# Preoperative assessment of cognitive function and risk assessment of cognitive impairment in elderly patients with orthopedics: A cross-sectional study.

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# Abstract

Background Preexisting cognitive impairment is emerging as a predictor of poor postoperative outcomes in seniors. Nevertheless, cognitive impairment in a large proportion of geriatric patients has not been well identified and diagnosed.

Methods This is a cross-sectional study. Mini-mental state examination scale was used to assess cognitive function of elderly patients aged ≥ 65 years undergoing orthopedic surgery preoperatively. The baseline, living habits and laboratory examination results of the two groups were compared, and multivariate Logistic regression model was used to identify independent predictors of preoperative cognitive impairment.

Results A total of 374 elderly patients with orthopedics met the inclusion criteria, and 28.61% with preoperative cognitive impairment. Multivariate Logistic regression analysis showed that age (OR=1.089, P<0.001), subjective sleep disorders (OR=1.996, P=0.021), atherosclerosis (OR=2.367, P=0.017), high cholesterol level (OR=1.373, P=0.028) were independent risk factors for preoperative cognitive impairment, while high education level performed as a protective factor (Compared with illiterate group, primary school group: OR=-0.885, P=0.009; middle school or above group: OR=-2.118, P<0.001).

Conclusions The prevalence of preoperative cognitive dysfunction in geriatric elective orthopedic surgical patients was high. Our study identified venerable age, low level of education, subjective sleep disorders, atherosclerosis, high cholesterol level as risk factors for preoperative cognitive impairment in these patients. Understanding these risk factors contribute to assist in prevention and directed interventions for the high-risk population.


# Introduction

More than 300 million people worldwide undergo major surgery each year, and approximately 1 in 3 surgical procedures is performed on a patient ≥ 65 years old.[1] The elderly has a higher rate of perioperative complications and poor surgical outcomes, including sustained functional decline. The premise of preoperative assessment of vital organ systems has been a routine part of preparation for surgery for decades, is viewed as especially important for the elderly,[2] and is that identifying organ dysfunction preoperatively helps provide information for perioperative care planning.[3]

The brain, which is arguably the organ of greatest importance for health needs, informed decision-making and good functional recovery, is unique among critical organ systems in having no formal preoperative assessment. In elders about to have surgery, there are several reasons to believe it should be. First, cognitive impairment is common in this age group. Survey studies have shown that 5–10% of persons older than 65 years in the community have dementia; if one includes mild cognitive impairment (MCI) as well as dementia, the prevalence of cognitive impairment increases to 35–50%.[4, 5] Secondly, a substantial fraction of this cognitive impairment, particularly at the MCI level, goes undetected.[6] Thirdly, cognitive complications such as delirium and postoperative cognitive dysfunction are the most common morbidities in geriatric surgical patients, affecting 20–80% and 12–15%, respectively. Preexisting cognitive impairment acts as a risk factor for both conditions as well as a predictor and/or modifier of postoperative outcomes.[7, 8] Therefore, it seems apparent that preoperative cognitive screening of the geriatric surgical population might offer many benefits.

Due to insufficient clinical staffing, unclear evaluation methods, lack of objective records, and insufficient understanding of the disease, the evaluation of preoperative cognitive function of elderly patients has not been classified as a routine project at home and abroad.[9] Mini-mental state examination (MMSE) is the most commonly used cognitive function test scale, and could be used as a screening for epidemiological investigations, and recommended to evaluate the preoperative cognitive status of elderly patients.[10] Moreover, Chinese Medical Association Geriatrics Branch recommended MMSE to evaluate the preoperative cognitive status of elderly patients in 2016.[11]

The aim of this study was, therefore, to explore the incidence of cognitive impairment in patients ≥ 65 years old with MMSE, and examine the association of delirium with preoperative risk factors in an older scheduled for orthopedic surgery population.

# Materials And Methods

## Ethical approval

All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional (The Clinical Research Ethics Committee from the First Affiliated Hospital, College of Medicine, Zhejiang University. The reference number: 900 on 10th August, 2018). All patients provided written informed consent for the publication of any associated data.

## Patients

This was a cross-sectional study and was completed in a manner consistent with the STROBE statement. The participants included in the current analysis were all patients scheduled for orthopedic surgery at our institution and recruited between August 2018 to June 2019. All patients provided written informed consent for the publication of any associated data. Patients were included if they were 65 years of age or more with ASA I-III, and underwent elective orthopedic surgery. Exclusion criteria were patients who underwent surgical treatment within 6 months, and conditions that prevented participation in the assessment such as limitations in visual, hearing and dominant hand ability, no surgical plan, and refusal to follow up.

## Data collection

Risk factors that have been epidemiologically defined in this perioperative setting were measured.[5,12] All participants were asked to complete a standardized set of self-report questionnaires. Demographic characteristics were recorded, including age, sex, height, and weight for body mass index (BMI), degree of education, marital status, smoking and drinking status, living situation, exercise (≥4 times per week) and subjective sleep quality (well or not). Comorbidities were recorded to calculate the Charlson Comorbidity Index (CCI), as well as the presence of known neuropsychiatric diagnoses. Primary diagnosis and pre-hospital psychotropic medication were also recorded.

Homocysteine (Hcy), albumin (ALB), alanine aminotransferase (ALT), triglyceride (TG), total cholesterol (TC), low density lipoprotein (LDL) and fasting blood glucose (FBG) were measured and collected on the basis of clinical need, but at least on the preoperative day.

### Neuro-psychologic testing

MMSE, as an effective screening tool for various degrees of cognitive impairment including MCI and dementia, assessing the domains of attention and concentration, executive functions, memory, language, visuocontructional skills, conceptual thinking, calculation and orientation. The total score is 30 points. The higher the score, the better the cognitive function. Considering the impact of education level on MMSE assessment, combined with actual situation in China and existing research report, the thresholds for those who were illiterate, or attended at most primary school, or middle school were ≤ 17, ≤ 20, and ≤ 22, respectively.[13] Individuals with a score below the threshold value were considered as cognitively impaired.

In this way, patients were divided into cognitive normal group and cognitive impairment groups. In our study the score for each domain and the overall score were recorded. A single researcher who was trained in the use of the tool prior to recruitment performed all of the cognitive screening patient interviews.

### Statistical Methods

We calculated descriptive statistics. Categorical variables were summarized as frequencies and proportions, normally distributed continuous variables as mean (Standard deviation, SD), and non-normally distributed continuous variables as median (Interquartile range, IQR). An unpaired t-test was used to test for normally distributed continuous variables, Mann–Whitney U-test was used for variables without normal distribution, and the chi-square test was applied for categorical data as appropriate.

Logistic multivariate regression model was performed to screen independent risk factors for predicting preoperative cognitive impairment. Variables with a statistical difference of $P<0.1$ in the univariate analysis were deliberately included in the following logistic multivariate analysis model to identify independent risk factors using the enter method.

Differences were considered to be statistically significant if the $P<0.05$ (two tailed). Statistical analysis was performed using SPSS version 23.0 (IBM Corporation, Armonk, NY, USA).

## Results

Data were available from 471 patients with questionnaire and cognitive testing. **Figure 1** shows a patient flow diagram. The number of patients completing follow-up neuro-psychologic testing preoperative was 374. The reasons for exclusion were patient refusal (15), study withdrawal during evaluation (27), no surgery plan (14), surgical treatment within 6 months (14), limitations in visual, hearing or dominant hand ability (21), ASA IV or more (6). Preoperative cognitive impairment was diagnosed in 107 (28.61%) patients according to the assessment of MMSE.

### Baseline parameters and preoperative characteristics

The characteristics of participant are shown in **Table 1** The mean ± SD age of the patients was 70.26 ± 3.88yr; 53.7% were female. There was significant difference in patient age between female and male (70.81 ± 3.87yr vs 69.67 ± 3.83yr, *P=0.004*). Notably, the incidence of cognitive impairment in different age groups is shown in **Figure 2**, and increased significantly with age. 53.2% of patients were admitted to hospital for spinal lesions, 29.7% for hip, knee or tibia lesions, and17.1% for other parts, in which there was no difference between patients with and without cognitive impairment.

Compared to those without cognitive impairment, subjects with probable or possible preoperative cognitive impairment were older[70 (67-74) vs 73(68-79); *P<0.001*], more likely to be female (47.9% vs 62.8%; *P<0.001*), to have a lower education level (illiteracy group, 17.2% vs 40.2%，primary school group, 46.8% vs 46.7%, middle school group or above group 36% vs 13.1%，*P<0.001*). And our data showed that a higher proportion of persons with cognitive impairment have atherosclerosis (18.4% vs 28.0%; *P=0.038*). Cognitive impairment incidence was not different among patients with hypertension (*P=0.626*), coronary heart disease (*P=0.903*), diabetes (*P=0.091*), hyperlipidemia (*P=0.152*), central nervous system diseases (*P=0.626*) compared with those patients with normal cognition. While patients with cognitive impairment had a higher CCI score than patients who did not exit [4(4-5) vs 4(3-5), *P=0.048*], and subjects with a ASA score of 3 was more in impairment group than in normal group (30.8% vs17.2%; *P=0.004*). **Table 1** describes the variables in more detail.

Patients in impairment group had a higher lever in Hcy (*P=0.046*), TC (*P=0.016*), FBG (*P=0.041*). Nevertheless, no significant difference was found between the two groups with reference to ALB, ALT, TG and LDL. **Table 2** describes the variables in more detail of preoperative serological index.

### Living habits and cognitive functions

In univariate analysis, there was a strong association between subjective sleep disorders and cognitive impairment. Of the 107 participants who developed cognitive impairment, 39.3% had sleep dysfunction at home, whereas of the 267 with normal cognition, 22.8% had sleep dysfunction at home (*P=0.001*). No statistical difference was observed in pre-hospital psychotropic medication, exercise, cigarette smoking, and history of alcohol consumption of >5 years between the two groups (**Table 3**).

### Risk factors for preoperative cognitive impairment

The variables showed association with preoperative cognitive impairment (*P<0.1*) were enrolled in the Logistics multivariate analysis, including sex, age, education level, subjective sleep disorders, diabetes mellitus, atherosclerosis, ASA score of 3, CCI score, level of Hcy, TC, and FBG. The results are showed in **Table 4**. Multivariate regression analysis demonstrated that age (OR=1.089, 95%CI: 1.037-1.144, *P<0.001*), subjective sleep disorders (OR=1.996, 95%CI 1.112-3.581, *P=0.021*), atherosclerosis (OR=2.367, 95%CI 1.169-4.794, *P=0.017*), high level of TC (OR=1.373, 95%CI : 1.035-1.820, *P=0.028*) were independent risk factors of cognitive impairment. Whereas higher education (compared with illiterate group: primary school group, OR=-0.885, 95%CI 0.213-0.799, *P=0.009*; middle school group or above group OR=-2.118, 95%CI: 0.052-0.280, *P<0.001*) appeared as protective factors of cognitive impairment.

Taking into account the positive impact of education on MMSE, we conducted a subgroup analysis to further discuss the differences in age, sleep quality, atherosclerosis and TC of people with different education levels. Our data showed that no statistical difference was observed in these aspects (*P>0.05*, **Table 5**).

# Discussion

The results of this study demonstrate that many geriatric elective surgical patients do poorly on cognitive screening tests preoperatively. Specifically, 28.61% of patients≥65 years-old scored in a range that suggests probable cognitive impairment.

### Preexisting cognitive impairment preoperatively

Cognitive impairment often goes undiagnosed, yet it has significant implications for surgical outcomes. Of the 374 patients included, 107 (28.61%) were identified as having cognitive impairment in this study, lower than previous literature reported. Studies have showed the prevalence of cognitive impairment is up to 35–50%in the community-dwelling older person, including mild cognitive impairment (MCI) as well as dementia.[4,12] The prevalence in elderly patients in surgical wards varies with the disease. A study about 152 subjects 60 yr of age and older who were scheduled for total hip joint replacement surgery underwent preoperative assessment, found 22% were classified as having MCI.[14] And the remarkably high prevalence of preoperative MCI in 70% of vascular surgery patients is a cause for concern, among which with 88% undiagnosed before admission.[6] These studies confirm that preoperative mild cognitive deficits are common in the older person undergoing major surgery.

Nevertheless, routine preoperative cognitive assessment continues to be overlooked in clinical practice today. Numerous clinical studies confirmed preoperative cognitive impairment in the older patient undergoing major elective surgery is also related to poor postoperative outcomes including infection and bleeding, increased length of stay, and mortality. In a retrospective study of 129 patients undergoing lumbar spine surgery, Lee et al. reported a high prevalence of undiagnosed cognitive impairment that led to higher rates of postoperative delirium, longer LOS, and poorer patient outcomes.[15] In another retrospective study of 82 older patients with spine deformity undergoing elective spinal surgery, Owoicho et al. found that patients with preoperative cognitive impairment were more likely to require an additional stay at a skilled nursing or acute rehabilitation facility.[16] In observational retrospective study of 1258 patients aged older than 69 years undergoing hip surgery, the severity of cognitive impairment was a prognostic factor for mortality and functional recovery.[17] Last but not least, in a study of 5407 patients undergoing cardiac surgery, Tully et al. showed baseline impaired cognitive status was associated with higher risk of long-term mortality.[7]

In addition, from June to November 2018, a similar paper was published in six well-known magazines, suggesting that perioperative neurocognitive disorders (PND) were used to describe the destruction or change of cognitive function during perioperative period to replace postoperative cognitive dysfunction (POCD), which not only extends the timeline of perioperative cognitive follow-up, but also emphasizes the importance of preoperative cognitive assessment.[18]

### Clinical Risk Factors for preoperative cognitive impairment

The size and function of the brain decreases with age, causing cognitive decline. In keeping with the clinical practice and literature, our multivariate Logistic regression analysis showed that venerable age was an independent risk factor for cognitive impairment (OR=1.099, $P<0.001$). In a prospective study of 215 patients undergoing elective surgery of all types, Smith et al. found the effect of ageing on cognitive impairment was apparent. The prevalence of MCI increased with age, with 42% of patients in the 65–69 years age group increasing to 80% of patients aged 80 years and above.[19] Nowadays, more and more elderly patients choose surgery to treat surgical disease. While one or more cardiovascular and cerebrovascular diseases as well as other systemic diseases are always combined in the elderly. Moreover, preoperative multiple medication, frailty, anxiety and depression coexisting further increase the prevalence of cognitive impairment and perioperative complications.[20] Univariate analysis from our data also showed higher ASA grade ($P = 0.004$) and CCI score ($P = 0.048$) in the cognitive impairment group when compared with the normal group.

The impact of gender on cognitive dysfunction has been a concern, while the results varied from different studies. Lee et al. have found that gender disparity in cognitive function in India. Compared with male, Indian women have poor cognitive function in their later years[21]. While the cognitive function status of women in developed countries is not significantly different from that of men, and even females are better.[22] Evidence-based analysis indicates that gender has an impact on cognitive impairment in elderly patients, which, on the other hand, might be interfered by differences in BMI, tobacco and alcohol, social and economic activity in different regions, educational attainment, and discrimination against women. The role of gender in cognitive function requires a multi-centered study of larger sample to confirm because of large clinical heterogeneity.

The degree of education has a great impact on cognitive function. Studies have shown that good education and cultural background have a positive effect on the ability of concept formation, vocabulary expression, spatial structure perception and memory; while cultural restriction may contribute to a negative effect.[23] Highly educated people often have high reserve of neurons. The more people receive education, the better subjective initiative and ability to adapt to the external environment, which may stimulate brain cells. The amount of nerve connections (neurons) and information hubs (synapses) are likely to be more numerous in people who are highly educated. Alternatively, even if the quantity of neurons and synapses is no different, the synapses are likely to be more efficient and/or alternative circuitry is likely to be operating in those who are highly educated. Cognitive reserve is an emerging dynamic concept and is thought to be modifiable in keeping with the concept of brain plasticity;[8] A recent clinical study demonstrated that preoperative cognitive reserve might have protective effects on long-term cognitive function after surgery.[24]

A variety of vascular risk factors such as diabetes, hypertension and hyperlipidemia are closely related to cognitive impairment.[25] Nevertheless, the results of the present study showed that there was no difference in diabetes, hypertension and hyperlipidemia between patients with and without cognitive impairment($P>0.05$). There is a possibility that severity of the disease and the intervention subjects received are not the same. Clinical research design in future is supposed to filter the enrolled subjects strictly, expand the sample size, and use subgroup analysis to explore the effects of these comorbidities and their intervention on cognitive function.

There is growing evidence that higher Hcy levels are involved in age-related cognitive deficits and various types of central nervous system disorders, including Alzheimer´s disease, Parkinson disease, multiple sclerosis, cerebrovascular diseases and strokes.[26] A review by Esther et al. revealed a positive trend between cognitive decline and increased plasma Hcy concentrations in general population and in patients with cognitive impairments.[27] Homocysteine is produced in all cells, and mechanisms of Homocysteine-induced cognitive impairment include neurotoxicity and vascular injury. Some studies suggest the post-translational modification of proteins by homocysteine, termed homocysteinylation, contributes to its toxicity, while others shown that homocysteinylation induces cellular damage via oxidative stress, as well as disrupts astrocytic end-feet.[26,28] Animal models have shown that high plasma levels of homocysteine contribute to ultrastructural changes to cerebral capillaries, endothelial damage, swelling of pericytes, basement membrane thickening, and fibrosis.[29] In keeping with the literature, patients in cognitive impairment group had a higher level of homocysteine, even though multivariate regression model did not find the difference.

Sleep disorders are quite common in the elderly and are mostly associated with neurodegenerative processes.[30] Moreover, sleep disorders and cognitive impairment often coexist and interact with one another in the early stages of Alzheimer's disease.[31,32] Sleep disorders in patients with MCI are associated with changes in memory and execution, suggesting that sleep dysfunction may be a precursor to cognitive changes. Structure of sleep and EEG may be also abnormal, even in the early stage of MCI. On our study, the elderly often complained sleep disruption due to frequent nocturia, easy to wake up or early awakening. Electroencephalo-graph (EEG) studies also show that such patients have reduced nighttime slow wave sleep, weakened sleep promotion process and enhanced wakefulness process.[33]

Altered sleep affects normal sleep patterns seriously: patients frequently recounted that they were sleepy at daytime, and several rapid-eye-movement sleep were exhibited in EEG during their naps.[34] In this study, compared with normal group, subjective sleep quality of impairment group was poorer.

### Limitations

This study has several important limitations. One is that MMSE, the most widely used cognitive screening test, is affected by significant ceiling effects and has insufficient sensitivity for detecting MCI and mild dementia, especially in individuals with higher education levels.[13,35] The Montreal Cognitive Assessment (MoCA) can be used instead of MMSE in order to improve the sensitivity, while with higher requirements for health status and longer test time.[36] Another issue is that other potential confounding biases still remained. For example, anxiety during the preoperative period is the most common problem (the prevalence up to 80%) with a number of perioperative complications such as an increase in cognitive dysfunction and delayed postoperative recovery.[37] While we did not quantify to further analysis the effect on cognition. As risk factors for cognitive impairment, impairments in hearing and vision have impact on perioperative complications in older.[38,39] We excluded these patients for the feasibility of assessment, which may underestimate the prevalence of preoperative cognitive impairment.

## Conclusions

Overall, our findings show that quite a few (28.61%) geriatric patients undergoing elective surgery do poorly on cognitive screening tests preoperatively and suggests probable cognitive impairment. Patients at high risk in this population include those who are venerable age, low education level, have subjective sleep disorders, atherosclerosis and high cholesterol level. Further research is necessary around preventive and targeted interventions in these patients.

## Abbreviations

ALB: albumin; ALT: alanine aminotransferase; BMI: body mass index; CCI: Charlson Comorbidity Index; EEG: Electroencephalo-graph; FBG: fasting blood glucose; Hcy: Homocysteine; IQR: Interquartile range; LDL: low density lipoprotein; MCI: mild cognitive impairment; MMSE: Mini-mental state examination; MoCA: Montreal Cognitive Assessment; SD: Standard deviation; TC: total cholesterol; TG: triglyceride; PND: perioperative neurocognitive disorders; POCD: postoperative cognitive dysfunction.

## Declarations

### Ethics approval and consent to participate

This study was performed after approval by The Clinical Research Ethics Committee from the First Affiliated Hospital, College of Medicine, Zhejiang University. Reference number: 900 on 10th August, 2018.

### Consent for publication

Not applicable.

### Availability of data and materials

The datasets used and/or analysed during the current study are available

from the corresponding author on reasonable request.

### Competing interests

All authors declare no conflicts of interest.

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### Authors' contributions

SMZ, SYG and CMW designed the study. YY and SYG performed acquisition of clinical data. XDT and JTW carried out data analysis. SYG prepared the manuscript and was a major contributor in writing the manuscript. YY and JTW prepared the tables and figures. YYZ revised the manuscript critically for important intellectual content.

All authors read and approved the final manuscript.

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# Tables

**Table 1** Demographic and clinical characteristics of patients with or without cognitive impairment

| Variables | Cognitive normal (n=267) | Cognitive impairment (n=107) | Statistical values | *P* |
|---|---|---|---|---|
| MMSE□median (IQR) | 25 (23-27) | 16 (13-19) | | |
| Age (yr)□median (IQR) | 70 (67-74) | 73 (68-79) | 3.930* | <0.001 |
| Female, n□%□ | 128 (47.9) | 73 (62.8) | 12.643† | <0.001 |
| BMI□kg m$^{-2}$□mean ± SD□ | 23.46 ± 3.48 | 23.00 ± 3.52 | 1.154‡ | 0.249 |
| Widowed or Divorced, n (%) | 24 (9.0) | 15 (14.0) | 2.069† | 0.150 |
| Level of education | | | 30.505† | <0.001 |
| Illiteracy, n (%) | 46 (17.2) | 43 (40.2) | | |
| Primary school, n (%) | 125 (46.8) | 50 (46.7) | | |
| Middle school or above, n (%) | 96 (36.0) | 14 (13.1) | | |
| Comorbidities | | | | |
| Hypertension, n (%) | 162 (60.7) | 62 (57.9) | 0.237† | 0.626 |
| Diabetes mellitus, n (%) | 49 (18.4) | 28 (26.2) | 2.854† | 0.091 |
| Hyperlipidemia, n (%) | 74(27.7) | 22 (20.6) | 2.049† | 0.152 |
| CHD, n (%) | 19 (7.1) | 8 (7.5) | 0.015† | 0.903 |
| CNS disease, n (%) | 32 (12.0) | 12 (11.2) | 0.044† | 0.835 |
| Atherosclerosis, n (%) | 49 (18.4) | 30 (28.0) | 4.301† | 0.038 |
| ASA □□n (%) | 46 (17.2) | 33 (30.8) | 8.496† | 0.004 |
| CCI□median (IQR) | 4 (3-5) | 4 (4-5) | 1.978* | 0.048 |
| Lesions | | | 0.889† | 0.641 |
| Spinal, n (%) | 142 (53.2) | 57 (53.3) | | |
| Hip, knee or tibia, n (%) | 82 (30.7) | 29 (27.1) | | |
| Other parts, n (%) | 43 (16.1) | 21 (19.6) | | |

* $Z$ values; † $\chi^2$ values; ‡ $t$ values. MMSE: Mini-mental: state examination; BMI: body mass index; ASA: American Society of Anesthesiologists; CCI: Charlson comorbidity index; SD: standard deviation; IQR: Interquartile range.

**Table 2** Laboratory test results of patients with or without cognitive impairment

| Variables | Normal (n=267) | Cognitive impairment (n=107) | Statistical values | *P* |
|---|---|---|---|---|
| Hcy (μmol/L), median (IQR) | 11.3 (9.8-13.8) | 12.3 (9.9-15.7) | 1.991* | 0.046 |
| TG (mmol/L), median (IQR) | 1.31 (0.97-1.78) | 1.23 (0.96-1.66) | -0.738* | 0.460 |
| TC (mmol/L, mean ± SD) | 4.22 ± 0.94 | 4.48 ± 1.05 | -2.431† | 0.016 |
| LDL (mmol/L), median (IQR) | 2.45 (1.98-2.94) | 2.37 (1.88-2.97) | -0.480* | 0.631 |
| FBG (mmol/L), median (IQR) | 4.89 (4.45-5.45) | 5.06 (4.63-5.99) | 2.043* | 0.041 |
| ALB(g/L), median (IQR) | 42.0 (38.7-44.7) | 41.3 (38.5-43.4) | -0.720* | 0.472 |
| ALT (U/L), median (IQR) | 15 (12-21) | 15 (10-22) | -0.591* | 0.555 |

* $\chi^2$ values; † *Z* values. Hcy: Homocysteine; TG: triglyceride; TC: total cholesterol; LDL: low density lipoprotein; FBG: fasting blood glucose; ALB: albumin; ALT: alanine aminotransferase; SD: standard deviation; IQR: Interquartile range.

**Table 3** Living habits of patients with or without cognitive impairment

| Variables | Normal (n=267) | Cognitive impairment (n=107) | $\chi^2$ values | *P* |
|---|---|---|---|---|
| Subjective sleep disorders, n (%) | 61 (22.8) | 42 (39.3) | 10.303 | 0.001 |
| Smoking >5 years, n (%) | 54 (20.2) | 19 (17.8) | 0.296 | 0.586 |
| Drinking >5 years，n (%) | 73 (27.3) | 24 (22.4) | 0.959 | 0.327 |
| Pre-hospital psychotropic medication, n (%) | 21 (7.9) | 7 (6.5) | 0.193 | 0.660 |
| Exercise ≥4 times per week，n (%) | 106 (40.6) | 32 (31.4) | 2.658 | 0.103 |

**Table 4** Logistics multivariable analysis of factors associated with preoperative cognitive impairment

| Variables | β | OR | 95% CI | *P* |
|---|---|---|---|---|
| Age | 0.085 | 1.089 | 1.037-1.144 | <0.001 |
| Sex | 0.192 | 1.212 | 0.659-2.229 | 0.536 |
| Education level (compared to illiterate group) | | | | |
| Primary school | -0.885 | 0.413 | 0.213-0.799 | 0.009 |
| Middle school group or above | -2.118 | 0.120 | 0.052-0.280 | <0.001 |
| Subjective sleep disorders | 0.691 | 1.996 | 1.112-3.581 | 0.021 |
| Diabetes mellitus | -0.325 | 0.723 | 0.295-1.770 | 0.477 |
| CCI | 0.010 | 1.010 | 0.848-1.202 | 0.913 |
| ASA | 0.089 | 1.093 | 0.520-2.298 | 0.815 |
| Atherosclerosis | 0.862 | 2.367 | 1.169-4.794 | 0.017 |
| FBG | 0.160 | 1.173 | 0.957-1.438 | 0.125 |
| TC | 0.317 | 1.373 | 1.035-1.820 | 0.028 |
| Hcy | 0.046 | 1.047 | 0.984-1.113 | 0.145 |

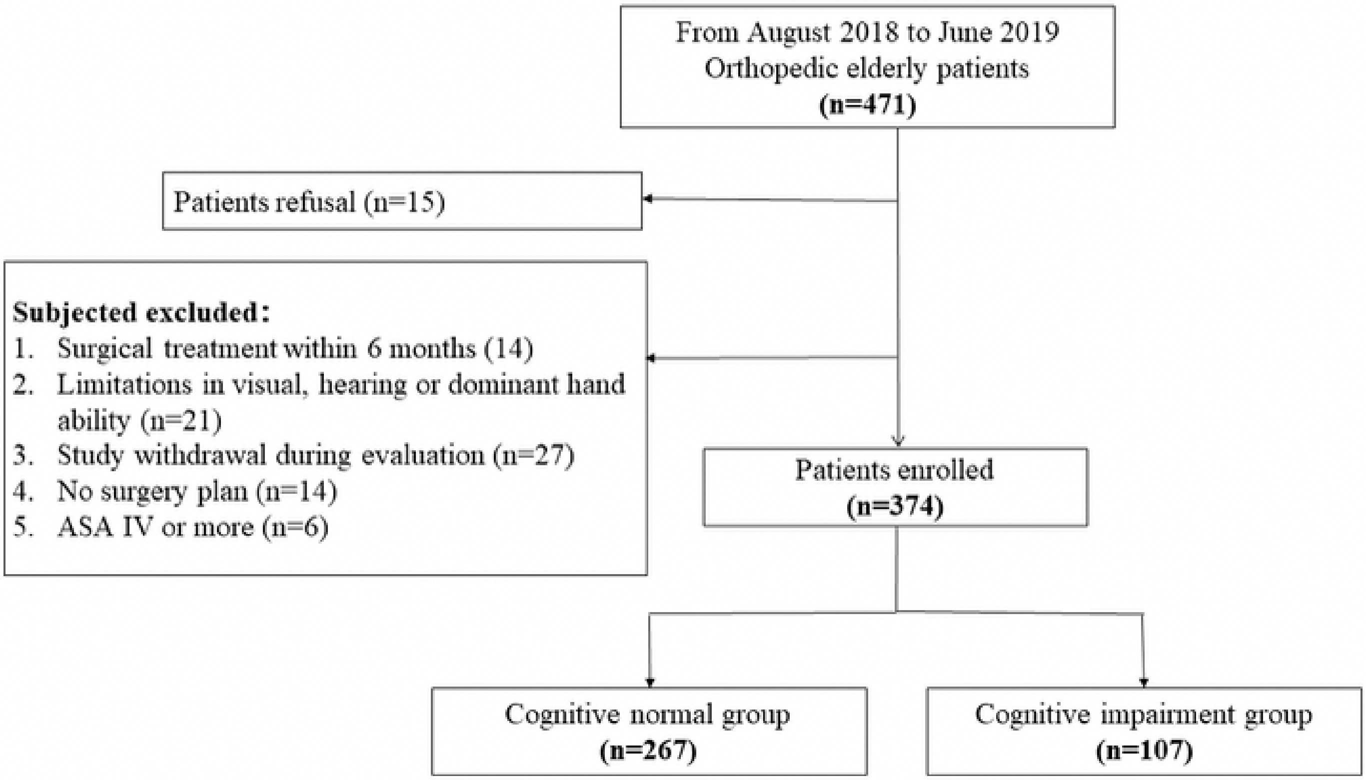
ASA: American Society of Anesthesiologists; CCI: Charlson comorbidity index; FBG: fasting blood glucose; TC: total cholesterol; Hcy: Homocysteine; OR: odds ratio; CI: confidence interval.

**Table 5** Effect of education level on age, subjective sleep disorders, atherosclerosis and TC

| Variables | Illiterate | Primary school | Middle school or above | Statistical values | *P* |
|---|---|---|---|---|---|
| Age (yr), median (IQR) | 70 (67, 76) | 70 (68, 75) | 71 (68, 76) | 1.561* | 0.458 |
| Subjective sleep disorders, n (%) | 28 (35.1) | 46 (26.3) | 29 (26.4) | 0.900* | 0.638 |
| Atherosclerosis, n (%) | 20 (22.5) | 32 (18.3) | 27 (24.5) | 1.716* | 0.424 |
| TC (mmol/L, mean ± SD) | 4.28±1.01 | 4.4±0.88 | 4.14±1.08 | 2.382† | 0.094 |

* $\chi^2$ values; † *F* values.SD: standard deviation; IQR: Interquartile range; TC: total cholesterol.

# Figures




## Figure 1

Consort recruitment diagram of patient enrollment, follow-up, exclusion and analysis

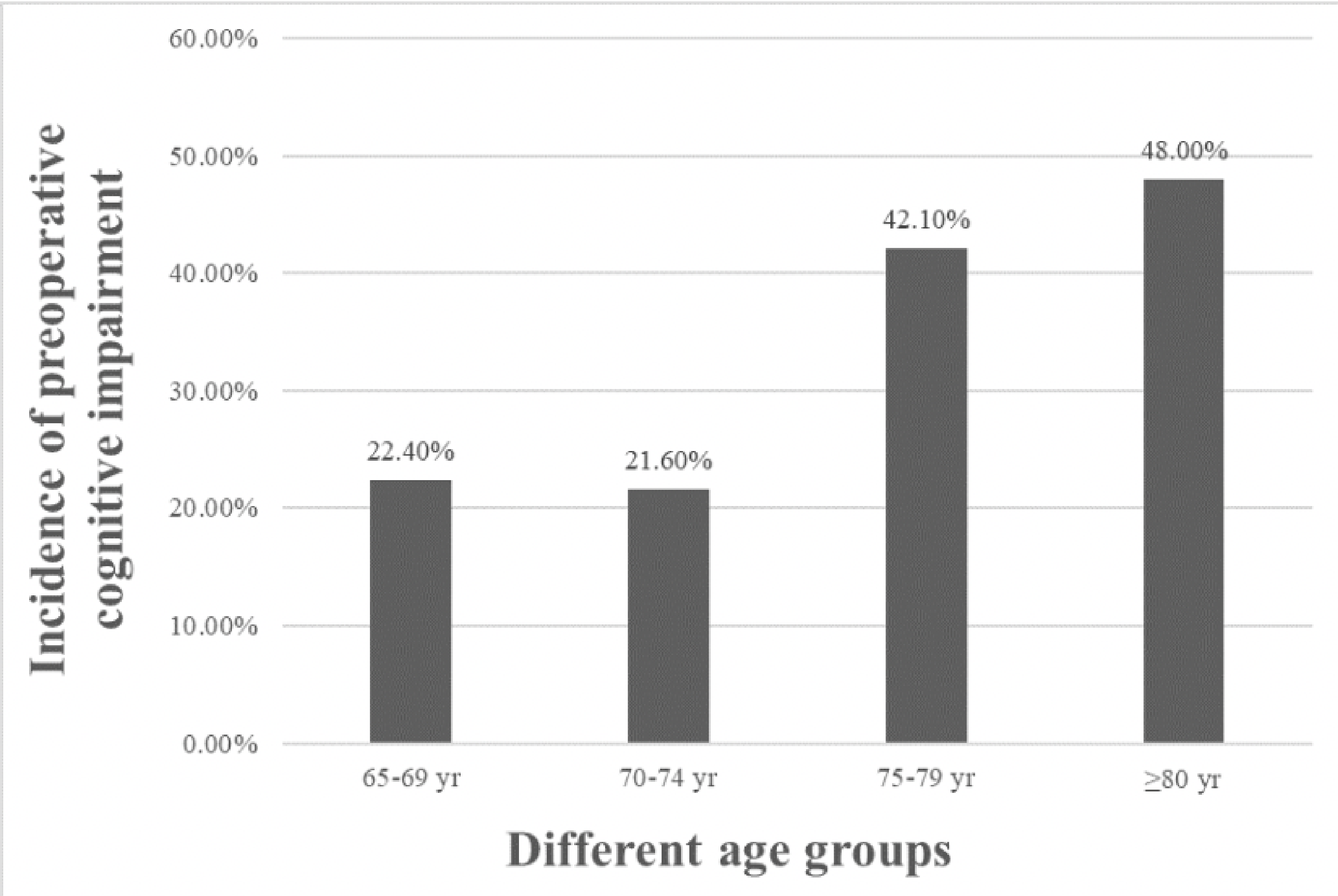



**Figure 2**

The incidence of cognitive impairment in different age groups