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Impact of time poverty on sleep quality: An Explanation Based on the Stress Process Model

Abstract

Objective: Based on the stress process model, this study explores the impact of time poverty on sleep quality among Chinese adults, as well as its physiological and psychological mechanisms.

Methods: Data from the "Online Survey on Sleep Status of Chinese Residents" conducted by the Center for Social Psychology, Institute of Sociology, Chinese Academy of Social Sciences in 2023 were adopted, with 6,255 adults as the research subjects. Through a chain mediation analysis, this study examined the direct effect of time poverty on sleep quality as well as the underlying mediating pathways. The empirical tests were divided into three steps: first, examed the chain mediating effects of cognitive evaluation and physical health status between time poverty and sleep quality. Second, examined the chain mediating effects of cognitive evaluation and depression in the relationship between time poverty and sleep quality. Finally, tested the chain mediating effects of cognitive evaluation and anxiety between time poverty and sleep quality.

Results: 1. Time poverty has a significant negative impact on sleep quality (β=-0.155, p<0.001). 2. The chain mediating effect of cognitive evaluation and physical health status is significant, with the proportion of the chain indirect effect being 15.50%. 3. The chain mediating effects of cognitive evaluation and depression/anxiety are significant, with the proportions of the chain indirect effects being 11.43% and 12.38% respectively. 4. In the model, compared with depression (β=-0.159, p<0.001) or anxiety (β=-0.163, p<0.001), physical health status (β=0.335, p<0.001) has a greater impact on sleep quality.

Conclusions: Time poverty can not only directly lead to poor sleep quality, but also indirectly affect sleep quality through independent or chain mediation pathways involving cognitive evaluation, physical health status, or depression/anxiety. This study provides a theoretical basis for individual time management interventions and the formulation of organizational health policies.

Keywords: time poverty, sleep quality, stress process model, cognitive evaluation, chain mediation

1. Introduction

Hartmut Rosa, a German sociologist, pointed out in his book *Acceleration: The Transformation of Time Structures in Modern Society* that technological acceleration (such as instant messaging and automated production) has shortened the time people spend on completing tasks, but it has not freed up leisure time. Instead, through the mechanism of "dynamic stabilization", it forces individuals to constantly adapt to new work and life rhythms, forming a vicious cycle of "catching up - becoming busier - catching up again". In addition, there is a paradox in social and cultural recognition of "busyness". Social media continues to shape the narrative logic that "success = busyness", making individuals have to actively compress their leisure time to pursue more social recognition, which further rationalizes the phenomenon of "time poverty". In the context of a fast-paced society, scarcity has become a social problem that is prevalent in daily life (Griskevicius et al., 2013; Fernbach et al., 2015). Among various types of scarcity, financial scarcity and time scarcity are the most common. Such a lack can be either substantial or perceived (Hamilton et al., 2019). The sense of financial scarcity can lead individuals into a state of "material poverty"; similarly, the sense of time scarcity can push individuals into the adverse situation of "time poverty". However, whether it is material poverty or time poverty, the perception of one's own resource scarcity can induce stress and negative emotions, thereby affecting personal physical and mental health.

"Time poverty" is defined as a chronic perception of "having too many things to do and not enough time to do them." This phenomenon is increasingly prevalent in contemporary society (Giurge et al., 2020) and has emerged as a significant social concern (Zeng et al., 2024). According to the data from *China Labor Statistical Yearbook*, the average weekly working hours of urban employed persons in China have continuously and steadily increased from 45.5 hours in 2015 to 48.3 hours in 2023[1], which has exceeded the statutory working hour system stipulating that employees work no more than 8 hours a day and an average of no more than 44 hours a week[2]. The extension of working hours directly squeezes individuals' non-working time, resulting in insufficient discretionary time for people. In addition to extended working hours, the intensification of work or tasks can also contribute to "time poverty." Key metrics for assessing time intensity include task pace, task complexity, and time pressure. High

[1] https://www.zgtjnj.org/navipage-n3023042404000155.html
[2] https://baike.so.com/doc/30506719-32302201.html

time intensity is manifested not only through elevated efficiency demands but also through heavy task loads and heightened time urgency in daily life.

Time poverty tends to have adverse effects on individuals' physical and mental health by inducing stress responses. Sleep health is an important part of physical health. In previous studies, the relationship between time poverty and sleep quality has not received sufficient attention from researchers. Therefore, investigating the impact of time poverty on sleep quality and its underlying mechanisms holds significant practical value and theoretical importance. Theoretically, this study makes three key contributions. First, it shifts the focus from time scarcity − the conventional conceptualization of time poverty − to time intensity as its core feature, thereby deepening the conceptual understanding of this construct. Second, it expands the scope of time poverty outcomes by revealing potential pathways through which it impacts individual health. While existing research has primarily examined its effects on well-being, mental health, and social behaviors (Browne et al., 2022; Ng et al., 2024; Zhang et al., 2025), the mechanisms by which time poverty erodes physical health−particularly fundamental physiological processes such as sleep−remain underexplored. Third, this study validates and extends the holistic explanatory power of the stress process model. That not only provides empirical support for the model's applicability in explaining the health impacts of emerging social stressors, but also strengthens its capacity to connect macro-level social structural factors with micro-level psychophysiological processes, highlighting its value as an integrative theoretical framework. From a practical perspective, the findings may enhance public awareness of the relationship between time management and sleep health, encouraging the adoption of effective strategies to mitigate the adverse effects of time poverty on sleep quality. This could indirectly reduce health risks associated with sleep disturbances, such as inflammation, cardiovascular diseases, and impaired immune function (Al-Rashed et al., 2025; Wang et al., 2022), thereby contributing to improved population health outcomes.

In summary, this study aims to systematically examine the impact of time poverty on sleep quality among Chinese adults and elucidate its underlying mechanisms. We not only seek to theoretically unpack the core mediating pathway of "cognitive appraisal—stress response," but also endeavor to identify actionable intervention points. The findings are expected to provide a scientific foundation for developing targeted health promotion and time management strategies.

2. Theory and Hypothesis

2.1. Time poverty and sleep quality

According to the three-dimensional theoretical model of time poverty (Sun et al., 2024), time intensity is a core dimension of time poverty. In this study, time poverty specifically refers to high time intensity. High time intensity refers to a state where individuals have to complete a large number of tasks within a unit of time, face high work pressure, and are in a state of high tension and busyness. Existing studies have pointed out that high work demands, heavy workloads, work tension, and high work pressure can all significantly reduce sleep quality (Åkerstedt et al., 2002; De Lange et al., 2009; Kalimo et al., 2000; Lallukka et al., 2010). In addition, Lyons and others found that poor sleep quality is associated with higher work intensity, indicating that if workers face more workloads and/or greater time pressure in the work environment, their sleep quality will decline (poorer sleep quality). Moreover, the impact of work intensity on sleep quality (8% - 9%) is significantly higher than that of working hours (3.2%), suggesting that "how to work" has a greater impact on sleep quality than "how long to work" (Lyons et al., 2022). The work intensity here focuses on the "pressure density within a unit of time" and includes three core elements: work rhythm (the requirement of work tasks for "speed", i.e., whether employees need to complete a large amount of work in a short time, reflecting the "urgency" in terms of physics or processes), work intensity (referring to the degree of mental or physical input in the work process, emphasizing the "difficulty" or "consumption" of task execution), and time pressure (referring to the sense of mismatch between the amount of work tasks and the available time, resulting in the inability to complete work calmly).

In summary, existing research has confirmed the adverse impact of time poverty on sleep quality in work settings, but demonstrates significant population limitations. Current findings are primarily based on working populations, failing to reveal whether time poverty, as a pervasive social stressor, exerts consistent detrimental effects across different life roles. This limitation constrains our understanding of the nature of time poverty—is it merely a workplace-specific stressor or a common health risk transcending occupational boundaries in modern society? Therefore, this study expands the research scope to a general population sample to examine the universality of time poverty's impact on sleep quality. Furthermore, previous investigations have relatively neglected the underlying mechanisms connecting these two variables.

2.2. Time poverty, cognitive evaluation and sleep quality

Time poverty is not only a prevalent experience in modern society but also a distinctive social stressor shaped by social structures, amplified through cognitive evaluation, and characterized by high permeability. Previous research has demonstrated that time poverty can induce stress (Boström et al., 2020; Creagh et al., 2025), while perceived stress shows a significant negative correlation with sleep quality (Lee et al., 2020).. A large number of studies have emphasized that perceived stress or other emotional disturbances (such as anxiety and depression) brought about by the COVID-19 pandemic are closely linked to sleep quality (Ahmed et al., 2021; Huang et al., 2024; Jahrami et al., 2021; Lin et al., 2021; Memarian et al., 2023), and stress can also lead to sleep difficulties (Amaral et al., 2018). In addition to the direct impact, the negative effect of perceived stress on sleep quality can also be realized through negative emotions. That is, individuals in stressful situations will experience negative emotions such as depression, anxiety, and hopelessness, which will have a negative impact on sleep quality (Li et al., 2019), a finding that has also been confirmed by the research of Pang et al. (Pang et al., 2021). Furthermore, the bidirectional relationship between perceived stress and sleep quality has been verified (Zhang et al., 2018). This bidirectional relationship plays an important role in the mechanism of maintaining bodily homeostasis to cope with internal and external challenges (McEwen and Karatsoreos, 2015).

Based on existing evidence, we can postulate a logical pathway from time poverty to sleep quality through perceived stress. However, according to the stress process model (Lazarus & Folkman, 1984), the level of stress an individual experiences in response to a stressor largely depends on their appraisal of the specific situation and their perceived capacity to cope with it. This indicates that the emergence of stress is directly influenced by cognitive evaluation—a critical point that has not been adequately emphasized in current literature.

2.3. Time poverty, physical health status and sleep quality

Time poverty has been documented to adversely affect physical health (Creagh et al., 2025; Zuzanek, 2004). Analyzing data from the Canadian General Social Survey-Time Use (GSS-TU), Spinney and Millward found that both time poverty and income poverty were associated with lower participation rates, frequency, and time allocation for physical activity. Individuals experiencing time poverty reported higher levels of time pressure, which collectively exert negative effects on physical and mental health(Spinney and Millward, 2010). Similarly, drawing on the American Time Use Survey (ATUS) and its Eating and Health Module, Kalenkoski and Hamrick demonstrated that time poverty significantly influences dietary and physical activity patterns. Specifically, although time-poor individuals were less likely to purchase fast food, they exhibited reduced meal frequency and decreased time spent on exercise, potentially increasing obesity risk(Kalenkoski and Hamrick, 2013). Strazdins et al. examining both the quantity and intensity dimensions of time use using Wave 9 data from the Household, Income and Labour Dynamics in Australia (HILDA) Survey, revealed that time poverty and frequent feelings of rush were associated with less physical activity, while frequent rushing was significantly correlated with poorer self-rated health and mental health status(Strazdins et al., 2016). A study conducted in Japan further indicated that time poverty negatively impacts physical health through multiple pathways, including reduced sleep duration, decreased frequency and intensity of physical activity, and the adoption of unhealthy lifestyles (Urakawa et al., 2020). Notably, the close relationship between physical health status and sleep quality is well-established and widely accepted in the literature (Golombek et al., 2025; Hong et al., 2025).

Furthermore, according to Self-Determination Theory, high levels of perceived time poverty may prevent individuals from fulfilling their basic psychological needs—particularly competence needs (as opposed to autonomy or relatedness). This deprivation accelerates the adoption of a fast life history strategy, which subsequently induces a state of psychological strain and adversely affects mental health(Zhang et al., 2025). Artazcoz et al.'s study indicates that women show significant associations with poor mental health status, sleep deprivation, suboptimal sleep quality, and reduced physical activity during leisure time(Artazcoz et al., 2024). The Global Burden of Disease Study 2019 conducted by the World Health Organization revealed that depression and anxiety were the two most prevalent mental disorders across all genders and years examined (1990-2019) (GBD 2019 Mental Disorders Collaborators, 2022). The bidirectional relationship between sleep and mental health has been well-established in the literature (Haddad, 2025; Yasugaki et al., 2025). Specifically, sleep disturbances often contribute to the development of mental health issues such as depression, anxiety, and stress (Akpoveta et al., 2025; Liu et al., 2024; Marino et al., 2021), while pre-existing mental health conditions can conversely exacerbate sleep problems, creating a self-perpetuating cycle that is difficult to break.

2.4. Stress process model

The stress process model holds that stress is a process involving multiple factors from stressors to stress responses. As shown in Fig. 1. Schematic Diagram of the Stress Process Model, according to the stress process model, stress refers to an individual's adaptation process to environmental threats or challenges; the cause of stress is life events; the result of stress is adaptive or maladaptive physical and mental responses. The process from life events to stress responses is affected by various factors such as an individual's cognitive evaluation, coping styles, social support, and personality traits. This theory suggests that sources of stress include life events and ongoing life stress, which can induce stress experiences and thereby affect various physiological, psychological, and behavioral manifestations of individuals (Pearlin et al., 1981). Sensitivity to stress can lead individuals to experience stress to varying degrees, which in turn results in different coping styles and emotional states when facing challenges and pressures in life. When an individual perceives that stimuli from the internal or external environment exceed their coping abilities and resources, stress arises. After a stressor acts on an individual, whether stress occurs mainly depends on two psychological processes: cognitive evaluation and coping styles. Cognitive evaluation refers to an individual's perception of whether the environment has an impact on themselves, including thoughts and expectations about stressors, while evaluating their own coping abilities. It is a mental activity involving perception, thinking, reasoning, and decision-making (Lazarus and Folkman, 1984).

Insert Fig. 1. here

In summary, based on the stress process model, this study regards time poverty as a life event (i.e., stressor), the perception of time poverty as the cognitive evaluation and experience of the stressor, physical health status at the physiological level and depression/anxiety levels at the psychological level as stress responses, and sleep quality as a health outcome. On this basis, this paper puts forward the following 8 research hypotheses, and the model is shown in Fig. 2.

H1: Time poverty negatively affects sleep quality.

H2: Cognitive evaluation plays a mediating role in the relationship between time poverty and sleep quality.

H3: Physical health status plays a mediating role in the relationship between time poverty and sleep quality.

H4: Depression plays a mediating role in the relationship between time poverty and sleep quality.

H5: Anxiety plays a mediating role in the relationship between time poverty and sleep quality.

H6: Cognitive evaluation and physical health status have a chain mediating effect in the relationship between time poverty and sleep quality.

H7: Cognitive evaluation and depression have a chain mediating effect in the relationship between time poverty and sleep quality.

H8: Cognitive evaluation and anxiety have a chain mediating effect in the relationship between time poverty and sleep quality.

Insert Fig. 2. here

3.Method

3.1. Data source

Data from the 2023 "Online Survey on Sleep Status of Chinese Residents" were adopted. The survey is conducted by the Center for Social Psychology, Institute of Sociology, Chinese Academy of Social Sciences, the research team has conducted region-gender stratification and PPS (Probability Proportional to Size) sampling based on the *China Statistical Yearbook (2022)* (National Bureau of Statistics, 2022), and *data from the Seventh National Census*. The survey sample covers 27 provinces (municipalities directly under the Central Government and autonomous regions) excluding Hong Kong, Macao, Taiwan, Tibet, Qinghai, Hainan, and Ningxia. During the questionnaire collection process, quality control personnel from the research team monitored the quality of returned questionnaires in real-time through the online survey platform's backend. They immediately excluded samples containing missing values, outliers, excessively short response times, or incorrect answers to attention-check questions. Ultimately, a total of 6,255 valid samples were collected. To enhance the national representativeness of the survey data, this paper uses weighted data for analysis[3]. The age of the survey samples ranges from 18 to 73 years old, with an average age of 42.10 ± 11.93 years old.

3.2. Research instruments

3.2.1. Sleep quality

Sleep quality of the participants was measured by the question "How would you rate your overall sleep quality in the past month?". There were 4 response options: 1 = "Very

[3] **Weighting Method:** Gender-region stratified weighting was applied based on the Seventh National Population Census. The weight=The proportion of this stratum in the sample / The proportion of this stratum the census..

poor sleep quality", 2 = "Poor sleep quality", 3 = "Fairly good sleep quality", 4 = "Very good sleep quality". A higher score indicates better sleep quality. It is worth mentioning that, to ensure the robustness of the results, this study also utilized the Pittsburgh Sleep Quality Index (PSQI) to measure the sleep quality of the respondents and conducted an empirical test using the same methodology, with PSQI as the dependent variable. The empirical analysis revealed that the results based on PSQI-measured sleep quality were similar to those reported in this paper, which used a single-item measure of sleep quality. There were no changes in the significance or direction (positive/negative) of the path coefficients, with only minor differences in their magnitudes. Furthermore, considering that the contribution of factors other than the subjective sleep quality component to the total PSQI score is relatively small and does not significantly affect the final results. Therefore, due to space constraints, this study only reports the empirical results using the single-item measure of sleep quality as the dependent variable in the model.

3.2.2. Time poverty

Time poverty was measured by the question "I feel there are always endless things to do every day" to assess the degree of respondents' time poverty. There are 5 response options for the question: 1 = "Strongly disagree", 2 = "Somewhat disagree", 3 = "Neutral", 4 = "Somewhat agree", 5 = "Strongly agree". A higher score indicates a higher degree of time poverty. It should be noted that to examine the criterion validity of the single-item time poverty measure, we calculated its correlation with the total score of the stress subscale from the DASS-21. The results revealed a statistically significant positive correlation ($r = 0.221$, $p < 0.001$), providing preliminary support for the validity of the single-item time poverty measurement. This indicates that the assessment of time poverty through this single item aligns with individuals' overall stress experiences.

3.2.3. Cognitive evaluation

"Cognitive evaluation" refers to an individual's assessment of the relationship between situational demands and their available coping resources. The cognitive evaluation of time poverty among respondents was measured by the question "I feel stressed due to time urgency". The rationale lies in the fact that this item reflects not merely an emotional experience, but rather a cognitive conclusion derived from internal evaluation—specifically, the perception that "current task demands exceed my available time and capability resources." In this context, "feeling stressed" is regarded as a cognitive marker or signal of this negative appraisal outcome, rather than an indicator of emotional state. There are 5 response options for the question: 1 = "Strongly disagree", 2 = "Somewhat disagree", 3 = "Neutral", 4 = "Somewhat agree", 5 = "Strongly agree". A higher score indicates a more negative cognitive evaluation of time poverty.

3.2.4. Physical health status

The physical health status of the respondents was measured by the question "How would you describe your current physical condition?". There are 5 response options for the question: 1 = "Very unhealthy", 2 = "Unhealthy", 3 = "Average", 4 = "Healthy", 5 = "Very healthy". A higher score indicates better physical health status.

3.2.5. Depression

The Depression Anxiety Stress Scale (DASS), developed by Lovibond and colleagues in 1995, is a self-report instrument comprising 42 items designed to measure anxiety, depression, and stress (Lovibond, 1995). The DASS-21 is a refined short form of the original scale. Research has demonstrated that the DASS-21 retains the stable factor structure and comparable reliability and validity of the full version, making it more suitable for rapid screening in both research and clinical contexts (Antony et al., 1998). In 2001, Taouk et al. translated and adapted a traditional Chinese version of the DASS-21, with validation studies in Hong Kong, China confirming its high reliability and validity (Taouk et al., 2001). Subsequently, mainland Chinese scholars introduced a simplified Chinese version of the DASS-21 and likewise confirmed its satisfactory psychometric properties (Gong et al., 2010). The simplified Chinese version of the DASS-21 consists of 21 single-choice questions, which can assess three psychological dimensions: depression, anxiety, and stress. Each subscale is composed of 7 questions, with scores ranging from 0 to 4, where 0 = "Not applicable", 1 = "Applied sometimes", 2 = "Applied", 3 = "Applied often", and 4 = "Applied always". A higher score indicates a higher level of depression, anxiety, or stress. In this study, the scale demonstrated excellent internal consistency reliability, with a Cronbach's α of 0.969. Meanwhile, the three-factor structure of the DASS-21 showed the following model fit indices: χ^2 = 6063.178, df = 186, $p < 0.001$, CFI = 0.943, TLI = 0.935, RMSEA = 0.071, SRMR = 0.031. It should be noted that given the large sample size of this study, the chi-square value might be inflated; however, other indices indicate an acceptable model fit. Therefore, the "Depression subscale" of the simplified Chinese version of the DASS-21 was employed to measure participants' depressive symptoms over the past week. The items include: "I didn't seem to feel any pleasure or comfort at all", "I found it difficult to get started on things", "I felt that I had nothing to look forward to in the near future", "I felt down-hearted and blue", "I couldn't get any enthusiasm for anything", "I felt I wasn't worth much as a person", and "I felt that life was meaningless". A higher score indicates a higher level of depression. The test showed that the Cronbach's α of this subscale was 0.927, indicating excellent internal consistency reliability. Meanwhile, the scale demonstrated excellent model fit (χ^2 = 522.14, df = 14, p < 0.001, CFI = 0.982, TLI = 0.973, RMSEA = 0.076, SRMR = 0.021).

3.2.6. Anxiety

The anxiety status of the respondents in the past week was measured using the "Anxiety Subscale" of the simplified Chinese version of the DASS-21. The items include "I felt dry in the mouth", "I felt difficulty in breathing (e.g., shortness of breath or being out of breath)", "I felt trembling (e.g., trembling in hands)", "I worried about situations that might make me panic or make a fool of myself", "I felt like I was about to collapse", "I felt my heart rate was irregular even when there was no obvious physical activity", and "I felt scared for no reason". A higher score indicates a higher level of anxiety. The test showed that the Cronbach's α of this subscale was 0.915, indicating excellent internal consistency reliability. Meanwhile, the scale demonstrated excellent model fit（χ^2 =443.518，df=14，p<0.001，CFI =0.983，TLI =0.974，RMSEA =0.070，SRMR =0.022）

3.2.7. Covariates

To minimize the interference of other demographic characteristics on the research results, drawing on relevant sleep research literature (Grandner, 2017; Liu et al., 2025), this study includes 12 factors as control variables, namely participants' gender, age, educational level, marital status, status of supporting the elderly, status of raising children, urban-rural distinction, residential region, living arrangement, monthly household income, employment status, and subjective socioeconomic class.

For details of the variables involved in this study and their explanations, see Table 1.

Insert Table 1. here

4. Data analysis

4.1. Assessment of Multicollinearity and Common Method Bias

The multicollinearity assessment revealed that the variance inflation factor (VIF) values for depression and anxiety were 5.263 and 5.208 respectively, while all other variables demonstrated VIF values below 3. With a mean VIF of 1.804, these results indicate that multicollinearity remains within acceptable limits and does not pose substantial threats to model estimation. Furthermore, Harman's single-factor test was employed to assess common method bias. The analysis identified seven factors with eigenvalues greater than 1, with the first factor accounting for 16.793% of the total variance—well below the critical threshold of 40%. This confirms the absence of significant common method bias in the present study.

4.2. Descriptive statistics and Correlation analysis

As shown in Table 2, The descriptive statistics reveal several key patterns in the sample: First, 43.876% of respondents reported "always having endless tasks to complete daily," with 36.556% maintaining a neutral stance. The mean score for time poverty was 3.300, exceeding the mid-point (=3), indicating a general perception of persistent time poverty among participants. Second, 71.734% rated their sleep quality as relatively good, with a mean score of 2.796, reflecting generally positive sleep evaluations. Third, 43.316% reported feeling stressed due to time poverty, with cognitive evaluation averaging 3.260 above the mid-point (=3), suggesting a predominantly negative evaluation of time poverty. Fourth, 46.256% self-rated their health as good, with a mean health score of 3.380 above the mid-point (=3), indicating slightly above-average physical health status. Finally, both depression and anxiety levels remained below their respective mid-points (=2), reflecting generally favorable mental health conditions among respondents.

Insert Table 2. here

The results of the correlation analysis between variables show that the perceived time poverty is significantly negatively correlated with sleep quality, indicating that the greater the perceived time poverty, the poorer the sleep quality. The perceived time poverty is significantly positively correlated with cognitive evaluation, suggesting that the greater the perceived time poverty, the more negative the cognitive evaluation of time poverty. The perceived time poverty is significantly negatively correlated with physical health status, meaning that the greater the perceived time poverty, the poorer the physical health status. The perceived time poverty is significantly positively correlated with the level of depression or anxiety, indicating that the greater the perceived time poverty, the higher the level of depression or anxiety. Sleep quality is significantly negatively correlated with cognitive evaluation, showing that the more negative the cognitive evaluation of time poverty, the poorer the sleep quality. Sleep quality is significantly positively correlated with physical health status, implying that the better the physical health status, the better the sleep quality. Sleep quality is significantly negatively correlated with the level of depression or anxiety, indicating that the higher the level of depression or anxiety, the poorer the sleep quality. The cognitive evaluation of time poverty is significantly negatively correlated with physical health status, meaning that the more negative the cognitive evaluation of time poverty, the poorer the physical health status. The cognitive evaluation of time poverty is significantly positively correlated with the level of depression or anxiety, suggesting that the more negative the cognitive evaluation of time poverty, the higher the level of depression or anxiety. physical health status is significantly negatively correlated with the level of depression or anxiety, indicating that the better the physical health status, the lower the level of depression or anxiety.

4.3. Regression analysis

4.3.1. Path relationship of time poverty-cognitive evaluation-physical health status-sleep quality

Taking time poverty as the independent variable, sleep quality as the dependent variable, and cognitive evaluation and physical health status as mediating variables, Model 6 in the SPSS macro program PROCESS was used to conduct a chain mediation effect analysis. All covariates and core independent variables were simultaneously entered into the regression model to comprehensively control for the potential confounding effects of all specified factors. The regression analysis results of the chain mediation effect model are as follows:

As shown in Table 3, the results of Model 1 indicate that time poverty has a significant positive predictive effect on cognitive evaluation ($\beta = 0.534, t = 50.168, p < 0.001$), the complete set of covariates together with time poverty collectively accounted for 30.5% of the variance in cognitive evaluation. The results of Model 2 reveal that time poverty can negatively predict physical health status ($\beta = -0.080, t = -5.644, p < 0.001$), and cognitive evaluation can also negatively predict physical health status ($\beta = -0.125, t = -8.786, p < 0.001$), the complete set of covariates, time poverty, and cognitive evaluation collectively accounted for 12.1% of the variance in physical health status. The results of Model 3 demonstrate that time poverty has a negative predictive effect on sleep quality ($\beta = -0.046, t = -3.375, p < 0.001$), cognitive evaluation has a negative predictive effect on sleep quality ($\beta = -0.107, t = -7.713, p < 0.001$), and physical health status can positively predict sleep quality ($\beta = 0.355, t = 29.101, p < 0.001$), the complete set of covariates, time poverty, cognitive evaluation, and physical health status collectively accounted for 18.4% of the variance in sleep quality. Fig. 3. presents the results of the standardized path analysis of the model. The data next to the lines are the standardized regression coefficients β. Solid lines represent statistically significant paths, while dashed lines represent non-statistically significant paths (this method of representing paths is consistent across all model diagrams in this research).

Insert Table 3. here

Insert Fig. 3. here

The results of the mediating effect test are shown in Table 4. The direct path is: time poverty → sleep quality, with a direct effect value of -0.046 and a 95% confidence interval of [-0.050, -0.013], which does not contain 0. This indicates that time pressure is significantly negatively correlated with sleep quality, that is, the greater the perceived time poverty, the poorer the sleep quality. There are three indirect paths. The first path is: time poverty → cognitive evaluation → sleep quality, with an indirect effect value of -0.057 and a 95% confidence interval of [-0.072, -0.042], which does not contain 0. This shows that cognitive evaluation has a significant mediating effect between time poverty and sleep quality. The second path is: time poverty → physical health status → sleep quality, with an indirect effect value of -0.028 and a 95% confidence interval of [-0.040, -0.018], which does not contain 0. This indicates that physical health status has a significant mediating effect between time poverty and sleep quality. The third path is: time poverty → cognitive evaluation → physical health status → sleep quality, with an indirect effect value of -0.024 and a 95% confidence interval of [-0.030, -0.018], which does not contain 0. This suggests that cognitive evaluation and physical health status have a significant chain mediating effect between time poverty and sleep quality. To sum up, time poverty can affect sleep quality not only through the independent mediating role of cognitive evaluation or physical health status, but also through the chain mediating role of cognitive evaluation and physical health status. Therefore, hypotheses H1, H2, H3, and H6 are verified.

Insert Table 4. here

4.3.2. Path relationship of time poverty-cognitive evaluation-depression-sleep quality

Taking time poverty as the independent variable, sleep quality as the dependent variable, and cognitive evaluation and depression as mediating variables, a chain mediation effect analysis was conducted using Model 6 in the SPSS macro program PROCESS. All covariates and core independent variables were simultaneously entered into the regression model to comprehensively control for the potential confounding effects of all specified factors. The regression analysis results of the chain mediation effect model are as follows:

As shown in Table 5, the results of Model 1 indicate that time poverty has a positive predictive effect on cognitive evaluation ($\beta = 0.534$, $t = 50.168$, $p < 0.001$), the complete set of covariates together with time poverty collectively accounted for 30.5% of the variance in cognitive evaluation. The results of Model 2 reveal that time poverty can positively predict the level of depression ($\beta = 0.107$, $t = 7.808$, $p < 0.001$), and cognitive evaluation can also positively predict the level of depression ($\beta = 0.209$, $t = 15.142$, $p < 0.001$), the complete set of covariates, time poverty, and cognitive evaluation collectively accounted for 17.3% of the variance in depression. The results of Model 3 demonstrate that time poverty has a negative predictive effect on sleep quality ($\beta = -0.058$, $t = -3.979$, $p < 0.001$), cognitive evaluation has a negative predictive effect on sleep quality ($\beta = -0.118$, $t = -1.762$, $p < 0.001$), and the level of depression can negatively predict sleep quality ($\beta = -0.159$, $t = -12.002$, $p < 0.001$), the complete set of covariates, time poverty, cognitive evaluation, and depression status collectively accounted for 9.4% of the variance in sleep quality. Fig. 4. presents the results of the standardized path analysis of the model.

Insert Table 5. here
Insert Fig. 4. here

The results of the mediating effect test are shown in Table 6. The direct path is: time poverty → sleep quality, with a direct effect value of -0.039 and a 95% confidence interval of [-0.058, -0.020], which does not contain 0. This indicates that time poverty is significantly negatively correlated with sleep quality, that is, the greater the perceived time poverty, the poorer the sleep quality. There are three indirect paths. The first path is: time poverty → cognitive evaluation → sleep quality, with an indirect effect value of -0.043 and a 95% confidence interval of [-0.054, -0.031], which does not contain 0. This shows that cognitive evaluation has a significant mediating effect between time poverty and sleep quality. The second path is: time poverty → depression → sleep quality, with an indirect effect value of -0.012 and a 95% confidence interval of [-0.016, -0.008], which does not contain 0. This indicates that the level of depression has a significant mediating effect between time poverty and sleep quality. The third path is: time poverty → cognitive evaluation → depression → sleep quality, with an indirect effect value of -0.012 and a 95% confidence interval of [-0.015, -0.009], which does not contain 0. This suggests that cognitive evaluation and the level of depression have a significant chain mediating effect between time poverty and sleep quality. To sum up, time poverty can affect sleep quality not only through the independent mediating role of cognitive evaluation or the level of depression, but also through the chain mediating role of cognitive evaluation and the level of depression. Therefore, hypotheses H4 and H7 are verified.

Insert Table 6. here

4.3.3. Path relationship of time poverty-cognitive evaluation-anxiety- sleep quality

Taking time poverty as the independent variable, sleep quality as the dependent variable, and cognitive evaluation and anxiety as mediating variables, a chain mediation effect analysis was conducted using Model 6 in the SPSS macro program PROCESS. All covariates and core independent variables were simultaneously entered into the regression model to comprehensively control for the potential confounding effects of all specified factors. The regression analysis results of the chain mediation model are as follows:

As shown in Table 7, the results of Model 1 indicate that time poverty has a positive predictive effect on cognitive evaluation ($\beta = 0.534$, $t = 50.168$, $p < 0.001$), the complete set of covariates together with time poverty collectively accounted for 30.5% of the variance in cognitive evaluation. The results of Model 2 reveal that time poverty can positively predict anxiety ($\beta = 0.110$, $t = 8.008$, $p < 0.001$), and cognitive evaluation can also positively predict anxiety ($\beta = 0.214$, $t = 15.489$, $p < 0.001$), the complete set of covariates, time poverty, and cognitive evaluation collectively accounted for 17.0% of the variance in anxiety. The results of Model 3 demonstrate that time poverty has a negative predictive effect on sleep quality ($\beta = -0.057$, $t = -3.916$, $p < 0.001$), cognitive evaluation has a negative predictive effect on sleep quality ($\beta = -0.116$, $t = -7.872$, $p < 0.001$), and the level of anxiety can negatively predict sleep quality ($\beta = -0.163$, $t = -12.352$, $p < 0.001$), the complete set of covariates, time poverty, cognitive evaluation, and anxiety status collectively accounted for 9.5% of the variance in sleep quality. Fig. 5. presents the results of the standardized path analysis of the model.

Insert Table 7. here
Insert Fig. 5. here

The results of the mediating effect test are shown in Table 8. The direct path is: time poverty → sleep quality, with a direct effect value of -0.038 and a 95% confidence interval of [-0.058, -0.019], which does not contain 0. This indicates that time poverty is significantly negatively correlated with sleep quality, meaning that the greater the perceived time poverty, the poorer the sleep quality. There are three indirect paths. The first path is: time poverty → cognitive evaluation → sleep quality, with an indirect effect value of -0.042 and a 95% confidence interval of [-0.053, -0.031], which does not contain 0. This shows that cognitive evaluation has a significant mediating effect between time poverty and sleep quality. The second path is: time poverty → anxiety → sleep quality, with an indirect effect value of -0.012 and a 95% confidence interval of [-0.016, -0.009], which does not contain 0. This indicates that the level of anxiety has a significant mediating effect between time poverty and sleep quality. The third path is: time poverty → cognitive evaluation → anxiety → sleep quality, with an indirect effect value of -0.013 and a 95% confidence interval of [-0.016, -0.010], which does not contain 0. This suggests that cognitive evaluation and anxiety level have a significant chain mediating effect between time poverty and sleep quality. In summary, time poverty can affect sleep quality not only through the independent mediating roles of cognitive evaluation or anxiety level, but also through the chain mediating role of cognitive evaluation and anxiety level. Therefore, hypotheses H5 and H8 are verified.

Insert Table 8. here

5. Discussion

5.1. The greater the time poverty, the worse the sleep quality

This study empirically confirms that time poverty (specifically referring to numerous and heavy tasks) has a significant negative impact on sleep quality, which is consistent with previous research findings (Hidayanti & Sumaryono, 2021; Lyons et al., 2022). The association between time intensity and sleep quality can be explained by cognitive overload. Cognitive Load Theory posits that individuals have limited cognitive resources. When the cognitive resources required to process certain tasks exceed the total resources available to an individual, cognitive load occurs, leading to decreased task processing efficiency or increased error rates in problem-solving (Sweller, 1988). Cognitive overload arises when an individual has too many things to consider and attempts to complete multiple tasks within a specific time frame. They perceive that there is insufficient time to accomplish all required tasks. This experience is often associated with expectations and a sense of responsibility—where there are too many things to do, and the task demands (whether real or perceived) exceed the individual's capacity. Even after leaving the task environment, the brain remains in a highly active "work mode," characterized by persistent task-related thoughts, worries about unfinished tasks, and planning or rumination about future tasks. However, sleep, as a crucial physiological process for physical and mental recovery, requires cognitive relaxation and "psychological detachment" to initiate. Cognitive overload prevents individuals from disengaging from task-related thoughts, and the brain cannot enter the "shutdown" state necessary for sleep. This may significantly prolong sleep onset latency or cause frequent nighttime awakenings, thereby impairing sleep quality.

Furthermore, the Limited Resource Theory suggests that an individual's resources are finite. Engaging in several activities simultaneously involves resource allocation, following the basic principle of "fixed total resources, more here means less there". During time use, time allocation, and task processing, various cognitive activities all consume cognitive resources. If the total resources required by all activities exceed the total resources available to the individual, insufficient resource allocation occurs. This not only affects task progress and outcomes but also triggers various stress responses, forcing the body into a prolonged "fight-or-flight" stress state. This leads to sustained activation of the sympathetic nervous system, elevated levels of stress hormones (such as cortisol), and maintained elevations in core body temperature, heart rate, and respiratory rate. These physiological responses are fundamentally incompatible with the physiological requirements for sleep and may directly cause difficulties falling asleep, sleep fragmentation, reduced deep sleep, and other sleep problems.

5.2. Cognitive evaluation, physical health status, and depression/anxiety each demonstrated independent mediating effects in the relationship between time poverty and sleep quality.

First, time poverty (e.g., high-intensity tasks and demanding work or study schedules) exposes individuals to considerable task pressure and time urgency. Our findings highlight a potential cognitive pathway linking stressors to sleep quality impairment. The demanding nature and complexity of tasks may lead individuals to perceive them as exceeding their coping capacities, resulting in negative cognitive evaluations and subsequent feelings of helplessness and distress. Furthermore, individuals with a stress-is-weakening mindset tend to interpret stress-related feedback as indicative of personal inadequacy, thereby actively avoiding such information—evidenced by only approximately 25% of those with this mindset being willing to receive personalized feedback. Feedback avoidance prevents individuals from timely identification of personal limitations and adjustment of behavioral strategies. Over time, this pattern not only impedes personal growth but also exacerbates stress perception as unresolved issues persist, ultimately forming a vicious cycle of "avoidance—heightened stress—increased avoidance" (Crum et al., 2013). From a sleep health perspective, negative cognitive evaluations maintain the brain in a state of persistent arousal and tension, thereby impeding relaxation. This heightened cognitive activation contributes to difficulties in sleep initiation and frequent nocturnal awakenings, ultimately compromising overall sleep quality. Gao et al.'s study demonstrated that employing negative cognitive emotion regulation strategies (e.g., self-blame, catastrophizing) increases susceptibility to stress-related insomnia (Gao et al., 2016).

Second, under conditions of high time intensity, individuals endure sustained pressure that leads to physical fatigue and energy depletion, and may even manifest in somatic symptoms such as headaches and muscle tension. These physiological responses often trigger negative self-perceptions of health status. Such unfavorable self-assessed health further compromises sleep quality, as physical discomfort and health-related concerns persistently intrude upon pre-sleep cognitive processes, maintaining the brain in a heightened state of arousal that impedes transition into deep sleep stages.

Finally, under conditions of elevated time intensity, individuals undergo significant alterations in their cognitive evaluation of environmental demands and personal resources, demonstrating a pronounced tendency toward negative appraisals—such as perceiving tasks as insurmountable or time constraints as excessive. These negative cognitive evaluations induce a state of persistent psychological strain, increasing mental load and thereby compromising psychological well-being. Chronic negative appraisal patterns can precipitate symptoms of depression and anxiety. Depressive manifestations include low mood, diminished interest, and impaired self-worth, while anxiety is characterized by excessive worry, tension, and irritability. The impact of these emotional states on sleep quality operates through two primary mechanisms: First, depression disrupts the balance of neurotransmitters involved in sleep regulation, leading to difficulties falling asleep, shallow sleep, and frequent awakenings. Second, anxiety activates the sympathetic nervous system, maintaining the body in a sustained state of hyperarousal that is incompatible with the physiological relaxation required for sleep initiation and maintenance (Han et al., 2012), ultimately resulting in diminished sleep quality.

5.3. Cognitive evaluation, physical health status, and depression/anxiety each demonstrated significant chain mediating effects in the relationship between time poverty and sleep quality.

First, our model reveals a previously underemphasized "physiological pathway." The results demonstrate that after being mediated by negative cognitive evaluation, the impact of time poverty extends beyond inducing psychological distress (such as depression and anxiety) to directly catalyzing subjective physical discomfort (e.g., diminished physical health status). These two pathways collectively elucidate the underlying mechanisms of sleep quality deterioration. This finding strongly suggests that the traditional stress process model, if focused solely on psychological mechanisms, fails to fully capture reality. It is imperative to reconceptualize the framework as a dual-pathway "psychological-physiological" model to more comprehensively and systematically capture the multidimensional erosive effects of stressors on individual health, thereby advancing our understanding of the stress-health relationship.

Second, this study clarifies the pivotal role of cognitive evaluation as a central hub in activating psychosomatic responses. Our data clearly demonstrate that individuals' threatening cognitive appraisal of time poverty functions as a critical "master switch," simultaneously triggering both emotional disturbances and somatic discomfort. This finding not only strongly corroborates the traditional concept of mind-body unity but also elevates the role of cognitive evaluation from a mere "processing station" generating psychological outcomes to a "central processing unit" that coordinates the entire organism—including both psychological and physiological systems—in responding to threats, thereby highlighting its dominant position in psychosomatic regulation mechanisms. According to Lazarus and Folkman's transactional theory (Lazarus and Folkman, 1987), stress does not arise directly from environmental stimuli per se, but rather from an individual's appraisal of the relationship between environmental demands and their personal resources. Within the context of our study, time poverty becomes a subjective stressor only when an individual evaluates it as a significant threat to their goals or well-being. Furthermore, cognitive evaluation serves as an indispensable bridge connecting objective social structures with subjective individual experiences. As a social and structural stressor, time poverty is inherently external. It must be transformed into psychological reality through the internal, active interpretive process of cognitive evaluation.

Finally, this study innovatively reconceptualizes the positioning of "physical health status" by shifting it from the conventional endpoint of the mediation chain to an active mediating component. This indicates that the adverse effects of stress on sleep quality manifest well before the emergence of clinical disorders—subclinical physical symptoms triggered by daily stress (e.g., mild fatigue, muscle tension, digestive discomfort) already constitute significant health impairment. Consequently, stress process theory should recognize physiological symptoms as a dynamic mediating pathway rather than a final outcome. This advancement not only deepens our understanding of how stress impacts health but also provides a solid theoretical foundation for intercepting its detrimental effects at earlier stages, prior to disease onset.

The results of this study have important practical significance. At the individual level, understanding the mechanism by which time poverty affects sleep quality through cognitive evaluation and physical health status helps individuals take targeted measures to improve sleep quality. For example, individuals can reduce the negative impact of time poverty by adjusting their cognitive evaluation methods, such as adopting positive coping strategies, thereby improving their physical health status and sleep quality. At the organizational level, companies could draw inspiration from initiatives such as Google's "20% Time Rule" by establishing protected time for free creation, allowing employees to dedicate 20% of their workweek to pursuing ideas, training, and learning. Such practices fundamentally enhance employees' sense of temporal autonomy, thereby fostering intrinsic motivation and well-being (Lu et al., 2025; Ryan & Deci, 2000). Empirical studies have demonstrated that enhancing employees' control over their work schedules effectively improves psychological well-being (Kelly et al., 2014). This improvement operates by shifting cognitive appraisal from perceiving situations as "exploitative threats" to viewing them as "challenges containing possibilities," thereby interrupting the activation of the stress cascade. Furthermore, organizations should implement "asynchronous communication" and designate "focus time blocks", while exploring the introduction of a "right to disconnect." These measures establish clear psychological and physical boundaries for employees, facilitating psychological detachment and resource recovery (Sonnentag et al., 2022; Sonnentag & Fritz, 2015). By systematically reducing work-related unpredictability and permeability, such institutional interventions play a crucial role in alleviating anxiety and preventing emotional exhaustion. This approach effectively disrupts the pathway through which time poverty impacts sleep quality via depression/anxiety.

5.4. Research limitations and future prospects

Regarding methodological considerations, several limitations should be acknowledged. First, as a cross-sectional study, this research cannot establish definitive causal relationships. Second, the influence of China's "face" culture and relational dynamics may lead respondents to moderate their emotional expressions in accordance with social desirability. Consequently, the self-reported levels of depression/anxiety in this study might underestimate the actual degree of emotional distress. Third, although several preventive measures were implemented during the research design phase—including ensuring respondent anonymity, counterbalancing item sequence, and employing validated scales with clear wording—the exclusive reliance on self-reported data leaves open the possibility of residual common method bias. Future research could address these methodological limitations by integrating multi-source data (e.g., spousal reports of sleep quality), implementing longitudinal designs, and incorporating behavioral experiments. Fourth, both time poverty and cognitive evaluation were assessed using single-item measures in this study. While this approach offers advantages in terms of brevity and efficiency, it may not fully capture the multidimensional nature of these constructs and could potentially lead to underestimation of the true relationships between variables. Future research would benefit from employing multi-item scales or experience sampling methods to enhance the reliability and validity of these measurements. Fifth, sleep quality was measured using a single-item self-report instrument in this study, which may introduce measurement bias. Subsequent investigations should incorporate more ecologically valid objective measures, such as actigraphy, to obtain more comprehensive, objective, and precise assessments of sleep quality.

Regarding theoretical considerations, while this study has focused on mediating variables such as cognitive evaluation, physical health status, and anxiety/depression, the stress process model suggests other potentially significant mediators—including social support, coping styles, and personality traits—may also influence the observed relationships. Future research would benefit from incorporating these additional mediators to provide a more comprehensive understanding of the underlying mechanisms. Furthermore, this investigation exclusively examined negative dimensions of cognitive evaluation. However, moderate levels of time poverty might potentially exert positive effects on sleep quality. Subsequent studies should integrate positive cognitive appraisal perspectives to enrich the theoretical implications of the stress process model.

Regarding cultural context, China's cultural emphasis on "hard struggle" and collectivist values may shape how individuals cognitively evaluate time poverty—potentially reframing it as a necessary responsibility rather than a deprivation of personal rights. This reinterpretation could consequently alter its relationship with negative emotional outcomes. Furthermore, strong familial obligations combined with highly permeable work-family boundaries exacerbated by digital platforms like WeChat may amplify the detrimental effects of time poverty on sleep quality. Consequently, the direct generalizability of our findings to other cultural settings may be limited. Future cross-cultural comparative research would help clarify the precise role of cultural factors within this mechanism.

6. Conclusion

This study empirically demonstrates the impact of time poverty as a social stressor on sleep quality and elucidates its underlying mechanisms. Our findings not only validate and extend the comprehensiveness and explanatory power of the stress process model by establishing the pivotal role of cognitive evaluation in activating psychosomatic responses, but also reveal potential pathways through which time poverty impairs sleep health. These insights provide a theoretical foundation for developing individualized time management interventions and organizational health policies.

CRediT authorship contribution statement

N.L.: Writing – review & editing, Writing – original draft. J.W.: Writing – original draft, W.Z.: Review & editing.

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Declaration of competing interest

The authors declare no competing interests.

Ethics Approval

This study was approved by the School of Sociology and Ethnology of University of Chinese Academy of Social Sciences (Approval No.: UCASS-SSE2023112001) on November 20, 2023. The scope of the approval included the purpose and content of this study, the investigating procedure and participants. All procedures complied with the Declaration of Helsinki and Chinese national research ethics guidelines.

Informed Consent

Electronic informed consent was obtained from all participants prior to data collection (Dates: 2-28 December/2023). Participants were explicitly informed of: (1) The survey is anonymous, ensuring the confidentiality of each participant; (2) The purpose and value of this research; (3) The collected data will be used solely for research purposes and analyzed at an aggregate level, without individual analysis of any participant's data; (4) Participation in this questionnaire survey is voluntary, and respondents may withdraw their consent at any time.

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Availability of Data and Materials

The data are now confidential and for internal use only, but they will be shared with the public soon. To know more information about the data, please refer to the Chinese Social Survey (http://css.cssn.cn) conducted by the same institution. Both surveys used the same sampling framework and some of their questions were the same.

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Appendix 1:

The construct of "cognitive evaluation" in this study was measured using the single item: "I feel stressed due to time urgency." Responses were recorded on a 5-point Likert scale, with higher scores indicating more negative cognitive evaluation. The development of this item was based on the following considerations:

1. It draws on Lazarus and Folkman's theoretical conceptualization of primary appraisal (evaluation of threat) and secondary appraisal (evaluation of coping resources).

2. It was adapted from the "Overall Appraisal" dimension of the Stress Appraisal Measure (SAM) developed by Peacock & Wong (Peacock & Wong, 1990), specifically from the item "I find this situation stressful."

3. It was contextualized to align with the conceptualization of time poverty in this study.

To evaluate the content validity of this item, three doctoral students and three experts in social psychology were invited to assess its relevance. The content validity index (CVI) was calculated as 0.83 (5 out of 6 raters), indicating satisfactory content validity. However, as this study is part of a primary survey, test-retest reliability was not assessed. We acknowledge the inherent limitations of using a single-item measure in terms of reliability, and this point has been explicitly addressed in the "Research limitations and future prospects" section of the paper.

Appendix 2:

Table 1 Regression analysis of cognitive evaluation and physical health status between time poverty and sleep quality

Variable Name	Model 1		Model 2		Model 3	
	Cognitive evaluation		Physical health status		Sleep quality	
	β	*t*	*β*	*t*	*β*	*t*
Time poverty	0.540^{***}	50.788	-0.062^{***}	-4.194	-0.057^{***}	-4.150
Cognitive evaluation			-0.141^{***}	-9.553	-0.116^{***}	-8.381
Physical health status					0.348^{***}	29.598
R	0.540		0.182		0.406	
R^2	0.292		0.033		0.165	
F	2579.396^{***}		107.469^{***}		410.487^{***}	

Note: *** $p<0.001$, the same notation applies to subsequent analyses.

Table 2 Regression analysis of cognitive evaluation and depression between time poverty and sleep quality

Variable Name	Model 1		Model 2		Model 3	
	cognitive evaluation		Depression		Sleep quality	
	β	*t*	*β*	*t*	*β*	*t*
Time poverty	0.540^{***}	50.788	0.084^{***}	5.771	-0.066^{***}	-4.564
cognitive evaluation			0.218^{***}	15.040	-0.133^{***}	-9.014
Depression					-0.147^{***}	-11.565
R	0.540		0.272		0.26	
R^2	0.292		0.074		0.067	
F	2579.396^{***}		249.522^{***}		150.706^{***}	

Table 3 Regression analysis of cognitive evaluation and anxiety between time poverty and sleep quality

Variable Name	Model 1		Model 2		Model 3	
	Cognitive evaluation		Anxiety		Sleep quality	
	β	*t*	*β*	*t*	*β*	*t*
Time poverty	0.540^{***}	50.788	0.088^{***}	6.096	-0.066^{***}	-4.543
Cognitive evaluation			0.216^{***}	14.933	-0.135^{***}	-9.100
Anxiety					-0.142^{***}	-11.149
R	0.540		0.274		0.257	

R^2	0.292	0.075	0.066
F	2579.396***	253.220***	147.401***

Fig. 1. Schematic Diagram of the Stress Process Model

Fig. 2. Model of time poverty, cognitive evaluation, stress responses and sleep quality

Fig. 3. Path analysis of cognitive evaluation and physical health status between time poverty and sleep quality

Fig. 4. Path analysis of cognitive evaluation and depression between time poverty and sleep quality

Fig. 5. Path analysis of cognitive evaluation and anxiety between time poverty and sleep quality

Table 1 Basic information of all variables involved in the empirical study

Variable Type	Variable Name	Variable Assignment
Dependent variable	Sleep quality	1 = "Very poor sleep quality", 2 = "Poor sleep quality", 3 = "Fairly good sleep quality", 4 = "Very good sleep quality"
Independent variable	Time poverty	1 = "Strongly disagree", 2 = "Somewhat disagree", 3 = "Neutral", 4 = "Somewhat agree", 5 = "Strongly agree"
Mediating variables	Cognitive evaluation	1 = "Strongly disagree", 2 = "Somewhat disagree", 3 = "Neutral", 4 = "Somewhat agree", 5 = "Strongly agree"
	Physical health status	1 = "Very unhealthy", 2 = "Unhealthy", 3 = "Average", 4 = "Healthy", 5 = "Very healthy"
	Depression	0-4 points, with higher scores indicating higher levels of depression
	Anxiety	0-4 points, with higher scores indicating higher levels of anxiety
Covariates	Gender	1 = Male; 2 = Female
	Age	Continuous variable, ranging from 18 to 73 years old
	Educational level	1 = Primary school and below; 2 = Junior high school; 3 = Senior high school/technical secondary school/vocational high school/technical school; 4 = Junior college/vocational college; 5 = Bachelor's degree; 6 = Postgraduate (Master's degree or above)
	Marital status	1 = Unmarried; 2 = First marriage with spouse; 3 = Remarried with spouse; 4 = Divorced; 5 = Widowed
	Status of supporting the elderly	1 = No elderly person; 2 = One elderly person; 3 = Two elderly persons; 4 = Three elderly persons; 5 = Four or more elderly persons
	Status of raising children	1 = Yes; 2 = No
	Urban-rural distinction	1 = Urban; 2 = Township; 3 = Rural
	Residential region	1 = North China; 2 = Northeast China; 3 = East China; 4 = Central China; 5 = South China; 6 = Southwest China; 7 = Northwest China
	Living arrangement	1 = Living alone; 2 = Not living alone
	Monthly	1 = 2,000 yuan and below; 2 = 2,001 - 6,000 yuan; 3 = 6,001 - 10,000 yuan;

	household income	4 = 10,001 - 15,000 yuan; 5 = 15,001 - 30,000 yuan; 6 = 30,001 - 45,000 yuan; 7 = 45,001 - 60,000 yuan; 8 = 60,001 - 100,000 yuan; 9 = More than 100,000 yuan
	Employment status	1 = Full-time student; 2 = Not working; 3 = Employed; 4 = Farming; 5 = Others
	Subjective socioeconomic class	1 = Upper class; 2 = Upper-middle class; 3 = Middle class; 4 = Lower-middle class; 5 = Lower class

Table 2 Descriptive statistics and correlation analysis of key variables

Main Variables	**M±SD**	**kurtosis**	**skewness**	1	2	3	4	5	6
Time poverty	3.300±0.974	-0.313	-0.254	1					
Sleep quality	2.796±0.675	0.331	-0.392	-0.163***	1				
Cognitive evaluation	3.260±0.992	-0.345	-0.302	0.535***	-0.246***	1			
Physical health status	3.380±0.860	0.248	-0.396	-0.128***	0.366***	-0.173***	1		
Depression	1.045±0.948	-0.238	0.840	0.172***	-0.210***	0.275***	-0.349***	1	
Anxiety	1.037±0.900	-0.051	0.896	0.188***	-0.202***	0.284***	-0.325***	0.894***	1

Note: ***$p < 0.001$

Table 3 Regression analysis of cognitive evaluation and physical health status between time poverty and sleep quality

Variable Name	**Model 1**		**Model 2**		**Model 3**	
	Cognitive evaluation		Physical health status		Sleep quality	
	β	t	β	t	β	t
Covariates	Controlled		Controlled		Controlled	
Time poverty	0.534***	50.168	-0.080***	-5.644	-0.046***	-3.375
Cognitive evaluation			-0.125***	-8.786	-0.107***	-7.713
Physical health status					0.355***	29.101
R	0.552		0.349		0.429	
R^2	0.305		0.121		0.184	
F	210.755***		61.611***		93.780***	

Note：***$p<0.001$.

Table 4 Test of the mediating effects of cognitive evaluation and physical health status between time poverty and sleep quality

Path	Effect	Boot SE	BootLLCI	BootULCI
Direct effect				
Time poverty→Sleep quality	-0.046	0.009	-0.050	-0.013
Indirect effect				
Time poverty→Cognitive evaluation→Sleep quality	-0.057	0.008	-0.072	-0.042
Time poverty→Physical health status→Sleep quality	-0.028	0.005	-0.040	-0.018
Time poverty→Cognitive evaluation→Physical health status→Sleep quality	-0.024	0.003	-0.030	-0.018
Total indirect effect	-0.109	0.009	-0.127	-0.091

Note: LLCI refers to the lower limit of the 95% confidence interval, and ULCI refers to the upper limit of the 95% confidence interval.

Table 5 Regression analysis of cognitive evaluation and depression between time poverty and sleep quality

Variable Name	Model 1		Model 2		Model 3	
	cognitive evaluation		Depression		Sleep quality	
	β	t	β	t	β	t
Covariates	Controlled		Controlled		Controlled	
Time poverty	0.534***	50.168	0.107***	7.808	-0.058***	-3.979
cognitive evaluation			0.209***	15.142	-0.118***	-7.991
Depression					-0.159***	-12.002
R	0.552		0.416		0.307	
R^2	0.305		0.173		0.094	
F	210.755***		93.086***		43.223***	

Note：*** p <0.001.

Table 6 Test of the mediating effects of cognitive evaluation and depression between time poverty and sleep quality

Path	Effect	Boot SE	BootLLCI	BootULCI
Direct effect				
Time poverty→Sleep quality	-0.039	0.010	-0.058	-0.020
Indirect effect				
Time poverty→Cognitive evaluation→Sleep quality	-0.043	0.006	-0.054	-0.031
Time poverty→Depression→Sleep quality	-0.012	0.002	-0.016	-0.008
Time poverty→Cognitive evaluation→Depression→Sleep quality	-0.012	0.001	-0.015	-0.009
Total indirect effect	-0.066	0.006	-0.078	-0.055

Note: LLCI refers to the lower limit of the 95% confidence interval, and ULCI refers to the upper limit of the 95% confidence interval.

Table 7 Regression analysis of cognitive evaluation and anxiety between time poverty and sleep quality

Variable Name	Model 1		Model 2		Model 3	
	Cognitive evaluation		Anxiety		Sleep quality	
	β	t	β	t	β	t
Covariates	Controlled		Controlled		Controlled	
Time poverty	0.534***	50.168	0.110***	8.008	-0.057***	-3.916
Cognitive evaluation			0.214***	15.489	-0.116***	-7.872
Anxiety					-0.163***	-12.352
R	0.552		0.412		0.309	
R^2	0.305		0.170		0.095	
F	210.755***		91.124***		43.835***	

Note: *** p <0.001.

Table 8 Test of the mediating effects of cognitive evaluation and anxiety between time poverty and sleep quality

Path	Effect	Boot SE	BootLLCI	BootULCI
Direct effect				
Time poverty→Sleep quality	-0.038	0.010	-0.058	-0.019
Indirect effect				
Time poverty→Cognitive evaluation→Sleep quality	-0.042	0.006	-0.053	-0.031
Time poverty→Anxiety→Sleep quality	-0.012	0.002	-0.016	-0.009
Time poverty→Cognitive evaluation→Anxiety→Sleep quality	-0.013	0.001	-0.016	-0.010
Total indirect effect	-0.067	0.006	-0.078	-0.056

Note: LLCI refers to the lower limit of the 95% confidence interval, and ULCI refers to the upper limit of the 95% confidence interval.


Coping styles
Cognitive evaluation
Life events
Personality traits
Other factors
Well-adapted/ Poorly adapted
Health/ Illness
Stressor
Mediating factors
Stress responses
Health outcomes


Stressor
Cognitive evaluation
Stress responses
Health outcomes
Physiological level
Physical health status
Time poverty
Evaluation and experience of stressors
Sleep quality
Depression/ Anxiety
Psychological level


Cognitive evaluation
-0.125***
Self-rated health status
0.534***
0.335***
-0.080***
-0.107***
Time poverty
Sleep quality
-0.046***

Note: ***p < 0.001


Cognitive evaluation
0.209***
Depression
0.534***
-0.159***
0.107***
-0.118***
Time poverty
Sleep quality
-0.058***

Note: ***p < 0.001


Cognitive evaluation
0.214***
Anxiety
0.534***
-0.163***
0.110***
-0.116***
Time poverty
Sleep quality
-0.057***

Note: ***p < 0.001