Associations of cognitive condition with nutritional status in an elderly population: an analysis based on a 7-year database in Chongqing, the Southwest of China

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DOI:
10.21203/rs.3.rs-21402/v1

SUBJECT AREAS
Geriatrics & Gerontology

KEYWORDS
cognitive impairment, nutritional status, malnutrition, risk factors, the elderly

Abstract

Background: Malnutrition is one of the health problems in the elderly population, which increases the risk of poor clinical outcomes. The purpose of this investigation was to evaluate the nutritional status and cognitive function of an elderly Chinese population, to explore the association between malnutrition and cognitive condition as well as the cognitive domain.

Methods: A cross-sectional study was conducted in 2365 participants aged 60 years or above from January 2013 to September 2019. We used the Mini Nutritional Assessment Short Form (MNA-SF), and the Mini Mental State Examination (MMSE) to assess the impact of malnutrition on cognitive function. Nutrition-associated factors were analyzed.

Results: 33.45% of the participants were identified as malnutrition risk and 5.54% were malnourished, while 36.74% had cognitive impairments. 48.63% had nutritional deficits and 53.65% had cognitive impairment in those over 80 years old. Malnutrition is associated with global cognition (ρ= 0.349, $P < 0.0001$) and the cognitive domain particularly in orientation (ρ= 0.343, $P < 0.0001$). The impact was extended to attention and calculation (ρ=0.310, $P < 0.0001$) as well as language (ρ= 0.302, $P < 0.0001$) of those over 80 years of age. Malnutrition is an independent risk factor for cognitive impairment after adjusting for other variables (OR=2.004, 95% CI: 1.621-2.479).

Conclusion: The prevalence of malnutrition and cognitive impairment was relatively high and increased with age. Malnutrition leads to cognitive decline and disorientation, and also contributes to attention problems, calculation problem and language impairment in the oldest old. Thus, clinicians should assess the nutritional and cognitive status of the elderly regularly to the early dictation and timely intervention.

1. Background

As the world becomes an aging society, malnutrition is one of the health problems and getting more prevalent in elderly populations, even in the developed world [1]. The previous study reported that more than 50% of the elderly in hospitals and institutions were malnourished [2]. Malnutrition would result in a range of adverse health outcomes, such as prolonged length of stay in the hospital, increase risk of falls, decreased physical function and increased mortality [3]. Similarly, with the aging of the population, cognitive impairment is another prevalent disease in the elderly and increasingly recognized as a serious, worldwide public health concern. Researches showed that individuals with cognitive impairment were at a higher risk of developed into dementia or Alzheimer’s disease (AD) [4]. More seriously, dementia will lead to various health problems including disability, frailty, and death and therefore caused a high burden for patients, their families, and society [5]. Unfortunately, there are still no resolutive pharmacological treatments but only a few symptomatic drugs are currently available to patients.

Based on this consideration, recent developments in AD have heightened the need for early detection and finding out protective factors. Among them, malnutrition was recognized as a risk factor of dementia and AD [6, 7]. Recent evidence suggests that malnutrition is associated with rapid cognitive decline, disease progression and the degree of impairment in daily functioning in patients with dementia [8–10]. While studies have shown that patients with dementia or AD were more likely to suffer from a poor nutritional status [11, 12]. Weight loss and malnutrition were prominent symptoms of dementia and could be detected at the early stages of AD [13, 14]. In short, there was a two-way relationship between malnutrition and cognitive function in patients with dementia.

Although the effects of malnutrition on progression in AD and dementia are becoming well established, the evidence regarding the impact of nutritional status in healthy aging adults and cognitive impairment has not been proved yet. Given the above, this study aimed to evaluate the nutritional status and cognitive status of an elderly Chinese population, to explore the association between malnutrition and cognitive impairment as well as the cognitive domain.

2. Materials And Methods

2.1 participants

In the present study, 2365 participants aged 60 years or above were recruited. 1666 of them were from Department of Geriatrics of The First Affiliated Hospital of Chongqing Medical University from January 2013 to January 2019. 699 participants were randomly enrolled from two community health centers of Chongqing, namely Dapin and Yangjiapin, both located in the urban areas. Inclusion criteria were as follows: (1) aged 60 years or older, (2) Patients had to be able to understand and cooperate with the requirements of the study. Exclusion criteria included: (1) people with severe speech or hearing difficulties, (2) in the acute phase of the disease or severe mental disorders. Informed consent was obtained from the participants.

2.2 Sociodemographic

Using face-to-face interviews, we examined the sociodemographic variables, nutritional status, cognitive status and physical function. participants were divided into three age groups: young older (60–69 years), middle older (70–79 years), and old older (≥ 80 years). Education status was classified as “illiteracy”, “higher” (years of education, >9 years) ,“lower” (years of education,1–9 years). Participants were also stratified Body mass index (BMI) according to the WHO Asian adult body weight standard. It was defined “obesity” with scores ≥ 25.0 kg/m^2, “overweight” with scores = 24.9–23.0 kg/m^2, 18.5–22.9 kg/m^2 for “normal” and BMI < 18.5 kg/m^2 for “underweight”. Marital status was listed as married or divorced/widowed.

2.3 Nutritional status assessment

Nutritional status was evaluated with the Mini Nutritional Assessment Short Form (MNA-SF). As a valid and sensitive rapid nutrition screen instrument, it compares well with the full the Mini Nutritional Assessment (MNA) [15]. It consists of 6 items: appetite, weight, mobility, health status, depression, and BMI value. If the individual was not able to give reliable answers, the questionnaire was confirmed by proxy. In this study, participants were classified as malnutrition (MNA-SF score < 8), at risk of malnutrition (MNA-SF score 8–11) or well-nourished (MNA-SF score > 11) [16].

2.4 Cognitive assessment

The Mini-Mental State Examination (MMSE) was performed to assess global cognitive function. The MMSE which consists of a variety of questions was a brief screening tool for cognition with high sensitivity and specificity. It has covered 6 cognitive domains: Orientation (10 points); Registration (3 points); Attention and Calculation (5 points); Recall (3 points); Language (8 points) and Visual Construction (1 point). Usually, we classified the visual construction task as one of the language items [17]. Cut-off points for the MMSE were 18 for illiterate persons, 24 for persons with 1–11 years of education and 27 for persons with ≥ 12 years of education in the current study [18, 19].

2.5 Functional assessment

We have used the Barthel Index which was translated and validated version for Chinese elderly to assess the activity of daily living. It is the best and most widely used tool to rate patient's independence.[20, 21] The scores range from 0 (complete dependency on others for daily activities) to 100 (indicating self-sufficiency).

2.6 Statistical Methods

Statistical analyses were performed by SPSS version 23.0. The quantitative data are presented as mean ± standard deviation (SD). Count data were expressed as percentages. According to the data types, the Chi-square test was used for categorical variables. One-way ANOVA was used for continuous variables that were found to follow the normal distribution. Mann–Whitney non-parametric test was used for non-normally distributed continuous variables between two groups, while the Kruskal–Walis non-parametric test was applied for non-normally distributed variables between three or more groups. We used Spearman correlations to test the association between two non-normally distributed continuous variables groups. Differences were considered significant at $P < 0.05$, at 95% Confidence Interval.

3. Results

3.1 Nutritional and cognitive status evaluation

Among the 2365 participants, 1086 (45.9%) were males and 1279 (54.1%) were females. The mean age of the participants was 76.24 years (SD = 7.91 years). According to the MNA-SF questionnaire, 5.54% of the 2365 participants were malnourished, 33.45% were at risk of malnutrition and 61.01% were well nourished (Fig. 1A). The prevalence of malnutrition increased with age. In the old older group (≥ 80 years), 7.88% were malnutrition and 40.75% were at risk for malnutrition (Fig. 1B). With respect to cognitive status, according to the MMSE questionnaire, 63.26% of participants had normal cognitive status, 36.74% of them had cognitive impairment (Fig. 1C). As shown in Fig. 1D, the old older group (≥ 80 years), reported significantly more cognitive impairment than the other two groups, which 53.65% showed cognitive impairment.

3.2 Association between malnutrition and cognitive decline.

A positive association was founded between the MNA-SF score and MMSE score (Fig. 3, $\rho = 0.349$, $P < 0.0001$) and it increased with age. It indicated that malnutrition contributes to cognitive decline. This effect was most pronounced in old older group (Table 1, ρ = 0.392, P < 0.0001). The orientation was affected severely among the five specific cognitive domains (Table 1, ρ = 0.343, P < 0.0001). The negative effect of malnutrition was extended to other cognitive domains with the increase of age. In the old older group, apart from the orientation (Table 1, ρ = 0.381, P < 0.0001), the attention and calculation (Table 1, ρ = 0.310, P < 0.0001) as well as the language (Table 1, ρ = 0.302, P < 0.0001) was also affected.

Cognitive impairment subjects had markedly higher prevalence of malnourished and at risk of malnutrition compared to those who had normal cognitive status (Table 2, 9.7% vs.3.1%, 44.4% vs.27.1%, P < 0.0001), while the majority of malnourished patients (64.1%) had cognitive impairment (Fig. 2). 18.77% had cognitive impairment in the young older group (60–69 years) and 32.24% showed cognitive impairment in the middle older group (70–79 years).

3.3 Association between participants' age, educational level, marital status, BMI, and nutritional status

There was a significant correlation between the nutritional status of participants and their age, marriage, education level, weight, BMI and Barthel Index (Table 2, p < 0.0001). It was found that well-nourished elderly were younger (mean age = 75.25 years) than those at risk of malnutrition (mean age = 77.62 years) and those who were malnutrition (mean age = 78.83 years). Widowed or divorced patients were more likely subjected to malnutrition (Table 2, p < 0.0001). Elderly participants of the lower educational level were presented at a higher risk of being malnutrition (Table 3, Odds Ratio (OR) = 1.385, 95% Confidence Interval (CI): 1.180–1.625). And elderly participants with lower BMI were at a higher risk of being malnutrition (Table 3, OR = 1.322, 95% CI: 1.020–1.713). Moreover, malnourished elderly were more likely to have a functional disability (Table 3, OR = 2.342, 95% CI: 2.010–2.730).

3.4 Nutritional deficit is an independent risk factor for cognitive impairment after adjustment for potential confounding factors

We used multiple logistic regression analysis to investigate the association between nutritional deficit (malnourished or risk of malnutrition) with cognitive impairment after adjustment of age, female gender, marriage, education level, weight, height, BMI and Barthel Index. Nutritional deficit and cognitive impairment maintained a marked association after adjusting for other variables (Table 3, OR = 2.004, 95% CI: 1.621–2.479).

4. Discussion

In the current study, we demonstrate that nutritional deficit is significantly associated with cognitive decline. The prevalence of malnutrition and cognitive impairment was relatively high and increased with age. In particular, malnutrition contributes to global cognition decline and disorientation. Moreover, malnutrition leads to attention problem, calculation problem and language impairment in the elderly who were over 80 years old.

We have used the MNA-SF to evaluate the nutritional status in the present study. Among the 2365 participants, 5.54% were malnourished, 33.45% were at risk of malnutrition. The prevalence was higher in those over 80 years old, nearly half of them (48.63%) were malnutrition or at risk of malnutrition. This data is comparable to those with large samples. A meta-analysis showed that the prevalence of malnutrition was 5.8% and 31.9% of community-living elderly persons were at risk of malnutrition [22]. It indicates that our results are closer to the actual nutritional status of the elderly. Further, we find participants above 80 years of age were at a higher risk of malnutrition, and few previous studies have focused on this age category. We think that aging, as well as consequently frailty progress, is associated with the greater overall prevalence of disability and function limitation, thus directly contribute to the development of malnutrition. Therefore, malnourished is pervasive in the elderly and clinicians should pay more attention to the nutritional status of those over 80 years old.

As far as cognitive status is concerned, in the present study, 63.26% of the participants had normal cognitive status, 36.74% of them had cognitive impairment according to the MMSE score. Recent studies have shown that the prevalence of cognitive impairment was 32.9%-34.4% [23, 24]. Our results are comparable. However, the previous studies showed that the prevalence of cognitive impairment was 11.0%-22.2% as assessed by MMSE in 2003–2011 [25–27], this different prevalence in various periods indicates that there is an increasing trend of cognitive impairment following aging. We also found that the prevalence of cognitive impairment is markedly higher among those over

80 years old (53.65% had cognitive impairment). Previous research indicates that elevated levels of cerebral protein beta-amyloid (Aβ) in apparently healthy persons are found in at least 50% of those over 80 years old [28]. As Aβ accumulation results in cognitive decline, advance ages (over 80 years old) are prone to cognitive impairment. Therefore, the cognitive status of the elderly is not optimistic and requires to be concerned immediately.

In this study, we find nutritional deficient, including malnutrition and at risk of malnutrition, is a risk factor for cognitive impairment. First of all, a correlation was observed between the MNA-SF score and the MMSE score after adjusting for other variables. Secondly, the elderly with cognitive impairment were more likely to be malnutrition while the majority of the elderly with malnutrition had cognitive impairment. In line with the previous study that malnutrition was a significant risk factor for cognitive decline and directly associated with AD pathology [7, 29]. The elderly who had cognitive impairment were more likely to suffer from malnutrition [11, 12]. The interrelationships between malnutrition and cognitive impairment are complex and reciprocal.

As we know, the brain is a complicated organ demand for high oxygen. Several nutrients, as essential constituents of brain tissue, play not only important roles for brain integrity and metabolism, but also prevent cognitive decline by counteracting pathological processes [30]. Nutrients deficiency and an unbalanced diet may contribute to synaptic dysfunction, promote neuronal loss, then lead to cortical thinning and results in cognitive impairment. Epidemiological evidence suggests that cognitive disorder is associated with the deficiency of some specific nutrients[31, 32]. For example, patients with cognitive impairment or dementia have a lower plasma level of several nutrients, including folate, vitamin A, vitamin B12, vitamin C, and vitamin E [33]. It indicates that nutrients deficiency is associated with cognitive decline and the pathological processes of AD. Moreover, the elderly with cognitive impairment may suffer a loss of appetite due to pathological changes in the olfactory system [34]. As the disease progresses, patients may lose their cognitive ability to initiate or continue effective eating strategies [35], which resulted in decreased nutritional intake and deterioration of nutritional status. To summarize, malnutrition precedes cognitive impairment, and this interplay may result in a vicious circle and thus lead to more pronounced malnutrition.

Our results indicate that malnutrition contributes to disorientation. Nutritional deficits may also lead to a decline in attention, calculation and language in the elderly who was over 80 years old. Considering sub-items of cognition are located in different regions of the brain, we think that different brain regions have different sensitivity to malnutrition. It is reported that the affected brain regions involved in disorientation include mostly the middle temporal and parietal cortices [36], networks involving the temporal and dorsolateral prefrontal cortex are shown to support language processing [37, 38], posterior cingulate cortex is related to attention function [39]. Thus, temporal cortex, parietal cortex, dorsolateral prefrontal cortex and posterior cingulate cortex are easily affected by malnutrition. A higher Mediterranean diet (MeDi) score and beneficial components of MeDi (fish, vegetables, legumes, and whole grains/cereals) are associated with larger cortical thickness in some specific brain regions, such as temporal, dorsolateral prefrontal, posterior cingulate cortex. Therefore, MeDi might be recommended to prevent cognitive decline associated with malnutrition. In addition, when patients show a sign of disorientation, nutritional status should be screened to find malnutrition earlier.

In this study, we find that lower weight and BMI are independent risk factors for malnutrition. It consists with previous research that the elderly with lower BMI were more likely to suffer from malnutrition [23, 40]. It reminds us that we should monitor the weight of the elderly regularly to detect weight loss and prevent malnutrition. Low education is also a risk factor for malnutrition. Similarly, previous researches have shown illiteracy was found to have a higher prevalence of malnutrition [23, 41]. This may be due to the elderly with higher educational status possibly had higher income and better dietary patterns. Regarding the functional status, we found that the elderly with nutritional deficits performed significantly poorer in the Barthel Index, it indicated that malnourished elderly were more likely to have a functional disability. This is consistent with results from previous studies that malnutrition and frailty were two interrelated factors [42].

Conclusions

The prevalence of malnutrition/at risk of malnutrition and cognitive impairment are relatively high especially in the elderly who were over 80 years old. Malnutrition may contribute to cognitive decline and disorientation. It may also lead to attention and calculation problem and language impairment in those over 80 years old. Thus, we should assess the nutritional and cognitive status of the elderly regularly.

Abbreviations

AD: Alzheimer’s disease; BMI: Body mass index; MNA-SF: the Mini Nutritional Assessment Short Form; MNA: the Mini Nutritional Assessment; MMSE: The Mini-Mental State Examination; MeDi: Mediterranean diet.

Declarations

Ethics approval and consent to participate

All procedures had been approved by the Ethics Committee of The First Affiliated Hospital of Chongqing Medical University (Approved on July 18, 2012, No 15). Informed consent was obtained from the participants.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors confirm that there are no conflicts of interest.

Funding

This study was supported by grants from National Key R&D Program of China (2018YFC2001700), General Project of Technological Innovation and Application Development of Chongqing Science & Technology Bureau (cstc2019jscx-msxmX0239), the Science and Technology Research Program Of Chongqing Municipal Education Commission (KJQN201900109), Sub-project of National Science and Technology Supporting Program of the Ministry of Science and Technology of China (2015BAI06B04), Key-project of Social undertakings and people's livelihood security of Chongqing Science &

Technology Commission (cstc2017shms-zdyfX0009), the Key Project of Chongqing Municipal Health Bureau (2016ZDXM005).

Author Contributions

WY was responsible for designing the study, and conducted the statistical analysis, interpreted the data, and wrote the manuscript; WY assisted in study design, data interpretation and manuscript revision. WY, XL, TW, CC were responsible for data collection. TW, LX, CH, SY, WZ, FZ, ZQ, WY, DC assisted in nutritional and cognitive assessment. YL was responsible for study design, data analysis and manuscript revision; All authors read and approved the final manuscript.

Acknowledgments

The authors would like to thank all participants or caregivers who volunteered for this study. We thank all the team members for their support on this study.

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Tables

Table1. Spearman correlations between the MNA-SF score and total MMSE score, subscores.

Parameters	Total	Young older	Middle older	Old older
	ρ	ρ	ρ	ρ
MMSE score	0.349*†	0.169*	0.341*†	0.392*†
Orientation (10)	0.343*†	0.169*	0.314*†	0.381*†
Registration (3)	0.203*	0.055	0.182*	0.221*
Attention and Calculation (5)	0.262*	0.079	0.227*	0.310*†
Recall (3)	0.207*	0.094*	0.194*	0.249*
Language (9)	0.273*	0.153*	0.266*	0.302*†

Young older=60-69 years; Middle older=70-79 years; Old older=over 80 years old.

*p <0.05 † A positive correlation.

Table 2. Relation of various factors to nutritional status.

Parameters	Nutritional status			
	Well nourished (n=131)	At risk of malnutrition (n=791)	Malnutrition (n=1443)	P-valu
Age (years ±SD)	75.25±7.78	77.62±7.90	78.83±7.56	0.000
Gender				
Male (n=1086)	654(60.2%)	371(34.2%)	61(5.6%)	0.764
Female (n=1279)	789(61.7%)	420(32.8%)	70(5.5%)	
Marriage				
Married (n=1734)	1104(63.6%)	548(31.5%)	85(4.9%)	0.000
Divorced/Widowed (n=628)	339(54.0%)	243(38.7%)	46(7.3%)	
Education				
Illiteracy (0) (n=188)	87(46.3%)	77(41.0%)	24(12.8%)	0.000
Lower (1-9) (n=1177)	707(60.1%)	415(35.3%)	55(4.7%)	
Higher (>9) (n=1000)	649(64.9%)	299(29.9%)	52(5.2%)	
Cognition				
Normal cognitive status (n=1496)	1044(69.8%)	405(27.1%)	47(3.1%)	0.000
Cognitive impairment (n=869)	399(45.9%)	386(44.4%)	84(9.7%)	
Weight (Kg)	62.15±9.82	55.99±11.29	50.70±11.28	0.000
Height (cm)	158.75±8.62	159.48±9.04	156.92±8.85	0.005
BMI (kg/m^2)	24.62±3.10	21.94±3.65	20.51±3.93	0.000
MMSE	25.92±4.16	22.79±6.06	19.61±7.41	0.000
Barthel Index	95.81±11.53	86.81±21.46	70.15±29.84	0.000

BMI=Body mass index; MMSE= Mini-Mental State Examination; Kg= kilogram; Cm=centimeter; m=meter

Table 3. Multiple regression analysis evaluating the association between cognitive impairment and nutritional deficit after adjustment for potential confounding factors

Parameters	Odds Ratio	95% Confidence interval	P-value
Age	0.995	0.982-1.009	0.504
Marriage	0.793	0.629-1.000	0.050
Gender	0.978	0.788-1.214	0.839
Educational level	1.385	1.180-1.625	0.000*
Weight	1.095	1.063-1.129	0.000*
Height	0.928	0.905-0.952	0.000*
BMI	1.322	1.020-1.713	0.035*
Barthel Index	2.342	2.010-2.730	0.000*
Cognition	2.004	1.621-2.479	0.000*

Figures

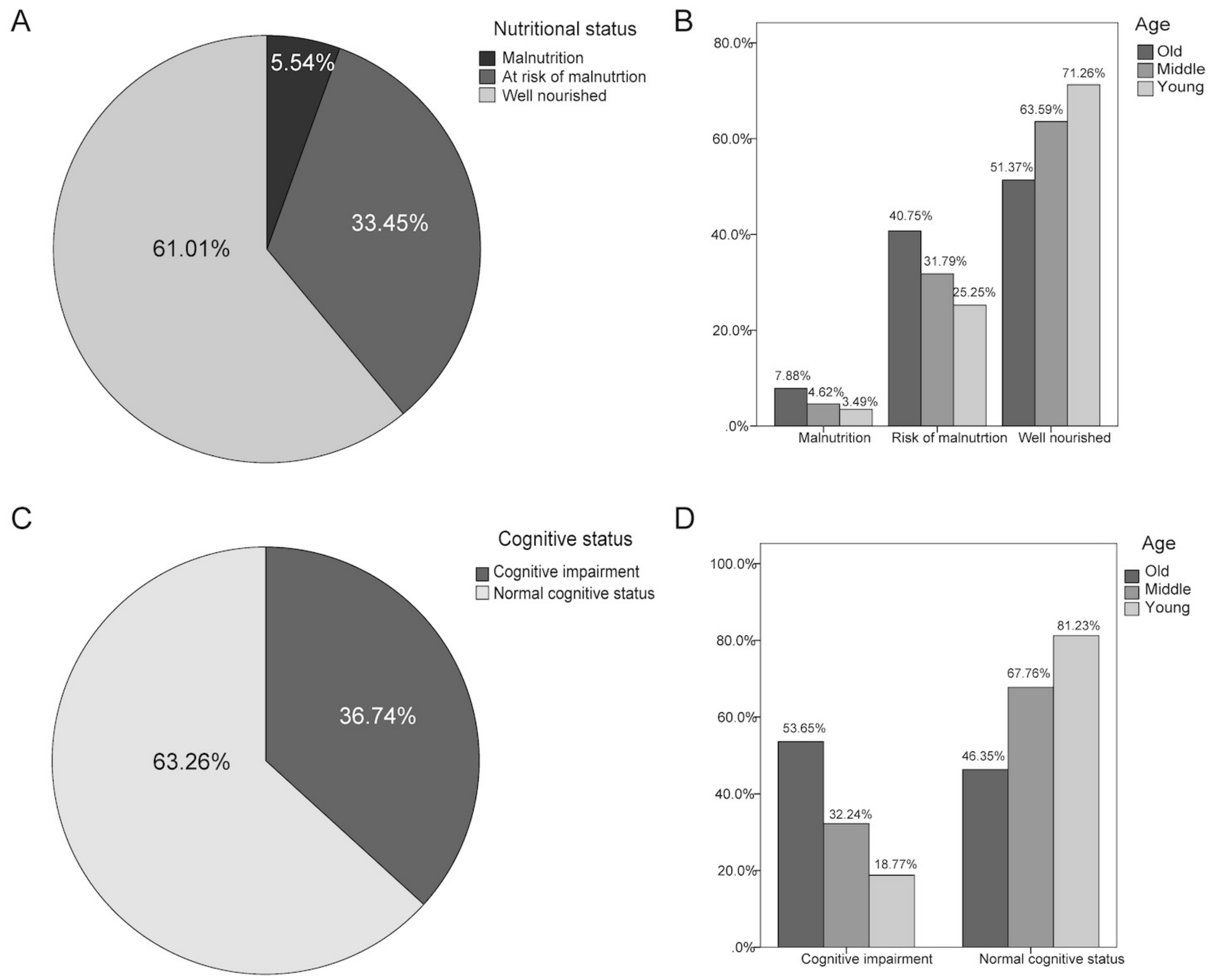

Figure 1

The prevalence of malnutrition and cognitive impairment. (A) The prevalence of malnutrition. (B) The prevalence of malnutrition in different age groups (C) The prevalence of cognitive impairment. (D) The prevalence of cognitive impairment in different age groups.

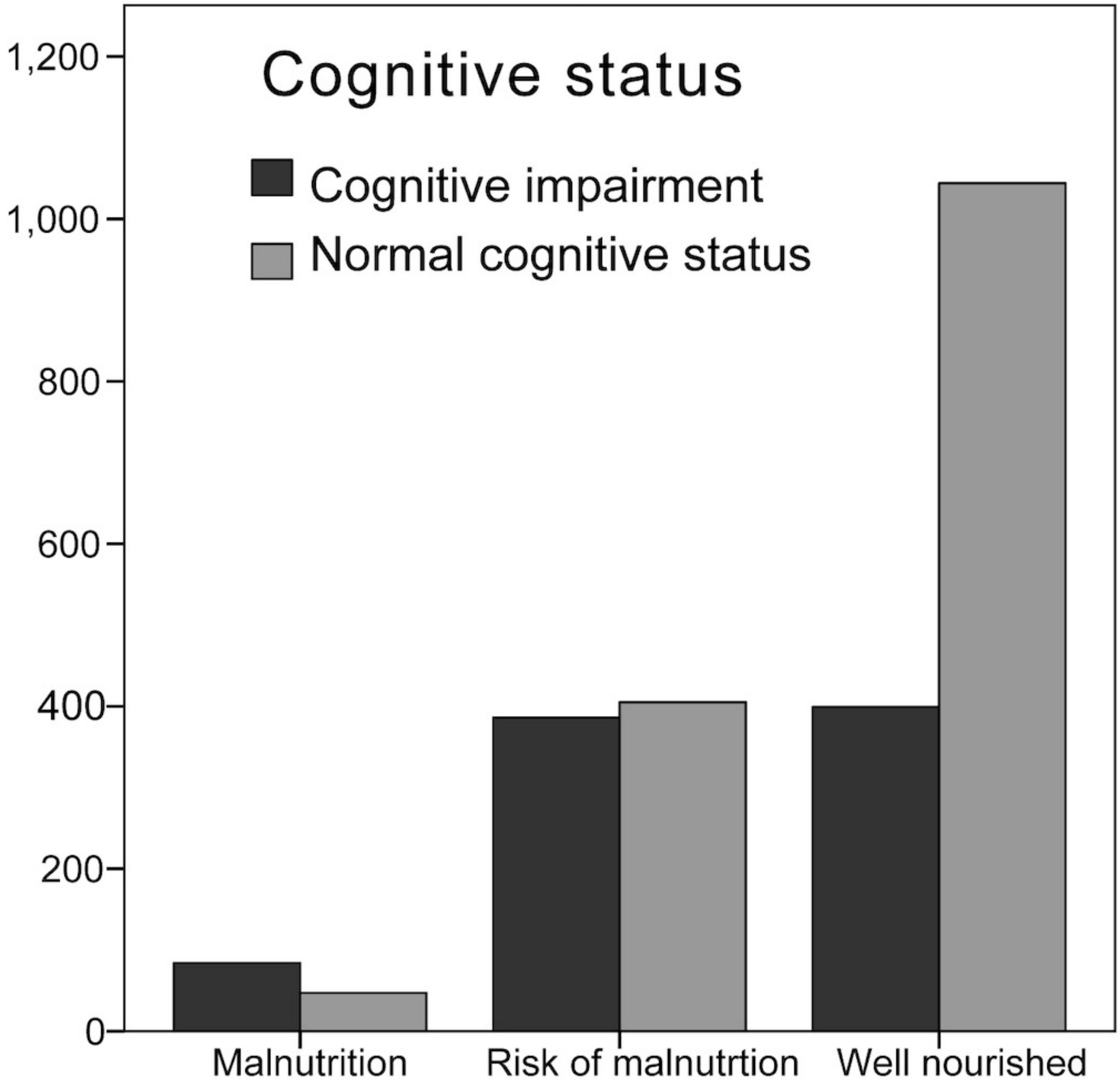

Figure 2

The prevalence of cognitive impairment in different nutritional status.

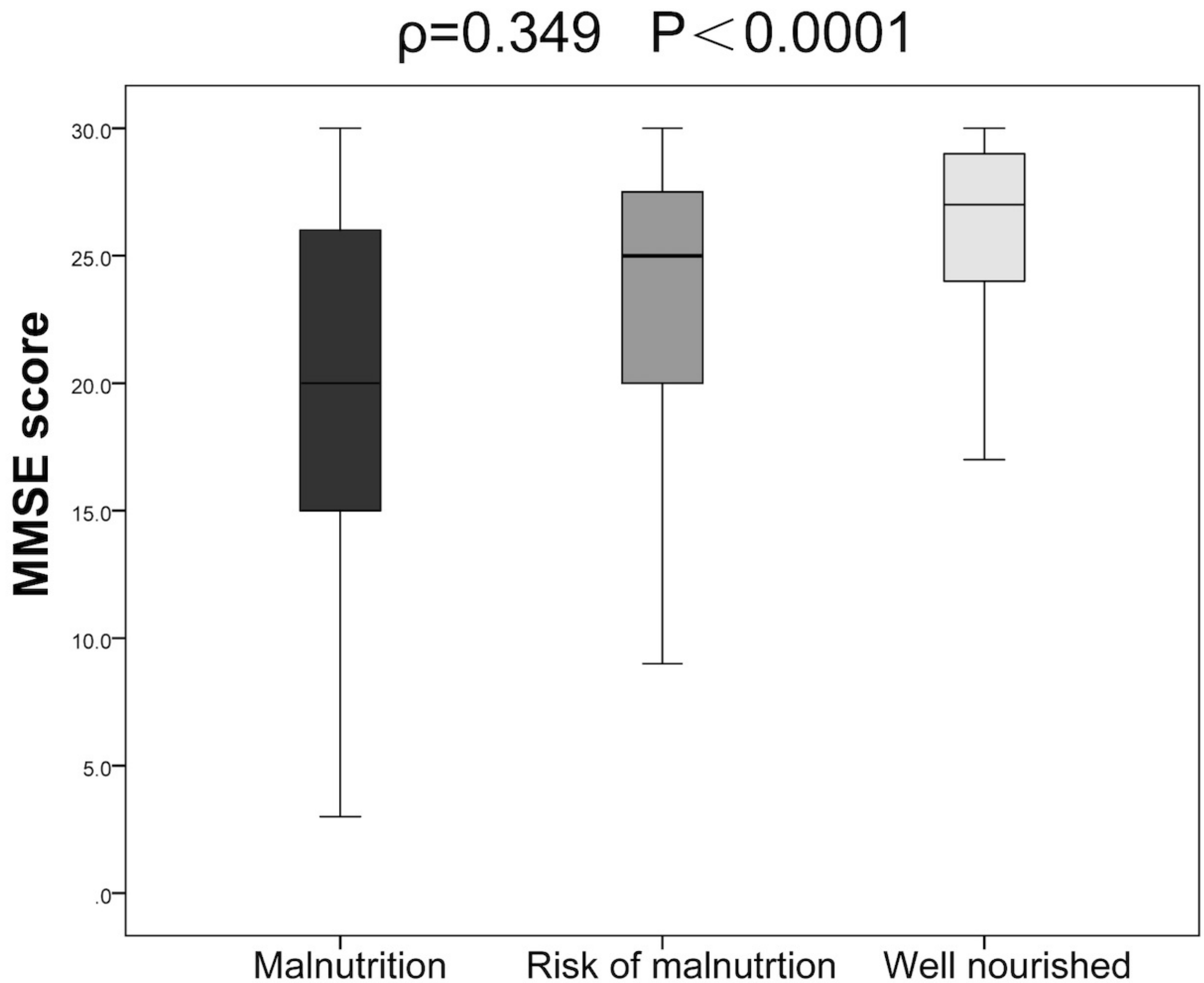

Figure 3

The association between nutritional status and MMSE score.