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# Socioeconomic status and internet addiction: double-mediated moderation

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## Abstract

**Background** Internet addiction is typically linked with a variety of psychological and behavioral problems, the prevalence of Internet addiction among Chinese college students was higher than that of the general population.

**Objective** The present study aimed to test the mediating and moderating effects of socioeconomic status (SES), loneliness, alienation and grade on Internet addiction among Chinese college students.

**Methods** Total of 496 college students were studied, partial least square structural equation modeling (PLS-SEM) was conducted to analyze the obtained data.

**Results** The study found that SES can negatively predict Internet addiction ( $\beta=-0.145, p < 0.001$ ). Moreover, loneliness and alienation play separate ( $\beta=-0.098, p < 0.001$ ;  $\beta=-0.046, p < 0.01$ ) and serial ( $\beta=-0.071, p < 0.001$ ) mediating roles between SES and Internet addiction, and multigroup analysis showed that grade (sophomore year as the baseline) plays a moderation role in the association between SES  $\rightarrow$  Internet addiction (sophomores vs. juniors;  $\beta = 0.249, p < 0.05$ ) and SES  $\rightarrow$  Loneliness (sophomore vs. seniors;  $\beta = 0.255, p < 0.05$ ). The VAF value was 70.27% for the mediation effect of the loneliness and alienation in the relationship between SES and Internet addiction.

**Conclusions** SES not only has a direct effect on college students' Internet addiction behavior but also has an indirect effect on it through the chain mediation effect of loneliness and alienation. The study reveals that grade level moderates the effects, suggesting tailored interventions are needed. This research could inform measures to mitigate addiction by addressing SES, loneliness, and alienation.

**Keywords** Socioeconomic status, Loneliness, Alienation, Internet addiction, PLS-SEM

## Introduction

Internet addiction (IA), or termed as the Internet addiction disorder (IAD), pathological Internet use (PIU) [1] with the definition of “an inability to control one’s use of the internet, which eventually causes psychological, social, school, and work problems” [2]. Internet addiction has become a major global public health problem due to its harmful effects [3]. Which is 1.6 times more prevalent among young college students than in the general population according to Shao et al., has a high incidence rate among this demographic and is expected to increase further in the coming years [4]. Previous research have shown that Internet addiction not only affects college

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students' mental health but also has profound impacts on their academic performance, interpersonal relationships, and overall quality of life, including issues like attention deficit, decreased learning efficiency, and even triggering depression and anxiety [5–7]. Therefore, identifying risk factors and elucidating the mechanisms underlying Internet addiction are essential for developing effective prevention and intervention strategies aimed at college students. Consequently, this study focuses on college students as the subject of research, investigating the mechanisms of factors influencing Internet addiction, thereby providing a theoretical foundation and practical support for the prevention of Internet addiction among college students and the promotion of their physical and mental well-being.

At present, socioeconomic status (SES) has been found to be an important factor affecting internet addiction [8–10], for instance, a study of indicated that youth with lower SES had a higher probability of internet addiction ( $\beta = -0.10, p < 0.01$ ) [8]. This result may be due to the fact that individuals from high SES households are less reliant on online social activities. In contrast, those from households with low SES may become more dependent on online social activities [11]. Moreover, in the theory of Internet addiction, Davis's cognitive-behavioral model of Pathological Internet Use (PIU) has been the most widely recognized, the causes of PIU symptoms are divided into proximal and distal triggers [12]. SES can be regarded as situational cues, individuals of lower SES may experience more stress and challenges, which may lead them to seek the Internet as a means of escaping from real-world problems, and maladaptive cognitions is the most critical and stable proximal factor affecting the formation and maintenance of Internet addiction [12].

In psychology, maladaptive cognition refers to those unhealthy or dysfunctional ways of thinking that can lead to maladaptive emotions and behaviors in an individual. Loneliness and alienation can be seen as part of maladaptive cognitions. Loneliness is a subjective emotional experience, often associated with an individual's perceived lack of social connection [13], and alienation is also regarded as a subjective sense of experience, that is, an individual cannot clearly locate his or her social role, and it is easy to have a sense of estrangement in the process of communicating with others, which will reduce his or her positive emotions and increase his or her negative emotions, including a sense of alienation from the surrounding social environment, community, or culture, and a lack of belonging and identity [14]. In the cognitive-behavioral theory of Internet addiction, loneliness and alienation may be the manifestation of maladaptive cognition and affect the dependence and use of the Internet. For example, individuals may turn to the Internet for social connection and emotional support because they

feel lonely or alienated which can lead to the development of Internet addictive behaviors [12]. Studies have shown that when individuals of low SES simultaneously experience loneliness, they are more likely to engage in health-risk behaviors (e.g., Internet addiction) [12]. This may be because they lack social support and health promotion resources, making them more susceptible to poor health behaviors [15].

In the family system, SES is one of the potential factors affecting the alienation of adolescents, which affects the development of adolescents by influencing the parenting style, parent-child relationship and family function [16]. A family's lower SES may lead parents to adopt less supportive and more negative parenting behaviors, such as neglect and punishment, which may increase adolescents' feelings of alienation [17]. On the one hand parents of high SES families encourage their children to communicate more and provide more education and support [18, 19]. Individuals with higher family socioeconomic status have higher self-expectations and exhibit more social and cultural identity [20]. On the other, for families with lower socioeconomic status, unstable jobs, constant economic pressure, and low social prestige increase parental adoption of punitive and boastful parenting behaviors, less support for children, and more negative evaluation and neglect [21]. In addition, Erickson pointed out that building new social relationships, gaining intimacy and avoiding loneliness are important developmental tasks for individuals at the college level [22]. However, because the self-regulation ability of college students at this stage has not been fully developed, they are prone to confusion and self-doubt in interpersonal communication, learning, life and environmental adaptation, which leads to psychological conflict and loneliness. The higher the loneliness, the more likely it is to have a sense of alienation from the outside world [23]. Specifically, individuals with lower socioeconomic status tend to face more financial and life stresses, which can lead to a lack of social support networks and thus loneliness [24]. Then loneliness may lead to an individual's sense of alienation from social relationships, which may drive individuals to turn to the Internet for social connection and emotional support [25]. Internet addiction may be seen as a means by which individuals attempt to escape real-life feelings of loneliness and alienation [26].

According to this theory, maladaptive cognitions is the most critical and stable proximal factor affecting the formation and maintenance of Internet addiction, while situational cues (e.g., SES) is the distal factor, and the distal factor influences Internet addiction through the mediation of the proximal factor [12, 27]. Based on the previous research, as well as the cognitive-behavioral model of Internet addiction, we assume that there may be separate and chain-mediated role of loneliness and alienation

in the relationship between SES and Internet addiction. Therefore, we propose the research hypothesis as follows:

**Hypothesis 1** SES can negatively predict Internet addiction.

**Hypothesis 2** Loneliness mediates the relationship between SES and Internet addiction.

**Hypothesis 3** Alienation mediates the relationship between SES and Internet addiction.

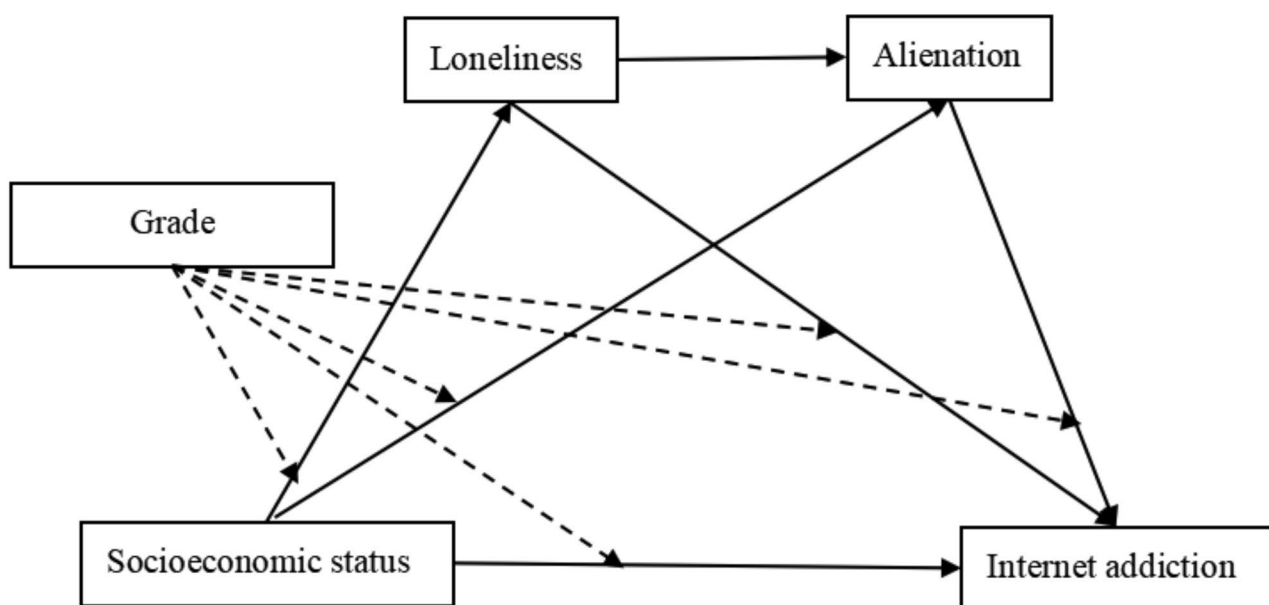
**Hypothesis 4** Loneliness and alienation will chain mediate the relationship between SES and Internet addiction. Some studies have found that college students' Internet addiction exhibits a "first rising and then decreasing" trend over time, this pattern may peak during the sophomore year [28, 29]. After experiencing the adaptation period of their freshman year, students in their sophomore year may face increased academic challenges as the curriculum becomes more demanding and focuses more on the integration of knowledge. This can lead to students with a weaker foundation from the freshman year to struggle to keep up with the pace of their studies, leading to exam anxiety and potential failure. In response, they may turn to the Internet as a means of escape, domestic scholars call this phenomenon "sophomore disease", and foreign countries call it "sophomore low tide". As students enter their junior and senior years, the pressures of employment and postgraduate entrance exams compel them to reduce their time spent online and devote more effort to their studies [28]. This paper integrates

relevant literature to suggest that most research on college students' Internet addiction has only focused on sophomores [30, 31]. However, a significant limitation of these studies is the lack of distinction between sophomores and other grade groups. Therefore, grade level may act as a potential moderator. Based on the analysis, the sophomore year was selected as the baseline for the multi-group analysis to test the moderating effect of grade in the hypothetical model of this study. Specifically, the moderating effect of grade may occur across any path in the study model. The proposed model is illustrated in Fig. 1.

## Methods

### Participants and procedures

The subjects were college students from Guizhou University, Guizhou Normal University, Guizhou University of Finance and Economics, Guiyang Medical College and Guiyang College of Traditional Chinese Medicine, etc. A total of 544 questionnaires were distributed by means of convenient sampling for the whole class, and 48 invalid questionnaires were excluded based on criteria such as incomplete responses, duplicate answers, or patterned responses, resulting in a total of 496 valid questionnaires, with an effective rate of 91.18%. In our study, the gender distribution was as follows: there were 177 male participants (35.7%) and 319 female participants (64.3%). Regarding the residential background, 404 participants (81.5%) were from rural areas, while 92 participants (18.5%) were from urban areas. In terms of academic disciplines, 187 participants (37.7%) were from the humanities, and 309 participants (62.3%) were from the sciences.



**Fig. 1** The proposed moderated mediation model

Concerning academic year, the distribution was 135 first-year students (27.2%), 198 s-year students (39.9%), 130 third-year students (26.2%), and 33 fourth-year students (6.7%).

The survey was conducted with the informed consent of students. We communicated through the school to inform students and their parents about the survey's objectives and procedures one week in advance. Each student was provided with an Informed Consent Form detailing the study's purpose, procedures, and their rights, including withdrawal without repercussions. Consent was voluntary, and forms were signed voluntarily by participants, indicating their understanding and agreement to participate. For minors, legal guardians' signatures were also secured. Consent forms were kept confidentially. Following the receipt of informed consent from both students and their guardians, the survey was conducted post-class during a 15-minute session and data collection took place in the students' classroom under the teacher's supervision. Each participant completed the questionnaire independently and consented to their data being utilized in the study. This study conforms to the ethical standards of the 2013 Helsinki Declaration and was approved by the Committee of the School of Psychology of Guizhou Normal University (GZNUPSY. LL.N2211021) and informed consent was obtained from all the participants and their legal guardians.

## Measures

### *Demographic information*

A background questionnaire, which inquired about details such as grade distribution, name, gender, family location, and academic background, was utilized to obtain demographic information about the participants.

### *Chinese internet addiction scale-revision (CIAS -R)*

The Chinese Internet Addiction Scale-Revision (IAS-R), compiled by Chen et al., consisted of 26 items and was divided into two factors [32]. Core Symptoms of Internet Addiction and Related Problems of Internet Addiction, as well as Compulsive Internet Use, Withdrawal from Internet Addiction, Tolerance of Internet Addiction, Interpersonal and Health-Related Problems of Internet Addiction, and Time Management Problems, and other five factors. Employing a 4-point Likert scale ranging from 1 ("strongly disagree") to 4 ("strongly agree"), the total score ranges from 26 to 104. The higher the score, the more pronounced the symptoms were. The scale demonstrated a Cronbach's alpha of 0.924, signifying a high level of reliability.

### *Socioeconomic status questionnaire (SESQ)*

For the assessment of SES, scholars have employed diverse indicators contingent upon the research

objectives, with the most common including household income, level of education, and occupational types [33–35]. Although occupation is commonly regarded as a significant indicator of SES internationally, there is considerable debate regarding occupational classification in our country. There is a substantial variation in income and educational levels among individuals with the same occupation [36]. Moreover, for low-income populations, occupation may not be a reliable indicator of SES [37]. Therefore, this study did not include occupation as a measure of SES. The present study aligns with the methodology of Veenstra [33], utilizing family income and parents' educational level as indicators. However, the education level of mothers is more closely associated with the intellectual and capability development of children, rather than direct economic and social status. In contrast, in light of the fact that maternal education primarily proxies for unobservable abilities, paternal education level is likely to be a more direct reflection of SES [38]. Therefore, this study measures SES based on paternal education level and household income.

Participants were queried on their father's educational level and the family's monthly income. A higher score indicated a higher perceived socioeconomic status.

### *Short-form of the university of California Los Angeles loneliness scale (ULS-8)*

The University of California Los Angeles Loneliness Scale (ULS) compiled by Russell et al. [39], and the Short-form of the University of California Los Angeles Loneliness Scale (ULS-8), revised by Hays and DiMatteo [40], was translated by Chen et al. [41]. This scale primarily measures an individual's subjective experiences of unhappiness and emotional distress. It comprised 8 items, with responses rated on a 4-point Likert scale ranging from 1 ("very inconsistent") to 4 ("very consistent"). The higher the score, the greater the reported loneliness experienced by an individual. The Cronbach's alpha coefficient for this scale was 0.726, indicating high reliability.

### *General alienation scale (GAS)*

The General Alienation Scale (GAS) was designed for adolescents by Jessor and Jessor [42], translated into Chinese by Robinson et al. [43] and its reliability and validity were tested by Chen et al. [14]. The scale measures alienation caused by environmental maladjustment in terms of uncertainty about one's role in the day, the meaning of activities, and the perception of being isolated by others. It comprised 12 items, with responses rated on a 4-point Likert scale ranging from 1 ("strongly disagree") to 4 ("strongly agree"). The higher the score, the greater the reported alienation tendency by an individual. The scale's internal consistency in this investigation was

substantiated by a Cronbach’s alpha value of 0.779, signifying a high level of reliability.

**Statistical analysis**

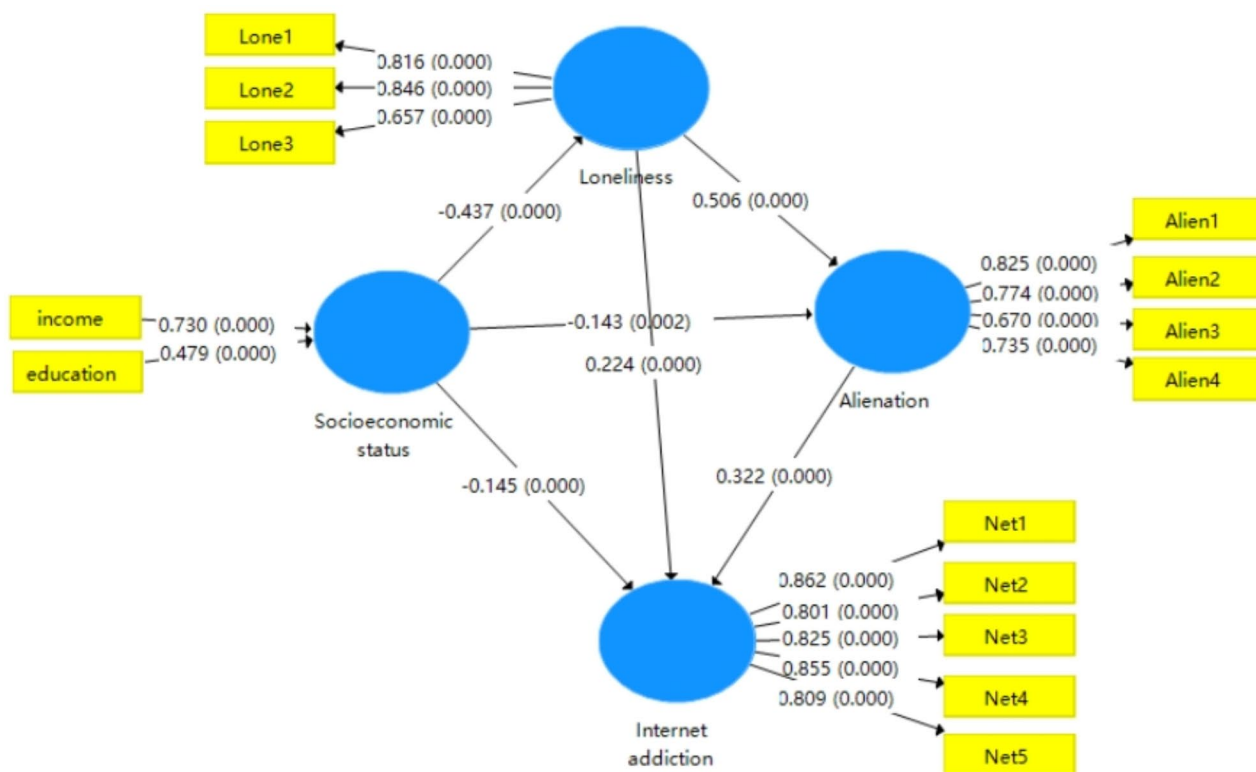
Partial least squares structural equation modeling (PLS-SEM) is a complete multivariate statistical investigation tool that was employed in this study to verify the study model [44]. Further, PLS-SEM path modeling can indeed be a “silver bullet” for estimating causal models in many theoretical model and empirical data situations [44]. It is a promising technique when dissimilar variables are analyzed together and the research objective is testing new relationships as well as theory building [44, 45]. PLS-SEM is able to handle both reflective and formative constructs [46, 47]. For the present study, we applied the PLS-SEM approach because the variables involved in the present study have both reflective and formative constructs. Thus, we used SmartPLS 3.0 to perform the analysis [45]. The present study followed a two-step process grounded in the measurement and structural model. Initially, we evaluated the measurement model for the validity and reliability of the variables, and then the structural model was appraised to explain the associations between the main variables. Additionally, PLS-SEM provides several statistical criteria for assessing the quality of formative measurement models.

**Results**

Loneliness and alienation are single-dimensional scales respectively that are subject to an item-packing strategy. By parallel analysis, suggesting that the loneliness scale and the alienation scale are both single dimension, because there are one-factor having larger actual eigenvalues than simulated or resampled eigenvalues, which meet the premise of item packaging [48]. Then, the loneliness scale is packaged into three indicators and the alienation scale into four indicators by using the item structural balance method. The structural model is shown in Fig. 2.

**Common method variance**

Since this study collected data using a single questionnaire, it was necessary to check for common method variance effects. Common method variance effects represent the amount of bogus correlation among the used variables, which may be produced using the same questionnaire to measure each variable [49]. We ran a thorough collinearity test, and the maximum pathological VIF for all components was 2.601, much below the recommended threshold of 3.3 [50]. Also, we used the correlation matrix approach [51], and the highest inter-construct correlation was 0.568, which was below the 0.90 threshold value [51]. Using SPSS 27 analysis software, the cumulative share of explanation of the first



**Fig. 2** A conceptual model with hypothesis testing



**Table 1** Psychometric properties of the measurement model

Construct	Item	Loading	Alpha	CR	AVE/VIF	HTMT	Weight
Socioeconomic status	income				1.132		0.730***
	education				1.132		0.479***
Internet addiction	Net1	0.862	0.888	0.917	0.690		
	Net2	0.801					
	Net3	0.825					
	Net4	0.855					
	Net5	0.809					
Loneliness	Lone1	0.816	0.667	0.819	0.604		
	Lone2	0.846					
	Lone3	0.657					
Alienation	Alien1	0.825	0.747	0.839	0.568		
	Alien2	0.774					
	Alien3	0.670					

Note: \*\*\*represents a significant correlation at level 0.001 (two-tailed). Education indicates the father's educational level, and income indicates the family's monthly income

**Table 2** Discriminant validity (HTMT)

Construct	Internet addiction	Loneliness	Alienation
Internet addiction			
Loneliness	0.610		
Alienation	0.602	0.778	

factor in Total Variance Explained was 23.15% (<40%). Therefore, these analyses lead to the conclusion that common method bias was not an issue [52].

## Measurement model

### Reflective model assessment

Reflective measurement models should be assessed in terms of their reliability and validity. The Cronbach's alpha and composite reliability (CR) were used to test the reliability of the corresponding measurement models, values must not be lower than 0.600 [53, 54]. The researcher can monitor reflective indicators' loadings to assess indicator reliability. Generally, indicator loadings should be significant at least at the 0.050 level and higher than 0.707 [55]. Reflective measurement models' validity assessment focuses on convergent validity and discriminant validity. For convergent validity, researchers need to examine the average variance extracted (AVE). An AVE value of at least 0.500 indicates that a latent variable is, on average, able to explain more than half of the variance in its indicators, thereby demonstrating sufficient convergent validity [56]. Finally, to test the discriminant validity, we used the Heterotrait-Monotrait (HTMT) ratio of correlations [57]. The HTMT ratio should be lower than 0.850 to verify discriminant validity [58].

All Cronbach's alpha and CR are greater than 0.600 (Table 1), additionally, all "Standardized Factor Loadings" exceeded the value of 0.707 (except Lone3 and Alien3) supporting internal consistency reliability. Moreover, the AVE values surpassed the cut-off (0.500), suggesting adequate convergent validity. Furthermore, as shown in

Table 2, the correlations of HTMT were all lower than the conservative criterion (0.850), indicating adequate discriminant validity of measures.

### Formative measurement models

Since formative model believes that the variation of indicators leads to the variation of latent variables, indicators define the characteristics of latent variables, representing a series of different, non-interchangeable reasons, each indicator represents a specific aspect of the variable, deleting an indicator will change the nature of the variable [59, 60]. We conceptualized SES as a formative model, with SES being determined by the father's educational level and monthly family income. Given that all dimensions are equally crucial for assessing an individual SES, it is not feasible to quantify SES by omitting any single construct. Moreover, research on SES typically treats SES as a formative construct rather than a reflective construct [34, 61].

Traditional statistical evaluation criteria for reflective scales cannot be directly transferred to formative indices. In a formative measurement model, indicators represent the latent construct's (potentially) independent causes and thus do not necessarily correlate highly. Furthermore, formative indicators are assumed to be error free [62]. Consequently, the concepts of internal consistency reliability and convergent validity are not meaningful when formative indicators are involved. The accuracy of this formative measurement was assessed by looking at the weights, t-values, and the variance inflation factor (VIF). First, we estimate the VIF, which is repeatedly used to assess the multicollinearity of the formative indicators. If the value of VIF is higher than the threshold of 3.300 [47], that indicates collinearity issues among the indicators. Finally, followed the measurement weight of the indicator and significant level to evaluate reliability and validity. Indicator weights, significance at the 0.050 level

**Table 3** The effect size ( $f^2$ )

Construct	Internet addiction	Socioeconomic status	Loneliness	Alienation
<b>Internet addiction</b>				
Socioeconomic status	0.024			
Loneliness	0.046	0.236		
Alienation	0.101	0.025	0.314	

suggests that an indicator is relevant for the construction of the formative index and, thus, demonstrates a sufficient level of validity. Some authors also recommend weight coefficients greater than 0.100 or 0.200 [55, 63].

In this study, Table 1. shows all indicator weights for the formative models, the father's educational level (weight=0.479;  $p < 0.001$ ) and monthly household income (weight=0.730;  $p < 0.001$ ) are significant that indicate reliable and valid formative construct. Moreover, VIFs are equal to 1.132 and less than the critical value 3.300, indicating that there is no collinearity problem.

#### Structural model assessment

After the measurement models have been successfully validated, the structural model can be analyzed. The first essential criterion for the assessment of the PLS structural equation model is each endogenous latent variables' coefficient of determination ( $R^2$ ).  $R^2$  measures the relationship of a latent variables' explained variance to its total variance. The values should be sufficiently high for the model to have a minimum level of explanatory power. Chin (1998b) considers values of approximately 0.670 substantial, values around 0.333 average, and values of 0.190 and lower weak [55]. Hypothesized relationships in the research model were examined by a PLS bootstrapping algorithm with 5000 subsamples at a significance level of 0.05. The  $R^2$  values of 0.191, 0.340 and 0.319, respectively, indicate that the study model has adequate predictive power, with all  $R^2$  values exceeding the threshold of 0.190. Evaluating the effect size of each path in the structural equation model by effect size ( $f^2$ ). Values for effect size between 0.020 and 0.150, between 0.150 and 0.350, and exceeding 0.350 indicate that an exogenous latent variable has a low, medium, or large effect on an endogenous latent variable [55, 64, 65]. According to the values of the effect size given in Table 3. all effect sizes are greater than 0.020, indicate the predictor variable has a substantial impact on a dependent latent variable. Furthermore, the Stone-Geisser  $Q^2$  criteria displayed a value (Internet addiction, 0.215; loneliness, 0.113; alienation, 0.185 ) higher than zero, further supporting the predictive ability of the study model [66].

#### Analysis of mediating effects

In the last step of the smart PLS calculations, a 5000 bootstrapping approach was conducted to assess the path coefficient effects and t significance values for the

direct and mediating relationships. The statistics of the structural model, including path coefficient, standard deviation, and t-value, are reported in Fig. 2. SES had significant and negative influence on Internet addiction ( $\beta = -0.145$ ,  $t = 3.916$ ,  $p < 0.001$ ). Hence Hypothesis H1 is accepted. For the mediating effects, the specific indirect effects in PLS-Sem revealed that loneliness negatively mediates the impact of SES and Internet addiction ( $\beta = -0.098$ ,  $t = 4.792$ ,  $p < 0.001$ ), therefore, Hypothesis H2 was accepted. Similarly, alienation significantly mediates the relationship between SES and Internet addiction ( $\beta = -0.046$ ,  $t = 2.055$ ,  $p < 0.01$ ), hence we can accept Hypothesis H3. Moreover, loneliness and alienation play a chain mediating role in the influence of SES on Internet addiction ( $\beta = -0.071$ ,  $t = 5.984$ ,  $p < 0.001$ ), therefore, Hypothesis H4 was accepted. Finally, the total effects of SES on Internet addiction showed a good explanatory power of 0.481.

Furthermore, the study used a widely accepted and recommended test called the variance accounted for (VAF) test to analyze the mediating effects. According to Hair et al., if the VAF value is less than 20%, it is considered no mediation; if it falls between 20 and 80%, it is considered partial mediation; and if it is greater than 80%, it is considered full mediation [47]. This can be calculated through the below equation:

$$\text{VAF} = \text{Indirect effect} / \text{total effect}.$$

The study found that the VAF value was 70.27% for the mediation effect of the loneliness and alienation in the relationship between SES and Internet addiction. This result indicate that loneliness and alienation partially mediate the relationship between SES and Internet addiction respectively. Additionally, loneliness and alienation play a chain mediating role in the influence of SES on Internet addiction.

#### Multigroup analysis

To explore the moderating effect of grade, conducting a bootstrap [67, 68]. The moderating effect of grade is significant. Further analyses showed there were significant grade differences between the sophomore and senior groups on the path of SES to loneliness ( $\beta = 0.255$ ,  $t = 2.131$ ,  $p < 0.05$ ), and significant grade differences between the sophomore and junior groups on the path of SES to Internet addiction ( $\beta = 0.249$ ,  $t = 2.527$ ,  $p < 0.05$ ).

## Discussion

The study advances the understanding of Internet addiction among Chinese college students by examining the interplay between SES, loneliness, alienation, and academic grade. Our findings, which support all four hypotheses, offer valuable insights into the theoretical underpinnings and practical applications for addressing this prevalent issue. Our study further substantiates the cognitive-behavioral model of Internet addiction by providing empirical evidence for the mediating roles of loneliness and alienation between SES and Internet addiction, thus enriching research on cognitive-behavioral model. This aligns with the model's proposition that maladaptive cognitions, such as loneliness and alienation, are critical proximal factors influencing the development and maintenance of Internet addiction, SES is the situational cues of Internet addiction [12]. Further confirm that the distal factor influences Internet addiction through the mediation of the proximal factor [12, 27]. In light of our study's findings, future interventions targeting Internet addiction among college students can be multifaceted, addressing not only the proximal factors of loneliness and alienation but also the distal factor of SES and its influence through the mediation of these proximal factors. By mitigating loneliness and alienation, especially among students with lower SES, and by implementing policies to reduce socio-economic disparities, we can effectively lower the risk of Internet addiction. This dual focus on immediate psychological support and long-term socio-economic interventions offers a robust framework for both prevention and treatment efforts.

The first hypothesis was consistent with previous studies and the results showed that SES could negatively predict Chinese college students' Internet addiction [8–10]. SES is a comprehensive reflection of personal mater and non-mater resources and their position in society, representing the economic capital, human and educational capital of the family [69, 70]. One of the most widely studied constructs in the social sciences. Indicator treated as reflective imply that SES is an underlying dimension that causes the observed variable, suggesting that observed variables are caused by SES. By contrast, indicators treated as formative are independent predictors of SES and therefore cause levels of SES [71]. We modeled SES as the formative model, SES is established through the father's level of education and monthly family income. All the dimensions are equally important to measure one's SES. However, many previous studies mistakenly regard SES as a reflective model [72, 73], which will seriously affect the construct validity and the properties of underlying constructs. Groups with higher socio-economic status tend to have healthier lifestyles. The reason is that the difference in social structure and social structure location resources will affect individuals' choice

of healthy lifestyle, and promote individuals' choice to form different lifestyles, thus forming different life behaviors and affecting health. This hypothesis is also known as "reproduction of lifestyle". By understanding the specific mechanisms through which SES influences addiction through the mediation of loneliness and alienation, we can tailor interventions to target these proximal factors more effectively. For instance, interventions might focus on bolstering social connections to reduce feelings of loneliness among individuals with lower SES, thereby mitigating the psychological vulnerabilities that increase the risk of turning to the Internet as a coping mechanism [15]. Moreover, recognizing the distinct roles of distal and proximal factors allows for a multi-tiered approach to prevention and intervention [12]. For distal factors like SES, policies aimed at enhancing economic opportunities, educational attainment, and social mobility can be developed to create a more level playing field and reduce the stressors that contribute to maladaptive coping strategies. At the same time, addressing the distal factor of SES involves broader societal efforts to reduce economic disparities and improve access to resources that can buffer against the development of maladaptive behaviors like Internet addiction. For proximal factors like loneliness and alienation, psychological interventions that provide emotional support, cognitive-behavioral therapy, and social skills training can be implemented to help individuals build resilience and foster healthier social connections.

Our study reveals the indirect effects of SES on Internet addiction through the mediating roles of loneliness and alienation, underscoring the comprehensive influence of these factors. Given the challenges in altering family SES, we propose targeted interventions to mitigate loneliness and alienation among students, particularly those from lower SES backgrounds. (1) Enhanced Parental Engagement: Establish regular communication channels between schools and low-SES families to discuss students' academic progress and behavioral concerns, promoting a collaborative approach to student support. Conduct workshops for parents on the importance of their involvement in their children's education and on strategies to support academic success and healthy Internet habits. (2) Financial and Educational Support: Create and promote scholarship programs aimed at low-SES students to alleviate financial burdens and reduce stress related to economic pressures. Provide subsidized or free tutoring services and mentoring programs to support the academic needs of low-SES students, helping them to keep pace with their peers, thus reducing the likelihood that they will feel lonely or alienation [18, 19, 23]. (3) Mental Health Service : Ensure that mental health services are accessible and tailored to address the specific needs of low-SES students, including group



therapy sessions focused on coping with loneliness and alienation. Raise awareness about the signs of mental health issues, including loneliness and alienation, and the resources available to address them. (4) Career and Future Planning: Providing career guidance and internships to low-SES students alleviates employment anxiety and lessens loneliness and alienation. These initiatives create a sense of belonging, foster community, and reduce the risk of Internet addiction by offering inclusive college experiences.

The multi-group method in PLS-SEM is one of the most effective methods to evaluate the moderating effects in multiple relationships. A general regulatory relationship test examines a single structural relationship between the product of two exogenous variables and the interaction between endogenous variables (i.e., the independent variable multiplied by the regulatory variable predicts the dependent variable). In contrast, multigroup analysis provides a more complete picture of the effect of the moderating variable on the analysis results, as the focus shifts from examining the effect of the moderating variable on one particular relationship to examining its effect on all modeled relationships. Through testing different group models, it is indicated that the moderating variable grade weakened the negative effect of SES on loneliness/Internet addiction, that is, grade significantly weakened or inhibited the effect of SES on loneliness/Internet addiction. This is inconsistent with previous research confirmed “sophomore slump” [74]. On the one hand, due to the increasing employment pressure, some second-year students have a clear plan for their future, and their learning interest and enthusiasm are in the peak period of the whole university. This part of students often put their sense of belonging on the realization of established goals. Some students are keen to realize the value of activities, organize and participate in various group activities, no matter the result is honored or frustrated, they can position themselves in it and find the feeling of belonging. On the other hand, sophomores gain a sense of belonging and feel less lonely in their relationships as their college life progresses. The nature of love of sophomore students is different from that of first-year students who are blind and seek comfort, showing the characteristics of concentration and stage. Therefore, sophomore year is also the golden period of the whole university.

#### Limitations and future directions

This study has made certain theoretical and practical contributions, yet it is not without limitations. Firstly, our investigation utilized a cross-sectional survey, future research could employ longitudinal methods to generate more reliable results. Secondly, the study examined only a limited number of factors affecting Internet addiction, and further research is needed to explore the causal

relationships among a broader range of influencing factors. Additionally, the analysis focused on the moderating effect of grade (with sophomore grade as the baseline) on the influence of SES on Internet addiction. However, Mikkelsen et al. also found that positive psychosocial factors, such as self-efficacy and self-esteem, may buffer against adolescents’ negative psychosocial factors, like loneliness and alienation [75]. This suggests an opportunity for future research.

#### Conclusion

The study, employing PLS-SEM, finds that loneliness and alienation play separate and serial mediating roles in the relationship between SES and Internet addiction. Additionally, it demonstrates that grade moderates the associations between SES and Internet addiction, as well as between SES and loneliness. The findings underscore the importance of addressing these psychological factors, especially for students from lower SES backgrounds, to mitigate the risk of Internet addiction. This research provides valuable insights for developing targeted interventions and highlights the need for policies that consider both individual and SES factors in Internet addiction prevention.

#### Acknowledgements

We would like to acknowledge the time and effort devoted by the editors and the typesetters to improve the quality of this article.

#### Author contributions

Wei Chen conceived the article and provided framework of the manuscript and collected the data. Gao Yujing and Ren Rongrong analyzed the data and drafted the manuscript. Chen Wei, Bi Yajie and Liao Yaxi revised the manuscript. The final version was approved by Chen Wei.

#### Funding

This study was funded by Phased Achievements of Guizhou Province Philosophy and Social Science Planning Project (21GZZD45), Guizhou Provincial Science and Technology Foundation under (Qiankehe Jichuzhik[2022]General 303)and Key Topics of Guizhou Educational Science Planning (2022A009).

#### Data availability

The datasets used and/or analyzed during the current study are available anytime from the corresponding author on reasonable request.

#### Declarations

##### Ethics approval and consent to participate

This study conforms to the ethical standards of the Helsinki Declaration in 2013 and has been approved by the Committee of the School of Psychology of Guizhou Normal University (GZNUPSY.LL.N2211021) and informed consent was obtained from all the participants and their legal guardians.

##### Consent for publication

Not applicable.

##### Competing interests

The authors declare no competing interests.

Received: 16 February 2024 / Accepted: 19 December 2024

Published online: 06 January 2025

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