking sites (Andreassen, 2015; Andreassen et al., 2016). SMA, characterized by the compulsive and excessive use of social media platforms, is often considered a psychological disorder. Research has consistently shown that the symptoms of SMA share similarities with substance abuse disorders, including social anxiety, depression, and withdrawal symptoms (Bányai et al., 2017).

Drawing from the diagnostic criteria for pathological gambling outlined in the DSM-IV-TR, Young (1998) was the first to introduce the concept of Internet Addiction Disorder (IAD), which includes such characteristics as tolerance, preoccupation, and difficulty in reducing usage. IAD is known as problematic or pathological Internet use, which is only considered for the DSM-5-TR. However, the DSM-5-TR and International Classification of Diseases (ICD-11) have no longer classified excessive Internet use as a recognized disorder (American Psychiatric Association, 2022; World Health Organization, 2022). Instead of being considered a formal disorder, it is included only in the appendix of DSM-5-TR given the insufficient empirical evidence supporting Internet addiction (American Psychiatric Association, 2022; Murali and George, 2006).

SMA, known as problematic SMU (D'Arienzo et al., 2019; Lin et al., 2024), is characterized as a behavioral addiction marked by excessive concerns about social media, driven by an uncontrollable urge to engage with or access social platforms, and spending too much time and effort that it interferes with other important aspects of one's life. However, it is controversial to use the term "addiction" in relation to social media and its potential for addiction (Domoff et al., 2022; Lin et al., 2024). Building upon this claim, it is necessary to expand the body of knowledge on SMA.

Individuals who use social media for more than two hours per day are twice as likely to suffer social isolation as those with an SMU of less than half an hour per day (Primack et al., 2017). Many individuals' uncontrollable desire to browse social media pages results in high engagement in online activities, which can be linked to negative consequences in the personal, professional/academic, and social domains, including addiction, loneliness, depression, work impairment, low self-esteem, a diminished capacity to form meaningful relationships, poor sleep quality, poor well-being, and underperformance at work (Arrivillaga et al., 2022; Bányai et al., 2017; Lin et al., 2016, 2024; Zarate et al., 2023). Consequently, excessive engagement with social media can contribute to the development of SMA, which significantly impacts psychological well-being (Sun and Zhang, 2021).

1.1 Social media use and social media addiction

In this digital age, individuals tend to concentrate their attention on social media platforms, actively engaging with the diverse content and interactions offered. This sustained focus involves the allocation of cognitive resources and time in browsing, posting, liking, and responding through an ever-expanding stream (e.g., posts, photos, videos, and stories). A virtual environment offers the ability to remain anonymous (or at least non-identifiable) to dyadic or group interaction partners as well as find interaction partners who share aspects of one's online self (Marriott and Buchanan, 2014). Social media platforms allow individuals to update, share, and publish content in various ways, enabling them to construct ideal and diverse self-presentations (Nadkarni and Hofmann, 2012). The captivating allure of visually appealing informative and interactive elements integrated within social media platforms contribute to individuals' enjoyment and satisfaction, fulfilling their psychological needs for self-expression, social connection, and content discovery. Nevertheless, this flow experience can also be characterized by intensified concentration, a gradual loss of self-awareness, and a merging of action and consciousness. It is also accompanied by a strong sense of control, a distorted perception of time, a feeling of relief, and a high level of intrinsic reward (Csikszentmihalyi, 1990). Such excessive concentration and pleasure may lead to SMA.

> *Hypothesis 1*: SMU positively predicts SMA (H1).

1.2 Positive and negative affect

Positive affect refers to the inclination to encounter positive emotions and engage in positive interactions with others despite life's difficulties, indicating the level of enthusiasm, activity, and alertness. High positive affect signifies a state of heightened energy, complete focus, and enjoyable involvement (Li et al., 2020; Watson et al., 1988). By contrast, negative affect refers to perceiving the world in a negative manner and

encompasses various aversive emotions such as anger, contempt, disgust, guilt, fear, and nervousness (Malodia et al., 2024). However, when expressed in the wrong situations, emotions tend to be harmful.

Flow experience can occur in both positive and negative emotional states, encompassing a wide range of emotional arousal (Brock, 2017). It is more likely to manifest when individuals are experiencing positive emotions (Csikszentmihalyi, 2014). Individuals engaged and immersed in activities tend to exhibit persistent behavioral involvement when accompanied by positive emotions (Skinner and Belmont, 1993). When individuals experience flow, they often describe being "in the zone" or feeling completely absorbed in the present moment. Individuals experience positive affect when engaging in pleasurable and exciting SMU, especially during the early stages of use, as they communicate with others and participate in various activities.

Nevertheless, individuals may experience negative emotions, including irritability, anxiety, and depression, as a result of excessive SMU, leading to the development of SMA. For instance, peer exclusion and rejection on social media can be distressing for adolescents, compromising feelings of belonging, competency, and autonomy, which can threaten their achievement of developmental tasks (Marengo et al., 2021; Zimmer-Gembeck, 2016). However, the impact of negative affect on flow experience merits further scholarly investigation.

> *Hypothesis 2*: Positive affect (H_{2a}) and negative affect (H_{2b}) act as mediators between SMU and SMA.

1.3 FoMO

FoMO is the pervasive fear that others may be enjoying rewarding experiences while one is missing out (Przybylski et al., 2013a), leading individuals to have a strong desire to stay updated on the statuses of others, even when they believe that others are experiencing satisfaction in their absence (Błachnio and Przepiórka, 2018). FoMO, which is strongly associated with high SMU (Dinçer et al., 2022), leads to the performance of continuous online activities (Cao et al., 2018; Rosen et al., 2018) and other adverse behaviors (Stead and Bibby, 2017). Studies have also found that SMU affects FoMO and has long-lasting consequences on individuals' psychological well-being (Baker et al., 2016; Marengo et al., 2021).

The abundance of hedonic gratifications provided by social media platforms has led to protracted engagement among users. The availability of diverse forms of social interaction and entertainment contributes to the allure of these platforms. Moreover, the reinforcement loop created by repeated exposure to gratifications fosters profound conditional behavior. Excessive SMU engenders compulsive checking behaviors, wherein individuals are predisposed to habitually inspecting their social media accounts in a state of unawareness. These compulsive disorders have been termed "disconnection syndrome" and "ring or phantom vibration syndrome" (Drouin et al., 2012).

The negative emotions arising from being exposed to unfavorable content and information on social media can intensify FoMO and lead to frequent engagement to avoid missing others' updates as well as concern about being overlooked. Individuals may experience agitation, anxiety, and unease when perceiving themselves as excluded by their peers. FoMO is often considered an antecedent of negative behaviors such as SMA and problematic Internet use (Fang et al., 2020; Gori et al., 2023; Servidio et al., 2024) as well as inauthentic self-presentation on social networking sites (Wang et al., 2018). Feelings

of anxiety or alienation increase SMU as a means to alleviate the fear of isolation and to seek relief. Driven by these compensatory mechanisms, individuals are negatively reinforced and potentially become addicted to social media (Monacis et al., 2021).

> *Hypothesis 3*: FoMO acts as a mediator between SMU and SMA (H_3).

1.4 Offline and online self-presentation

Self-presentation is a behavioral trait where individuals intentionally build their image to create a desired impression on others (Fox and Vendemia, 2016). Individuals can be deliberate about how they present themselves online; for example, they can intentionally post specific content, edit existing information, and delete content that shows them in a less favorable way (Fullwood et al., 2020). In particular, social media allows people to experiment with various self-presentations and see how others react. By receiving approval (e.g., likes and comments), a particular self-presentation can be authenticated, which may then be incorporated into one's offline identity (Manago et al., 2008).

Zhao et al. (2008) found that emerging adults use specific strategies to present their online self on Facebook. However, other studies show consistency between offline and online self-presentation despite omitting or exaggerating certain aspects of themselves (Fullwood et al., 2016; Marriott and Buchanan, 2014; Strimbu and O'Connell, 2019). Individuals who present a false ideal self are less affected psychologically by the reality of the situation and disappointment than those who think they are presenting their real selves to others online (Attrill-Smith, 2019). Consequently, this behavior can increase the risk of SMA among certain individuals.

> *Hypothesis 4*: Offline and online self-presentation acts as a mediator between SMU and SMA (H_4).

Human psychological development and emotional suffering are adversely affected by negative experiences (e.g., FoMO) in SMU, particularly in the early stages of adolescence (Marengo et al., 2021). Studies have found that individuals experiencing depression exhibit specific patterns of SMU, including perceiving themselves in an idealistic manner compared with others, sharing risky behaviors, posting negative or harmful content, and engaging in negative verbal interactions with others (Radovic et al., 2017). Additionally, excessive SMU is associated with negative impacts such as FoMO, multiple online self-presentation, and addiction (Al-Busaidi et al., 2023; Fullwood et al., 2016; Talan et al., 2024; Wang, 2021; Wolniewicz et al., 2018). However, the impact of excessive SMU on individuals has not been fully explored, particularly its interrelations with positive and negative affect, FoMO, online self-presentation, and SMA. Hence, the interconnectedness of these factors and their role as serial multiple mediators in the relationship between SMU and SMA need to be investigated.

> *Hypothesis 5*: Positive affect and FoMO (H_{5a}) as well as negative affect and FoMO (H_{5b}) act as serial mediators between SMU and SMA.

> *Hypothesis 6*: Positive affect and offline and online self-presentation (H_{6a}) as well as negative affect and offline and online self-presentation (H_{6b}) act as serial mediators between SMU and SMA.

Hypothesis 7: FoMO and offline and online self-presentation act as serial mediators between SMU and SMA (H_7).

Hypothesis 8: Positive affect, FoMO, and offline and online self-presentation (H_{8a}) as well as negative affect, FoMO, and offline and online self-presentation (H_{8b}) act as serial mediators between SMU and SMA.

Based on the foregoing, this cross-sectional study investigates the serial mediating effects of positive and negative affect, FoMO, and offline and online self-presentation on the relationship between SMU and SMA, providing insights into the psychological impacts of SMU. Figure 1 illustrates the hypothesized serial multiple mediation model.

2 Materials and methods

2.1 Participants

2.1.1 Recruitment feasibility

Power analysis was performed using the G*Power 3.0.10 program to determine the required sample size for the study. Accordingly, with a power level of 0.95 and a significance level of 0.05, a small effect size of $r = 0.20$ (Cohen, 1988) was determined. Based on the analysis, the required sample size was 385.

To be eligible for inclusion, participants ($N = 385$, age range = 18–60; $M = 25.37$ years; $SD = 8.61$) had to report using social media. Women were overrepresented ($n = 324$, 84.2%) compared with men ($n = 61$, 15.8%). Most belonged to Gen Z ($n = 306$, 79.5%). The majority had completed a bachelor's degree ($n = 151$, 39.2%) and sub-degree programs ($n = 130$, 33.8%). More than half of the participants were working in a part-time job ($n = 208$, 54%). Table 1 summarizes the participants' characteristics.

2.2 Measures

2.2.1 SMU

The following 10 items captured SMU: (1) time spent on social media daily; (2) types of social media platforms used (e.g., Facebook, Instagram); (3) types of social media platforms most often used; (4) social media functions most often used (e.g., instant messaging, social networking); (5) functions of AI-generated content (e.g., AI-generated content/writing, image creation with AI/augmented reality filter); (6) social media content most often browsed (e.g., pictures, text, stories); (7) the frequency of updating your status/sharing or publishing posts, photos, videos, or text on social media; (8–10) and the frequencies of browsing, liking, and responding to others' status updates, posts, photos, videos, and text on social media. Items (7–10) were answered on a six-point Likert scale (1 = *very rarely/never*, 6 = *several times a day*), with higher scores indicating a higher frequency of SMU. The SMU scale had a Cronbach's alpha coefficient of 0.75 in this study.

2.2.2 Positive and Negative Affect Schedule

The Positive and Negative Affect Schedule (Watson et al., 1988) measures positive and negative affect over the past week. It consists of 20 items rated on a five-point Likert scale (1 = *very slightly or not at all*, 5 = *extremely*), divided into two 10-item subscales related to positive affect (e.g., "interested") and negative affect (e.g., "distressed"). Higher scores represent higher levels of positive affect, while lower scores represent lower levels of negative affect. The Cronbach's alphas for the two subscales ranged from 0.87 to 0.95, with the overall scale having a Cronbach's alpha of 0.93 in this study.

2.2.3 Fear of Missing Out Scale

The Fear of Missing Out Scale (Przybylski et al., 2013a, 2013b) assesses participants' FoMO via their everyday experiences. The scale has 10 items (e.g., "I get anxious when I do not know what my friends
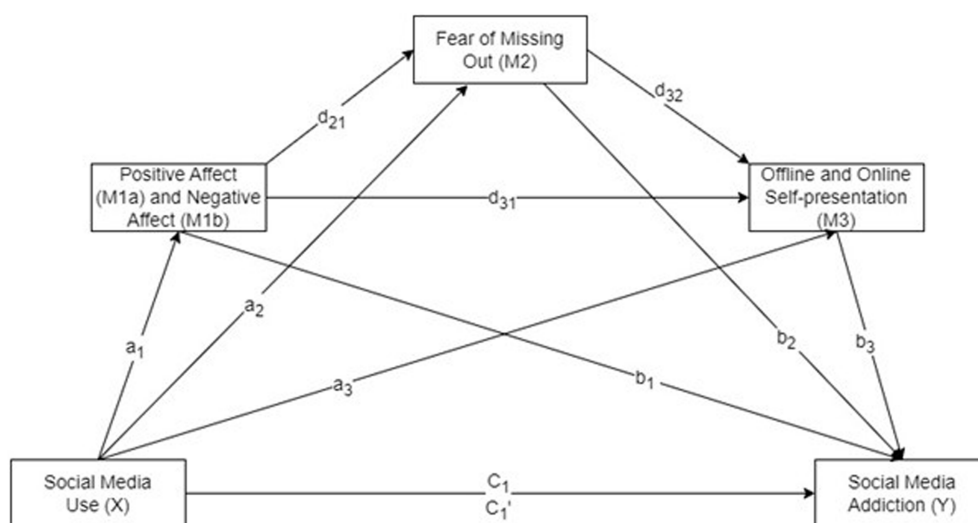

FIGURE 1
The hypothesized serial multiple mediation model with three mediators (M_{1a} = positive affect, M_{1b} = negative affect, M_2 = fear of missing out, M_3 = offline and online self-presentation). Positive affect and negative affect were tested separately.

are up to") rated on a five-point Likert scale (1 = *not at all true of me*, 5 = *extremely true of me*). Higher scores indicate a higher level of FoMO. The total scale had a Cronbach's alpha of 0.89 in this study.

2.2.4 Presentation of Online Self Scale

The Presentation of Online Self Scale (Fullwood et al., 2016) assesses participants' experiences of offline and online self-presentation. It consists of 21 items rated on a five-point Likert scale (1 = *strongly disagree*, 5 = *strongly agree*). The scale comprises four subscales: ideal self (e.g., "I can show my best qualities online"), multiple selves (e.g., "I enjoy acting out different identities online"), consistent self (e.g., "I feel I am the same person in the cyber world that I am in the real world"), and online presentation preference (e.g., "I find it difficult to be myself in the real world"); these subscales have nine, five, four, and three items, respectively. Higher scores indicate higher presentation. Given the risk of the discrepancy between one's ideal self and true self, this study investigated the ideal self, multiple

selves, and online presentation preference subscales. The Cronbach's alphas for these subscales ranged from 0.64 to 0.92 and the overall scale had a Cronbach's alpha of 0.86 in this study.

2.2.5 Bergen Social Media Addiction Scale

The Bergen Social Media Addiction Scale (Andreassen et al., 2016) assesses experiences with addictive behaviors in the previous 12 months. It consists of six items (e.g., "You feel an urge to use social media more and more") rated on a five-point Likert scale (1 = *very rarely*, 5 = *very often*). Higher scores indicate a greater risk of problematic SMU. The scale had a Cronbach's alpha of 0.82 in this study.

2.3 Data collection and analysis

The participants were recruited via three of the most popular social media platforms (i.e., Facebook, Instagram, and WhatsApp) by convenience sampling. A link or QR code with an overview of the study was provided via a self-administered online survey, which took approximately 20 min. The online survey was divided into five parts: an introductory page, an informed consent statement, SMU habits, questionnaires of the four scales, and demographic questions. The online survey offered an acceptable degree of privacy and anonymity. IBM SPSS 29 was used for quantitative analyses. There were no missing data. To examine the relationships between the variables in the serial multiple mediation analyses, bivariate correlations were computed. Harman's single-factor test was used to check that common method bias was not present (Podsakoff et al., 2003). All the variables were included in an exploratory factor analysis and the unrotated factor solution was examined (McFarlin and Sweeney, 1992).

Sequential mediation models were analyzed to investigate the hypotheses. To ascertain the indirect effects, 10,000 bootstrap samples were employed in conjunction with Model 6 of the PROCESS macro in SPSS (version 4.3.1; Hayes, 2022). Using the bootstrapping technique of Bollen and Stine (1990) yielded 95% bias-corrected bootstrap confidence intervals. Statistical significance was set at 5% (Cohen et al., 2016).

2.4 Ethical considerations

This study followed the ethical guidelines and standards set forth by the American Psychological Association and received approval from the university's Research Ethics Committee after a thorough review. The primary data remained confidential and the participants' identities were protected, as only aggregated findings were presented, without disclosing individual details in the analysis. All the participants were

TABLE 1 Participants' characteristics (*N* = 385).

		N	%
Gender	Male	61	15.8
	Female	324	84.2
Age (years)	12–27 (Generation Z)	306	79.5
	28–43 (Millennials)	54	14.0
	44–59 (Generation X)	24	6.2
	60–69 (Boomers II)	1	0.3
Educational attainment	Secondary school	2	0.5
	High school/university-preparatory school	82	21.3
	Sub-degree (e.g., certificate, higher diplomas, diplomas)	130	33.8
	Bachelor's degree	151	39.2
	Master's, postgraduate diploma, postgraduate certificate, postgraduate diploma in education	18	4.7
	PhD	2	0.5
Employment status	Working full-time	75	19.5
	Working part-time	208	54.0
	Retired	1	0.3
	Unemployed	3	0.8
	Not employed	77	20.0
	Student	21	5.4

TABLE 2 Means, standard deviations, and correlations among the variables (*N* = 385).

Variable	M	SD	1	2	3	4	5
1. SMU	5.49	3.72					
2. Positive affect[@]	25.70	6.89	0.11*				
3. Negative affect[@]	19.36	7.71	0.18***	0.58***			
4. FoMO[^]	23.67	7.83	0.13*	0.39***	0.42***		
5. Offline and online self-presentation[#]	42.46	11.57	0.17**	0.51***	0.47***	0.51***	
6. SMA[©]	14.42	4.70	0.14**	0.49***	0.47***	0.62***	0.59***

[@]Positive and Negative Affect Schedule; [^]Fear of Missing Out Scale; [#]Presentation of Online Self Scale without consistent self; [©]Bergen Social Media Addiction Scale. Values on the diagonal are the Cronbach's α coefficients. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

fully informed about the aims of the study and informed consent was obtained. There was a clear statement that their involvement would not cause them any harm, either physically or psychologically. Further, the participants were informed that they could withdraw from the study at any time without incurring any consequences.

3 Results

3.1 Descriptive statistics

As presented in Table 2, all the variables were significantly correlated (Cohen, 1988). SMU had a weak, positive, and statistically significant correlation with positive affect ($r = 0.11$, $p < 0.05$), negative affect ($r = 0.18$, $p < 0.001$), FoMO ($r = 0.13$, $p < 0.05$), offline and online self-presentation ($r = 0.17$, $p < 0.01$), and SMA ($r = 0.14$, $p < 0.01$). Positive affect had a moderate, positive, statistically significant correlation with negative affect ($r = 0.58$, $p < 0.001$), FoMO ($r = 0.39$, $p < 0.001$), offline and online self-presentation ($r = 0.51$, $p < 0.001$), and SMA ($r = 0.49$, $p < 0.001$). Negative affect had a moderate, positive, statistically significant correlation with FoMO ($r = 0.42$, $p < 0.001$), offline and online self-presentation ($r = 0.47$, $p < 0.001$), and SMA ($r = 0.47$, $p < 0.001$). FoMO had a moderate, positive, statistically significant correlation with offline and online self-presentation ($r = 0.51$, $p < 0.001$) and a strong, positive, and statistically significant correlation with SMA ($r = 0.62$, $p < 0.001$). Offline and online self-presentation had a moderate, positive, and statistically significant correlation with SMA ($r = 0.59$, $p < 0.001$).

3.2 Serial multiple mediation analyses

Table 3 summarizes the results of the first PROCESS analysis. Figures 2, 3 show the results of the serial multiple mediation analyses.

3.3 Mediating roles of positive affect, FoMO, and offline and online self-presentation

The results showed a total effect (c) of SMU on SMA through the mediators, $B = 0.18$, $p < 0.01$. This finding indicated that increased SMU generated a greater degree of SMA with the mediators. However, when the mediators were removed from the analysis, this coefficient was not statistically significant (direct effect, c'), $B = 0.03$, $p = 0.57$, rejecting H$_1$. SMU was also found to be a positive predictor of positive affect ($B = 0.21$, $p < 0.05$) (a$_1$), but not a predictor of FoMO ($B = 0.18$, $p = 0.66$) (a$_2$) or offline and online self-presentation ($B = 0.24$ $p = 0.07$) (a$_3$) (Figure 2).

As shown in Table 4, the analysis of the indirect mediating effects by bootstrapping found that the resulting data supported the significance of Path 1 (SMU ➜ Positive affect ➜ SMA; $B = 0.0248$, $SE = 0.0159$, 95% CI [0.0030, 0.0641]), confirming H$_{2a}$; Path 3 (SMU ➜ FoMO ➜ SMA; $B = 0.0303$, $SE = 0.0202$, 95% CI [0.0009, 0.0797]), confirming H$_4$; Path 4 (SMU ➜ Positive affect ➜ FoMO ➜ SMA; $B = 0.0210$, $SE = 0.0134$, 95% CI [0.0026, 0.0555]), confirming H$_{5a}$; Path 5 (SMU ➜ Positive affect ➜ Offline and

TABLE 3 Summary of the multiple regression analyses for the serial multiple mediation model.

Variable	Model 1					Model 2					Model 3					Model 4				
	B	95% CI	SE B	β	t	B	95% CI	SE B	β	t	B	95% CI	SE B	β	t	B	95% CI	SE B	β	t
Constant	24.56	[23.34, 25.79]	0.62		39.42***	11.55	[8.66, 14.44]	1.47		7.85***	12.87	[8.92, 16.82]	2.01		6.40***	0.39	[−1.12, 1.90]	0.77		0.51
SMU	0.21	[0.02, 0.39]	0.09	0.11	2.22*	0.18	[−0.01, 0.38]	0.10	0.09	1.85	0.24	[−0.01, 0.49]	0.13	0.07	1.91	0.03	[−0.06, 0.12]	0.05	0.02	0.57
Positive affect						0.43	[0.33, 0.54]	0.05	0.38	8.06***	0.61	[0.46, 0.75]	0.07	0.36	8.26***	0.12	[0.06, 0.18]	0.03	0.18	4.12***
FoMO											0.53	[0.41, 0.66]	0.06	0.36	8.22***	0.23	[0.18, 0.89]	0.03	0.39	9.17***
Offline and online self-presentation																0.12	[0.09, 0.16]	0.02	0.31	6.73***
	$R^2 = 0.01$, $F_{(1, 383)} = 4.91$, $p < 0.05$					$R^2 = 0.16$, $F_{(2, 382)} = 36.29$, $p < 0.001$					$R^2 = 0.38$, $F_{(3, 381)} = 78.83$, $p < 0.001$					$R^2 = 0.51$, $F_{(4, 380)} = 99.55$, $p < 0.001$				

$N = 385$. Model 1, predictor variable: SMU; outcome variable: positive affect. Model 2, predictor variables: SMU and positive affect; outcome variable: FoMO. Model 3, predictor variables: SMU, positive affect, and FoMO; outcome variable: offline and online self-presentation. Model 4, predictor variables: SMU, positive affect, FoMO, and offline and online self-presentation; outcome variable: SMA. SE, standard error. *$p < 0.05$, ***$p < 0.001$.
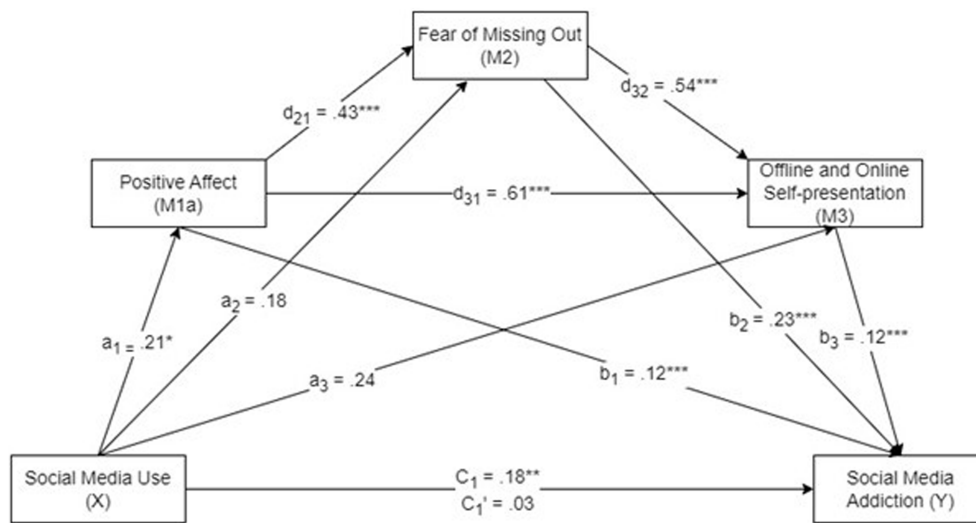
FIGURE 2
The serial multiple mediation analysis of the relationship between social media use and social media addiction mediated via positive affect, fear of missing out, and offline and online self-presentation. c: total effect of SMU; c': direct effect of social media use with the mediators controlled for. Unstandardized regression coefficients are reported. $*p < 0.05$, $**p < 0.01$. $***p < 0.001$.
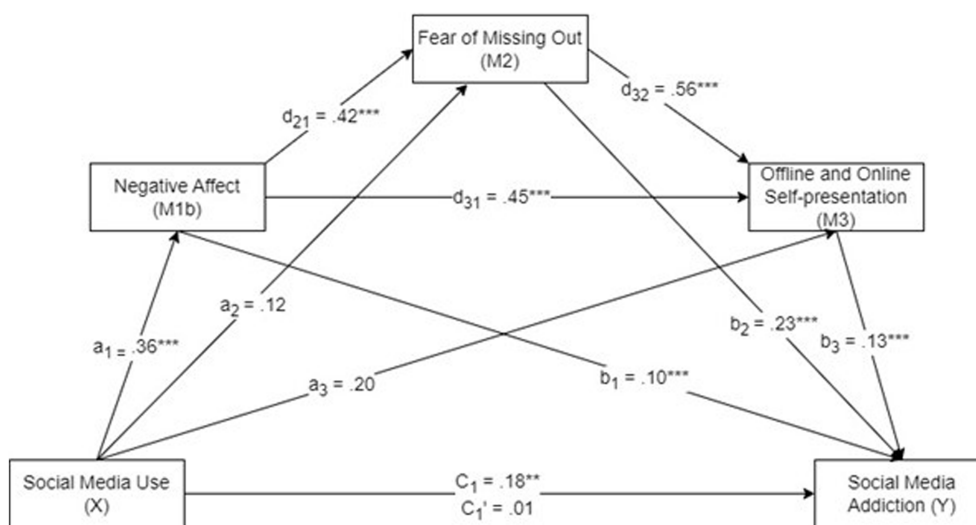

FIGURE 3
The serial multiple mediation analysis of the relationship between social media use and social media addiction mediated via negative affect, fear of missing out, and offline and online self-presentation. c: total effect of SMU; c': direct effect of SMU with the mediators controlled for. Unstandardized regression coefficients are reported. $**p < 0.01$, $***p < 0.001$.

online self-presentation ➔ SMA; $B = 0.0158$, $SE = 0.0099$, 95% CI [0.0020, 0.0405]), confirming H_{6a}; and Path 7 (SMU ➔ Positive affect ➔ FoMO ➔ Offline and online self-presentation ➔ SMA; $B = 0.0060$, $SE = 0.0038$, 95% CI [0.0008, 0.0155]), confirming H_{8a}. However, Paths 2 and 6 were not significant, rejecting H_3 and H_7, respectively.

The results revealed a significant indirect effect of SMU on SMA through positive affect, FoMO, and offline and online self-presentation ($b = 0.0060$, $t = 1.5789$), supporting H_{8a}. Furthermore, the total effect of SMU on SMA in the presence of the mediators was significant ($b = 0.1792$, $p < 0.01$). Hence, positive affect, FoMO, and offline and

online self-presentation fully mediated the relationship between SMU and SMA. Table 4 summarizes the mediation model results.

3.4 Mediating roles of negative affect, FoMO, and offline and online self-presentation

Table 5 summarizes the results of the second PROCESS analysis. The results showed a total effect (c) of SMU on SMA through the mediators, $B = 0.18$, $p < 0.01$. This finding indicated that increased SMU generated a

TABLE 4 Bootstrapping indirect effects and 95% CI for sequential mediation model 1.

Model pathway	Effect	Boot SE	95% CI	
			Lower	Upper
Path 1 SMU ➜ Positive affect ➜ SMA	0.0248	0.0159	0.0030	0.0641
Path 2 SMU ➜ FoMO ➜ SMA	0.0429	0.0242	−0.0055	0.0920
Path 3 SMU ➜ Offline and online self-presentation ➜ SMA	0.0303	0.0202	0.0009	0.0797
Path 4 SMU ➜ Positive affect ➜ FoMO ➜ SMA	0.0210	0.0134	0.0026	0.0555
Path 5 SMU ➜ Positive affect ➜ Offline and online self-presentation ➜ SMA	0.0158	0.0099	0.0020	0.0405
Path 6 SMU ➜ FoMO ➜ Offline and online self-presentation ➜ SMA	0.0122	0.0074	−0.0014	0.0281
Path 7 SMU ➜ Positive affect ➜ FoMO ➜ Offline and online self-presentation ➜ SMA	0.0060	0.0038	0.0008	0.0155
Total	0.1530	0.0557	0.0681	0.2823

CI, Confidence interval; 10,000 bootstrap samples with 95% CI.

greater degree of SMA with the mediators. However, when the mediators were removed from the analysis, this coefficient was not statistically significant (direct effect, c'), $B = 0.01$, $p = 0.77$, rejecting H_1. SMU was also found to be a positive predictor of negative affect ($B = 0.36$, $p < 0.001$) (a_1), but not a predictor of FoMO ($B = 0.12$, $p = 0.22$) (a_2) or offline and online self-presentation ($B = 0.20$, $p = 0.13$) (a_3) (Figure 3).

As presented in Table 6, the analysis of the indirect mediating effects by bootstrapping found that the resulting data supported the significance of Path 1 (SMU ➜ Negative affect ➜ SMA; $B = 0.0349$, $SE = 0.0158$, 95% CI [0.0110, 0.0729]), confirming H_{2b}; Path 4 (SMU ➜ Negative affect ➜ FoMO ➜ SMA; $B = 0.0355$, $SE = 0.0135$, 95% CI [0.0163, 0.0685]), confirming H_{5b}; Path 5 (SMU ➜ Negative affect➜ Offline and online self-presentation ➜ SMA; $B = 0.0204$, $SE = 0.0088$, 95% CI [0.0078, 0.0421]), confirming H_{6b}; and Path 7 (SMU ➜ Negative affect ➜ FoMO ➜ Offline and online self-presentation ➜ SMA; $B = 0.0112$, $SE = 0.0047$, 95% CI [0.0046, 0.0229]), confirming H_{8b}. However, Paths 2, 3, and 6 were not significant, rejecting H_3, H_4, and H_7, respectively.

The results revealed a significant indirect effect of SMU on SMA through negative affect, FoMO, and offline and online self-presentation ($b = 0.0115$, $t = 2.3958$), supporting H_{8b}. Furthermore, the total effect of SMU on SMA in the presence of the mediators was significant ($b = 0.1792$, $p < 0.01$). Hence, negative affect, FoMO, and offline and online self-presentation fully mediated the relationship between SMU and SMA. Table 6 summarizes the mediation model results. This relationship was mediated only by negative affect, but not FoMO or offline and online self-presentation. These findings reconfirmed those of previous studies that the duration of SMU is positively related to SMA by enhancing negative affect, FoMO, and offline and online self-presentation (Radovic et al., 2017; Wolniewicz et al., 2018).

4 Discussion

A serial multiple mediation model was used to examine how positive and negative affect, FoMO, and offline and online self-presentation mediated the relationship between SMU and SMA. Significant correlations were found among all the variables. In the serial multiple mediation analyses, SMU had no direct effect on SMA, inconsistent with the findings of prior studies (e.g., Sun and Zhang, 2021; Talan et al., 2024) that have shown that SMU is a significant predictor of SMA.

These findings raise concerns about the exclusion of IAD from the DSM-5-TR; as noted above, owing to insufficient empirical evidence, it was included only in the appendix of DSM-5-TR instead of being considered a formal disorder (American Psychiatric Association, 2022; World Health Organization, 2022). Hence, excessive SMU, though considered unhealthy, is no longer formally categorized as an addiction or disorder, leading to a lack of consensus on this behavior (Wegmann et al., 2020). Specifically, SMU can promote feelings of happiness among users (Pittman, 2018). However, individuals addicted to the virtual world have trouble communicating face-to-face; spend less time with their family, friends, acquaintances, and immediate surroundings; and can suffer mood disorders (e.g., dissatisfaction and stress) (Geçikli, 2020; Hussain and Griffiths, 2021). The total effect of SMU on SMA was significant and their relationship was mediated by positive affect, but not by FoMO or offline and online self-presentation. These findings reaffirm and broaden research on the relationship between positive affect and SMA (Wang, 2021). Specifically, the longer users engage with social media, the higher positive affect, which exacerbates FoMO and promotes inconsistent offline and online self-presentation. These factors collectively contribute to the manifestation and progression of SMA (American Psychiatric Association, 2022; World Health Organization, 2022).

Similarly, SMU and SMA were mediated by negative affect, but not by FoMO or offline and online self-presentation, consistent with a previous finding that individuals exhibit elevated negative affect when engaging with social media (Hunt et al., 2018). The longer individuals engage with social media, the higher negative affect, resulting in anxiety that others are having more rewarding experiences, and concurrently experiencing apprehension characterized by FoMO. Previous studies have shown that social media users have varying motives and expectations from social media, including its ability to regulate negative emotions, fulfill social needs, and provide positive feedback from others (Krämer and Winter, 2008; Neubaum and Krämer, 2015). This sense of comparative evaluation increases the tendency to present an inconsistent self-presentation aligned with users' desired self-image, raising the inclination to use social media excessively. Consequently, this excessive usage can lead to the development of SMA.

As hypothesized, the results showed that the relationship between SMU and SMA was mediated by positive and negative

TABLE 5 Summary of the multiple regression analyses for the serial multiple mediation model.

Variable	Model 1					Model 2					Model 3					Model 4				
	B	95% CI	SE B	β	t	B	95% CI	SE B	β	t	B	95% CI	SE B	β	t	B	95% CI	SE B	β	t
Constant	17.36	[16.01, 18.72]	0.69		25.15***	14.86	[12.80, 16.93]	1.05		14.15***	19.47	[16.09, 22.85]	1.72		11.33***	1.43	[0.51, 2.81]	0.70		2.04*
SMU	0.36	[0.16, 0.57]	0.10	0.18	3.49***	0.12	[−0.07, 0.31]	0.10	0.06	1.22	0.20	[−0.06, 0.46]	0.13	0.06	1.52	0.01	[−0.08, 0.11]	0.05	0.01	0.30
Negative affect						0.42	[0.33, 0.51]	0.05	0.41	8.81***	0.45	[0.31, 0.59]	0.07	0.30	6.47***	0.09	[0.04, 0.14]	0.03	0.15	3.55***
FoMO											0.56	[0.42, 0.69]	0.07	0.38	8.22***	0.23	[0.18, 0.28]	0.03	0.38	8.84***
Offline and online self-presentation																0.13	[0.10, 0.17]	0.02	0.33	7.43***
	$R^2 = 0.03$, $F_{(1, 383)} = 12.20$, $p < 0.001$					$R^2 = 0.18$, $F_{(2, 382)} = 42.79$, $p < 0.001$					$R^2 = 0.34$, $F_{(3, 381)} = 66.74$, $p < 0.001$					$R^2 = 0.51$, $F_{(4, 380)} = 97.42$, $p < 0.001$				

$N = 385$. Model 1, predictor variable: SMU; outcome variable: negative affect. Model 2, predictor variables: SMU and negative affect; outcome variable: FoMO. Model 3, predictor variables: SMU, negative affect, and FoMO; outcome variable: offline and online self-presentation. Model 4, predictor variables: SMU, negative affect, FoMO, and offline and online self-presentation; outcome variable: SMA. SE, standard error. *$p < 0.05$. ***$p < 0.001$.

affect as well as FoMO and offline and online self-presentation. These results provide support for our hypothesis that SMU has an elevated impact on both positive and negative affect. Wang (2021) found that satisfaction, a sense of pride, and a sense of belonging are the most influential positive factors contributing to social media overuse. Hence, to address SMA, it is crucial to not only focus on negative emotions but also pay attention to fostering these specific positive emotions.

4.1 Limitation

These are three potential limitations of the study. First, the predominantly female sample (84.2%) in this study may limit the generalizability of the findings, as women are often more emotionally expressive than men (Ciarrochi et al., 2005). A more balanced gender representation in future research, including recruiting individuals from different generations and geographic locations, could thus enhance generalizability. The lack of geographic borders allows the dissemination of social media information across locations and time zones. Hence, exploring the impact of FoMO in different regions would be a worthwhile future research avenue. Findings derived by involving participants of various ages and genders could better reflect and apply to a more extensive population.

Second, the present study solely relied on quantitative data. To better understand the underlying factors shaping positive and negative affect in relation to SMU, future research could employ a mixed-methods design that combines surveys with interviews. By incorporating qualitative and quantitative data, researchers could gather rich in-depth insights and narratives from social media users to shed light on the intricate relationship between SMU and its impact on affect.

Third, this research failed to differentiate between personal, professional, and academic SMU. Therefore, further investigation is needed into the impact of SMU on psychological and physiological health considering the specific contexts in which it is used. It is imperative to avoid the over-pathologization of everyday behaviors, while concurrently refraining from trivializing conditions that hold clinical importance and warrant public health consideration. To develop professional standards, the implementation of empirical-based studies could guide both the research endeavors and the clinical practices of psychiatrists and psychologists (Brand et al., 2020).

4.2 Implication

Notwithstanding these limitations, this study's findings have three important implications. First, this study demonstrates the significance of positive and negative emotions, emphasizing the importance of positive and negative affect in the context of SMU. Individuals are inclined to share misinformation when it aligns with their personal identity or social norms, when it is novel, and when it elicits strong emotions. Research indicates that detecting misinformation is challenging, as individuals tend to focus on understanding and deciding what to do with new information, rather than critically evaluating its accuracy (American Psychological Association, 2023). By recognizing the

TABLE 6 Bootstrapping indirect effects and 95% CI for sequential mediation model 2.

Model pathway	Effect	Boot SE	95% CI	
			Lower	Upper
Path 1 SMU ➔ Negative affect ➔ SMA	0.0349	0.0158	0.0110	0.0729
Path 2 SMU ➔ FoMO ➔ SMA	0.0279	0.0236	−0.0187	0.0762
Path 3 SMU ➔ Offline and online self-presentation ➔ SMA	0.0241	0.0211	−0.0076	0.0785
Path 4 SMU ➔ Negative affect ➔ FoMO ➔ SMA	0.0355	0.0135	0.0163	0.0685
Path 5 SMU ➔ Negative affect ➔ Offline and online self-presentation ➔ SMA	0.0204	0.0088	0.0078	0.0421
Path 6 SMU ➔ FoMO ➔ Offline and online self-presentation ➔ SMA	0.0088	0.0074	−0.0057	0.0243
Path 7 SMU ➔ Negative affect ➔ FoMO ➔ Offline and online self-presentation ➔ SMA	0.0112	0.0047	0.0046	0.0229
Total	0.1628	0.0541	0.0790	0.2899

10,000 bootstrap samples with 95% CI.

influence of these affective states, researchers could develop effective strategies and interventions to mitigate the risk of SMA. The integration of verification and fact-checking mechanisms into the educational system could help prevent, recognize, and avoid the spread of fake news and misinformation.

Second, these insights could also inform the design of preventive measures and interventions that consider the impact of positive and negative affect on individuals' psychological well-being in the context of SMU, alongside their other needs (e.g., cognitive, affective, personal integrative, social integrative, and tension-free needs). The development of educational tools such as SimCity videogames, scenario-based learning activities, and virtual reality experiences centered on SMU and SMA could provide the public with valuable pre-exposure to the associated risks and challenges. Subsequently, post-experience debriefing sessions could foster group reflection, offer recommendations, and suggest effective approaches through collaborative discussions.

Third, this study provides insights that can encourage individuals to find a healthy equilibrium between their online and offline activities and prevent the development of SMA. While the widespread adoption of social media has diminished the importance of geographic proximity, concern about the escalation of SMU leading to potential issues such as SMA is growing. Social media users often underestimate the severity of SMA due to a lack of awareness of its critical nature (Sun and Zhang, 2021). Unlike drug addiction, where evident consequences such as weight loss, financial loss, and strained relationships bring the issue to the forefront, SMA may be more challenging to acknowledge or accept due to the absence of such overt signs (Giordano, 2022). Despite the exclusion of IAD from the DSM-5-TR, studies must explore this phenomenon and better understand its implications. Further research in this area could shed light on the conceptualization and classification of problematic Internet use within the broader spectrum of mental health disorders.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by University's Research Ethics Committee, Hong Kong Metropolitan University. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

WH: Conceptualization, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. YL: Investigation, Project administration, Writing – review & editing. LL: Investigation, Writing – review & editing. EL: Investigation, Writing – review & editing. RM: Investigation, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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