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Understanding the impact of COVID-19 on quality of life using surveys and Mendelian randomization

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The COVID-19 pandemic has significantly impacted the quality of life (QoL) of individuals in China, affecting both their physical and mental well-being. This study aims to comprehensively analyze the factors influencing QoL in China during the pandemic. In 2022, we collected data using a self-developed questionnaire (dataset 2) and obtained dataset 1 from the 2021 China General Social Survey (CGSS). After confirming the scale's reliability and validity, we employed a random forest algorithm to prioritize the factors. Subsequently, Mendelian randomization analyses were conducted using data from the MRC IEU OpenGWAS data infrastructure. By comparing data from two periods with low and high infection rates, the results showed that among the various influences brought about by the prevalence of COVID-19, sleep disorders have a significant and widespread impact on the quality of life, especially for the elderly. Through the inclusion of Mendelian randomization analysis, we found that COVID-19 have a relative increase in the risk of developing insomnia by approximately 26.7% (OR = 1.267). These findings can inform the development of targeted interventions and strategies to improve overall well-being.

Keywords Quality of life, Sleep disorder, COVID-19, Mendelian randomization, SF-12 scale, Mental health, Machine learning

Abbreviations

QoL	Quality of life
COVID-19	Corona virus disease 2019
MR	Mendelian randomization
SF-12	Short form-12 questionnaire
PCS	Physical component summary
MCS	Mental component summary
PSS	Psychological strain scale
SWB	Subjective well-being scale
KMO	Kaiser–Meyer–Olkin value
CFI	Comparative fit index value
GFI	Goodness-of-fit index value
IFI	Incremental fit index value
RMSEA	Root mean square error of approximation

Since the emergence of the COVID-19 pandemic in 2019, it has profoundly affected the quality of life (QoL) in China[1]. This crisis has significantly impacted both physical and mental health, creating a complex interplay

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between various health determinants. The physical symptoms post-infection are primarily characterized by respiratory distress, which can lead to severe complications such as organ failure and death, thereby directly worsening physical health outcomes[2,3]. Additionally, long-term sequelae reported across various countries encompass a range of symptoms, including sleep disturbances, loss of smell (anosmia), loss of taste (ageusia), prolonged chest tightness, hair loss (alopecia), fatigue, and cognitive decline[4]. A global analysis has indicated that the cumulative prevalence of long-term sequelae in patients with a history of COVID-19 infection ranges from 9 to 63%[5], revealing a substantial burden on health systems that is significantly higher than similar post-viral syndromes[6–8].

In addition to its physical health implications, the COVID-19 pandemic has significantly escalated the risk of mental health issues[9,10]. The implementation of stringent measures, such as social distancing and isolation, while necessary for public safety, has inadvertently led to diminished social interactions and heightened feelings of loneliness[11–13]. This has resulted in increased anxiety, depression, and stress among affected individuals. The correlation between extended periods of isolation, prevailing uncertainty, and the surge in mental health disorders is unmistakable[9,14]. Furthermore, reduced access to social support networks, the closure of recreational facilities, and limited opportunities for physical activity have collectively exacerbated the decline in overall well-being, eroding individuals' sense of purpose and life satisfaction[14,15].

While current research primarily focuses on virus variants and the causes of post-infection sequelae, there remains a significant gap regarding the impact of the pandemic on QoL. Understanding these factors is crucial, as they can profoundly and lasting effects on individuals' mental and physical health. In this context, comprehensive research is needed to assess the specific factors influencing perceived QoL under varying rates of infection. This knowledge will aid in swiftly formulating response policies for future emergencies and help mitigate the effects of the pandemic in the post-COVID era, ultimately enhancing people's quality of life.

Our study employs survey instruments to explore intrinsic factors affecting QoL during the pandemic, conducting comparative analyses across different age cohorts and temporal divisions spanning 2021 and 2022. Random Forest algorithm renowned for its resilience against noise, formidable capacity for classification, and swift processing speeds for both training and classification tasks16. Utilizing the Random Forest algorithm, we prioritize these factors based on their significance. Furthermore, we apply Mendelian Randomization (MR) 17,18 to analyze the relationship between COVID-19 and insomnia, confirming that COVID-19 serves as a significant exposure factor for insomnia. This finding underscores the necessity of addressing sleep disorders, particularly in high infection rate scenarios, where their impact on physical health is pronounced. Notably, our results indicate that the impact of insomnia on physical health post-COVID-19 shows an increasing trend with age, suggesting that COVID-19 infection leads to a higher rate of insomnia, significantly affecting the physical health of older adults.

Methods

Data source and study design

We utilized two questionnaire datasets to analyze the changing influence of time-based factors on people's QOL during the pandemic. Dataset 1 is derived from the 2021 Chinese General Social Survey (http://cnsda.ruc.edu.cn, CGSS)[19], along with the comprehensive impact module of the new coronavirus epidemic available at www.cnsda.org. Notably, the CGSS in 2021 introduced the comprehensive impact module of the new coronavirus epidemic, which we utilized in conjunction with the core data. The design of our research is illustrated in Fig. 1.

Dataset 2 was collected by our team in December 2022. Participants were randomly selected from various provinces in southwestern China and surveyed amidst a widespread COVID-19 outbreak. The participant pool included individuals with medical backgrounds. We distributed the online questionnaire via social platforms such as WeChat and QQ, utilizing the online platform Questionnaire Star (wenjuan.com) for editing purposes. Additionally, our study has been approved by the Ethics Committee of the People's Liberation Army Western Theater General Hospital, All participants had read the informed consent before completing the questionnaire, and could only continue to fill it out after clicking "agree". The ethical approval document (2023EC5-ky007) and informed consent has been uploaded as Related files.

We included datasets from the two aforementioned time points for longitudinal research. Due to variations in survey timeframes and environments between the two datasets, the focus of the questionnaire survey differed. The 2021 database, in addition to collecting basic demographic and physical health information, delved into individuals' perspectives on the impact of the COVID-19 pandemic. This survey encompassed two distinct time periods: pre-pandemic and during a significant outbreak. Consequently, the second dataset placed greater emphasis on investigating COVID-19 symptoms and sequelae among participants. Please refer to the Appendix List in Supplementary material S1 for the English version of the questionnaire and the included variables of Dataset-2.

We utilized data from the Genome-Wide Association Study (GWAS) database (https://gwas.mrcieu.ac.uk/) for Mendelian randomization analysis[20,21]. The COVID-19 data (GWAS id: ebi-a-GCST011073) were utilized as the exposure factor, while the insomnia data (GWAS id: ukb-e-1200_AFR) served as the outcome variable for analysis. The COVID-19 dataset comprised 38,984 cases and 1,644,784 controls, whereas the Sleeplessness/insomnia data included 6,557 cases.

Eligibility and exclusion criteria

Dataset 1 focuses on the comprehensive impact module, encompassing sociodemographic attributes, health, and the new coronavirus epidemic. Out of a total of 8148 respondents, 2717 individuals (33.34%) completed the SF-12 scale, while 2690 individuals (33.01%) completed the SWB scale. It is important to note that all participants included in the dataset are over 18 years old.

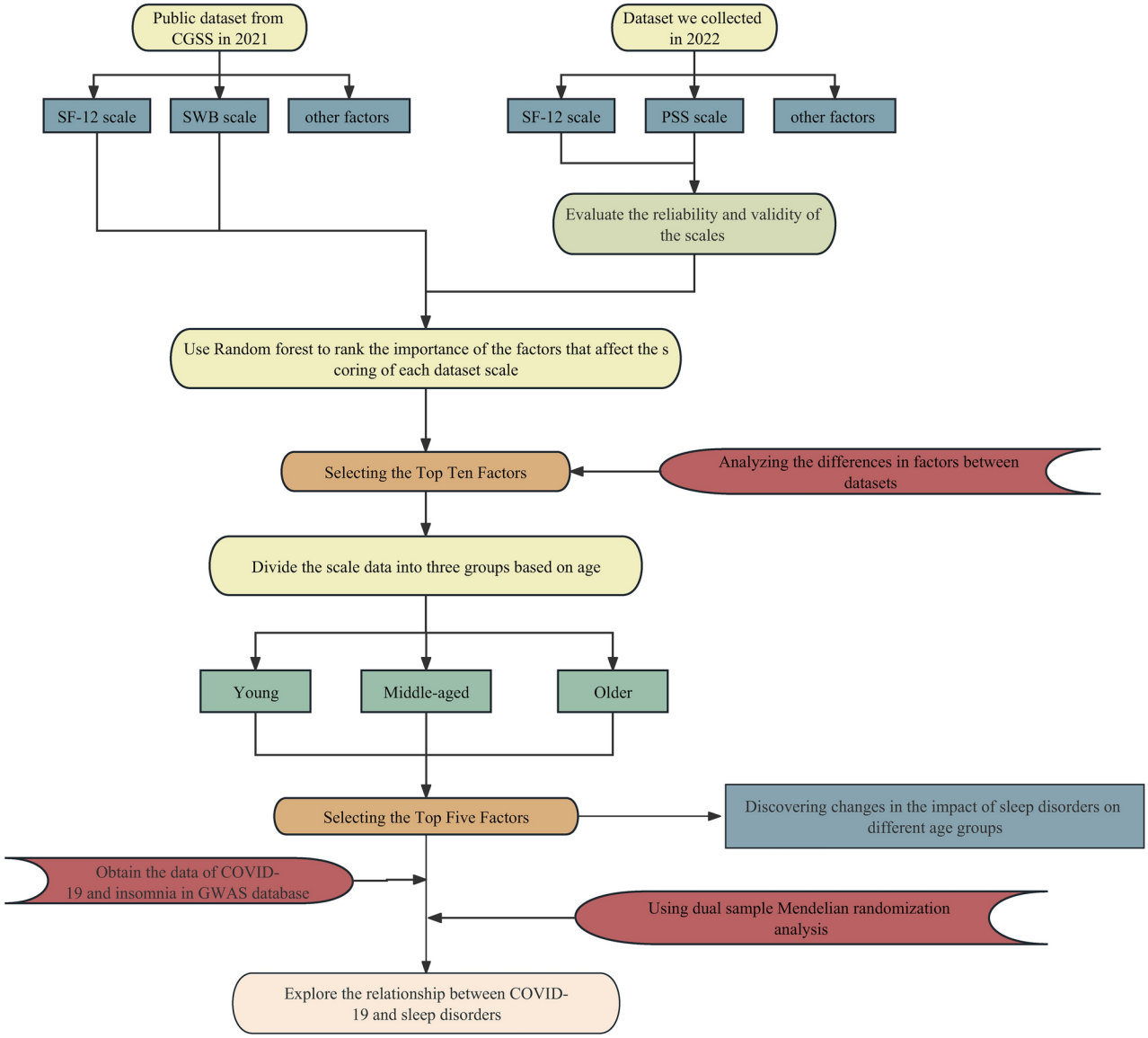

Fig. 1. Research design flow chart. The flow chart illustrates the sequential steps involved in the research design process.

Dataset 2 comprises basic information, self-reported recent coronavirus infection status, the Chinese version of the Short Form-12 (SF-12) questionnaire, and the Psychological Strain Scales (PSS). A total of 1,340 questionnaires were distributed, resulting in the collection of 830 completed questionnaires. The average response time for participants was approximately six minutes. Participants under the age of 18 were excluded from the study, resulting in a final sample size of 818 individuals.

Questionnaires and influencing factors

Subjective well-being (SWB), as defined by Diener[22], refers to an individual's overall evaluation of their quality of life based on their own standards. It encompasses two dimensions: emotion and cognition. The Chinese version consists of 20 items[23]. A higher score on the scale indicates a greater sense of well-being.

The SF-12 is a concise and versatile measure of health status[24]. It assesses eight common concepts found in widely used surveys, including physical functioning, limitations in daily activities due to physical health issues, bodily pain, general health perception, vitality (energy/fatigue), social functioning, limitations in daily activities due to emotional problems, and mental health (psychological distress and well-being). The tool's eight subscales can be summarized into two indices: the Physical Component Summary (PCS) and the Mental Component Summary (MCS). Higher scores on the PCS and MCS indicate a better quality of life[25].

The Perceived Stress Scale (PSS) measures individuals' perception of stress and their ability to cope with it, as well as relevant personality traits[26]. In this study, the PSS-14 was utilized, which consists of two dimensions: perceived helplessness and perceived nervousness. A higher score on the scale indicates a higher level of psychological stress[27].

The study also collected participants' demographic characteristics, which can be found in Table S1 of the Supplementary Material.

Reliability and validity

In the self-compiled Dataset 2, we conducted an analysis to evaluate the reliability and validity of the scales used.

Reliability of the PSS and SF-12: The reliability, specifically internal consistency, of the multi-item questionnaire scales was assessed using Cronbach's alpha coefficient[28]. As recommended by Nunnally and Bernstein[29], internal consistency estimates above 0.70 were considered acceptable for group comparisons. Split-half reliability was evaluated using the Spearman-Brown coefficient, with a coefficient of 0.70 or higher indicating a stable measurement function and good split-half reliability of the scale.

Validity of the PSS and SF-12: To assess the validity of the two scales, we examined structural validity, and convergent validity. Acceptability was determined based on a Kaiser–Meyer–Olkin (KMO) value of 0.5 or higher and a significance level (P-value) of ≤ 0.05 in Bartlett's sphericity test. Confirmatory factor analysis was subsequently conducted using the maximum likelihood method (MLM). An acceptable overall fit of the model was indicated when the comparative fit index (CFI), goodness-of-fit index (GFI), and incremental fit index (IFI) were all above 0.90, the root mean square error of approximation (RMSEA) was ≤ 0.08, and the chi-square degree of freedom ratio (X2/df) was between 3 and 5.

Random forest analysis

To identify the most important factors associated with each dependent variable, random forest analysis was conducted. Random forest analysis was performed using the R packages "randomForest" and "ggplot2", and the R package "missRanger" was used to fill in missing values. We considered 500 trees to screen and rank the most influential factors.

The Random Forest algorithm utilizes the total scores of each participant on various scales from different datasets as the outcome variable, with all other questionnaire variables serving as independent variables. For categorical variables, it calculates the average reduction in impurity (Gini impurity) resulting from each decision tree's split nodes. In the case of regression problems, the algorithm computes the average reduction in error across all split nodes. Ultimately, the average importance score for each feature is derived from its values across all trees, allowing for a ranking of features. Features with higher scores are deemed to have a greater influence on the model's predictive outcomes, enabling the identification of the most significant factors affecting the scale results.

Mendelian randomization

We conducted a two-sample Mendelian randomization analysis using the R packages "TwoSampleMR" and "gwasglue." Mendelian randomization utilized single nucleotide polymorphisms (SNPs) as instrumental variables to infer causal relationships. We included COVID-19 as the exposure factor and insomnia as the outcome variable. Single-nucleotide polymorphisms (SNPs) were filtered from summary-level genome-wide association studies (GWAS) data, employing rigorous quality control measures. Multiple MR methods were employed to assess results, including inverse variance weighting (IVW) with random effects, IVW with fixed effects, maximum likelihood, weighted median, MR-Egger regression, and penalized weighted median.

Statistical analysis

For each dataset in the study, we reported means and standard deviations for continuous variables, while frequencies were reported for categorical variables in Table S1. Additionally, each sociodemographic and clinical variable was individually assessed using one-way ANOVA, with statistical significance set at $P < 0.05$. All statistical analyses were conducted using SPSS 25.0, R 4.3.2, and Amos 24.0 software.

Results

Participants characteristics

Table S1 contains demographic data and relevant statistical information about the participants in dataset 2. The median age range of the 818 participants was 41.0–50.0 years, comprising 346 (42.3%) males and 472 (57.7%) females. A total of 665 (81.3%) individuals received three or more doses of the COVID-19 vaccine. Among the participants, 684 (83.6%) had experienced COVID-19 symptoms or were infected during the pandemic, with 446 (65.2%) reporting postrecovery symptoms. The respective mean scores for PCS, MCS, and PSS were 43.01 ($\pm$8.45), 45.58($\pm$10.8), and 23.4 ($\pm$7.8).

As a comparison, the PCS, MCS, and SWB scores in dataset 1 were 45.61 ($\pm$10.9), 45.14 ($\pm$9.15), and 91.34 ($\pm$11.88), respectively.

PSS and SF-12 scale: reliability and validity

The calculated Cronbach's alpha coefficients and Spearman-Brown coefficients for both scales exceeded the threshold of 0.70. This indicates that the reliability of the PSS and SF-12 scales is considered acceptable in Dataset 2. Furthermore, the KMO values for both the PSS and SF-12 scales were greater than 0.5, and Bartlett's sphericity test yielded significant results ($P < 0.001$). These findings suggest that exploratory factor analysis can be conducted on both scales.

Upon conducting exploratory factor analysis, the results indicated that the dimensions of the items in the PSS scale were consistent with the theoretical model1. However, it was found that the dimensions of the SF and RE items in the SF-12 scale were inconsistent with the theoretical model, which may be related to differences in scale usage between countries[30].

	SF-12	PSS
Cronbach's alpha	0.81	0.82
Spearman-Brown	0.71	0.83
KMO	0.82	0.89
Bartlett's sphericity test	< 0.001	< 0.001
CFI	0.90	0.95
GFI	0.91	0.94
IFI	0.91	0.93
RMSEA	0.08	0.07
X^2/df	3.21	5.04

Table 1. Reliability and validity of the PSS and SF-12 scales.

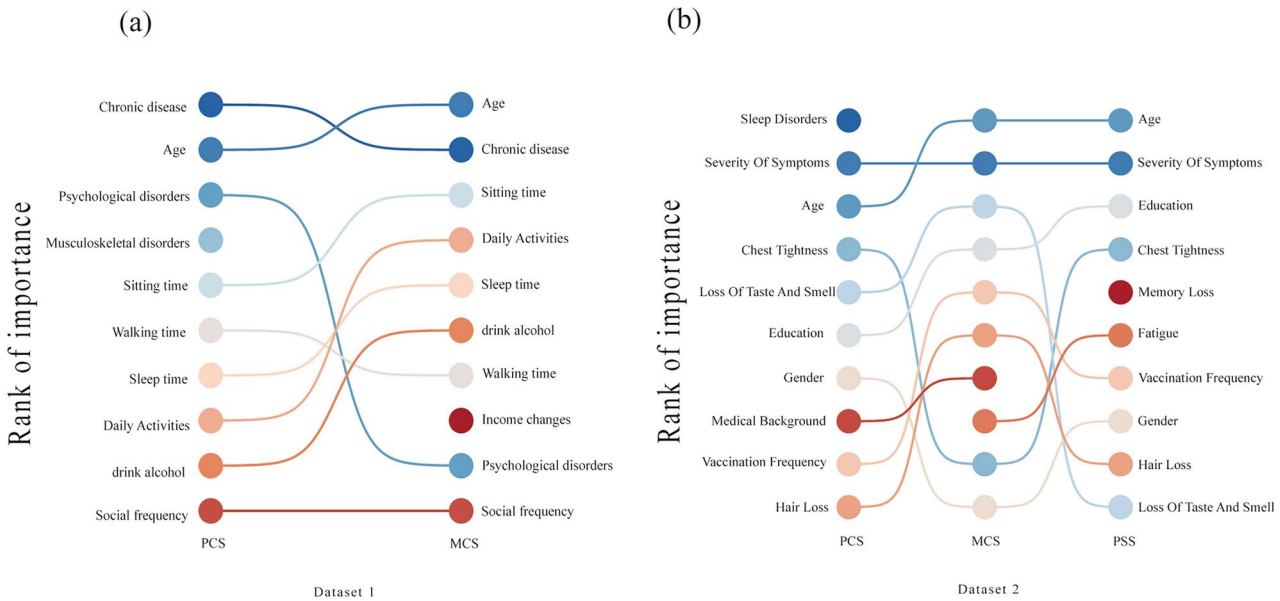

Fig. 2. Rank of importance of factors associated with QOL of two datasets. (**a**) The rank of importance of factors of Dataset 1. PCS and MCS are two dimensions in the SF-12 scale. (**b**) The rank of importance of factors of Dataset 2. Including the SF-12 scale and PSS scale.

In the confirmatory factor analysis, the PSS and SF-12 scales exhibited good model fit. The Comparative Fit Index (CFI), Goodness-of-Fit Index (GFI), and incremental fit index (IFI) values for both scales exceeded the threshold of 0.9 (Table 1). The root mean square error of approximation (RMSEA) and X2/df values were within an acceptable range, except for the slightly higher X2/df value of the PSS scale, which exceeded the upper limit of the range (3–5). Overall, the model fit of both the PSS and SF-12 scales was considered good. The data on the reliability and validity of the two scales are shown in Table 1.

Ranking of factors associated with QOL

It is interesting to observe that the most important associated factors of QOL differed between the two datasets, as determined by the random forest models. In the SF-12 scale, the influencing factors of the Physical Component Summary (PCS) and Mental Component Summary (MCS) in both datasets, along with their explanatory power for the dependent variable, are shown in Fig. 2a,b.

In 2021, various self-chronic diseases, particularly liver diseases and digestive system diseases, were found to be the main factors affecting people's PCS. However, in dataset 2, the symptoms and sequelae of COVID-19 infection emerged as the main factors impacting PCS. Specifically, sleep disturbance caused by COVID-19 infection became the most significant factor affecting PCS.

Regarding the influencing factors of MCS in 2021, factors such as daily sitting time, exercise, and sleep duration were among the prominent contributors. Unlike the PCS results, the fear of COVID-19 infection was also among the top ten influencing factors for MCS. In dataset 2, the severity of COVID-19 infection symptoms ranked second, aligning with the results for PCS.

Additionally, we analyzed the influencing factors of the Subjective Well-Being (SWB) scale in dataset 1 and the Perceived Stress Scale (PSS) in dataset 2, utilizing random forest to rank their importance. We then selected the top five influencing factors for the SWB scale (Fig. 3c) and the top ten for the PSS (Fig. 3d). The factors

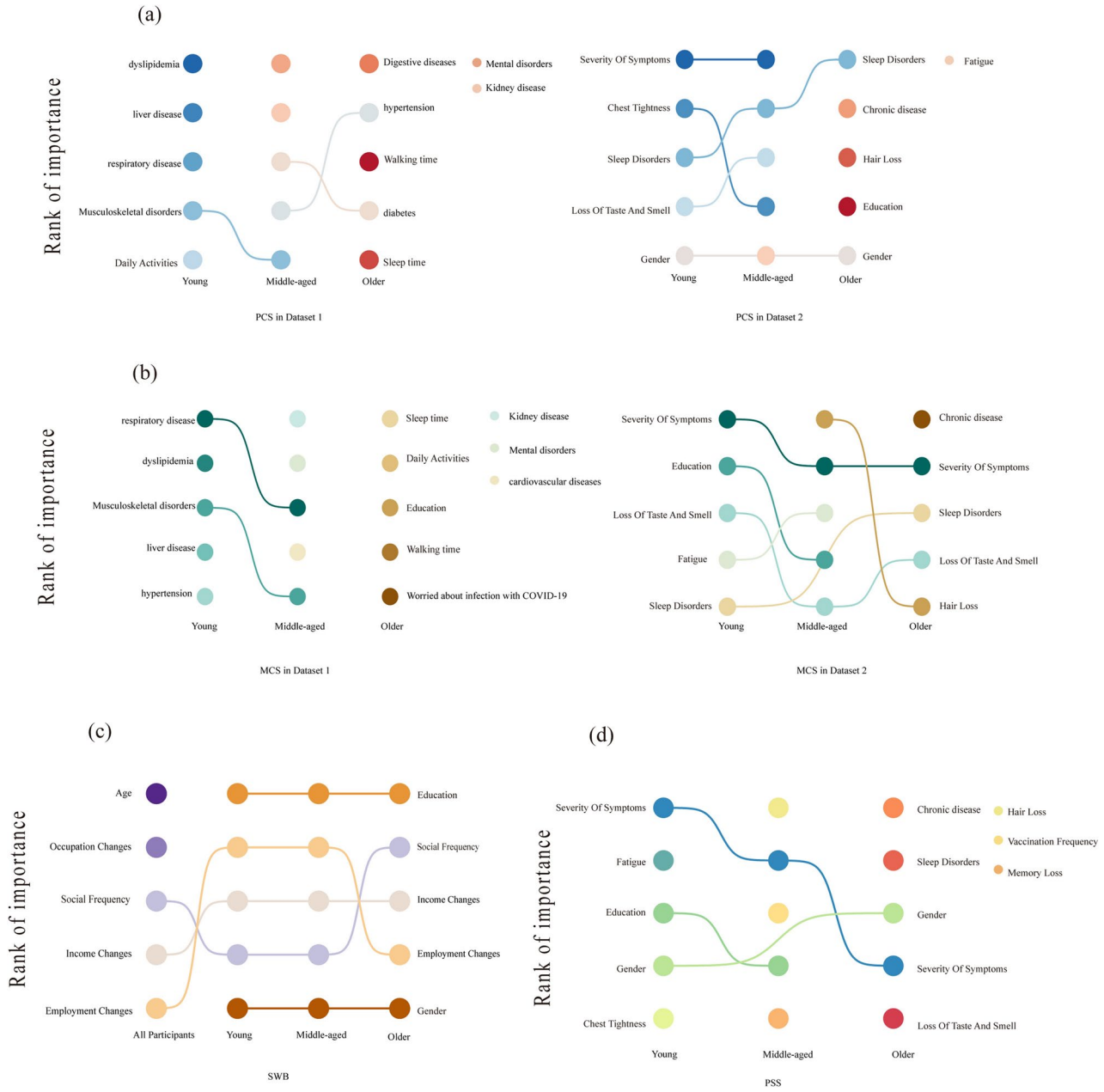

Fig. 3. Age-based ranking of factors associated with QOL in the two datasets. (**a**) The rank of importance of factors of PCS in two datasets. (**b**) The rank of importance of factors of MCS in two datasets. (**c**) The rank of importance of SWB scale factors in dataset 1. (**d**) The rank of importance of factors of the PSS scale in dataset 2.

related to subjective well-being in 2021 primarily revolved around industry, social life, employment, and income, while the factors associated with stress in 2022 were linked to symptoms, education, and sequelae.

Age-based ranking of factors associated with QOL

According to the overall analysis, age emerged as one of the top three important variables in the ranking of all scales in both datasets. To further explore the impact of age on quality of life in different scenarios, the results were divided into six groups: dataset 1 PCS, dataset 2 PCS, dataset 1 MCS, dataset 2 MCS, dataset 1 SWB, and dataset 2 PSS. Each group was further divided into three subgroups: young (< 40 years old), middle-aged (40–60 years old), and older (> 60 years old). The ranking of influencing factors for each scale in each group was analyzed, focusing on the top five factors. The ranking results for the six groups can be seen in Fig. 3.

The ranking of influencing factors for PCS in each group closely aligns with the overall analysis results. In dataset 1, we included detailed categories of chronic diseases, which ranked first among total participants for analysis. The young group exhibited a higher susceptibility to dyslipidemia, liver disease, and respiratory diseases compared to the middle-aged and elderly groups. Mental disorders ranked as the first influential factor

in the middle-aged group, followed by kidney disease and diabetes. The elderly group was affected by various chronic diseases, with insomnia predominantly impacting this age group. In dataset 2, we found insomnia to be a significant factor influencing physical health across all age groups, with its importance increasing with age. This phenomenon, not observed in dataset 1, suggests an exacerbation of the impact of insomnia on individuals following COVID-19 infection.

Regarding happiness, the impact of employment changes before and after the epidemic ranked higher for the young and middle-aged groups, while changes in the frequency of meeting with family and friends had a greater influence on the older group. The overall top factor in the ranking was the level of education. In terms of stress factors in dataset 2, the education level of young and middle-aged individuals ranked among the top five influencing factors.

Two-sample Mendelian randomization (MR) analysis

We confirmed there was no significant heterogeneity or horizontal pleiotropy, therefore IVW was chosen as the primary method for causal inference. The results of the scale analysis indicate that insomnia has become a significant factor affecting the physical and mental health of individuals across all age groups following COVID-19 infection. We further employed Mendelian randomization to provide genetic evidence supporting this finding. As depicted in the scatter plot, COVID-19 is positively correlated with insomnia, and the leave-one-out (LOO) plot indicates reliable results (Fig. 4). The IVW MR analysis suggested a causal relationship between COVID-19 and insomnia. Using the Inverse variance weighted method, we found that COVID-19 exposure was

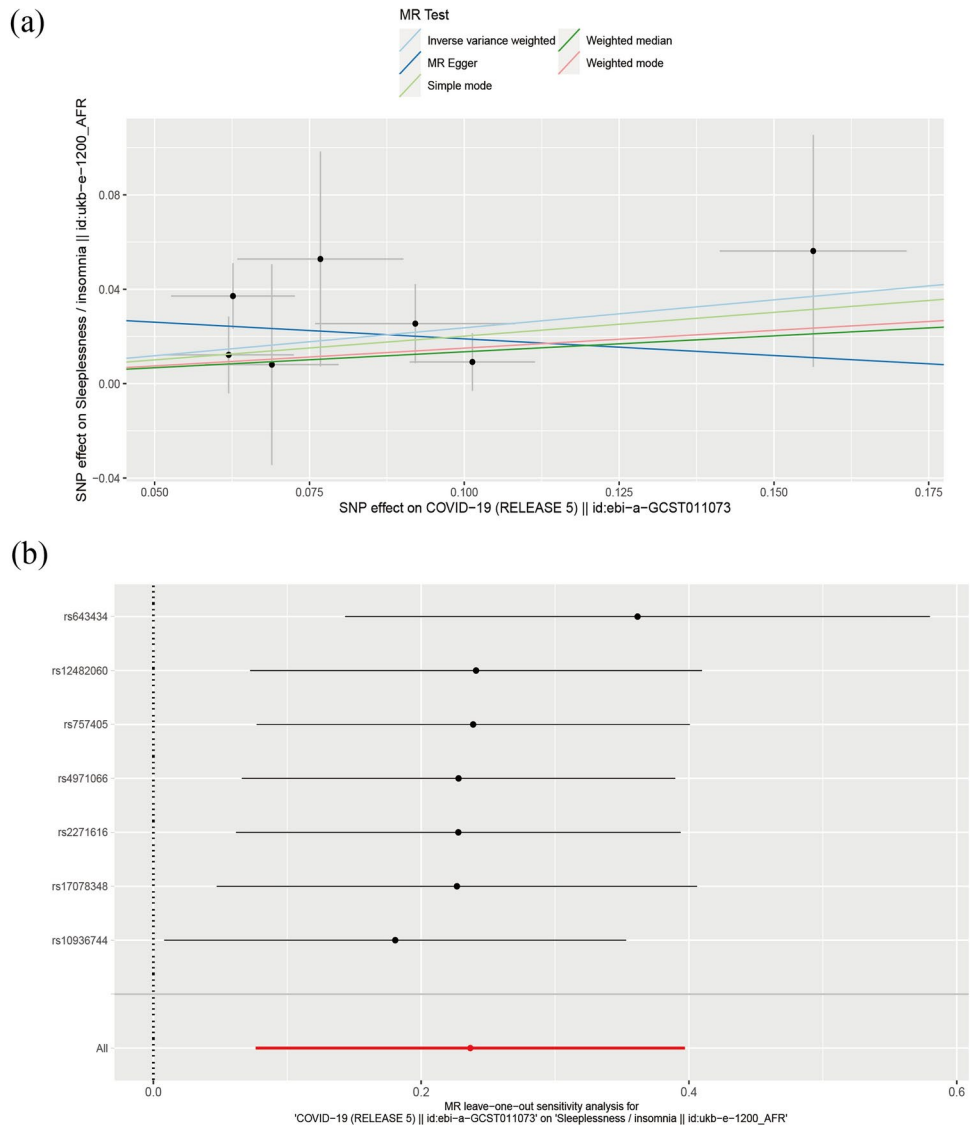

Fig. 4. Mendelian randomization analysis of the effect of COVID-19 on sleeplessness/insomnia. (**a**) Scatter plot of the SNP effects on COVID-19 and Sleeplessness/insomnia, with the slope of each line corresponding to the estimated MR effect per method. (**b**) Leave-one-out plot: MR sensitivity analysis for COVID-19 and Sleeplessness/insomnia.

associated with a significant increase in the risk of insomnia (OR = 1.267, 95% CI 1.079–1.487, Beta = 0.237, P = 0.004).The MR results are presented in Table 2 and Fig. 4. These findings further support our conclusion that COVID-19 leads to an increased incidence of insomnia.

Discussion

The outbreak of the COVID-19 pandemic has significantly disrupted the normal functioning of countries worldwide, affecting nearly everyone's lives. In response, the World Health Organization issued five calls to action on World Health Day, April 7, 2021, urging nations to establish a fairer and healthier world post-COVID-19 to improve the health of all individuals[31]. A comprehensive understanding of the specific factors influencing individual physical and mental health before and after the pandemic is essential for achieving relevant health goals. This analysis is particularly crucial for China, where the aging population is rapidly increasing. However, there is a lack of comprehensive analysis regarding the changes in quality of life factors across different age groups before and after the COVID-19 pandemic, indicating an urgent need for investigation. It is well established that employing linear regression to analyze survey data can yield misleading results. This method assumes a linear relationship between features and the target variable, failing to filter out variables with non-linear relationships, which can decrease the model's predictive capability. Moreover, using principal component analysis (PCA) to identify the most influential features may also be inaccurate, as it necessitates manual selection of dimensions, introducing significant subjectivity that can compromise the interpretation of results. Therefore, in this study, we investigated the specific factors influencing individuals' physical and psychological well-being before and after the COVID-19 pandemic. We employed a random forest algorithm with multiple data fitting and automatic feature selection to rank these influencing factors. Based on a comprehensive analysis of the results, we present the ranking of the factors affecting physical and mental health across different age groups before and after the pandemic. We anticipate that sleep disturbances will play a critical role in health outcomes, particularly following COVID-19 infection. Furthermore, we validated this finding using Mendelian randomization.

In situations of self-isolation with low infection rates, the primary factors affecting physical health include underlying diseases, age, and musculoskeletal disorders. Notably, time spent sitting, walking, sleeping, and engaging in daily activities also play significant roles, indicating that restrictions on outdoor activities due to isolation have adversely impacted physical health. Conversely, in environments with high infection rates, insomnia emerges as the most critical factor affecting physical health, even surpassing the symptoms associated with COVID-19 infection.

Our further analysis employed Mendelian randomization to assess the causal relationship between COVID-19 and insomnia, determining whether genetic factors support this conclusion. We found that individuals exposed to COVID-19 have a relative increase of approximately 26.7% in the risk of developing insomnia (OR = 1.267). This finding aligns with the conclusions of Klāvs Putenis et al., whose cohort study revealed that COVID-19 patients experienced poorer sleep quality and more depressive symptoms six months post-infection, indicating a decline in quality of life[32]. Additionally, research by Samiuer et al. emphasized that chronic sleep deprivation is a significant risk factor for respiratory infections, including COVID-19, suggesting a possible bidirectional relationship between COVID-19 and sleep disorders[33]. However, our results indicate that sleep disturbances caused by COVID-19 are prevalent and significantly diminish quality of life. Notably, in the post-infection data, the impact of insomnia on physical health showed an increasing trend with age, a pattern not observed in the dataset with low infection rates. This suggests that COVID-19 infection leads to increased rates of insomnia, significantly affecting the physical health of older adults. On one hand, COVID-19 symptoms are more severe in older individuals, who often have a higher likelihood of underlying conditions, resulting in greater suffering post-infection and subsequently affecting sleep quality. On the other hand, normal changes in sleep physiology and circadian rhythms with aging may render older adults more susceptible to sleep deprivation[34]. To address these issues, targeted interventions such as cognitive behavioral therapy for insomnia (CBT-I), enhanced sleep hygiene education, and mental health support tailored for older adults should be considered to mitigate the impact of sleep disturbances and improve overall well-being.

In every dataset analyzed, age emerged as a crucial factor influencing health outcomes, particularly ranking higher in psychological health scores. In October 2020, the World Health Organization highlighted that mental health should be considered a vital component of COVID-19 response measures. Data from psychological hotline services in China during the early stages of the pandemic revealed a significant volume of calls related to insomnia and emotional distress[35]. Similar increases in queries about sleep disturbances during social distancing measures have been reported across various countries and regions[36,37]. The pandemic's isolation period intensified the psychological toll from fear of infection, social isolation, loneliness, educational interruptions, restricted access to healthcare, and economic uncertainties, significantly impacting mental health. A substantial portion of the population experienced symptoms of anxiety, depression, and post-traumatic stress[12,38] findings

Exposure	Outcome	Method	NO.SNP	Beta	SE	OR	CI	P-value
COVID-19	Sleeplessness/insomnia	MR Egger	7	-0.141	0.339	0.868	0.447–1.678	0.694
		Weighted median	7	0.135	0.111	1.145	0.921–1.423	0.224
		Inverse variance weighted	7	0.237	0.082	1.267	1.079–1.487	0.004*
		Simple mode	7	0.201	0.176	1.223	0.865–1.729	0.297
		Weighted mode	7	0.151	0.107	1.162	0.942–1.434	0.210

Table 2. MR estimates of causal effect of COVID-19 on sleeplessness/insomnia.

that align with our research; disturbances in sleep quantity and quality are frequently observed among those suffering from mental distress. This interrelation appears to be bidirectional, where sleep interruptions can exacerbate symptoms of depression and anxiety[39,40]. Therefore, the impact of sleep disturbances extends beyond physical health, signifying a crucial link with mental well-being that warrants attention.

Further analysis of age indicates that during periods of home isolation, the time spent on sedentary activities, the frequency of exercise, and sleep duration significantly impacted mental health overall. Notably, these effects were particularly pronounced among the elderly population. Additionally, the extent of social interactions with family members during isolation emerged as a critical factor influencing the well-being of older adults (Fig. 3c). These findings underscore the urgent need to address mental health issues among the elderly during pandemics, especially given the notable lack of social support services specifically designed for this age group[41,42].

Our study aimed to investigate the key elements influencing individual quality of life during the spread of the COVID-19 pandemic and to identify the underlying factors affecting physical and mental health across varying infection rates. However, it is important to acknowledge the limitations of our investigation. A primary limitation was the lack of a pilot phase and reliability retesting for our self-developed questionnaire. Additionally, preliminary small-scale surveys and modeling contributed to refining the scale's structure, enhancing the credibility of the results.

Despite these limitations, all scales employed in our research have been extensively validated in previous studies, confirming their reliability and validity, which indicates that their assessment capabilities are robust. Furthermore, through the evaluation of internal consistency and the assessment of convergent validity, we are confident in the efficacy of the Perceived Stress Scale (PSS) and the Short Form-12 Health Survey (SF-12) in measuring quality of life during the COVID-19 pandemic.

Nonetheless, the geographical scope of our survey hindered our ability to obtain a representative sample that reflects diverse regions and age groups within Dataset 1. Lastly, we did not include diagnostic criteria for various diseases, such as the confirmation of COVID-19 (via hospital nucleic acid testing or self-test kits) and diabetes diagnosis (based on fasting blood glucose levels), among others. Our team plans to further refine the experimental design in future research.

Conclusions

Our study underscores the importance of comprehending the factors influencing quality of life (QoL) during an epidemic. We have successfully demonstrated that the SF-12 Health Survey and the Perceived Stress Scale (PSS) reliably and validly measure the physical and mental health of individuals within the Chinese epidemiological context, meeting established standards. Additionally, our research, through the comprehensive analysis of scale results and Mendelian randomization, has revealed the impact of COVID-19 on individuals' sleep quality, with this impact increasing with age. These findings provide valuable insights for policymakers and public health professionals to develop targeted interventions and strategies aimed at enhancing overall well-being.

Data availability

The dataset 1 analysed during the current study are available in the CGSS repository, [http://www.cnsda.org]. For our Mendelian randomization analysis, we leveraged data from the Genome-Wide Association Study (GWAS) database, accessible at https://gwas.mrcieu.ac.uk/. This included COVID-19 data (GWAS id: ebi-a-GCST01107 3) and insomnia data (GWAS id: ukb-e-1200_AFR). The dataset2 is available from the corresponding author on reasonable request.

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Author contributions

All authors have made contributions in this study. Kexin Jiang analyzed preliminary data and completed the manuscript writing, Hua Ji completed Mendelian randomization analysis. Lihong Ma completed the main revisions and language polishing of the article. Zhirong Zhao provided guidance on professional knowledge in the research direction and participated in the writing and revision of the manuscript. Yiwen Zhao and Jiajie Feng conducted the main visual analysis, and participated in the screening and analysis of all literature. Zheng Tang processed the data. Ruiwu Dai conducted the final manuscript editing and research design. We hereby declare that Kexin Jiang and Hua Ji are co-first authors of this study, having contributed equally to the data analysis and manuscript writing.

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Declarations

Competing interests

The authors declare no competing interests.

Ethics approval and consent to participate

Our study has been approved by the Ethics Committee of the People's Liberation Army Western Theater General Hospital, and all the methods were performed in accordance with the Ethics Committee of the People's Liberation Army Western Theater General Hospital guidelines and regulations. For this study involving human participants, informed consent was obtained from all participants prior to their completion of the questionnaire.

Additional information

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