The longitudinal associations between perceived importance of the internet and depressive symptoms among a sample of Chinese adults

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Objective: The aim of this study is to examine the extent to which individuals' cognitive evaluation of the importance of the Internet is associated with depressive symptoms, and in what ways.

Methods: This study utilized a sample of 4,100 participants from the fourth (2016), fifth (2018), and sixth (2020) waves of the China Family Panel Studies. Structural equation modeling was employed for data analysis.

Result: The findings of this study reveal that individuals' cognitive evaluation of the importance of the Internet in 2016 was positively linked with the frequency of Internet use and subjective socioeconomic status in 2018. Furthermore, the frequency of Internet use and subjective socioeconomic status in 2018 were found to be negatively associated with depressive symptoms in 2020. These results indicate that the perceived importance of the Internet has an indirect effect on depressive symptoms through the identified pathway.

Conclusion: The present findings contribute to the existing literature by highlighting the importance of individuals' perceived importance of the internet as a significant factor that influences depressive symptoms. The results suggest that policy makers should take actions to increase public awareness of the importance of the Internet in the digital era, and to ensure equitable access to the internet, thus facilitating convenient internet use and helping individuals adapt to the digital age.

KEYWORDS

internet cognition, internet behavior, internet use, depressive symptoms, adults

1. Introduction

The internet has become an indispensable aspect of our daily lives, and its social significance has been globally recognized. According to the International Telecommunication Union's (1) report in 2022, as many as 4.1 billion individuals worldwide had access to the internet in 2019, enabling them to access a variety of products and services such as online shopping, entertainment,

health management apps, and work-related activities on a computer. However, excessive use of the internet can lead to pathological and problematic internet use, which can adversely affect mental health, including depression (2), as several studies have shown (3–5). Depression is a person who is depressed usually experiences several of the following symptoms: feelings of sadness, hopelessness, reduced energy and vitality, slowness of thought or action, and disturbed sleep or insomnia (6). The World Health Organization (WHO) estimates that 5% of adults globally suffer from depression, making it a leading cause of disability and contributing significantly to the global burden of disease (7). The COVID-19 pandemic has dramatically increased the incidence of clinically significant depressive symptoms worldwide (8), amplifying the concerns of both academia and society about its negative impact on mental health and the strain it puts on healthcare systems.

According to the cognitive theory of emotion, emotions stem from the evaluation of stimuli and are influenced by environmental events, physiological conditions, and cognitive processes. Among these factors, cognition plays a critical role in determining the nature of emotions (9). Lazarus further argues that emotions are a result of the interaction between a person and the environment, as individuals evaluate their perceptions, leading to behavioral and physiological changes. In emotional situations, people constantly evaluate events in relation to themselves to comprehend their significance and select appropriate action responses (10). Consequently, an individual's evaluation or perception of a thing can affect their emotions and behaviors. A notable example of this theory is the misperception of the internet among adolescents, leading to internet addiction and mood disorders like depression (11–13). The perceived importance of the internet (PII) is a common perception among individuals that the internet has a significant impact on their life or work, and they consider it to be essential. Based on the cognitive theory of emotion, individuals with a positive perception of the internet are likely to exhibit positive emotions and behaviors, which can reduce the risk of depression (14). However, this conclusion requires further validation, and the hypothesis deserves further investigation as it offers a new perspective for future studies on internet and depression, beyond just internet behavior to internet cognition.

Previous studies have primarily focused on the relationship between internet use and depressive symptoms, with more emphasis on internet behavior than internet cognition (15–17). For instance, research has shown that the internet can provide valuable information that transcends time and space barriers (18), and when used appropriately, it can help people manage their depressive symptoms and improve their mental well-being (14, 19). Other studies have highlighted the positive effects of proper internet use, such as reducing loneliness, increasing social capital, and enhancing happiness and life satisfaction (20–23). On the other hand, numerous studies have indicated that pathological or problematic internet use can increase the risk of depression and lead to various occupational, social, psychological, and physiological impairments (24–29). Internet addiction, akin to addiction to drugs or alcohol, can exacerbate an individual's depression and cause a host of problems in different areas of their life (10, 11, 30, 31). Furthermore,

studies have found that the internet's effects on an individual's mental health are not limited to direct causes; socio-psychological factors can also indirectly influence their depressive feelings. For example, subjective socioeconomic status (SSS) reflects an individual's subjective perception of their position in the socioeconomic structure, including their attitudes, behaviors, and confidence in their prospects and perceptions of social phenomena (32–35). Recent research has shown that internet use can enhance people's social capital, happiness, and life satisfaction, leading to an improvement in their perceived subjective socioeconomic status (36), which, in turn, positively affects their mental health and reduces the risk of depression (37, 38). However, there is still much to learn about the complex relationship between internet use and depression, and further investigation is needed to fully understand the impact of internet cognition on depressive symptoms.

Taken together, Previous studies have primarily focused on the relationship between Internet behavior and depression, while paying little attention to the role of cognition regarding Internet use (39, 40). Building on the cognitive theory of emotion and existing research, we propose the following hypotheses: (H1) There is a positive relationship between the perceived importance of the Internet and both the frequency of Internet use and subjective socioeconomic status; (H2) The frequency of Internet use and subjective socioeconomic status are negatively associated with depressive symptoms. By investigating the cognitive aspects of Internet use, our study seeks to deepen our understanding of how Internet-related variables contribute to mental health outcomes. In addition, most researchers adopted cross-section data to study internet and depression problems, which could be presumptuous to assume causal relationships. Hence, this study used longitudinal data to investigate mediation associations with an aim to extend the previous conclusions. Hypothesized associations between the variables are presented in Figure 1.

2. Methods

2.1. Study design and participant

The present study utilized data collected from the China Family Panel Studies' fourth (2016), fifth (2018), and sixth (2020) waves. The China Family Panel Studies (CFPS) is a nationally representative, longitudinal survey administered biannually since 2010 by the
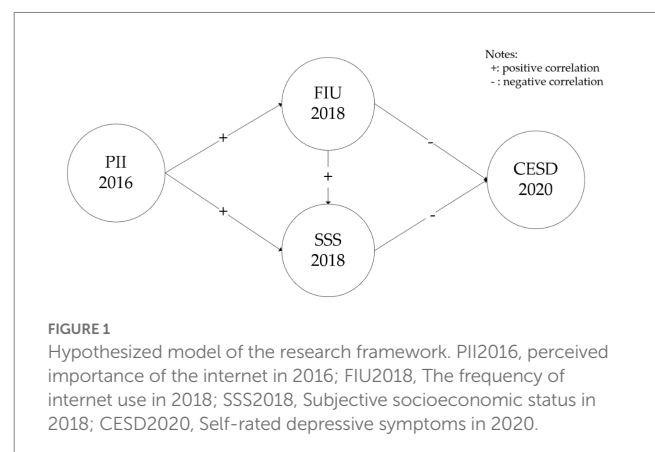
FIGURE 1
Hypothesized model of the research framework. PII2016, perceived importance of the internet in 2016; FIU2018, The frequency of internet use in 2018; CESD2020, Self-rated depressive symptoms in 2018; CESD2020, Self-rated depressive symptoms in 2020.

Institute of Social Science Survey (ISSS) at Peking University. Its aim is to gather longitudinal data at individual, family, and community levels, primarily focusing on economic activities, educational outcomes, family dynamics and relationships, migration, and health. Data was obtained through face-to-face interviews. The CFPS baseline sample was selected using a multistage probability sampling method with implicit stratification. Each subsample in the CFPS underwent three stages of selection: the county (or equivalent), the village (or equivalent), and the household. Inclusion and exclusion criteria for the current sample were presented in Figure 2 in the form of a flowchart.

2.2. Measures

The following items and scales were used in this study:

2.2.1. Perceived importance of the internet (PII)

The perceived importance of the internet (PII) refers to individuals' belief that the Internet has a significant impact on their life or work, and they consider the Internet to be very important to them. It was measured in this study by four items, including '*(A1) How important of the internet is for leisure and entertainment? (A2) How important of the internet for daily life? (A3) How important of the internet is for information access? (A4) How important of the internet is to stay in touch with your family and friends?*' The response options ranged from 1 = very unimportant to 5 = very important. The higher the score, the higher the perceived importance of the internet. The Cronbach's alpha value of this study was 0.76. The fit indices of the scale are as follows: $X^2/df = 4.139$, GFI = 0.999, AGFI = 0.995, NFI = 0.998, IFI = 0.999, TLI = 0.992, CFI = 0.999, RMSEA = 0.028, SEMR = 0.006.

2.2.2. Subjective socioeconomic status

Subjective socioeconomic status is more indicative of an individual's sense of belonging to a particular social class, their
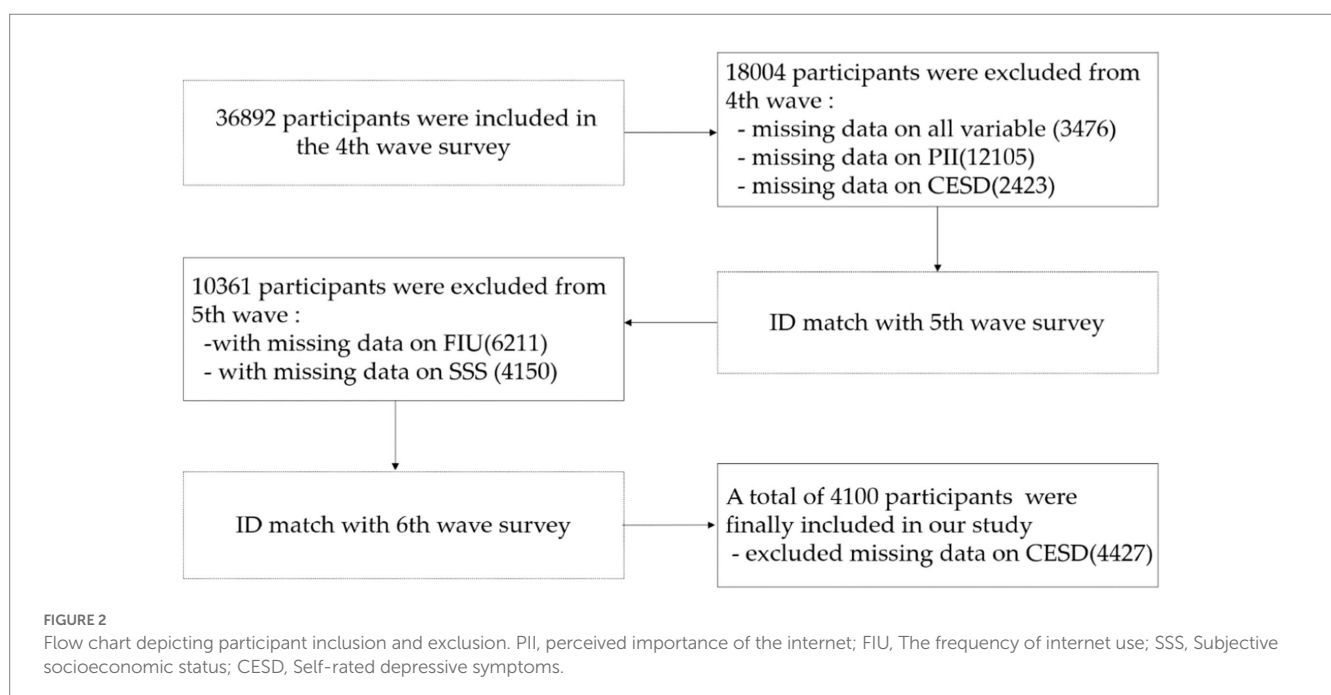
confidence in the prospects, perceptions of social phenomena and job opportunities, and their attitudes and behaviors toward themselves and others around them. It was measured in this study with three items, including '*(B1) How confident are you about your future? (B2) What is your relative income level in your local area? (B3) What is your social status in your local area?*'. The item was scored on an 5-point Likert scale ranging from 1 = very low to 5 = very high. The higher the score, the higher the sense of subjective socioeconomic status. The Cronbach's alpha value of this study was 0.63.

2.2.3. The frequency of internet use

The frequency of internet use refers to how often individuals use the Internet for entertainment, life, and work, etc. It was measured in this study with five items, including '*(C1) In general, how frequently do you use the Internet to socialize? (C2) In general, how frequently do you use the Internet to entertain? (C3) In general, how frequently do you use the Internet to study? (C4) In general, how frequently do you use the Internet to work?*' The response options ranged from 1 = never to 7 = everyday. The higher the score, the higher the frequency of internet use. The Cronbach's alpha value of this study was 0.62. The fit indices of the scale are as follows: $X^2/df = 10.707$, GFI = 0.999, AGFI = 0.984, NFI = 0.992, IFI = 0.993, TLI = 0.931, CFI = 0.993, RMSEA = 0.049, SEMR = 0.011.

2.2.4. Depressive symptoms

Depressive symptoms refer to a set of symptoms associated with a depressive disorder. This study used the 8-item Chinese short version of the Center for Epidemiologic Studies Depression Scale (CES-D) to assess depression symptoms. The CES-D was developed by Radloff (41). Chinese researchers translated and revised the simplified version to create the Chinese version and establish national urban norms for China (42). It was measured in this study using eight items, including '*(D1) I felt sad, (D2) I felt lonely, (D3) I felt depressed, (D4) My sleep was restless, (D5) I thought my life had been a failure,*

FIGURE 2
Flow chart depicting participant inclusion and exclusion. PII, perceived importance of the internet; FIU, The frequency of internet use; SSS, Subjective socioeconomic status; CESD, Self-rated depressive symptoms.

(D6) I was happy, (D7) I enjoyed life, and(D8) I could not get going.'
Each item was scored on a 4-point Likert scale ranging from 0 = never
to 3 = most of the time. The Cronbach's alpha value of this scale was
0.86. The fit indices of the scale are as follows: X^2/df = 4.885,
GFI = 0.996, AGFI = 0.990, NFI = 0.991, IFI = 0.993, TLI = 0.987,
CFI = 0.993, RMSEA = 0.031, SEMR = 0.021.

2.3. Data analysis

Pearson correlation analysis was used to assess the relationship
between the continuous variables AGE, PII, FIU, SSS, and CESD,
which were normally distributed. T-tests were performed to compare
the mean differences of PII, CESD, and FIU with categorical variables
such as gender, education, and marital status. The analysis was
conducted using SPSS 26. The measured models for PII, SSS, FIU, and
CESD were constructed using observed variables A1-A4, B1-B3,
C1-C4, and D1-D8, respectively. These measured models were then
used to construct the structural model consisting of PII, SSS, FIU, and
CESD. The analysis was performed using AMOS 26. The control
variables included age, gender, education length, marital status, and
baseline depressive symptoms in 2016. We evaluated model fit using
the IFI, CFI, AGFI, and NFI indices, which indicate excellent fit when
they exceed 0.90 (43, 44). A RMSEA value of <0.05 indicated a close
fit (45, 46).

3. Results

3.1. Descriptive analysis

Sample characteristics and descriptive statistics were presented in
Table 1. The final sample included 2,105 (51.34%) males and 1995

TABLE 1 Participant characteristics and descriptive statistics (*n* = 4,100).

Variables	N (%)	Mean (SD)
Age(years)		34.35 (9.56)
Gender		
Male	2,105 (51.34%)	
Female	1995 (48.66%)	
Education		
High school or less	2,338 (57.02%)	
College or more	1762 (42.98%)	
Marital status		
Married/living with partner	2,703 (65.93%)	
Single, never been married	1,397 (34.07%)	
PII2016		3.53 (0.79)
FIU2018		5.11 (1.26)
SSS2018		3.28 (0.61)
CESD2016		0.58 (0.41)
CESD2020		0.85 (0.45)

PII2016, perceived importance of the internet in 2016; FIU2018, The frequency of internet
use in 2018; SSS2018, Subjective socioeconomic status in 2018; CESD2020, Self-rated
depressive symptoms in 2016; CESD2020, Self-rated depressive symptoms in 2020.

(48.66%) females. The mean age of respondents was 34.35 years
(SD = 9.56). 2,338 (57.02%) participants' education was high school or
less, and 1762 (42.98%) participants had a college education. 2,703
(65.93%) participants were married, and 1,397 (34.07%) participants
were single. The mean score for depressive symptoms of the
respondents was 0.58 (SD = 0.41) in 2016, and the score increased to
0.85 (SD = 0.45) in 2020.

Correlations between all variables can be seen in Table 2. PII2016
(r = −0.033, p < 0.001), FIU2018 (r = −0.031, p < 0.05), and SSS2018
(r = −0.177, p < 0.001) were negatively correlated with CESD2016;
FIU2018 (r = −0.044, p < 0.01), and SSS2018 (r = −0.182, p < 0.001)
were negatively correlated with CESD2020; CESD2016 (r = 0.360,
p < 0.001) were positively correlated with CESD2020. Age was
negatively correlated with PII2016 (r = −0.065, p < 0.001) and FIU2018
(r = −0.107, p < 0.001). Besides, Gender, Education, and Marital status
were significantly associated with other independent or dependent
variables in different degrees.

3.2. Structural equation modeling results

The model fit indices showed that the hypothesized model fit the
data well. Specifically, the GFI (0.968), NFI (0.910), IFI (0.921), TLI
(0.901), CFI (0.921), and AGFI (0.955) values were above the reference
point (0.9), the RMSEA (0.040) and SRMR (0.0397) values were lower
than that of the reference point (0.05). The goodness-of-fit indices for
the model are shown in Figure 3.

The results of the study indicate that the perceived importance of
the Internet in 2016 was positively associated with the frequency of
Internet use (β = 0.114, p < 0.001) and subjective socioeconomic status
(β = 0.054, p < 0.01) in 2018, thus supporting hypothesis H1.
Additionally, the frequency of Internet use (β = −0.073, p < 0.01) and
subjective socioeconomic status (β = −0.126, p < 0.001) in 2018 were
negatively associated with depressive symptoms in 2020, which
supports hypothesis H2. Notably, the mediating effect of the frequency
of Internet use on the relationship between perceived importance of
the Internet and subjective socioeconomic status was fully supported.
Similarly, the mediating effect of subjective socioeconomic status on
the relationship between the frequency of Internet use and depressive
symptoms was also fully supported. Specifically, the frequency of
Internet use and subjective socioeconomic status had a mediating
effect of 0.013 (95%CI 0.005, 0.026) and-0.029 (95%CI-0.060, −0.010),
respectively.

Furthermore, the study found a significant association between
depressive symptoms in 2016 and 2020 (β = 0.411, p < 0.001), with age
and gender negatively influencing CESD2020 (β_{age} = −0.040, p < 0.01;
β_{gender} = −0.052, p < 0.01) and education and marital status positively
associated with CESD2020 ($\beta_{education}$ = 0.064, p < 0.01; $\beta_{marital\ status}$ = 0.084,
p < 0.001). These findings suggest that younger, female, unmarried,
and well-educated individuals may experience higher levels of
depressive symptoms.

4. Discussion

The primary objective of this study was to examine the impact of
individuals' cognitions about the Internet on their depressive
symptoms. Overall, the study findings support our hypotheses.

TABLE 2 Correlations or covariances between all used variables (*n*=4,100).

	2	3	4	5	6	7	8	9. Marital status
1. PII2016	0.273***	0.068***	−0.033*	0.005	−0.065***	2.052*	−8.999***	1.279
2. FIU2018		0.052**	−0.031*	−0.044**	−0.107***	−3.505***	−26.745***	6.764***
3. SSS2018			−0.177***	−0.182***	0.014	−1.833	−1.590	−2.759**
4. CESD2016				0.360***	0.012	1.554	5.370***	0.160
5. CESD2020					0.007	2.958**	−1.002***	−5.347***
6. Age						−2.445*	10.230***	−38.621***
7. Gender							3.205	27.290***
8. Education								124.499***

Significance level: *0.05; **0.01; ***0.001. PII2016, perceived importance of the internet in 2016; FIU2018, The frequency of internet use in 2018; SSS2018, Subjective socioeconomic status in 2018; CESD2020, Self-rated depressive symptoms in 2016; CESD2020, Self-rated depressive symptoms in 2020.

FIGURE 3
Structural equation modeling results. PII2016, perceived importance of the internet in 2016; FIU2018, The frequency of internet use in 2018; SSS2018, Subjective socioeconomic status in 2018; CESD2020, Self-rated depressive symptoms in 2020.
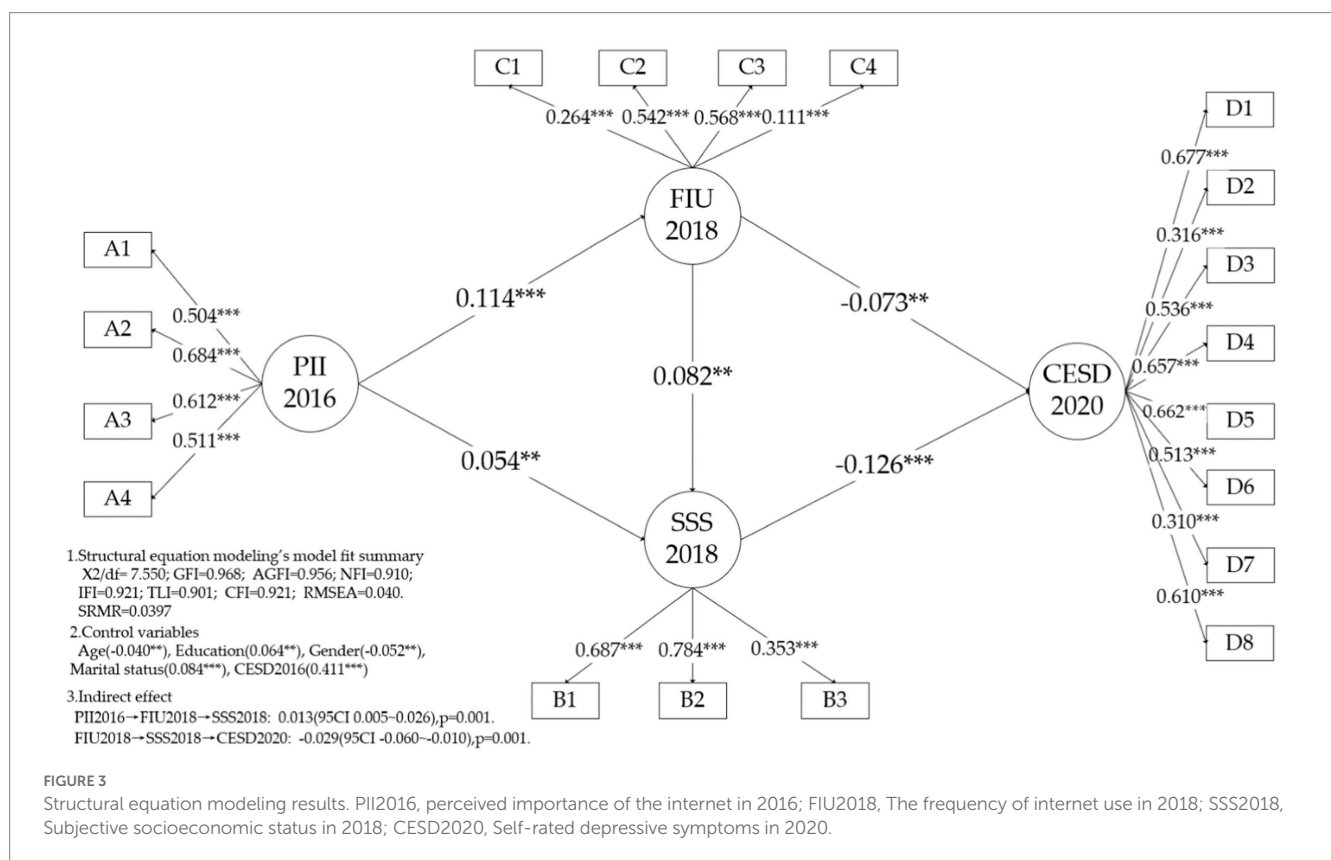
The study results indicate a positive relationship between the perceived importance of the internet, the frequency of internet use, and subjective socioeconomic status. This conclusion aligns with prior research on the topic. Previous studies have demonstrated that the perceived importance of the internet is a significant factor in determining its frequency of use. For example, Lin and Lu (47) found that individuals who perceive the internet as more important use it more frequently than those who do not. This suggests that an individual's cognition influences their behavior, with cognition being a basic mental process that shapes an individual's decisions, behavior, and ability to assess and avoid external threats. Thus, individuals who place a high value on the internet are more likely to use it to improve their lives, as per the cognitive theoretical model. Moreover, the study

revealed that the perceived importance of the internet's effect on subjective socioeconomic status is mediated by the frequency of internet use. This relationship could be explained by the fact that internet use provides individuals with access to resources and information, which influences their perception of their social and economic position relative to others in society. Additionally, frequent internet use can bridge digital inequalities, promote health information-seeking, reduce health disparities, and enhance well-being, as demonstrated by previous studies (48–51). However, it is essential to note that this relationship may not be causal. For instance, studies indicate that individuals with higher subjective socioeconomic status tend to use the internet more frequently than those with lower subjective socioeconomic status (52), indicating that subjective

socioeconomic status may influence an individual's frequency of internet use. Overall, the findings suggest that policies aimed at expanding internet access should also focus on individuals' perceptions of its importance. Policymakers could consider strategies to raise awareness of the internet and digital technologies' benefits, particularly among individuals who do not currently value its importance.

Secondly, the study's results reveal a negative correlation between depressive symptoms and both the frequency of internet use and subjective socioeconomic status. This finding is consistent with previous research, which has demonstrated that the internet has numerous beneficial effects on mental health (53, 54), such as increasing life satisfaction and reducing negative emotions (55, 56). Studies have also shown that internet usage can expand social networks, enhance social participation, and improve social capital, all of which have been linked to lower levels of depression (57–61). Similarly, individuals with a higher subjective socioeconomic status are less likely to experience depressive symptoms due to their better access to resources and greater sense of control over their circumstances (62, 63). This finding is supported by research that indicates that high subjective socioeconomic status has a protective effect against depression and positively affects psychological factors such as well-being, self-esteem, and perceived stress (64–66). Overall, the negative associations between the frequency of internet use and subjective socioeconomic status with depressive symptoms highlight the potential benefits of addressing inequalities in internet access and use, as well as addressing social determinants of mental health such as socioeconomic status. The finding also highlights the importance of addressing socioeconomic inequality in access to the internet and digital technologies. Policymakers could implement measures aimed at reducing the digital divide, such as providing subsidies for internet access and digital devices for low-income households and investing in infrastructure to expand access to high-speed internet in rural and remote areas.

Finally, the finding that the earlier depressive symptoms revealed a significant effect on later depressive symptoms, which is consistent with past studies (67, 68). Depression is a negative psychological state that can easily reoccur (60, 61, 69). Studies have shown that mild depression may get recover without treatment, but moderate and severe depression without timely intervention may cause long-term symptoms and even suicidal tendencies (68). Therefore, we advocate taking intervention measures for these people who are fall into earlier depressive symptoms, helping them relieve these depressive symptoms. Moreover, the current found indicating that young, well-educated, female, unmarried people may be at higher risk of having depressive symptoms. While these findings may seem counterintuitive, they are supported by previous research that has identified similar risk factors for depression. For example, studies have consistently shown that women are more likely than men to experience depression (70), and that individuals with higher levels of education may also be at increased risk (71). The fact that young, unmarried individuals are also at increased risk for depression is also consistent with previous research (72, 73). This may be because young adulthood is a time of significant life transitions and stressors, such as starting a new job or relationship, and because the lack of social support that can come with being unmarried can exacerbate these stressors. These findings have important implications for mental health professionals, policymakers, and public health practitioners. Mental health professionals need to be aware of the elevated risk for depression in these populations and

tailor their interventions accordingly. They should also consider specific risk factors that may be more prevalent in these groups, such as academic or career-related stress, social isolation, and relationship issues.

5. Limitations

Despite the contributions of the current study, it also has some limitations.

Firstly, one limitation of the present study is the possibility that some correlations reported in Table 2 may have been influenced by a large sample size, leading to statistical significance despite weak effect sizes. It is important to note that statistically significant findings may not necessarily translate to practical significance. Weak correlations do not always imply a strong or meaningful relationship between variables, and as such, their interpretation must be approached with caution. To address this limitation, future research may consider using different statistical techniques, increasing the sample size, or collecting additional data to better understand the nature of the relationship between the variables. Additionally, acknowledging this limitation is essential when interpreting the results of this study, as it highlights the need for further investigation into the relationship between the variables of interest.

Secondly, the present study is related to the sample size and representativeness of the data. Despite the use of nationally representative data from the CFPS, the current sample size was relatively small compared to the original baseline data. Moreover, certain questionnaires were only administered to a subsample, resulting in a significant amount of missing data. As such, the present findings may lack generalizability to other populations or contexts. To address this limitation, future research could use larger and more diverse samples, as well as more comprehensive measures of the variables of interest. Additionally, it may be useful to investigate other behaviors and emotions that may alleviate depressive symptoms and promote better emotional health outcomes, using the CFPS data as delimiting variables. By doing so, a more nuanced understanding of the relationship between these factors can be gained, and interventions can be developed to improve emotional well-being in various contexts.

Thirdly, the present study relates to the measurement of subjective socioeconomic status, which was assessed using only three items. While three-item scales have been acknowledged in the literature as valuable instruments for measuring SES, their validity and reliability may be further improved by utilizing multi-item scales in future research. Furthermore, to enhance the validity of the findings in the present study, it may be beneficial for future research to employ more comprehensive scales to measure the perceived importance of the Internet, as well as the frequency of Internet use. Doing so would allow for a more detailed understanding of the relationship between these variables and depressive symptoms, and may uncover potential mechanisms underlying these associations. By addressing these limitations, future studies can better inform interventions aimed at improving emotional well-being in different populations and settings.

A fourth limitation of the present study pertains to the analysis of longitudinal data. Although an implied model was used in the present study, a cross-lagged model would be the optimal choice for analyzing longitudinal data, as it takes into account the values of all previous variables in the next one. Unfortunately, the CFPS data did not meet

the requirements for this model. To overcome this limitation, future research may consider using a cross-lagged model to analyze research hypotheses, thereby providing a more nuanced understanding of the relationship between variables over time. Such an approach can be useful in identifying potential causal pathways.

Finally, a limitation of the present study is that the measures used did not explore the personal value of the Internet or the emotional states experienced when using it. Rather, the study solely measured the perceived importance of the Internet to the participants. It is important to note that a person may perceive the Internet as highly important to themselves but may still engage in problematic Internet use, which can ultimately lead to poor social functioning and emotional distress. Such a pathway has been well-documented in the literature. Therefore, the results of the present study may require further analysis to fully understand the underlying mechanisms of the observed associations between the variables of interest. Future research may consider employing more nuanced measures that capture the multidimensional nature of Internet use and its effects on emotional well-being, including measures of emotional experiences and problematic Internet use.

6. Conclusion

In conclusion, our study demonstrates that the perceived importance of the internet has a protective effect on individuals' depressive symptoms. The conclusion proves the notion of cognitive theory of emotion with data, which states individual's perception of things can affect they feelings and behaviors, this also implies that the perception of the Internet also affects one's mood, not only the behavior of Internet use. In addition, these findings have positive implications for public health and public policy. From a public health perspective, these findings suggest that the internet may have a critical role in promoting mental health and preventing depression. Given the significant burden that depression imposes on individuals and society, identifying protective factors that can help mitigate its risk is of paramount importance. Therefore, interventions aimed at promoting the use of the internet and enhancing individuals' perceptions of its importance may be beneficial in preventing depression. Moreover, this study underscores the necessity of promoting equitable access to the internet, particularly in disadvantaged communities. The internet has the potential to serve as a valuable resource for individuals facing social and economic challenges, providing access to information, resources, and social support that may help mitigate the risk of depression. From a policy perspective, these findings suggest that policymakers should consider the potential mental health benefits of promoting internet access and use. Policies aimed at increasing internet access, affordability, and digital literacy may help reduce disparities in mental health outcomes and improve overall population mental health. In sum, the present study's findings suggest that the perceived importance of the internet may play a protective role in preventing depression, and promoting equitable access to the internet has the potential to improve population mental health. Therefore, further research in this area is warranted to better understand the mechanisms underlying the relationship between internet use and mental health, and to inform the development of evidence-based interventions aimed at improving mental health outcomes.

Data availability statement

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

Ethics statement

The studies involving human participants were reviewed and approved by the Biomedical Ethics Review Committee of Peking University approved this study (IRB00001052-14010), and all participants signed informed consent. The patients/participants provided their written informed consent to participate in this study.

Author contributions

ZW and JbZ: conceptualization. JwZ and Y-WX: funding acquisition. ZW: methodology, software, and writing–original draft. JbZ, JwZ, and MJ: validation. MJ: visualization. JbZ, MJ, JwZ, and Y-WX: writing–review and editing. All authors will be informed about each step of manuscript processing including submission, revision, revision reminder, etc. via emails from our system or assigned Assistant Editor.

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Conflict of interest

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

Publisher's note

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