ORIGINAL RESEARCH

The Impact of Social Media on Users' Self-Efficacy and Loneliness: An Analysis of the Mediating Mechanism of Social Support

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Purpose: The integration of social media into all areas of society has become a typical phenomenon of the Internet era. This study's core objective is to dissect the relationship between social media, self-efficacy and loneliness, especially emphasizing the mediating function of social support.

Patients and Methods: The research data is derived from the pooled cross-sectional data combined from the four-period data of the China Family Panel Studies (CFPS). The study employs Ordinary Least Squares (OLS) regression as the basic research method, and utilizes Instrumental Variables (IV) and other methods to conduct robustness checks.

Results: Social media usage frequency (SMUF) enhances self-efficacy and loneliness through social support. Social support promotes self-efficacy and alleviates users' loneliness. In self-efficacy, social support plays a fully mediating role. Moreover, education (human capital) has a significant moderating effect. There are noticeable differences in the response of different characteristics groups to SMUF.

Conclusion: This study reveals how social media impacts self-efficacy and loneliness through social support. Based on the research results, avoiding prolonged usage of social media and improving digital literacy are the crucial means to exert the positive benefits of social media.

Keywords: social media, self-efficacy, loneliness, social support, mediation analysis

Introduction

The rapid development of information technology such as the internet and artificial intelligence is altering the underlying logic of social structures, driving the transition from modernization to mediatization. The growth of 4G and 5G networks has increased the cohesion between virtual networks and real society, deepening the extent of "mediatization embedding". Social media, embodying the integration of network systems and social systems, allows users to create, share, and receive content on online platforms or apps, thereby enabling social interaction.[1] Presently, social media has supplanted traditional forms of social interaction as the most common tool in the internet era. While people enjoy the higher dimension of convenience brought by social media, there is growing concern about its impact on users' psychological states.

Many researchers have conducted extensive studies on the theme of social media and mental health, and their findings are often striking and assertive. For instance, Berryman et al, using data from an American school, have proposed that there is a potential ambiguous relationship between social media and users' mental health.[2] In subsequent studies, an increasing number of scholars have segmented study groups based on group characteristics to explore the heterogeneity of the psychological benefits of social media. Some scholars have focused on the impact of social media use on different physiological stages of groups, particularly on adolescents known as "digital natives".[3] Additionally, there is a concern among other scholars regarding the factor of gender, and they believe that women have more significant response to social media than men.[4] Diggins et al collected continuous follow-up data from 11,196 respondents and verified that

women are disadvantaged in the virtual world, which is constructed by the social media. The prevalence of depression in women is notably higher than male groups.[5] Although current research is rich, it largely explores individual psychological states from aspects such as depression, anxiety, and happiness, with less focus on self-efficacy and loneliness.[6–8]

In existing research concerning social media and self-efficacy, self-efficacy is often considered a mediating or moderating factor, with a lack of analysis on related mechanisms. Loneliness research is relatively diverse in content and form, but the focus is mostly on elderly and adolescent populations, overlooking the responses of middle-aged individuals to social media.[9] Overall, comprehensive research on the relationship between social media, self-efficacy, and loneliness remains scarce. This study, based on the characteristics of social media and considering social support as an intermediary factor, delves into the effects of social media on users' self-efficacy and loneliness. The contributions of this study are mainly as follows: First, existing literature mostly focuses on a specific group, leaving a gap in comprehensive research. This study expands the research group and analyzes the impact of social media on individual self-efficacy and loneliness from a holistic perspective. Second, another focus of this study is to explore the mechanisms of social media's interaction with self-efficacy and loneliness. Regarding loneliness, this study's exploration in terms of the full sample and the middle-aged group will address the deficiencies of existing research. The discussion on the mechanism between social media and self-efficacy by quantitative approach is groundbreaking. This will provide new perspectives for other areas that have not yet received attention.

Literature Review and Research Hypotheses
The Relationship Between Social Media Use and Loneliness

Social media has become a significant factor for scholars researching loneliness. In the initial phase of research, nonparametric statistics were the mainstream methodology. Scholars collected data such as the number of accounts, user activity, and feelings of loneliness from various platforms to statistically assess the correlation among these factors. Some studies did not find that social media use could predict a users' level of loneliness, but many researchers do not subscribe to this conclusion.[10] For instance, after researching with a vast amount of data from Facebook, some scholars assert a strong correlation between social media and loneliness, although this connection sometimes becomes blurred due to many influencing factors.[11] The findings from Utz et al,[12] based on other platform data, support this view. As research delves deeper, the specific directional relationship between social media use and loneliness has become a focus of scholarly attention.

Although many studies have found that social media can mitigate loneliness by strengthening social support, the academic mainstream believes this association mechanism only exists among certain groups. Extensive literature indicates that spending time on social networking sites is not beneficial for reducing users' loneliness, and this adverse effect becomes more evident with increased use.[13,14] Proponents of this view argue that social media has become a positive predictor for increased loneliness primarily because the solitary use of a screen replaces the richness of social behaviors (substitution effect). Individuals incur resource costs, particularly in terms of time, when engaging with social media; online activities supplant offline interactions, diminishing the time spent in face-to-face contact, thereby presenting a significant barrier to personal social participation.[15] Additionally, social media contains a vast amount of negative information, which may become a new source of stress, weakening the bond strength in social network and resulting in a reduced level of emotional and material support, plunging individuals into deeper loneliness. The spatial dimension is also an important perspective for scholars explaining how social media increases loneliness.[16] Online communication not only replaces the time spent on traditional social behaviors but also replaces the spatial aspect of offline socialization. The social support provided by virtual network systems reduces users' loneliness, but this benefit cannot restrain the reality of spatial loneliness.[17] Some studies indicate that loneliness could lead to unhealthy social media use patterns. However, Yang et al,[18] in a study across different time points, have refuted this, finding insufficient evidence to prove a necessary connection between loneliness at time point A and social media use at time point B.

Based on existing research experience and theoretical grounds, this study proposes the first hypothesis:

H1: An increase in social media use will lead to a deeper state of loneliness in users.

The Relationship Between Social Media Use and Self-Efficacy

Many scholars have touched upon self-efficacy in their studies of social media use behaviors but tend to consider self-efficacy as an intermediary or an insignificant variable in their research. For example, Fankhauser and others, when exploring whether social network can predict cognitive impairment in the elderly, found that self-efficacy played a mediating role in the influencing process.[19] Mumcu et al also reported the potential influence of self-efficacy on students' smartphone use behavior.[20] A few scholars have taken self-efficacy as their mainly research objective, and attempted to expound how social media plays a role in users' self-efficacy from the theoretical perspective.[21,22]

An increasing number of researchers consider social media as a positive predictor of self-efficacy, and this viewpoint is becoming mainstream.[23] Social media has fundamentally altered the landscape of social interaction, individual privacy, trust mechanisms, etc., offering opportunities for novel modes of production. Users extend the boundaries of inter-personal interaction with the internet attributes of social platforms, enabling high-frequency exchange of informational resources within their social network and restructuring their material, labor, and social capital,[24] meaning the level of social support obtained by users will be higher. Additionally, individuals engage in observational learning by their own volition when benefiting from enhanced social support, thereby acquiring certain behavioral traits to sustain this incentive.[25] The proponents of "social cognitive" theory have expanded based on above foundations. Users gain more opportunities to exchange resource through social media, and it is easier to develop group identities within the extent of social networks, thus enhancing their level of self-efficacy. This network gain effect is a unique phenomenon in the digital age.[26]

The relationship between social media use and self-efficacy remains inconclusive, requiring more in-depth exploration. Based on current research findings and theory, this study proposes the second hypotheses:

H2: An increase in social media use will enhance users' self-efficacy.

The Mediating Role of Social Support

In the relevant studies on social media and loneliness, two types of pathways can be distinguished. Some scholars use the social substitution effect as the theoretical basis, suggesting that social substitution and time replacement impacts brought by social media use affect users' loneliness. The essence of the substitution effect is the negative impact on individuals' social network or social resource support (material or emotional), becoming a positive intermediary factor for increased loneliness.[27] Specifically, as social media use frequency increases, the quality of social opportunities and social support decreases due to the substitution effect, thereby increasing feelings of loneliness. Other scholars believe that social media use comes with a spatial substitution—spatial isolation—having a direct impact on loneliness. As mentioned earlier, several empirical studies have highlighted the importance of spatial factors in understanding social media use and loneliness. The substitution effect, coupled with the spatial dimension, creates a mediating role for social support in this complex relationship.

In studies concerning the relation between social media use and self-efficacy, both the optimists, who believe in the "net gain" of online engagement, and the pessimists, who emphasize the burden of "information overload", utilize social cognitive theory as their framework, highlighting the pivotal role of social support in this process.

Building on the aforementioned discussions, this study advances the following hypotheses:

H3: Social media impacts loneliness and self-efficacy through the mediation of social support.

H4: Social media can exert a direct influence on feelings of loneliness without the intermediary role of social support.

Materials and Methods
Data Sources

The stringent internet regulations and privacy settings of social media in China pose a challenge to data mining through platforms like WeChat and Weibo. The resulting data, influenced by political factors, exhibits a selective bias that cannot be overlooked due to significant deviations from reality, thereby questioning its completeness and

reliability. Based on the defined scope of the research subject, after a comprehensive comparison of various micro-databases, the China Family Panel Studies (CFPS) was ultimately selected for conducting the study. This database has been conducting surveys since 2010, with a focus on 25 provinces, municipalities, and autonomous regions in China during the years 2010 and 2012. Subsequent surveys have incorporated the remaining six provinces on the Chinese mainland into the study, with data updates occurring biennially. When selecting target samples, the CFPS team employed an implicit stratification method for three-stage equal probability sampling. The three stages included administrative districts (counties), administrative villages (residential committees), and terminal household units. Using this method, the survey encompassed over 22,000 household units and 66,000 within-household individual units, representing approximately 95% of the Chinese population characteristics. Overall, the CFPS database provides high-quality microdata that reflects the living conditions and social welfare issues in China. Utilizing this data ensures a high degree of authenticity in the study's findings.

In terms of the selection of data years, the Chinese government's succession of policies aimed at social informatization from mid-to-late 2012 marks the country's formal entry into the informational society phase.[28] Accordingly, this study preliminarily sets 2012 as the temporal benchmark. However, the implementation of these policies exhibits a characteristic latency in effect. As reported in the "2014 China Internet Network Security Report", the widespread adoption of smartphones and social media platforms like WeChat and Weibo across Mainland China in 2014 entrenched social media as an integral part of individual daily life.[29] Taking into account the aforementioned discussion and the characteristics of the CFPS data, this study selected the four waves of data from 2014, 2016, 2018, and 2020 for empirical analysis.

Despite the CFPS being a longitudinal survey dataset that tracks families, merging its four waves into a panel dataset presents challenges such as mismatches in sample units, loss of tracked samples, and insufficient sample sizes. Moreover, using four separate cross-sectional datasets may hinder the empirical analysis from supporting causal inferences. Compared to the former data types, pooled cross-sectional data boast a larger sample size, thereby enhancing the empirical statistical power. This data type allows for observations of different groups at different points in time, offering greater flexibility in analyzing specific subgroups and mitigating selection bias. After careful consideration of the characteristics of each data type, this study combined the four waves into pooled cross-sectional data. For research purposes, after excluding missing and outlier values, the final effective sample size obtained was 57,102.

Variable Settings
Explained Variables

(1) Self-Efficacy. The construct of self-efficacy embodies an individual's conviction in their adeptness to accomplish specific tasks or realize particular aspirations. Since its advent in the 1970s, the notion has garnered extensive attention across multiple disciplines such as psychology and sociology, though its precise characterization is subject to ongoing debate. Schwarzer and Jerusalem's seminal work in 1995 led to the formulation of the Generalized Self-Efficacy Scale (GSES) through rigorous developmental, design, and evaluative processes, offering an instrumental scale that has gained broad endorsement in research circles.[30] In response to the nuances of Chinese societal dynamics, as opposed to Western capitalist frameworks, Wang et al in 2001 enhanced the scale by including "perceptions of happiness in life", augmenting its applicability and accuracy in reflecting Chinese self-perception of efficacy.[31]

In the CFPS questionnaire, the design of items related to self-efficacy closely aligns with the Generalized Self-Efficacy Scale (GSES), although certain items are exclusively posed to specific demographic groups, resulting in inadequate sample sizes for a comprehensive analysis. After an in-depth evaluation of the GSES and considering the scale of the sample and the design of survey questions, this study assesses individual self-efficacy from three perspectives: mastery over events, belief in task completion, and perception of life contentment. These assessments are derived using respondents' answers to construct proxy variables. The response to each item is measured on a scale from 0 to 5, summing to a total range from 0 to 15. Self-efficacy is considered a positive metric; thus, higher scores signify elevated levels of an individual's self-efficacy. This methodology provides a robust proxy for self-efficacy, ensuring a relevant and culturally sensitive gauge for the Chinese population.

(2) Loneliness. In its assessment of loneliness, the CFPS survey team crafted items to gauge individuals' self-perceived solitude, using respondents' answers to establish a loneliness scale ranging from 1 to 5. On this scale, a score of 1 corresponds to the minimal experience of loneliness, while a score of 5 denotes a profound degree of isolation.

Explanatory Variable

In exploring the effects of social media use on individual self-efficacy and feelings of loneliness, this study designates social media usage frequency (SMUF) as its central explanatory variable. Social media is fundamentally characterized by two aspects: being an internet-based platform and possessing instant messaging functions.[32] On this premise, proxy variables were identified within the CFPS adult survey. For the initial three periods of data, the explanatory variable was operationalized using responses to "How frequently do you use the internet for social activities?" with an assigned scoring range from 0 to 7, where a higher score indicates increased frequency of social media usage.

Advancements in digital technology have led to the widespread adoption of smartphones and other mobile communication devices, with WeChat becoming a pervasive social platform in China, capturing 99.6% of Chinese internet users.[33] Therefore, in the 2020 data, this study selects "How frequently do you use the WeChat for social activities?" to articulate the explanatory variable. This measure ensures a consistent valuation with the earlier waves, thereby maintaining temporal continuity in analyzing the trajectory of social media's impact on psychosocial variables.

Mechanism Variables

Social support is a multifaceted construct, and the Social Adjustment Rating Scale has been a widely accepted benchmark for evaluating social support since its early adoption in academia.[34] Xiao synthesized a social support assessment scale suitable for Chinese individuals by integrating social support evaluation indicators with the social realities of China.[35] This scale has evolved alongside societal progression. Given the focus on the Chinese population in this study, Xiao's social support rating scale was employed as the benchmark for gauging social support, encompassing socioeconomic support, social network, and socioemotional support.

(1) Socioeconomic Support. Claes posits in his study on socioeconomic status and anxiety that an individual's perception of their socioeconomic standing is intricately linked to the extent of economic support they can access within society.[36] Those with a higher awareness of their economic standing are prompted to maintain a higher level of social stratification. Under the dynamics of "clustered social behaviors", individuals within the same social strata engage in social interactions more frequently, thus securing a higher degree of socioeconomic support. Accordingly, this research employs self-assessment of income position within the local context from the survey to construct the socioeconomic support variable, with assigned values ranging from 1 to 5—1 indicating a lower socioeconomic status and 5 a higher status.

(2) Social Network. Interpersonal relationships are essential in the construction and maintenance of social network. Viewing statically, these relationships depict the scope and depth of an individual's social network, reflecting the diversity and extent of social activity they engage in. Additionally, social network exhibit dynamic evolution. To a degree, Interpersonal relationships also mirror the active agency of individuals in social engagement, providing insight into the fluid trends of social networking. This study evaluates the strength of social network through the score of "relations with people" from the survey, with a value range of 0 to 10, where an increasing score denotes a stronger network.

(3) Socioemotional support. Social dependence is a critical metric for assessing the quality of an individual's social network and support system. While socioeconomic support focuses on evaluating the material aid an individual receives, social dependence accentuates the psychological support they garner within their social support framework. Taking into account the social support rating scale, assessments of social reliance,[37] and survey questions, this study constructs a proxy for social dependence from the responses to "trust in others" and "the appraisal of willingness to help". Higher values indicate a greater degree of an individual's reliance on social support.

Control Variables

Drawing on related research, this study selects a series of individual characteristic variables as control variables. These include gender, age, marital status, urban or rural residence, education, health, political affiliation, frequency of exercise, and religious beliefs. Within the educational variable, respondents are classified into eight categories based on their educational attainment: illiterate or no schooling (1), primary school (2), junior high school (3), general high school or secondary vocational education (4), junior college (5), undergraduate (6), master's (7), and doctoral (8). Given the unique nature of the Chinese politics, Communist Party membership is closely related to social behavior and psychological states. Hence, non-party members are designated as 0, while party members are coded as 1. Religious belief, as a soft binding force affecting individuals, is factored into the study by marking non-adherents as 0 and believers as 1, thus creating a dummy variable for religion. Table 1 details the specific circumstances of each variable type.

Research Design

Considering each variables' data characteristics, this study employs OLS regression to carry out a series of correlation analyses. The whole research is divided into three main parts: correlation regression among variables, mechanism analysis, and in-depth exploration.

In the correlation regression section, the focus is on using pooled cross-sectional data to analyze the influential effect of social media usage on self-efficacy and loneliness. In order to ensure the reliability of the research results, we employ instrumental variables, reducing the sample size, and replacing independent variables to conduct the generalized robustness test. Based on robust basic regression results, the study explores the mechanisms of action between social media and self-efficacy and loneliness by using social support as a mediating variable, providing richer theoretical support for existing research. This study also employs moderation tests, quantile regression, and heterogeneity tests for analysis, aiming to gain more comprehensive insights and understand more deeply how social media impacts self-efficacy and loneliness.

Descriptive Statistical Analysis

The statistical results from Table 1 indicate that the average score for individual feelings of loneliness stands at 1.486, with self-efficacy averaging at 15 and self-rated health at a mean level of 3.042. From the perspective of social statistics, these figures suggest a relatively high overall health status among Chinese residents. However, the mean education level

Table 1 Descriptive Statistical Results of Each Variable

Variables	Definition	Mean	Min	Max
Loneliness	Degree of loneliness: 1–5	1.486	1	5
Self-Efficacy	Total score across three dimensions	11.721	2	15
SMUF	Frequency of social media usage	3.961	0	6
Gender	Female = 0, Male = 1	0.501	0	1
Age	Age at the time of survey	44.955	9	104
Marital Status	Single = 1; Married/Cohabiting = 2; Divorced/Widowed = 3	1.928	1	3
Household registration	Rural = 0, Urban = 1	0.267	0	1
Education	Level of education: 1–8	2.686	1	8
Self-Rated Health	Self-assessment of health level: 1–5	3.042	1	5
Political Affiliation	Non-Party Member = 0, Party Member = 1	0.050	0	1
Exercise Frequency	Frequency of exercise per week	2.108	0	50
Socioeconomic Status	Income level in the local context: 1–5	2.666	1	5
Religion	Non-religious = 0, Religious = 1	0.022	0	1
Interpersonal Relations	Level of interpersonal relationships: 0–10	7.156	0	10
Social Dependence	Degree of social dependence: 1–3	2.279	1	3
Social Trust	Distrustful = 0, Trusting = 1	0.565	0	1
Helping Behavior	Unwilling to assist = 0, Willing to assist = 1	0.713	0	1

Notes: SMUF is the social media usage frequency.

is only 2.686, signifying that the general education level among Chinese residents is low, posing a severe social challenge. The mean usage rate of social media is at 3.961, denoting that, in the era of information society, social media has become an essential tool for individual external communication, asserting an increasingly significant role at both societal and individual levels.

Table 2, building on the foundation laid by Table 1, provides a further descriptive statistical analysis of the study's dependent and independent variables, highlighting the differences across sample groups concerning the three variables to gain insight into group differences in SMUF, personal self-efficacy, and loneliness.

Regarding urban-rural disparities, the rural populace is at a distinct disadvantage compared to their urban counterparts, with 10.17% of rural individuals reporting high levels of loneliness, significantly more than in urban areas. Preliminary analysis suggests that this may be closely related to the flow of labor between urban and rural areas. The pronounced disparities in economic resources and public services between urban and rural locales have precipitated a migration of a significant portion of the rural workforce to urban centers. This shift has left a considerable segment of the population in rural areas—particularly those of the middle-aged, elderly, and younger demographics—in a prolonged state of being left behind, which has heightened their sense of loneliness. City dwellers benefit from higher-level social services, translating to noticeably greater self-efficacy than that of rural residents. The proportion of high-frequency social media users does not differ markedly between urban and rural areas, thanks primarily to the widespread adoption of mobile devices.

Dividing the total sample based on responses to self-rated health, we categorize the groups into those who perceive themselves as unhealthy and those who see themselves as healthy. The data reveals that the proportion of individuals experiencing higher levels of loneliness in the unhealthy group (19.13%) vastly exceeds that in the healthy group (7.50%), suggesting that individuals with self-rated poor health tend to experience higher loneliness. The findings for self-efficacy mirror the pattern observed for loneliness. Analysis of SMUF suggests that individuals who self-rate as unhealthy spontaneously may reduce their use of social media.

Based on educational attainment, this study categorizes the entire sample into low human capital (junior high school and below), medium human capital (high school), and high human capital (junior college and above) groups. Results presented in Table 2 indicate that individuals within the high human capital group exhibit higher levels of loneliness and self-efficacy. Moreover, the proportion of individuals with higher frequency of social media usage increases with educational level.

For age segmentation, this research follows the age categorization defined in China's official document "Medium and Long-Term Youth Development Plan (2016–2025)", labeling individuals under 35 as the youth group, those 35–59 as the

Table 2 Statistical Results for Loneliness, Self-Efficacy, and SMUF by Group (%)

Dimension	Loneliness	Self-Efficacy	SMUF
Rural	10.17	57.33	66.21
Urban	6.77	62.15	66.04
Self-rated Unhealthy	19.13	37.23	54.57
Self-rated Healthy	7.50	62.43	65.97
Low Human Capital	10.28	57.32	49.03
Medium Human Capital	6.88	61.25	58.51
High Human Capital	4.84	62.99	62.12
Youth	8.24	55.49	60.92
Middle-aged	8.42	56.91	45.54
Elderly	11.88	63.24	37.47

Notes: Indicators in the table are expressed in percentage (%). Individuals scoring 3 or above are categorized as experiencing high levels of loneliness; those with scores over 12 are marked as having high self-efficacy; and individuals with a value greater than 4 are identified as high-frequency social media users.

middle-aged group, and those over 60 as the elderly group.[38] Statistical outcomes for different age groups show an increasing proportion of individuals experiencing high levels of loneliness with advancing age. In contrast, the percentage of individuals with high self-efficacy is notably higher among the elderly compared to the youth and middle-aged groups. The frequency of social media usage is highest among the youth, aligning with their characterization as "digital natives".

Results

Basic Regression

Given the time-specific characteristics of the pooled cross-sectional data, this study introduces time fixed effects into the regression model and conducts unbiased estimation of microdata. The specific formula is as follows:

$$Mental_{it} = \alpha_i + \beta SMUF_{it} + \gamma_t + \in_{it} \tag{1}$$

In the formula (1), $Mental_{it}$ and $SMUF_{it}$ represent the dependent and independent variables, respectively. γ_t captures the common influence of all units at different time points, indicating that the study controls for time effects. $\in_{it}$ is the random error term in this study.

As presented in Table 3, columns (1) and (3) present the regression outcomes for loneliness and self-efficacy based on the SMUF. Upon the inclusion of control variables and time effects, the results are updated to models (2) and (4). The coefficients for SMUF are positive and significant at the metric level, indicating that, with time benefits considered, an

Table 3 Results of Basic Regression

Variables	(1)	(2)	(3)	(4)
	Loneliness	Loneliness	Self-Efficacy	Self-Efficacy
SMUF	0.00662***	0.00717***	0.0511***	0.0142*
	(0.00177)	(0.00205)	(0.00750)	(0.00791)
Gender		0.00956		−0.163***
		(0.00723)		(0.0282)
Age		−0.0814***		0.0552*
		(0.00733)		(0.0303)
Marital Status		−0.00617		0.131***
		(0.0101)		(0.0369)
Household registration		−0.0534***		0.0929***
		(0.00849)		(0.0335)
Education		−0.0253***		0.0552***
		(0.00328)		(0.0126)
Self-Rated Health		−0.0919***		0.678***
		(0.00370)		(0.0145)
Political Affiliation		0.0202		0.135**
		(0.0163)		(0.0663)
Exercise Frequency		−0.00344**		0.0624***
		(0.00135)		(0.00548)
Socioeconomic Status		−0.0459***		0.651***
		(0.00420)		(0.0167)
Religion		0.0477*		0.107
		(0.0251)		(0.101)
Fixed time	YES	YES	YES	YES
Constant	2.799***	3.582***	16.26***	11.80***
	(0.0294)	(0.0483)	(0.0424)	(0.120)
Observations	48,944	37,468	40,528	33,160
R-squared	0.102	0.110	0.052	0.186

Notes: Statistically significant values: * p<0.05, ** p<0.01, and *** p<0.001.

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increase in the frequency of social media use significantly raises users' levels of loneliness and self-efficacy. This also suggests that social media usage is not a purely positive factor for a users' psychological state. The results of the basic regression validate the hypotheses 1 and 2.

Robustness Test

Endogeneity Test

In the data processing and analysis phase, there are numerous factors that influence estimation outcomes, with a limited selection of control variables. Unobservable factors such as individual capability and quality may lead to omitted variable bias, resulting in inaccurate estimations, and in severe cases, may even alter the nature of the impact under study. Moreover, the frequency of individual social media use may be related to one's feelings of loneliness and self-efficacy due to reverse causality—for instance, individuals with lower self-efficacy may intentionally decrease their social media usage. The statistical outcomes for different groups in Table 2 also support the potential existence of reverse causality. To avoid the issues caused by omitted variables and reverse causality leading to endogeneity, this study reprocessed the data using instrumental variables (IVs).

Effective instrumental variables must possess the dual qualities of strong relevance and exogeneity. Firstly, the IV must be correlated with individual social media use. Secondly, it should only influence the feelings of loneliness and self-efficacy through the channel of SMUF. Drawing on the academic consensus, this study adopts the "Internet penetration rates of Chinese provinces in 2014" and "importance of the Internet for socializing" as instrumental variables.[39,40] From a practical point of view, the 2014 Internet penetration rate in provinces represents the foundation for future digital technology development in the region, which is closely related to social media usage, and is also widely recognized by scholars as a viable IV. From the perspective of empirical data, the Two-Stage Least Squares (2SLS) method can be used to examine whether the IV significantly influences the core independent variable in the first stage, and joint F-test can be used to evaluate whether the selected IV has weak correlation. According to Stock and others' rule of thumb, an F-value exceeding 10 indicates no concern of weak IVs.[41] For the exogeneity of the IV, this study employs an over-identification test, comparing the original regression results with the Hausman test after applying the IV, with findings reported in Table 4.

In the assessment of self-efficacy, the preliminary regression within the 2SLS framework demonstrates significant impacts from both instrumental variables on SMUF. The substantial exceedance of the critical F-test value threshold of 10 eliminates concerns over the strength of the selected IVs. The pronounced significance of the Durbin-Wu-Hausman (DWH) statistic negates the exogeneity of SMUF, advocating for the use of IVs to rectify endogeneity within the study. The Sargan statistic and C statistic of the over-identification test suggest that this study accept the null hypothesis of the

Table 4 Results of Endogeneity Test

	Self-Efficacy	Loneliness
Module A: Results using IVs (2SLS)	1.033***	
	(0.0641)	
Control Variables	YES	
Module B: First stage regression results		
Provincial Internet penetration rate	0.448***	0.409***
	(0.0623)	(0.0553)
Importance of the Internet for socializing	0.2318***	0.219***
	(0.0073)	(0.0063)
Control Variables	YES	YES
Observations	30,571	34,928
D-W-H statistic	335.353***	3.158
F-Value	540.421***	634.523***
Sargan	0.468 (p:0.494)	
C Statistic	0.558 (p:0.455)	

Notes: Statistically significant values: ***p<0.001.

IVs' exogeneity. The validity of the IVs is affirmed, and the final outcomes using IVs significantly differ from those of multiple linear regressions, suggesting that the IV method can overcome endogeneity to some extent. Despite different estimated coefficients, a positive correlation between SMUF and users' self-efficacy remains evident. This conclusion stands even after considering endogeneity issues.

Regarding loneliness, the F-value remains above 10, while the significance of the D-W-H statistic is insufficient. This indicates that the exogeneity of the explanatory variable concerning loneliness is plausible, thereby lending credibility to the base regression outcomes.

Reduction of Sample Size

The basic regression analysis incorporates pooled cross-sectional data from four time periods between 2014 and 2020. In this module, robustness tests were conducted using a reduced sample volume approach. Pooled cross-sectional data constructed from three time periods spanning 2014 to 2018 and from 2016 to 2020 were used for re-estimation of regression models. The results are presented in Table 5. Examination of the OLS estimates from columns for 2014–2018 reveals that an increased frequency of social media use continues to elevate feelings of loneliness and self-efficacy. Data outcomes for the columns covering 2016–2020 remain consistent with those from the initial regression phase. No significant changes in the regression coefficients across different sample sizes were observed, suggesting that the findings of this research carry a degree of universality.

Replacement of Independent Variables

There are numerous approaches to robustness testing; this study utilized the replacement of independent variables following the reduced sample size (2014–2018) for further validation. With the advancement of digital technologies like the internet, the characteristics of social media are not confined to specific platform types, and the boundaries between platforms' functionalities have become increasingly blurred. Educational platforms, work-related platforms, and shopping platforms have all acquired characteristics of social media, fulfilling certain social functions, a trait that has been particularly pronounced during the development of the internet in China. Users frequently engage in social activities on the internet incidentally while learning or working. Consequently, this study constructs replacement independent variables based on "frequency of using the Internet for learning activities" and "frequency of using the Internet for work activities", named Frequency 1 and Frequency 2, respectively. The values for these variables in Table 5 were kept consistent with the original SMUF. Both variables showed high statistical significance in their coefficient estimates, with no substantial change compared with the results of basic and sample reduction module.

The results of endogeneity test and robustness tests through multiple approaches indicate that the conclusions of this study are generalizable and reliable. Hypotheses 1 and 2 have both been substantiated.

Table 5 Results of Robustness Tests

Variables	2014–2018		2016–2020		Study		Work	
	Loneliness	**Self-Efficacy**	**Loneliness**	**Self-Efficacy**	**Loneliness**	**Self-Efficacy**	**Loneliness**	**Self-Efficacy**
SMUF	0.00494**	0.0164*	0.00698***	0.0274***				
	(0.00242)	(0.00981)	(0.00204)	(0.00791)				
Frequency 1					0.00748***	0.0146*		
					(0.00196)	(0.00786)		
Frequency 2							0.00356*	0.0156**
							(0.00192)	(0.00785)
Control Variables	YES	YES	YES	YES	YES	YES	YES	YES
Fixed time	YES	YES	YES	YES	YES	YES	YES	YES
Constant	3.546***	11.93***	2.021***	10.34***	3.507***	12.20***	3.524***	12.23***
	(0.0513)	(0.149)	(0.0315)	(0.170)	(0.0488)	(0.132)	(0.0496)	(0.141)
Observations	25,861	21,552	36,787	25,115	25,863	21,555	23,281	18,976

Notes: Statistically significant values: *$p<0.05$, **$p<0.01$, and ***$p<0.001$.

Intermediary Mechanism Test

Model Design

The empirical results solidly established a significant positive relationship between the SMUF and heightened feelings of loneliness and self-efficacy among individuals. Nevertheless, the precise mechanisms driving these outcomes had not been fully determined. Despite hypotheses proposed in the literature review section, these theories required verification using detailed data analyses. A multitude of methods exists for testing mediation mechanisms, among which causal stepwise regression is known for its clarity of structure, strong interpretability, and high flexibility, making it one of the most popular methods for mediation analysis. Consequently, this study employed causal stepwise regression as the model for assessing mediating effects to investigate potential mechanisms by which individual use of social media may enhance feelings of self-efficacy and loneliness. The basic model is specified as follows:

$$\begin{cases} Y_i = cX_i + e_1 \\ M_i = aX_i + e_2 \\ Y_i = c'X_i + bM_i + e_3 \end{cases} \tag{2}$$

In this model, M_i signifies the mediator variable. If the coefficient c is significant and coefficients a and b also pass the test of significance, then mediation is considered significant. With a significant mediating effect established, a significant value for c' would indicate that the mediating variable plays a partial role in the mediation process; if c' is not significant, the situation is termed full mediation, meaning the mediating variable M_i is the sole pathway through which the core explanatory variable exerts its effect.

Analysis of Intermediary Effect

For conciseness, this study created diagrams of the mediating mechanisms (Figures 1 and 2) based on the data results. In the domain of social media usage and self-efficacy, path 1 analysis revealed a significant positive-going effect of SMUF on users' perception of socioeconomic status, which significantly enhanced self-efficacy with a notable effect size of 0.651. Mediation tests indicated that socioeconomic status (socioeconomic support) partially mediates the relationship between SMUF and self-efficacy. Differing from the pattern observed with socioeconomic support, the findings from path 2 exhibited a significant positive correlation between SMUF and the users' social network. Interpersonal relationships (social network) also presented a significant and relatively strong positive impact on self-efficacy. However, when
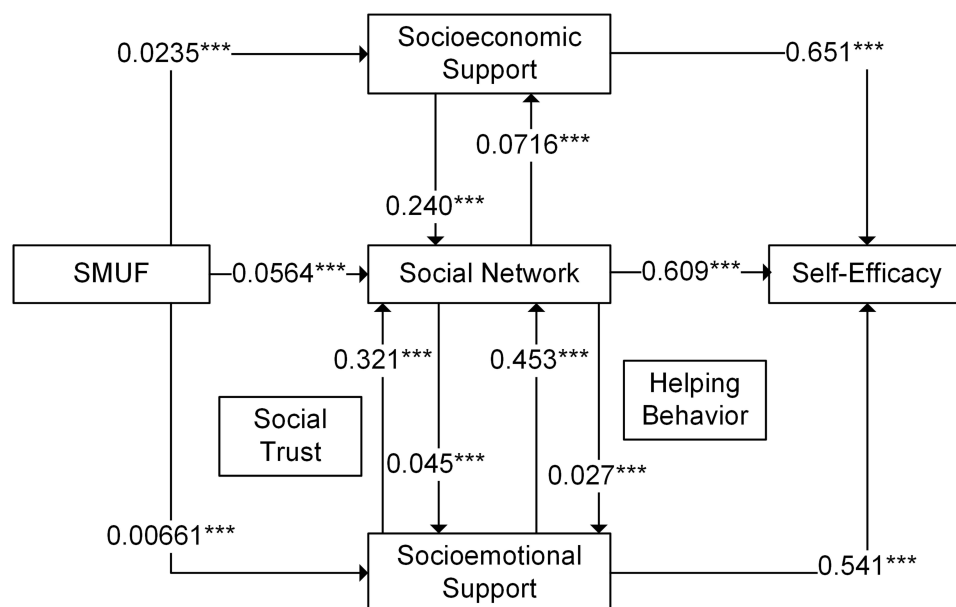

Figure 1 The mediating mechanism between SMUF and self-efficacy.
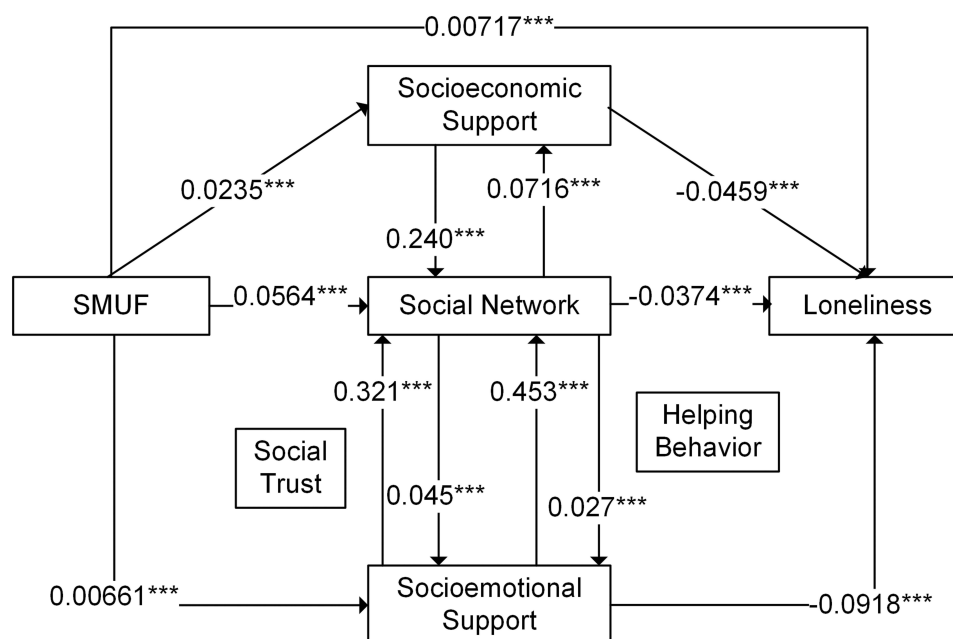**Notes**: SMUF is the social media usage frequency. Statistically significant values: ***p<0.001.

Figure 2 The mediating mechanism between SMUF and loneliness.
Notes: SMUF is the social media usage frequency. Statistically significant values: ***p<0.001.

incorporating these relationships into the third-step regression, the coefficient for SMUF's effect on self-efficacy was not significant, suggesting that social network play a complete mediating role. Path 3 data was consistent with Path 1, showing that social dependence (socioemotional support) exerted a partial mediating benefit. Further exploration into socioeconomic status, interpersonal relations, and social dependence revealed a positive and interdependent relationship among them. Collectively, social support mediates the process in which SMUF enhances self-efficacy; social network acts as a complete mediator, while socioeconomic and socioemotional support contribute both directly to self-efficacy and indirectly by improving interpersonal relationships. The enhancement of social network promotes the acquisition of further economic and emotional support, creating a complex positive cyclical structure.

To maintain overall conciseness, this study constructed diagrams illustrating the mediating mechanisms of loneliness, analogous yet distinct from those of self-efficacy (Figure 2). The figure reflects two critical phenomena. First, socio-economic status (socioeconomic support), interpersonal relationships (social network), and social dependency (socio-emotional support) all have inhibitory effects on users' loneliness. In terms of data significance, social support plays a negative mediating role in this process, yet in real-life contexts, social support positively impacts the psychological well-being of social media users.[42] Second, social network serves as a partial rather than a complete mediator in path 2. Across all examined pathways, SMUF consistently exerts a direct positive effect on users' feelings of loneliness. Although social support attempts to alleviate the increase in loneliness, the direct effects of online social interaction still intensify loneliness. This phenomenon further validates the "social substitution theory" and the "intimacy-frequency effect".

All results of the mediation effect tests displayed high significance, with the stepwise method providing robust explanatory power, negating the need for Bootstrap methods to affirm significance. In summary, the mediation analysis accepted Hypotheses 3 and 4 and further substantiated the reliability and intrinsic mechanisms of Hypotheses 1 and 2.

Further Analysis

It is important to recognize the variability of social media's effects on different demographic cohorts. Adopting a differential perspective, this section divided the sample into distinct groups based on varying criteria to explore the heterogeneity in the effects of social media usage.

The Moderating Effect of Education

The correlation between human capital and both self-efficacy and loneliness is well-documented, with preliminary statistics in Table 2 suggesting a potential association. The academic community often employs education level as a proxy for human capital. Based on the educational classifications provided in Table 2, this study stratified the sample into three subgroups: low human capital, medium human capital, and high human capital. This stratification facilitated a subgroup regression analysis to assess the potential moderating role of education.

Regression results in Table 6 indicate significant positive reactions to SMUF in the low human capital subgroup in terms of self-efficacy and loneliness. As educational levels increased, enhancing human capital, the response to SMUF is diminished and become less significant. Precisely, there is insufficient evidence to suggest that increased frequency of social media usage impacts the self-efficacy and loneliness in the middle and high human capital groups. Overall, education does play a moderating effect by increasing the level of human capital.

Quantile Regression Analysis

OLS regression, based on sample means, may not have captured the full scope of the conditional distribution. In contrast, quantile regression, based upon the quantiles of the dependent variable, afforded a more comprehensive understanding of the conditional distribution, offering deeper insights for research. Given that loneliness constitutes an ordered categorical variable, quantile regression analysis was less informative; therefore, this study focused solely on the self-efficacy component. Quantile regression is expressed as follows:

$$Q_{SE}(\tau|SMUF) = \alpha_i(\tau) + \beta(\tau)SMUF_{it} + \gamma_t(\tau) + \in_{it}(\tau) \tag{3}$$

$$Q(\beta_q) = \sum_{i:SE_i>SMUF'\beta_q}^{N} q|SE_i - SMUF'\beta_q| + \sum_{i:SE_i<SMUF'\beta_q}^{N} q|SE_i - SMUF'\beta_q| \tag{4}$$

The study divided the distribution of self-efficacy scores at the 15th, 45th, and 85th percentile quantiles, yielding corresponding estimated outcomes (as detailed in Table 7). The intergroup coefficient test reveals a significant value of 10.16, which indicated the presence of variability in coefficient magnitude across different quantiles, thus confirming the reliability of Table 7 findings. At the 15th percentile, the positive effect of SMUF on self-efficacy is significant; this effect weakens at the 45th percentile, with the coefficient decreasing from 0.0308 to 0.0198; and turns negative at the 85th percentile. The emergence of this negative turn at higher quantiles is likely attributable to the adverse impacts of excessive social comparison on social media platforms, where users tend to showcase their success and accomplishments. Under such circumstances, users with higher self-efficacy often engage in self-comparison and set higher aspirations for themselves. Upward comparisons on social media may have led to a disparity between expectations and reality or a perceived gap with others, adversely affecting the elevation of their self-efficacy. The data shows that the benefits of social media usage manifested negatively at higher quantiles, suggesting issues with the stability of high levels of self-efficacy.

Table 6 Results of Educational Moderating Effect

	Self-Efficacy			Loneliness		
	Low	**Medium**	**High**	**Low**	**Medium**	**High**
SMUF	0.0215**	0.0224	−0.0267	0.00873***	0.00255	0.00577
	(0.0105)	(0.0164)	(0.0170)	(0.00264)	(0.00417)	(0.00498)
Control Variables	YES	YES	YES	YES	YES	YES
Fixed time	YES	YES	YES	YES	YES	YES
Constant	11.48***	11.82***	12.59***	3.675***	3.469***	3.007***
	(0.181)	(0.212)	(0.326)	(0.0637)	(0.0898)	(0.164)
Observations	18,330	7575	7255	21,218	8294	7956

Notes: Statistically significant values: ***p<0.001.

Table 7 Results of Quantile Regression Analysis

Variables	15%	45%	85%
SMUF	0.0308**	0.0198**	−0.0201**
	(0.0108)	(0.00920)	(0.00841)
Control Variables	YES	YES	YES
Fixed time	YES	YES	YES
Wald test	10.16***		
Constant	7.574***	11.16***	16.26***
	(0.149)	(0.166)	(0.161)
Observations	33,160	33,160	33,160

Notes: Statistically significant values: **p<0.01, and ***p<0.001.

Heterogeneity Analysis

Social media use, a form of social behavior, may result in diversified benefits influenced by factors such as resource reserves, cultural contexts, and individual attributes.[43] Differences in development between urban and rural settings, such as the varying levels of digital infrastructure and social services, create distinct individual characteristics within objective environments. This divergence manifests in significant heterogeneity in the benefits individuals receive from using social media. In terms of subjective intention, individuals with different health statuses may hold substantial subjective variations in their use of social media, leading to diverse effects experienced. Furthermore, the characteristic differences across various age groups hold significant implications for a deeper exploration of the benefits of social media use. In the digital economy era, particularly at the crucial juncture of post-pandemic economic recovery, research on the social media use of the middle-aged and elderly populations can contribute to alleviating severe aging issues and invigorating their social productivity. Therefore, to examine the differentiated impact of SMUF on self-efficacy and loneliness among diverse groups, this study conducted grouping regressions based on individual lifecycle stages, self-assessed health status, and urban-rural residency. The grouping standard is consistent with Table 2.

Results in Table 8 indicate that SMUF's positive impact on self-efficacy is not significant for youth and elderly, with the most pronounced and significant effect occurring in the middle-aged group. Compared to other age cohorts, the middle-aged demographic exhibits the most active expansion of social network breadth, which are more stable during this life phase. Consequently, the positive effects of SMUF are magnified under the influence of mature social support. In contrast, the youth, characterized by physiological and psychological immaturity, demonstrates unstable self-efficacy. The elderly, often referred to as "digital refugees", have comparatively lower digital skills, creating a significant gap between them and other age groups. These characteristics render the young and the elderly more vulnerable to both positive and negative impacts of social media, which may manifest as non-significant effects in empirical findings.

Regarding the variable of loneliness, youth and middle-aged individuals show a sensitive response to SMUF, with increased loneliness corresponding to increased frequency of usage. Younger individuals' unstable psychological characteristics make them sensitive to external factors, and the side effects of spatial isolation due to increased SMUF are significant. Notably, although the impact of SMUF on the elderly did not reach statistical significance, the effect trended towards reducing loneliness, aligning with the findings of many scholars. Scholars commonly use the perspective of family behavioral studies to explain this phenomenon: for the elderly, children are crucial social contacts, and social media can enhance interactions with offspring, providing stronger socio-emotional support and thus reducing loneliness.[44] However, the non-significance of the estimated coefficients for loneliness in Table 8 may be due to the small sample size used in the regression.

Differences among health status groups, as evidenced by the intergroup coefficient variance tests, reveal distinct disparities and comparability in the estimated coefficients. The data suggest that individuals who self- rated as unhealthy benefit more from social media usage in terms of enhancing their self-efficacy as the frequency of usage increases. The resource compensation logic also posits that interventions from external factors are more impactful for those in a disadvantaged resource position, leading to a decrease in marginal benefits as the intensity of resource compensation

Table 8 Results of Heterogeneity Analysis

Variables	Youth	Middle-Aged	Elderly	Self-Rated Healthy	Self-Rated Unhealthy	Rural	Urban
Self-Efficacy							
SMUF	0.00943	0.0211*	0.00684	0.0185**	0.0785**	0.0233**	0.0225*
	(0.0121)	(0.0115)	(0.0282)	(0. 00787)	(0. 0332)	(0.00998)	(0.0122)
Control	YES	YES	YES	YES	YES	YES	YES
Fixed time	YES	YES	YES	YES	YES	YES	YES
Constant	11.47***	13.63***	13.91***	13.03***	14.75***	13.02***	13.04***
	(0.148)	(0.251)	(0.807)	(0.112)	(0.466)	(0.136)	(0.184)
Wald test				2.93*		0.05	
Observations	17,900	13,579	1681	34,163	2696	24,669	12,190
Loneliness							
SMUF	0.00835**	0.00691**	−0.00441	0.00641***	0.00444	0.00765***	0.00296
	(0.00335)	(0.00282)	(0.00632)	(0.00202)	(0.00796)	(0.00251)	(0.00318)
Control	YES	YES	YES	YES	YES	YES	YES
Fixed time	YES	YES	YES	YES	YES	YES	YES
Constant	3.637***	1.223***	0.476**	3.286***	2.532***	3.389***	3.188***
	(0.0533)	(0.0659)	(0.206)	(0.038)	(0.282)	(0.0444)	(0.0699)
Observations	19,864	15,689	1915	34,509	3076	28,613	13,300

Notes: Statistically significant values: *p<0.05, **p<0.01, and ***p<0.001.

escalates.[45] Moreover, the SMUF has an insignificant effect on users who self- rated as unhealthy but appears to increase feelings of loneliness among healthy individuals.

The urban-rural grouping fails to pass the test for coefficient variation; however, self-efficacy responses to SMUF are positive for both urban and rural residents. There is insufficient evidence to establish a beneficial impact of SMUF on loneliness among urban residents. These findings on loneliness highlight the considerable resource disparity between China's urban and rural areas, with the rural population being at a particular disadvantage.

Discussion

Mental health remains a crucial social issue of concern at all strata. This study, starting from the mediating perspective of social support, attempts to analyze the impact of social media on self-efficacy and loneliness, simultaneously obtains significant conclusions in the areas of moderation, heterogeneity, and others.

The Psychological Benefits of Social Media

The results of empirical data convincingly demonstrate that SMUF is a risk factor leading individuals to deeper levels of loneliness. For every unit increase in SMUF, loneliness will be statistically elevated significantly by 0.00717. This conclusion aligns with the nature of most current research findings, though not identical in numerical value. In the pathway of social support's role, SMUF alleviates individual loneliness by enhancing the level of social support. However, for loneliness, there seems to be another factor acts as a mechanism role, prompting SMUF to heighten the sense of loneliness. Addressing this issue, some scholars in physiology, combining psychological and sociological views, believe that biological factors like neural stimulation and bodily metabolism play a significant role.[46] Specifically, in the digital society, people usually engage in high-frequency interactions with large numbers of people through social media. However, online interactions fail to stimulate the brain's image-locking as traditional face-to-face interactions do, potentially leading to lower-quality social interactions. The "busyness" of high-frequency socializing conflicts with low-quality interpersonal interactions, failing to meet social needs, thereby increasing individual loneliness.[47]

In terms of self-efficacy, this study validates the hypothesis that "SMUF is a positive predictor of self-efficacy", but this does not cover the whole sample. The regression results at the 85th percentile contradict those at other percentiles, suggesting that SMUF is not an entirely positive factor for self-efficacy. This also supports the views of some scholars who argue that the vast amount of information brought by social media can become an undeniable source of stress. Individuals are prone to information overload, which negatively affects the improvement of self-efficacy.[48]

Mediated Circular Pathways of Social Support

Figures 1 and 2 present a clear cycle of the mediating path of social support. SMUF acts as a positive factor for both socioeconomic and socioemotional support, with sub-mediating pathways existing among them. First, social media provides a low-cost, high-efficiency platform for the sharing of resources (economic or emotional). On this platform, information, opportunities, and other forms of resources are rapidly and widely disseminated. As users increase their frequency of social media usage, they augment the chances and intensity of acquiring social support. Moreover, this resource sharing is bidirectional; for example, once an individual obtains resources from the social media, a resource flow channel is established between them and the sharer, culminating in the accumulation of social capital.[49] This "direct" pathway propels users' socioeconomic and socioemotional support into a progressive state of "increment-stock-increment". Second, with the increased use of social media, individuals have greater opportunities to establish new social connections and maintain existing network systems. This not only broadens the scope of their social network but is also crucial for deepening their engagement. Moreover, frequent activity on social media platforms establishes a continuous online presence for individuals. According to diffusion of information theory, such social behavior increases their visibility and recognition within social network, thereby generating positive effects on socioeconomic or socioemotional support.[50]

It is noteworthy that social support plays different roles in self-efficacy and loneliness. In terms of self-efficacy, this study innovatively finds that social support is the complete pathway for the effect of SMUF. In contrast, in the case of loneliness, social support acts more like a buffer, serving as a partial mediating factor. Its presence mitigates the enhancing effect of SMUF on deepening loneliness.

The Moderating Role of Education

The moderating role of education (human capital) is evident. Accumulation of human capital typically coincides with enhanced cognitive abilities.[51] Individuals with higher education levels are more likely to critically evaluate information received from social media, resisting the effects of information overload and various kinds of impacts it may have. Additionally, individuals with higher educational attainment possess greater autonomy and control in their personal and professional lives, meaning they have a strong and stable sense of self-efficacy; thus, the impact of social media on them is not significant, be it positive or negative.[52] Furthermore, the purpose behind the use of social media by individuals with higher education levels may differ from other users. This segment of the population uses social media for professional, academic, or information exchange purposes, favoring a "tool-information acquisition" behavior model that prioritizes the quality over the frequency of social interactions, which manifests as an insignificant response to SMUF in the data.[53]

Psychological Sensitivity of Middle-Aged Groups

Whether it is self-efficacy or loneliness, the middle-aged group is the most obvious reflection of social media, which is different from previous studies. Most current research has either overlooked the middle-aged group or shown inconspicuous results in empirical data.[54] However, the middle-aged group is precisely at the edge of digital technology revolution, with digital characteristics of both youth and older age groups, making them more susceptible to the dual influence of factors such as social media. The findings of this study also indirectly illustrate this group characteristic. Compared to other age groups, the middle-aged have more sensitive psychological traits, at least in terms of self-efficacy and loneliness. Additionally, the study's data indicate that the rural middle-aged population requires extra attention.

Conclusion

This study utilized four waves of the CFPS data from 2014, 2016, 2018, and 2020 to construct pooled cross-sectional data, which served as the basis for analyzing the relationship between social media use and self-efficacy and loneliness, as well as exploring the mediating role of social support. The following conclusions were drawn: (1) Under given time effects, SMUF is a significant positive predictor of self-efficacy and loneliness. Upon testing for endogeneity and robustness, the conclusion remains valid. (2) Social support mediates through three pathways: social network, socio-economic support, and socioemotional support, with social network playing a full mediating role in self-efficacy. Social support has been found to promote self-efficacy and inhibit the deepening of users' loneliness. (3) Education (human capital) plays a moderating role, with higher levels of education stabilizing users' self-efficacy and loneliness, making the impact of social media on these constructs insignificant. (4) SMUF yields the most significant positive effects for those with low self-efficacy, whereas it negatively affects those with high self-efficacy. (5) There is heterogeneity in the response to SMUF across groups with different characteristics, whether in terms of self-efficacy or loneliness. Based on the above conclusions, this study provides the following recommendations from micro-individual and macro-social levels in order to provide theoretical support for improving the health of the entire population in the digital age.

At the individual level, users should enhance their digital literacy, strengthen their ability to judge and filter the diverse online information, so that they can consciously select content when using social media and avoid negative impacts due to excessive exposure to negative information. Considering the potential spatial loneliness when using social media, individuals must control their time investment in social media to allow sufficient time for offline social interactions. For instance, they could proactively set daily or weekly usage limits and engage more in face-to-face interactions with family and friends. Particularly for the youth and middle-aged groups, there should be extra vigilance against being in a state of weak social quality due to prolonged social media use and to avoid an over-virtualization of social support.

Although social media usage is an individual-level social behavior, it is also influenced by the social environment. Therefore, governments, businesses, and social organizations should build a favorable social media usage atmosphere at the social level and establish scientific and reasonable digital technology usage concepts. Special attention should be paid to easily influenced social groups like youth and middle-aged, providing them with appropriate assistance. Faced with the complexity and volume of digital information on social media, digital technology companies should collaborate with governments to build unified standards for information filtering mechanisms, promptly cutting off channels for the spread of negative information, and objectively maintaining high-quality digital information.

With the advancement of digital technology, social media is poised to become the primary socialization tool for individuals. Users should recognize the positive predictive effect of social media on their self-efficacy, especially the mediating role of social support therein. Simultaneously, users need to pay attention to the spatial loneliness brought by the use of social media and to seek ways to enhance their psychological health.

Statement on AI Usage

All content in this study is original to the authors and no AI was used to generate research content.

Data Sharing Statement

The microdata used in this study are derived from the China Family Panel Studies (CFPS), which can be accessed at the website [www.isss.pku.edu.cn/cfps/]. All empirical results of the study are presented in this published article.

Ethics Approval and Informed Consent

This study and its protocols have received approval from the Qingdao University Human Research Ethics Committee. All methods were carried out in accordance with the guidelines of the Declaration of Helsinki and were approved by the aforementioned ethics committee. All participants were informed about the survey and provided their consent, as well as informed consent obtained from the China Family Panel Studies (CFPS) office.

Consent for Publication

All authors consent to the publication of this study, and there are no objections to the use of images and tables within the research.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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