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Original Article

Trends in cognitive impairment among older adults in China from 2002 to 2022: Evaluating the impact of the COVID-19 pandemic

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ABSTRACT

Background: Cognitive impairment is a growing public health concern, particularly in aging populations. While trends in CI prevalence in China were studied up to 2018, no previous research has explored how the COVID-19 pandemic has affected these trends.

Objectives: This study aims to extend the analysis to 2022, examining the impact of the pandemic on cognitive impairment prevalence.

Participants: The Chinese Longitudinal Healthy Longevity Survey (CLHLS) data across multiple waves (2002 to 2022) was used (n=64,872).

Measurements: Cognitive impairment was assessed using a Chinese version of the Mini-Mental State Examination (MMSE). The rural/urban-sex-single age-specific prevalence of cognitive impairment across different waves were estimated using the DemoRates R package. Cognitive impairment trends before and after the onset of the COVID-19 pandemic were compared to identify any significant changes.

Results: In 2018 and previous waves, an average of 16,191 participants per wave were surveyed (four waves), with a cognitive impairment prevalence of 4.3%. In 2022, post–COVID-19, the survey included 14,022 participants and showed a significant increase in CI prevalence to 6.8%. The observed trends were independent of gender, age group, and residential environment (*P*-trend < 0.001). However, a significant decrease in mean calf circumference, increase in proportion of overweight participants, and increases in daily fruit and vegetable intake and regular physical activity were notable after the pandemic.

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Conclusion: The study suggests that the COVID-19 pandemic may have contributed to the observed increase in cognitive impairment prevalence in China, underscoring the importance of further research into the long-term cognitive effects of global health crises. These findings highlight the need to strengthen healthcare systems to support cognitive health in an aging population, while considering both pandemic-related and ongoing factors in the management of cognitive impairment.

1. Introduction

Cognitive impairment (CI) is the core symptom of all dementias, although the progression of impairment and pattern of domains affected could be different between types of dementia and individual patients, the impairment eventually reaches a stage that causes the loss of ability to work, socialize, live and self-care. Chronological age is the most important risk factor of dementias. Hence, with worldwide population ageing and the fact that no cure is available, large number of persons living with dementia is expected. This also will lead to an enormous financial and healthcare burden, as well as psychological distress to the caregivers. In 2019, dementia cost the global economy 1.3 trillion US dollars, approximately 50% of these costs are attributable to care provided by informal carers, who provide on average 5 hours of care and supervision per day [1].

While most patients with dementia live in low and middle-income countries, much less research have been conducted there, as compared to richer counterparts in Europe and North America [2]. It is obvious that critical data from low and middle-income countries are urgently needed, including and especially for China, which has the largest population, and the largest number of individuals with CI [3].

In the 20th century, the consensus is that dementia rate will rise continuously but this did not happen in some high-income countries. United States of America and Sweden have demonstrated reduced rate of dementia using data from large, prospective cohort studies [4–6]. It is intriguing to hypothesise that if such trend is also true in middle-income countries such as China, as the country have experienced dramatic economic, social, educational, and health care reforms and development [7]. Today, China is the second largest economy in the world with a Gross Domestic Product (GDP) per capita of $12,614 USD [8]. Unlike dementia, CI captures earlier and subtler changes that are modifiable through interventions. Therefore, having a scientific evidence-based projection of the prevalence of CI in the coming decades will be helpful for policy makers to design and prepare the healthcare and social welfare systems, to be able to accommodate at least the basic needs of future patients and their caregivers. Furthermore, recent studies have raised concerns regarding the long-term cognitive effects of COVID-19 [9], which warrant investigation using longitudinal population-based data.

The aim of the study is to examine the trend of cognitive impairment in China from 2002 to 2022 using data from the Chinese Longitudinal Healthy Longevity Surveys (CLHLS) [1], Additionally the impact of the Coronavirus disease 2019 (COVID-19) pandemic is investigated. It is hypothesized that the incidence of CI reduced over the investigated years and reversed during COVID.

2. Method

The data are from the Chinese Longitudinal Healthy Longevity Survey (CLHLS), a large national survey on older adults of China. The survey began in 1998 across 22 of China's 31 provincial-level administrative regions, covering approximately 85% of the national population [10]. Initially, it focused exclusively on the oldest-old population (aged 80 and above), with follow-up waves conducted in 2000, 2002, 2005, 2008, 2011, 2014, 2018, and 2022. Starting in 2002, the survey expanded to include younger-old adults aged 65 to 79 years, thereby enhancing the representativeness of the older population in China. In the CLHLS, the same individuals were tracked across waves, with new participants added to compensate for the sample loss due to death and/or being lost to track. The total nine waves have conducted about 140,000 home-based interviews. Details of the CLHLS methodology have been published [11,12]. For the present analysis, we included all participants aged 65 and older from the 2002 wave onward. The data for the 2011 and 2014 waves were dropped as these two surveys were not replenished with new samples.

Cognitive impairment was measured using a Mini-Mental State Examination (MMSE), which had been validated in the Chinese cultural context [13,14]. The MMSE includes 24 items regarding orientation, registration, attention, calculation, recall, and language, with a total score ranging from 0 to 30. Education-specific cut-off scores were applied to define cognitive impairment, based on the most recent normative and validation study of the MMSE in the Chinese population: $\leq$16 for individuals with no formal education, $\leq$19 for those with 1 to 6 years of education, and $\leq$23 for those with more than 6 years of education [15].

We used the DemoRates R package to estimate the rural/urban-sex-single age-specific prevalence of CI in China for the waves of 2002, 2008/2009, 2017/2018 and 2021/2022. DemoRates is an R program used to calculate and smooth demographic prevalence rates based on survey data [16]. Specifically, the number of cognitively impaired older persons was divided by the total number of older persons at each age by sex and rural/urban residence, and these outcomes were then smoothed by a Poisson model, generating an age trajectory of CI. To obtain the national prevalence, we further applied the census data as the weight with the rural/urban-sex-single age-specific population distribution from China's 2000, 2010, and 2020 censuses. We also analysed data on demographics, lifestyle and health conditions to look for potential effects of these variables on the CI trend. These variables include age, sex, category of residence, calf circumference, waist circumference, body-mass index (BMI), fruit and vegetable intake, and physical exercise participation. Differences in continuous variables between pre- and post-COVID-19 periods were assessed using analysis of variance (ANOVA), while differences in categorical variables were examined using chi-square tests.

2.1. Role of the funding source

The funders provided financial support for data collection and analysis but had no role in the writing of the report, interpretation of the results, or submission for consideration of publication. The first and corresponding authors had full access to all the data in the study and had final responsibility for the decision to submit for publication.

3. Results

A total of 64,872 observations were made across five waves. The sample sizes for 2002, 2005, 2008, 2018, and 2022 data waves were 13,382, 12,859, 12,373, 12,731, and 13,527 respectively. Characteristics of the study samples are shown in Table 1.

3.1. Trend in cognitive impairment (CI) prevalence

The standardized prevalence (P) of CI among Chinese older adults varied across the study period (Fig. 1). It was lowest in 2002 (P: 4.1%, 95% CI: 4.1-4.1), peaked in 2008 (P: 4.8%, 95% CI: 4.8-4.8), declined sharply to 4.2% (95% CI: 4.2-4.2) in 2018, and then reached its highest level in 2022 (P: 6.8%, 95% CI: 6.8-6.8), which was post–COVID-19 pandemic. Time trend analyses indicated that these patterns were independent of gender, age group, and residential environment (*P*-trend < 0.001) (Table 2). Across all survey waves, CI prevalence was consistently higher among females compared with males, among rural residents compared with urban residents, and in the oldest age groups compared with younger age groups (Figs. 2 and 3).

3.2. Participant characteristics before and after COVID-19 pandemic

When comparing participant characteristics before (2002–2018) and after (2022) the COVID-19 pandemic (Table 1), several significant differences emerged. Post-COVID-19 participants had a significantly lower mean calf circumference ($p< 0.001$) and a higher proportion classified as overweight according to BMI ($p < 0.001$). In contrast, mean waist circumference did not differ significantly between the two periods ($p = 0.47$). Lifestyle behaviours also showed notable changes, with significantly higher proportions reporting daily fruit and vegetable consumption and regular physical activity in 2022 compared with the pre-pandemic period (all $p < 0.001$). Overall, the mean MMSE score was

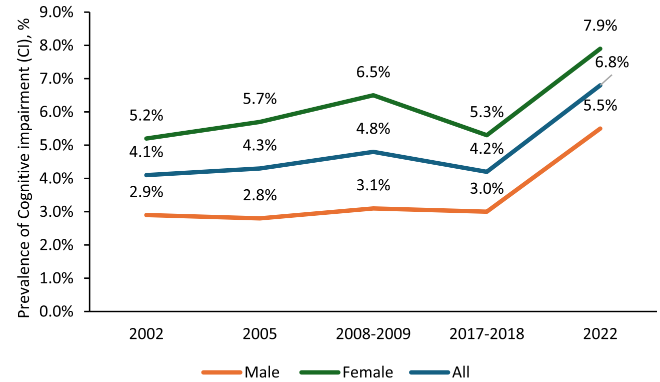

Fig. 1. Prevalence of cognitive impairment (CI) from 2002 to 2022, with comparison between male and female.

Table 1
Participant characteristics.

	Total	2002	2005	2008	2018	2022	P-value, all waves	P-value, 2018 vs 2022
N	78,787	15,971	15,590	15,239	15,138	14,022		
Age, mean (SD)	86.3 (11.5)	86.34 (11.6)	86.16 (11.6)	87.3 (11.3)	85.5 (11.5)	86.8 (10.9)	<0.001	0.815
Age group							<0.001	<0.001
65-79	23,981 (30.4%)	4,841 (30.3%)	4,954 (31.8%)	3,992 (26.2%)	5,145 (34.0%)	4,060 (29.0%)		
80-90	20,623 (26.2%)	4,233 (26.5%)	3,909 (25.1%)	3,935 (25.8%)	3,848 (25.4%)	3,964 (28.3%)		
90+	34,183 (43.4%)	6,897 (43.2%)	6,727 (43.1%)	7,312 (48.0%)	6,145 (40.6%)	5,998 (42.8%)		
Sex							0.227	0.16
Male	33,831 (42.9%)	6,816 (42.7%)	6,678 (42.8%)	6,463 (42.4%)	6,613 (43.7%)	6,010 (42.9%)		
Female	44,956 (57.1%)	9,155 (57.3%)	8,912 (57.2%)	8,776 (57.6%)	8,525 (56.3%)	8,012 (57.1%)		
Category of residence							<0.001	<0.001
Rural	39,475 (50.1%)	8,615 (53.9%)	8,629 (55.3%)	9,039 (59.3%)	6,616 (43.7%)	4,844 (34.5%)		
Urban	39,312 (49.9%)	7,356 (46.1%)	6,961 (44.7%)	6,200 (40.7%)	8,522 (56.3%)	9,178 (65.5%)		
MMSE, mean (SD)	22.5 (8.2)	22.89 (7.24) (n=13,382)	23.35 (7.27) (n=12,859)	22.48 (7.72) (n=12,373)	23.77 (7.32) (n=12,731)	19.90 (10.26) (n=13,527)	<0.001	<0.001
Calf circumference, mean(SD)	31.1 (5.3)	NA	NA	NA	31.2 (5.4)	31.0 (5.3)	<0.001	<0.001
Waist circumference, mean(SD)	84.3 (11.9)	NA	NA	NA	84.3 (11.2)	84.2 (12.8)	0.47	0.47
BMI							<0.001	<0.001
Underweight (<18.5)	10,550 (13.4%)	3,825 (23.9%)	0 (0%)	2,846 (18.7%)	2,129 (14.1%)	1,432 (10.2%)		
Normal (18.5 -24.9)	31,839 (40.4%)	9,292 (58.2%)	0 (0%)	8,524 (55.9%)	7,027 (46.4%)	5,846 (41.7%)		
Overweight (>24.9)	16,812 (21.3%)	2,634 (16.5%)	0 (0%)	3,450 (22.6%)	4,911 (32.4%)	4,985 (35.6%)		
Fruit intake							<0.001	<0.001
No	44,619 (56.6%)	10,617 (66.5%)	9,969 (63.9%)	9,330 (61.2%)	8,238 (54.4%)	6,110 (43.6%)		
Yes	34025 (43.2%)	5,350 (33.5%)	5,621 (36.1%)	5,907 (38.8%)	6,861 (45.3%)	7,861 (56.1%)		
Vegetable intake							<0.001	<0.001
No	9757 (12.4%)	2,307 (14.4%)	2,352 (15.1%)	1,918 (12.6%)	1,770 (11.7%)	1,317 (9.4%)		
Yes	68904 (87.5%)	13,656 (85.5%)	13,238 (84.9%)	13,318 (87.4%)	13,337 (88.1%)	12,661 (90.3%)		
PE participation							<0.001	<0.001
No	53,455 (67.8%)	10,908 (68.3%)	10,821 (69.4%)	11,133 (73.1%)	10,427 (68.9%)	8,542 (60.9%)		
Yes	24755 (31.4%)	5,029 (31.5%)	4,769 (30.6%)	4,105 (26.9%)	4,477 (29.6%)	5,327 (38%)		

Abbreviations: SD: standard deviation; MMSE: mini-mental state examination; CI: cognitive impairment; BMI: body-mass index; PA: physical exercise.

Table 2
Standardized prevalence rate (P) of cognitive impairment in CLHLS cohorts in 2002 to 2022, by gender, age groups and category of residence.

	2002			2005			2008			2018			2022			P for trend
	P	95%CI		P	95%CI		P	95%CI		P	95%CI		P	95%CI		
Total	4.1%	(4.1%	4.1%)	4.3%	(4.3%	4.3%)	4.8%	(4.8%	4.8%)	4.2%	(4.2%	4.2%)	6.8%	(6.8%	6.8%)	<0.001
Sex																
Male	2.9%	(2.9%	2.9%)	2.8%	(2.8%	2.8%)	3.1%	(3.1%	3.1%)	3.0%	(3.0%	3.0%)	5.5%	(5.5%	5.5%)	<0.001
Female	5.2%	(5.2%	5.2%)	5.7%	(5.7%	5.7%)	6.5%	(6.5%	6.5%)	5.3%	(5.2%	5.3%)	7.9%	(7.9%	7.9%)	<0.001
Age group																
65-79	2.6%	(2.6%	2.6%)	2.8%	(2.8%	2.8%)	2.6%	(2.6%	2.6%)	2.1%	(2.1%	2.1%)	3.6%	(3.6%	3.6%)	<0.001
80-89	12.6%	(12.6%	12.6%)	12.7%	(12.6%	12.7%)	13.7%	(13.7%	13.7%)	11.0%	(11.0%	11.0%)	17.3%	(17.3%	17.4%)	<0.001
90-99	29.4%	(29.3%	29.5%)	28.3%	(28.2%	28.3%)	31.9%	(31.8%	32.0%)	28.2%	(28.1%	28.2%)	42.3%	(42.3%	42.3%)	<0.001
80+	13.9%	(13.9%	13.9%)	13.9%	(13.9%	13.9%)	15.4%	(15.4%	15.4%)	13.1%	(13.1%	13.1%)	20.5%	(20.5%	20.5%)	<0.001
Category of residence																
Rural	4.6%	(4.5%	4.6%)	4.8%	(4.7%	4.8%)	5.3%	(5.3%	5.3%)	4.6%	(4.6%	4.6%)	6.9%	(6.9%	6.9%)	<0.001
Urban	3.3%	(3.3%	3.3%)	3.5%	(3.5%	3.5%)	4.3%	(4.3%	4.3%)	3.8%	(3.8%	3.8%)	6.7%	(6.7%	6.7%)	<0.001

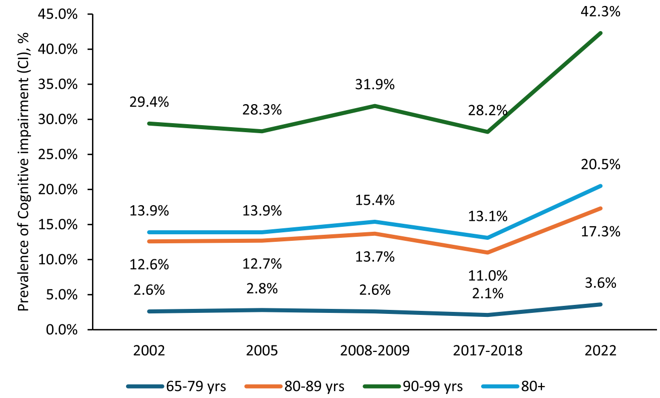

Fig. 2. Prevalence of cognitive impairment (CI) from 2002 to 2022, with comparison between age groups.

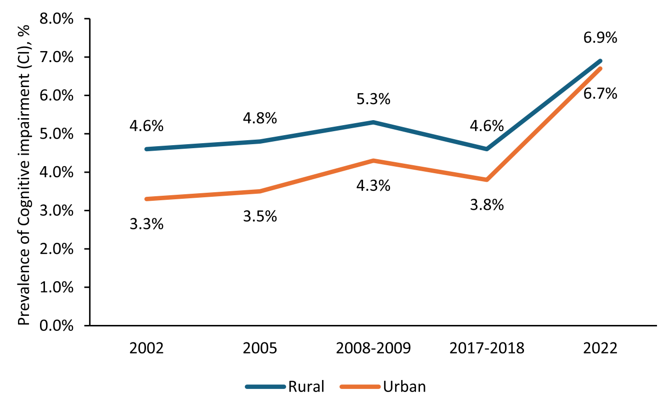

Fig. 3. Prevalence of cognitive impairment (CI) from 2002 to 2022, with comparison between rural and urban regions.

significantly lower in 2022 than in the pre-pandemic waves ($p < 0.001$).

4. Discussion

The current study observed that CI prevalence in China increased from 2002 to 2008 and then decreased until 2018, followed by a sharp increase in 2022. Cognitive impairment prevalence was higher in females compared to males and those residing in rural areas than those resides in urban areas. The CI prevalence also increased with increasing age. An inverted U shape in CI prevalence was observed from 2002 to 2018 with a peak in 2008. Potential reasons of the reversed U pattern from 2002 to 2018 have been discussed adequately in our early work [3]. However, CI prevalence increased significantly during the COVID epidemic. The novel findings of a sharp increase during COVID need to be interpreted carefully, from biological, psychological, social and environmental aspects.

4.1. Potential cerebral injury from COVID-19 infection

There is growing evidence that viral infections such as SARS-CoV-2 may have direct neurotropic effects, potentially leading to long-term neurological and cognitive consequences. Mechanistic studies and neuroimaging findings have identified several pathways through which COVID-19 may induce cerebral injury, including blood-brain barrier disruption, neuroinflammation, microvascular damage, and post-infectious autoimmune responses [17,18]. Clinical observations have also reported that individuals infected with COVID-19, even with mild respiratory symptoms, may experience persistent impairments in memory, attention, and executive function, collectively referred to as "brain fog" [19]. A follow-up study of survivors from the Wuhan outbreak found a higher incidence of cognitive impairment among those previously infected, particularly in patients who had experienced severe illness [20]. Interestingly, the severity of respiratory symptoms does not always predict cognitive outcomes [21,22], rather, elevated post-infection inflammatory markers have been shown to correlate with sustained cognitive alterations [23]. Multiple studies have reported acute and long-term deficits across several cognitive domains, with impairments in attention and executive function commonly reported 6 to 9 months after recovery [21,23,24]. The pathways underlying this cognitive damage are multifactorial, involving ischemia, stroke, and neuroinflammation, suggesting a complex and interdependent cascade through which COVID-19 may elevate the risk of cognitive decline and future dementia [25].

Given these potential effects, it is plausible that part of the observed increase in CI prevalence in the 2022 cohort reflects delayed consequences of prior COVID-19 infection among older adults. However, a key limitation of the present study is that we did not collect individual-level data on COVID-19 infection status in the 2022 wave. As a result, we are unable to directly assess whether infection history or disease severity contributed to elevated CI prevalence. While our findings align with broader concerns about the neurological impact of the pandemic, future studies incorporating serological testing or self-reported infection data will be necessary to explore this relationship more precisely.

4.2. Potential impact of Covid-19 pandemic on mental health and data collection

Another possible mechanism is the effects of adverse mental health, which deteriorated during opposed government restrictions in response to COVID-19. The citywide lockdowns, intermittent mobility restrictions, and strained healthcare resources across provinces significantly reduced access to dementia care and mental health services, particularly in rural or less-resourced areas. Additionally, heightened psychological stress, social isolation, fear of infection, and limited access to routine medical care could have adversely affected the cognitive function of older adults [26,27]. Although detailed information on mental health before and after the COVID-19 outbreak was not collected, it is likely that older adults experienced varying levels of loneliness, anxiety, depression, stress, and fear. These negative emotional states may have collectively contributed to poorer mental health and potentially influenced cognitive outcomes.

However, these outcomes may also be influenced by methodological artifacts stemming from pandemic-related disruptions. Although in-person visits were conducted where feasible, following strict COVID-19 safety protocols, lockdowns and public health restrictions still affected overall fieldwork logistics, leading to potential changes in survey participation and data collection methods. For instance, older adults with severe cognitive or physical impairment may have been more difficult to reach or more likely to drop out, potentially introducing selection bias. These opposing effects, a possible true increase in cognitive impairment and biases due to sampling and measurement changes, may have interacted in complex ways. As such, caution is warranted when interpreting trends over time, and especially when making comparisons across pre-pandemic and post-pandemic waves.

4.3. Risk and protective factors, and secular health trends

Beyond the pandemic's immediate effects, secular trends in modifiable risk factors may help contextualize changes in CI prevalence. Over the past two decades, China has experienced rising rates of chronic conditions such as type 2 diabetes [28], hypertension [29], and cardiovascular disease [30], each associated with increased risk of cognitive impairment and dementia [31–33]. In our previous study, we reported a rising prevalence of major chronic conditions, including hypertension and type 2 diabetes, in the CLHLS cohort between 2002 and 2018. These trends may partially account for the increasing CI prevalence observed in later survey waves. In contrast, rates of smoking and alcohol consumption declined substantially during the same period, which may have exerted a protective effect on cognitive outcomes. These opposing trends highlight the complex interplay of risk and protective factors influencing cognitive health over time [3].

Moreover, our data indicate that in 2022, there was an increase in reported fruit and vegetable consumption, as well as higher rates of physical activity among older adults. These behaviours are known to protect against cognitive decline by reducing oxidative stress, lowering inflammation, and supporting brain health [34–36] . However, CI prevalence still rose during this period, and we also found a significant decrease in calf circumference between the pre- and post-COVID waves. Calf circumference is a commonly used anthropometric marker for muscle mass, and reductions may indicate sarcopenia or frailty, both of which are associated with poorer cognitive outcomes [37,38]. This apparent contradiction suggests that while healthier lifestyle behaviours may confer long-term benefits, their immediate impact might have been outweighed by negative influences during the pandemic, as discussed above. Additionally, muscle loss and increased frailty during lockdowns, likely exacerbated by reduced mobility and disrupted routines, may have further amplified cognitive vulnerability. Taken together, while these lifestyle improvements are promising for long-term cognitive health, they may not have offset the adverse impacts of the COVID-19 period on cognition.

4.4. Study limitations

This study is subject to limitations. First, like most longitudinal cohort studies, the CLHLS is subject to survival bias and selective attrition. Healthier individuals are more likely to survive and participate in subsequent waves, potentially leading to an underrepresentation of frail or cognitively impaired individuals in earlier datasets [39]. Second, the study did not incorporate clinical diagnoses of mental health or dementia. Although the CLHLS collected indicators related to psychological well-being, such as self-reported loneliness, life satisfaction, and mood, these are not standardized psychiatric assessments and may not fully capture the mental health burden within the cohort. Given the strong bidirectional relationship between mood disorders (e.g., depression, anxiety) and cognitive function, this limitation restricts our ability to disentangle the effects of mental health on CI prevalence [40]. Third, several important dementia risk factors were not captured or analysed in this study. Notably, long-term exposure to air pollution has been linked to accelerated cognitive decline and greater neurodegenerative risk [41, 42]. Other unmeasured factors, such as hearing loss, traumatic brain injury and low social engagement, are also known to affect cognitive trajectories [42]. The omission of these domains limits our ability to fully explain the observed trends, underscoring the need for future studies that integrate comprehensive environmental, sensory, and lifestyle data for a more complete understanding of cognitive aging in China.

5. Conclusion

The current study, using two decades of nationally representative CLHLS data, found significant fluctuations in CI prevalence among older Chinese adults. The highest recorded level was seen in 2022 following the COVID-19 pandemic. The pandemic likely affected cognitive health through reduced access to care, increased stress, social isolation, and possible direct neurocognitive effects of the SARS-CoV-2 infection. These adverse effects of the pandemic may have outweighed short-term lifestyle gains reported in 2022, such as more fruit and vegetable consumption and higher physical activity. These findings underscore the urgent need for targeted public health interventions to address the lasting cognitive health consequences of the COVID-19 pandemic, enhance the resilience of healthcare systems, and implement strategies that can mitigate both medical and social factors contributing to cognitive decline in older adults.

Declaration of generative AI and AI-assisted technologies in the writing process

AI was not used in the writing process.

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CRediT authorship contribution statement

Lei Feng: Writing – review & editing, Writing – original draft, Methodology, Funding acquisition, Conceptualization. **Kaisy Xinhong Ye:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation. **Qiushi Feng:** Writing – review & editing, Supervision, Resources, Data curation. **Yan Mo:** Writing – review & editing, Software, Formal analysis, Data curation. **Zuqi Cai:** Writing – review & editing, Software, Formal analysis, Data curation. **Chunbo Li:** Writing – review & editing. **Jintai Yu:** Writing – review & editing. **Bin Li:** Writing – review & editing. **Andrea B. Maier:** Writing – review & editing. **Yi Zeng:** Writing – review & editing, Supervision, Resources, Project administration, Methodology, Funding acquisition, Data curation, Conceptualization. **Zhenglian Wang:** Writing – review & editing, Validation, Supervision, Software, Project administration, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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ZLW designed the study and performed the statistical data analysis. FLF and KXY wrote the paper. QHF helped to draft the paper and provide critical suggestions. All authors discussed and contributed to the theoretical framework, and interpretation of the results, and gave final approval of this manuscript.

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