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Association between sensation, perception, negative socio-psychological factors and cognitive impairment

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ABSTRACT

Background: Evidence has suggested that sensation and socio-psychological factors may be associated with cognitive impairment separately in older adults. However, the association between those risk factors and cognitive impairment is still unknown.
Objective: To investigate the association between sensation, perception, negative socio-psychological factors, and cognitive impairment in institutionalized older adults.
Methods: From two public aged care facilities, 215 participants were investigated. The Mini-mental State Examination was applied to assess cognitive function. The sensory function was bifurcated into auditory and somatosensory realms which were evaluated using pure tone audiometry and Nottingham Sensory Assessment, respectively. Albert's test, left and right resolution, and visuospatial distribution were used to evaluate perception. Depression and social isolation were selected as negative socio-psychological factors and were evaluated by the Geriatric Depression Scale and the Lubben Social Network Scale. The multivariate analysis was performed utilizing binary logistic regression.
Results: Participants with moderately severe or severe hearing loss exhibited significant cognitive impairment compared to those with mild hearing loss. It was observed that perceptual dysfunction and depression were independently related to cognitive impairment. However, there was no significant association between somatosensory function, social isolation, and cognitive impairment in the institutionalized older adults.
Conclusion: More profound hearing loss, abnormal perception, and depression are associated with cognitive impairment in older adults. Subsequent research endeavors should delve into the causal mechanisms underpinning these associations and explore whether combined interventions have the potential to postpone the onset of cognitive impairment.

1. Introduction

Older adults who experience cognitive impairment that may or may not progress to dementia will experience poor quality of life and an enormous social and economic burden [1]. Identifying modifiable risk factors for cognitive impairment is highly prioritized, which could be an important basis for providing effective and targeted early prevention strategies in the absence of current effective treatment [2]. Aging presents great challenges to older adults' sensation, perception, and psychosocial functioning, which may further

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pose a threat to cognitive function.

Sensory dysfunction is a common age-related condition that affects older adults. By 2050, it is estimated that approximately 2.5 billion people worldwide will experience hearing loss, with up to one-third of older adults in China already affected [3]. Hearing loss, the most prevalent sensory dysfunction in older adults, has been associated with cognitive impairment. It has been shown that older adults with hearing loss have a 24 % higher risk of cognitive impairment than those without [4]. This association between hearing loss and cognitive function remains significant even after adjusting for visual impairment [5]. Recent evidence suggests that this link may be attributed to the reallocation of cognitive processing resources to degraded auditory signals and the decline in right temporal lobe and brain volume [6].

Somatosensory impairment is another common sensory dysfunction among older adults, with previous study reporting a prevalence of 26 % for 65–74 years old, and 54 % for those 85 and older [7]. Research indicates that somatosensory impairment may increase the risk of cognitive impairment and even dementia [8]. Notably, early involvement of the somatosensory cortex has been observed in the progression of Alzheimer's disease, potentially leading to behavioral and functional consequences [8]. However, limited research has focused on examining the association between somatosensory abnormalities and cognitive impairment.

Perception, which encompasses figure discrimination, spatial perception, and orientation, plays a crucial role in the cognitive process [9]. Co-existing perceptual and cognitive deficits can magnify cognitive impairment, potentially leading to misattribution of cognitive causes to perceptual deficits. Previous study has suggested that optimizing perceptual input could restore normal cognition [10]. Nevertheless, there is a lack of research investigating the relationship between perception and cognitive function. In addition, terminological confusion exists among existing studies regarding the distinction between sensation and perception.

Apart from sensory and perceptual challenges, older adults may also experience psychosocial difficulties. Among these, social isolation and depression stand out as significant issues within the older population. Recent data has shown that over 30.0 % of older adults are socially isolated [11] and 25.2%–40.7 % exhibit depressive symptoms [12]. Data from the 2002–2018 waves of the Chinese Longitudinal Healthy Longevity Survey showed that social isolation independently predicted a higher risk of cognitive impairment [13]. However, social isolation was assessed by questions such as marital status, living arrangement, type of social network, and sometimes social engagement, without a cut point. These metrics may not provide a precise representation of social isolation, as the fact that an older adult lives alone doesn't automatically indicate social isolation, and conversely, those who live with family can still experience significant isolation [14]. Therefore, it is challenging and requires careful consideration to elucidate the relationship between social isolation and cognitive impairment solely based on a few simple items. Furthermore, depression has been associated with a 20–30 % risk of Alzheimer's disease, with evidence suggesting that depression can precede cognitive impairment [15,16].

While previous studies have explored the relationship between sensation, perception, negative socio-psychological factors, and cognitive impairment, most have tended to concentrate on just one or two variables at a time. To provide targeted efforts for early prevention, it is essential to examine these factors collectively and identify which carries a greater risk for cognitive impairment. Therefore, the aim of this study was to investigate the association between sensation, perception, negative socio-psychological factors, and cognitive impairment among older adults.

2. Materials and methods

2.1. Participants

The data used in this study was originally collected as a component of a project centered around path analysis. The sample size of our project was determined using the empirical formula based on previous studies and expert opinions, as well as the recommendations outlined by James Grace [17]. It recommends a minimal sample size of 200 for conducting structural equation modeling and path analysis. In alignment with the research query at hand and the accessibility of the available data, we opted to scrutinize it using binary logistic regression analysis. As for the sampling approach employed, we utilized a convenience sampling strategy to enlist participants from the intended population.

A total of 215 participants were enrolled in this study from two public aged-care facilities in Wuhan, China. The inclusion criteria encompassed individuals aged 60 years or older who had been resided in these public aged-care facilities for a minimum duration of one month. Exclusion criteria involved participants with a history of cognitive impairment caused by other central nervous system disorders, such as Lewy's body dementia, neurosyphilis, and intracranial tumors, as well as those diagnosed with severe disabilities that prevented them from participating in the study. All participants were invited to provide demographic information, which included age, sex, education, marital status, and comorbidities. Regarding the comorbidities, we classified the participants into three groups: individuals without any comorbidity, those with a single comorbidity, and those with multiple comorbidities. We conducted a thorough review of the health records of older adults residing in these two public aged-care facilities to ensure data accuracy.

2.2. Cognitive function

The Chinese version Mini-Mental State Examination (MMSE) [18] was applied to assess cognitive function by a well-trained researcher. This instrument is a valid tool to measure global cognitive function and has been widely used in previous studies [19]. The MMSE consists of subtasks to assess orientation, attention, numeracy, immediate recall, delayed recall, language function, and visuospatial ability, with a total score of 30. Participants with a total MMSE score below 24 (for those with more than 6 years of education or secondary education and above), 20 (for those with 6 years or fewer of education, equivalent to lower secondary education), or 17 (for illiterate individuals) are classified as having cognitive impairment [20].

2.3. Sensation

The Nottingham Sensory Assessment scale (NSA) was used to assess somatosensory function. The NSA scale was originally developed by Lincoln and colleagues [21], and its cultural adaptation and psychometric validation for implementation within the Chinese population were conducted by Yang Yuqi and colleagues [22]. The NSA scale consists of three dimensions: tactile sensation, kinesthetic sensations, and stereognosis, with a total of eight subtasks including light touch sensation, temperature sensation, pinprick sensation, pressure sensation, tactile localization sensation, two-point discrimination sensation, proprioception, and solid sensation. Participants who correctly performed across all three dimensions are categorized as having normal somatosensory function, while those with incorrect performances are classified as having abnormal function.

All participants underwent Pure Tone Audiometry (PTA) for hearing loss in a quiet environment. Achieving a quiet environment involved measures such as conducting assessments in a sound-controlled consultation room, minimizing external noise sources (e.g., closing windows, turning off fans), and scheduling data collection during quieter times of the day. A portable audiometer (Tiger DRS Inc, Shanghai), which was provided by the Resource Center of Disabled Technology Adapter, was used. Before the test, instructions were provided to ensure participants' understanding and cooperation in the test. The average pure tone threshold for participants' better ears at 0.5, 1, 2, and 4 kHz was taken as the pure tone average. According to the World Health Organization criteria [23], the defined hearing loss degree includes normal hearing (<20 dB), mild (20 to <35 dB), moderate (35 to <50 dB), moderately severe (50–65 dB) and severe (65 to <80 dB).

2.4. Perception

There is no universally accepted instrument for assessing perception. Given the definition of perception and drawing from relevant literature, we integrated several tools, namely Albert's test [24], left and right resolution, and visuospatial distribution. This amalgamation provided us with uncomplicated means to evaluate perception. The rating scale for Albert's test is categorized as follows: none (1–2 crossed-out lines omitted), suspicious neglect (3–23 crossed-out lines omitted), and unilateral neglect (≥23 crossed-out lines omitted). The assessment of left and right resolution comprises two components. Firstly, participants were instructed to raise either their left or right hand. Secondly, participants were asked to identify specific body parts such as the left eye (or right eye), left ear (or right ear), and left knee (or right knee). The researcher then evaluated the accuracy of the participants' responses, categorizing them as either completely correct or incorrect. The visuospatial distribution involved figure-background discrimination. Participants were presented with a set of overlapping images and were required to identify a particular item within this arrangement. The researcher assessed the accuracy of the participants' answers, determining whether they were correct or incorrect. Furthermore, another aspect of the visuospatial distribution entails participants being provided with a picture and instructed to replicate the same shape and spatial position on the opposite side. The researcher evaluates the correctness of participants' reproductions. Those tools were commonly used in rehabilitation clinics. Participants who performed correctly in all three subtasks were classified as normal; otherwise, they were classified as abnormal.

2.5. Negative socio-psychological factors

Depression was assessed using the Geriatric Depression Scale-30 (GDS-30), originally developed by Brink et al. [25]. It stands as the most extensively employed assessment of depression among older adults, especially those who might encounter cognitive impairment, even within the Chinese population [26]. Each item is assigned a score ranging from 0 to 1. A higher score corresponds to a heightened level of depression, with a cutoff point set at 11. Scores below 11 are considered normal, while scores equal to or greater than 11 indicate depression.

Social isolation was assessed by the Lubben Social Network Scale-6 (LSNS-6) developed by Lubben and colleagues [27]. A Chinese version of this instrument has also been developed [28]. The scale comprises six items, each with five options, scoring from 0 to 5. The total scores range from 0 to 30, with scores below 12 indicating a risk of social isolation.

2.6. Data collection

The hearing testing was conducted by the first author, who underwent training by professionals at the Resource Center of Disabled Technology Adapter in Hubei Province. The testing frequencies were conducted in the order of 1, 2, 4, and 0.5 kHz, with a final retest of the threshold at 1 kHz. Audiometric thresholds were measured in 5 dB HL (hearing level decibels) increments and reduced by 10 dB HL. If the retest result differed by 10 dB from the initial result, a retest was performed for 2 and 4 kHz, with the second result being considered valid. The overall testing duration was approximately 20 min. In addition, the first author received training from a rehabilitation specialist and medical doctor, both of whom are faculty members at our institution. The cognitive function assessment was conducted by the first author, who received training from a neurologist during a previous study on MMSE. In cases where participants reported challenges in hearing clearly, the researcher conducted the assessment of the MMSE by allowing participants to visually observe each item. Concurrently, the researcher adjusted the volume and read each item aloud, providing assistance to the participants and asking if they could hear clearly. Importantly, the researcher refrained from engaging in or guiding the participants' responses to the items during this process. To ensure consistency in the assessment process, the first author was primarily responsible for conducting evaluation of hearing function, somatosensory and perception, and cognitive function, while the second author was responsible for assessing depression, social isolation, and demographic information. The second author provided precise instructions on how to complete the questionnaires and demographic forms. During the data collection process, the second author adopted a neutral and non-judgmental attitude.

2.7. Ethics statement

The study was approved by the Ethics Permission Committee of Wuhan Polytechnic University (BME-2021-1-01). All participants signed informed consent.

2.8. Statistical analyses

Statistical analyses were performed with SPSS (version 26.0). Data were presented as means and standard deviation for numeric variables, while categorical variables were presented as frequencies for. Firstly, univariate analysis was applied to recognize the possible associated factors of cognitive impairment. The Wilcoxon non-parametric test was used for numeric variables that were not normally distributed. The chi-squared test was used for categorical variables, including sex, education, marital status, comorbidities, hearing loss, somatosensory, perception, depression, and social isolation. Secondly, multivariate analysis was performed by binary logistic regression analysis. Model 1 was constructed without adjustments for other variables, while Model 2 was adjusted for age, sex, education, marital status, and comorbidities. A p-value of 5 % or lower was considered statistically significant.

3. Results

The mean age of participants was 73.1 ± 9.5 years old, with women accounting for 56.7 % of the total. Among the participants, 59.5 % had less than a lower secondary education, and widows constituted 45.6 % of the group. More than half of the older adults experienced comorbidities, and 60.5 % were socially isolated. Out of the total participants, 105 individuals (48.8 %) were identified as having depression. Moreover, it was found that over half of the participants had abnormal somatosensory and perception.

Table 1 depicts a profile of participant characteristics based on cognitive impairment and normal cognition. Of the 215 participants, 81 (37.7 %) were categorized as having normal cognition, and 134 (62.3 %) were categorized as having cognitive impairment. There was no significant difference in age between the participants with cognitive impairment and normal cognition ($p > 0.05$). The normal cognition group was more likely to have a higher educational level ($p < 0.001$). When compared to older adults with normal cognition, older adults with cognitive impairment suffered greater hearing loss. The proportions with moderate, moderately severe, and severe hearing loss were 29.9 %, 43.3 %, and 17.9 %, respectively. The prevalence of abnormal perception among older adults with cognitive

Table 1
Demographic characteristics of participants.

Variable	Total (n = 215)	Normal cognition (n = 81)	Cognitive impairment (n = 134)	χ^2/t	*p*
Age, y, mean (Standard Deviation)	73.1 (9.5)	72.4 (8.5)	73.4 (10.0)	−0.78	0.436
Gender, female, n (%)	122 (56.7)	48 (59.3)	74 (55.2)	0.34	0.563
Education, n (%)				21.64	<0.001
Less than lower secondary	128 (59.5)	32 (39.5)	96 (71.6)		
Secondary or above	87 (40.5)	49 (60.5)	38 (28.4)		
Marital status, n (%)				3.51	0.173
Married	109 (50.7)	36 (44.4)	73 (54.5)		
Widowed	98 (45.6)	40 (49.4)	58 (43.3)		
Others	8 (3.7)	5 (6.2)	3 (2.2)		
Comorbidities, n (%)					0.090
None	19 (8.8)	5 (6.2)	14 (10.4)		
Single	79 (36.7)	37 (45.7)	42 (31.3)		
Multiple	117 (54.4)	39 (48.1)	78 (58.2)		
Social isolation, n (%)				2.96	0.085
Yes	130 (60.5)	43 (53.1)	87 (64.9)		
No	85 (39.5)	38 (46.9)	47 (35.1)		
Depression, n (%)				10.59	0.001
Yes	105 (48.8)	28 (34.6)	77 (57.5)		
No	110 (51.2)	53 (65.4)	57 (42.5)		
Somatosensory, n (%)				3.00	0.083
Normal	31 (14.4)	16 (19.8)	15 (11.2)		
Abnormal	184 (85.6)	65 (80.2)	119 (88.8)		
Perception, n (%)				16.64	<0.001
Normal	52 (24.2)	32 (39.5)	20 (14.9)		
Abnormal	163 (75.8)	49 (60.5)	114 (85.1)		
Hearing loss, n (%)				21.93	<0.001
Mild	35 (16.3)	23 (28.4)	12 (9.0)		
Moderate	72 (33.5)	32 (39.5)	40 (29.9)		
Moderately severe	78 (36.3)	20 (24.7)	58 (43.3)		
Severe	30 (14.0)	6 (7.4)	24 (17.9)		

impairment was 85.1 %, compared to 60.5 % among those with normal cognition. The percentages of somatosensory abnormalities and social isolation were similar in both groups, with more than 80 % and 50 %, respectively. Older adults with cognitive impairment were more likely to exhibit depression than those with normal cognition ($p < 0.05$).

The associations of sensation, perception, and negative socio-psychological factors with cognitive impairment are shown in Table 2. Depression, perception, and hearing loss were significantly associated with cognitive impairment with (Model 2) or without (Model 1) the adjustment of other covariates. In model 2, in comparison to individuals with less than lower secondary education, those with secondary education or above exhibited a significantly lower risk of cognitive impairment, with an odds ratio of 0.309 (95 % CI = 0.148, 0.642). Furthermore, participants who experienced depression and abnormal perception had elevated risks of cognitive impairment, with odds ratios of 2.480 (95 % CI = 1.249, 4.924) and 4.428 (95 % CI = 2.022, 9.700) respectively. Compared to those with mild hearing loss, those with moderately severe and severe hearing loss had 4.619 (95%CI = 1.642, 12.997) and 5.836 (95%CI = 1.525, 22.327) higher odds of cognitive impairment.

4. Discussion

This study provides support for an independent association between cognitive impairment and sensation, perception, as well as negative socio-psychological factors. Specifically, older adults with moderately severe and severe hearing loss, as well as those experiencing abnormal perception, exhibited a significant association with cognitive impairment. Furthermore, depression emerged as an independent risk factor for cognitive impairment, while higher levels of education were identified as a protective factor. However, no significant associations were found between cognitive impairment and social isolation, abnormal somatosensory, and moderate hearing loss.

Sensory dysfunction, including hearing, vision, and olfaction impairments, has been identified as a common risk factor for cognitive impairment, with a growing body of evidence supporting these associations [29,30]. These findings further substantiate previous research on the link between hearing loss and cognitive function. Longitudinal population-based studies have consistently demonstrated a robust connection between hearing loss and incident cognitive impairment [31,32], although some studies have reported weak or nonsignificant associations [33]. The discrepancy in findings may arise from variations in the assessments of hearing loss. Prior studies often employed different methods, such as clinical testing or epidemiologic measures, including self-reported assessments like whispered voice tests and pure tone audiometry. Another possible explanation for inconsistent results could be attributed to the diversity in cognitive screening instruments employed across various studies, alongside variations in adjusting for potential confounding factors. Our findings indicated that older adults with moderately severe and severe hearing loss were at higher risk of cognitive impairment compared to those with mild hearing loss. This observation aligns with the notion that the severity of hearing

Table 2
Results of binary logistic regression analysis.

	Model 1	Model 2
Variables	OR (95 % CI)	OR (95 % CI)
Depression No (reference) vs Yes	2.279 (1.198, 4.336)	2.480 (1.249, 4.924)
Social isolation No (reference) vs Yes	1.295 (0.679, 2.470)	1.236 (0.622, 2.456)
Somatosensory Normal (reference) vs Abnormal	1.240 (0.513, 2.996)	1.176 (0.442, 3.127)
Perception Normal (reference) vs Abnormal	4.544 (2.164, 9.541)	4.428 (2.022, 9.700)
Hearing loss Mild (reference) vs Moderate	2.356 (0.948, 5.855)	2.107 (0.791, 5.611)
Hearing loss Mild (reference) vs Moderately severe	5.613 (2.177, 14.474)	4.619 (1.642, 12.997)
Hearing loss Mild (reference) vs Severe	9.447 (2.681, 33.290)	5.836 (1.525, 22.327)
Age		1.028 (0.987, 1.070)
Sex Male (reference) vs Female		1.115 (0.548, 2.267)
Education Less than lower secondary (reference) vs Secondary or above		0.309 (0.148, 0.642)
Marital status Married (reference) vs Widowed		0.790 (0.381, 1.640)
Marital status Married (reference) vs Others		0.284 (0.045, 1.775)
Comorbidities None (reference) vs Single		0.322 (0.082, 1.273)
Comorbidities None (reference) vs Multiple		0.485 (0.127, 1.846)

Note: Model 1 represents the results without controlling for variables such as age, sex, education, marital status, and comorbidities. Model 2, on the other hand, includes the results after incorporating these control variables.

loss is associated with the degree of cognitive impairment [34]. The underlying mechanisms explaining the impact of hearing loss on cognitive function are still under investigation. Two commonly known explanations are the sensory deprivation hypothesis and the information-degradation hypothesis [35]. The sensory deprivation hypothesis suggests that auditory deprivation leads to neural deafferentation, cortical reallocation to support other processes, and atrophy in brain regions associated with speech perception processing [36]. Previous study has also observed reductions in temporal lobe volume among individuals with peripheral hearing loss [37]. On the other hand, the information-degradation hypothesis proposes that degraded auditory ability increases demands on cognitive processing, leading to compensatory efforts [38]. Another hypothesis suggests that a degraded peripheral hearing system resulted in the dysfunction of the central auditory system and interacted with existing cognitive impairment [39]. Regardless of the specific hypothesis, existing study suggests that moderately severe or a greater degree of hearing loss might represent promising and modifiable targets for secondary prevention of cognitive impairment in older age.

Apart from hearing loss, our research also focused on somatosensory function, which emcompass tactile sensation, kinesthetic sensations, and stereognosis. With aging, there is a decline in the sensitivity and discrimination abilities of sensory receptors, leading to a deterioration in somatosensory function [40]. This co-occurrence conditions in aging might suggest a potential link with cognitive impairment. However, our findings indicated that individuals with abnormal somatosensory function showed no significant risk of cognitive impairment when compared to those with normal somatosensory function. This finding differs from what was reported in a previous study [8]. One plausible explanation for this absence of significant finding could be that the particular nature of the somatosensory impairment might not directly impact the cognitive processes associated with cognitive impairment. The brain engages distinct regions and circuits in somatosensory processing and cognitive function, and if these areas are not closely interconnected, the impact on cognitive function could be constrained. The disparities in results might also stem from variations in measurement instruments.

Perception and cognitive impairment are considered to be potentially related, as both are susceptible to the effects of aging. In this study, abnormal perception demonstrated a significant association with cognitive impairment, consistent with findings reported by Robert and Allen [41]. As perceptual input becomes more challenging to discriminate, additional compensatory cognitive processes are required to decode the incoming signals [41]. A previous study showed that visual acuity, contrast sensitivity, and stereo acuity impairments were associated with lower scores on the Modified MMSE [42]. However, Komes' findings indicated that poor perception might not necessarily correlate with poor memory performance [43]. It is possible that pre-attentive or unconscious processing in spatial neglect could impact conscious perception and decision-making, which might not have a direct connection to memory performance [44]. Further investigation is needed to gain a better understanding of the interplay between perceptual disorders and impairments in various cognitive domains.

Our findings indicated that depression constituted a significant risk factor for cognitive impairment, whereas social isolation did not exhibit a significant association. Nevertheless, contrasting results were reported in a prior study concerning the link between social isolation and cognitive impairment. Several longitudinal studies have demonstrated an independent association between social isolation and cognitive decline, even after adjusting for depression and other covariates [45,46]. A meta-analysis that encompassed fifty-one articles found a statistically significant, albeit small effect size, association between social isolation and cognitive function [47]. The disparities between these studies and our findings could be attributed to variations in the instruments employed to assess social isolation. Social isolation is typically evaluated based on factors such as the types or size of social networks, the frequency of social contacts, and engagement in social activities [47]. However, few instruments provide definitive cutoff points to identify instances of social isolation. Additionally, when examining the relationship between social isolation and cognitive impairment, it is crucial to consider not only the quantity but also the quality of social interactions. Even individuals with extensive social networks might experience loneliness and isolation if they lack intimate and supportive emotional connections [48]. This phenomenon is referred to as "emotional isolation", which represents a form of social isolation. A previous study indicated that heightened levels of emotional isolation were associated with an elevated risk of cognitive decline and dementia [49]. In forthcoming research, it is imperative to encompass the multidimensional nature of social isolation, with a focus on the importance of factors such as social network structure, interpersonal connections, and the diversity of social activities.

There are several limitations of this study. Firstly, the MMSE was applied in this study by using verbal language instructions. Despite our efforts to improve audibility by adjusting the volume and allowing participants to wear their own glasses, it remains possible that the impact of hearing loss on the assessment could not be entirely eliminated. As a result, there is a potential for an overestimation of participants' cognitive function. Secondly, a portable audiological assessment instrument was used to evaluate the pure tone hearing thresholds of both ears in a relatively quiet room, rather than in a standardized environment. This choice may have potential impact on the reliability and generalizability of the findings. We recommend future studies be conducted under standardized conditions and then compared with results obtained in non-standard environments. Additionally, exploring alternative methods or technologies that minimize such influences would also be beneficial. Thirdly, it is imperative to acknowledge the constraints inherent in employing non-standardized instruments for the evaluation of perception in this study. Consequently, it is crucial for future research endeavors to prioritize the validation and enhancement of the assessment methodology. Additionally, causal inferences could not be established by this cross-sectional study. Longitudinal studies are needed to provide more robust evidence that validates our observed results and to further elucidate the intricare relationship between sensation, perception, negative socio-psychological factors, and cognitive impairment. Moreover, it's worth noting that this study had a relatively small sample size, and only two public aged-care facilities were selected as the research sites. Consequently, the generalizability of the findings might be limited. Larger studies with more diverse populations could offer further insights into the relationship between sensation, perception, negative socio-psychological factors, and cognitive impairment. Finally, despite our efforts to control for potential confounding factors, there remains the possibility of unaccounted variables influencing the outcomes, such as lifestyle choices and genetic predisposition.

5. Conclusions

Cognitive impairment, abnormal sensation, abnormal perception, and negative socio-psychological factors are prevalent age-related conditions that contribute to significant negative health outcomes and substantial disease burden. This study suggests that older adults with moderate to severe hearing loss or more, abnormal perception, and depression face a heightened risk of cognitive impairment. Fortunately, these identified independent risk factors hold the potential for modification to some extent. Strategies such as hearing protection, rehabilitation, and non-pharmacological interventions targeting perception and depression could offer promising and cost-effective avenues for enhancing the prevention and management of cognitive impairment.

Credit author statement

Wu Fan: Conceptualization, Methodology, Writing – original draft preparation, Software, Validation, Writing- Reviewing and Editing. Liu Hanxin: Conceptualization, Data curation, Methodology, Writing – original draft preparation, Investigation. Liu Wenbin: Supervision, Software, Validation, Writing-Reviewing and Editing.

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Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:Fan Wu reports financial support was provided by the Education Department of Hubei Province.

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