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ABOUT COVER

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The primary aim of *World Journal of Psychiatry* (*WJP*, *World J Psychiatry*) is to provide scholars and readers from various fields of psychiatry with a platform to publish high-quality basic and clinical research articles and communicate their research findings online.

WJP mainly publishes articles reporting research results and findings obtained in the field of psychiatry and covering a wide range of topics including adolescent psychiatry, biological psychiatry, child psychiatry, community psychiatry, ethnopsychology, psychoanalysis, psychosomatic medicine, *etc.*

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ORIGINAL ARTICLE

Observational Study

Predictive value of nutritional status and serological indicators in elderly patients with mild cognitive impairment

Ying Yang, Shou-Rong Lu, Qiao Xu, Jie Yu, Zhuo Wang, Bing-Shan Zhang, Kan Hong

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Abstract

BACKGROUND

Mild cognitive impairment (MCI) in elderly individuals is a transitional stage between normal cognition and dementia. Understanding the risk factors for MCI and identifying those at high risk are extremely important for the elderly population.

AIM

To analyze the risk factors for MCI in the elderly population and construct a clinical prediction model.

METHODS

Total 295 elderly individuals presenting with memory loss diagnosed at Wuxi People's Hospital between March 2021 and March 2024 were included. Comprehensive demographic, clinical, and serological data were collected for analysis. Participants were categorized into either an MCI group or a normal group based on their performance on the Montreal Cognitive Assessment Scale. An elaborate clinical predictive model was developed to predict the likelihood of MCI in stroke patients; its accuracy was evaluated using area under curve values and calibration curves.

RESULTS

The results of the study showed that old age, hypertension, diabetes, hyperlipidemia, smoking, high-salt diet, high-cholesterol diet, decreased red blood count, increased neutrophil lymphocyte ratio and increased low-density lipoprotein cholesterol were risk factors for the onset of MCI, with A high vitamin diet and

elevated high-density lipoprotein cholesterol being protective factors. In addition, the prediction model constructed in this study exhibits good degrees of differentiation and calibration.

CONCLUSION
The risk factors for MCI are diverse. Early identification of individuals at high risk of MCI can better intervene and improve their quality of life of MCI patients.

Key Words: Nutritional status; Serum detection; Cognitive impairment; Mild symptom; Forecast; Risk factor

Core Tip: The degree of cognitive impairment in the elderly is affected by many factors, which makes its early diagnosis still a certain challenge. Nutritional status and serological indicators are believed to be closely related to changes in cognitive function. Therefore, exploring the predictive value of nutritional status and serological indicators in elderly patients with mild cognitive impairment can not only provide a new scientific basis for early diagnosis, intervention and treatment of patients, but also help promote health management strategies in the field of public health.

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INTRODUCTION

Mild cognitive impairment (MCI) is a transitional phase between normal aging and dementia in which people experience mild declines in memory or other cognitive functions that go beyond normal aging but do not yet meet the diagnostic criteria for dementia[1]. MCI is often considered a precursor stage to types of dementia such as Alzheimer's disease (AD), in which patients may show functional decline in one or more areas of memory, language, attention, executive function, or visuospatial ability[2]. MCI currently has a prevalence of more than 15% in older age groups and progresses to dementia at a rate of 8% to 15% per year[3]. As a precursor symptom of various neurodegenerative diseases, early diagnosis and intervention of MCI are of vital significance to delay or prevent cognitive decline and improve the quality of life of the elderly[4]. However, the current diagnosis of MCI primarily depends on clinical assessment and neuropsychological tests, which, although sensitive and specific, are often constrained by subjective judgment, time consumption, and operational complexity[5]. Therefore, the exploration of more objective, convenient, and cost-effective methods for predicting MCI has emerged as a focal point in neuroscience and gerontology research.

In recent years, significant progress has been made in the study of nutrition in the field of senile cognitive impairment [6]. Previous studies have shown that there is a close correlation between nutritional status and cognitive function in the elderly[7,8]. Insufficient food, poor nutrition, and unbalanced nutrient intake may lead to cognitive decline in the elderly, thereby increasing the risk of MCI[9]. In terms of nutritional status, a number of clinical trials and epidemiological investigations have shown that a balanced diet and increased intake of foods rich in unsaturated fatty acids, antioxidants and B vitamins can help improve or delay cognitive decline[10]. For example, the Mediterranean diet pattern, which is high in healthy fats, whole grains, vegetables and fruits, has been shown to have a positive effect on protecting cognitive function [11]. This may be because malnutrition leads to an inadequate supply of energy to neurons, affecting the synthesis and release of neurotransmitters, which impairs cognitive function[12]. And certain nutrients, such as vitamins, cholesterol, minerals, *etc.* are essential for maintaining the normal structure and function of the nervous system, and their deficiency can accelerate cognitive decline[13,14]. In addition, some objective indicators that can reflect the physiological and pathological state of the body, such as red blood cell count, neutrophil count, total cholesterol, low density lipoprotein, interleukin, *etc.*, have gradually attracted attention in the diagnosis and prediction of MCI[15,16]. Although existing studies have initially revealed the relationship between nutritional status and serological indicators and cognitive function, their predictive value in elderly patients with MCI needs to be further explored.

In this study, elderly patients presenting for memory decline were divided into MCI group and normal group using the Montreal Cognitive Assessment Scale (MoCA). Through comprehensive analysis of demographic information, diet information and serological information between the two groups, to explore the predictive effect of these factors on the occurrence of MCI. This study can provide scientific basis for the development of personalized nutritional intervention programs for patients with MCI, which can help delay or prevent the further deterioration of cognitive function. This study is expected to provide clinicians with a simple and practical method for early identification and intervention of elderly patients with MCI, so as to reduce the risk of AD occurrence and improve the quality of life of the elderly.

MATERIALS AND METHODS

Patient population

A total of 295 elderly patients who came to Wuxi People's Hospital for memory loss were included in this study. Patients were collected from March 2021 to March 2024. Their inclusion criteria are as follows: (1) Patients were ≥ 50 years old; (2) Patients complained of memory loss, or family members reported memory loss; (3) Patients without serious underlying diseases or organ failure; (4) Patients without other neurological disorders that may cause cognitive impairment; and (5) Patients with complete clinical data. These patients all met the following exclusion criteria: (1) Patients who have been diagnosed with dementia[17]; (2) Patients with severe neurological diseases, such as Parkinson's disease, stroke, multiple sclerosis, encephalitis, *etc.*; (3) Patients with severe mental illness, such as depression, schizophrenia, bipolar disorder, *etc.*; (4) Patients with a history or current use of psychotropic drugs; and (5) Patients with severe speech impairment.

Grouping standard

The MoCA scale was used to assess patients' cognitive function. The MoCA scale covers multiple cognitive domains, including attention, executive function, memory, language, visuospatial ability, abstract thinking, computation, and orientation[18]. The total score of the MoCA scale is 30 points, and subjects with less than 12 years of education are added 1 point to the total score to adjust for the effect of education level on the score. Patients with a final score below 26 were assigned to the MCI group, otherwise they were assigned to the normal group.

Information collection

The data of all patients were collected and analyzed through structured questionnaire and medical record system. The patient data collected mainly included demographic information, dietary information and serological test results. Demographic information included age, sex, body mass index (BMI), hypertension, diabetes, hyperlipidemia, cardiovascular disease, lung disease and kidney disease. Dietary information includes smoking, alcohol consumption, tea, coffee, spicy diets, high-sugar diets, high-fried diets, high-salt diets, high-cholesterol diets, high-vitamin diets, and types of cooking oil. Serological measures include red blood cell (RBC) count, white blood cell count, neutrophil lymphocyte ratio (NLR), interleukin-6, total cholesterol (TC), triglycerides, high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C).

Statistical analysis

SPSS 23.0 was used to statistically analyse the data. Data included for continuous variables that met normal distribution were expressed as mean ± SD and comparisons between groups were made using the independent samples *t*-test. Data that did not conform to normal distribution were expressed as median (quartiles) and comparisons between groups were made using the Kruskal-Wallis test, categorical count data were expressed as percentages and comparisons between groups were made using the chi-square test. Univariate and multivariate logistic regression was used to analyse the extent of the influence of each factor on MCI, and the odds ratio (OR) values and their 95% confidence intervals (95%CI) were calculated. Variables with $P < 0.05$ in univariate Logistic regression will be included in multivariate Logistic regression analysis. $P < 0.05$ was considered as statistically significant difference, and tests were two-sided.

Clinical prediction model

A clinical prediction model was constructed based on Logistic regression to predict the risk of MCI in the elderly. The 295 patients were randomly divided into a train set (206 patients) and a text set (89 patients) at a ratio of 7:3 for internal validation of the model. Then *t*-test or Pearson χ^2 test was used to check the balance between the train set and the test set. A nomogram model was drawn based on multivariate Logistic regression. The variance inflation factor (VIF) was calculated for collinearity diagnosis. VIF < 5 was considered to be non-multicollinearity. The area under curve (AUC) of receiver operating characteristic (ROC) was used to evaluate the differentiation of the model. Hosmer-Lemeshow was used to evaluate the calibration degree of the model. When $P > 0.05$, it indicated that there was no statistical difference between the predicted value and the observed value, and the model fit was good. Calibration curve was used to evaluate the calibration degree of the model, and decision acceptance curve (DAC) was used to evaluate the clinical application value of the model. In addition, computational accuracy, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were used to evaluate the performance of the model and evaluate the cost-effectiveness of different interventions.

RESULTS

General information

Among 295 elderly patients, 161 (54.58%) were diagnosed with MCI by MoCA scale and 134 (45.42%) were normal (Table 1). The mean age of the MCI group was 72.63 ± 8.71, and that of the normal group was 68.33 ± 7.56, and the disparity observed between the two groups was found to be statistically significant. ($P < 0.05$). No statistical differences in gender composition ($P > 0.05$) and BMI ($P > 0.05$) were observed between the two groups (Table 1).

Table 1 Difference of demographic information, dietary information and serological information between two groups

Variables	Total (*n* = 295)	NMCI group (*n* = 134)	MCI group (*n* = 161)	Statistic	*P* value
Demographic information					
Age, mean ± SD	70.68 ± 8.47	68.33 ± 7.56	72.63 ± 8.71	t = -4.49	< 0.001
Sex, *n* (%)				χ^2 = 0.42	0.516
Male	137 (46.44)	65 (48.51)	72 (44.72)		
Female	158 (53.56)	69 (51.49)	89 (55.28)		
BMI, mean ± SD	22.57 ± 4.15	22.75 ± 3.78	22.43 ± 4.45	t = 0.65	0.514
Hypertension, *n* (%)				χ^2 = 4.47	0.035
No	211 (71.53)	104 (77.61)	107 (66.46)		
Yes	84 (28.47)	30 (22.39)	54 (33.54)		
Diabetes, *n* (%)				χ^2 = 10.18	0.001
No	228 (77.29)	115 (85.82)	113 (70.19)		
Yes	67 (22.71)	19 (14.18)	48 (29.81)		
Hyperlipemia, *n* (%)				χ^2 = 4.23	0.040
No	233 (78.98)	113 (84.33)	120 (74.53)		
Yes	62 (21.02)	21 (15.67)	41 (25.47)		
Cardiovascular disease, *n* (%)				χ^2 = 4.59	0.032
No	225 (76.27)	110 (82.09)	115 (71.43)		
Yes	70 (23.73)	24 (17.91)	46 (28.57)		
Pulmonary disease, *n* (%)				χ^2 = 0.35	0.554
No	256 (86.78)	118 (88.06)	138 (85.71)		
Yes	39 (13.22)	16 (11.94)	23 (14.29)		
Kidney disease, *n* (%)				χ^2 = 0.06	0.808
No	265 (89.83)	121 (90.30)	144 (89.44)		
Yes	30 (10.17)	13 (9.70)	17 (10.56)		
Dietary information					
Smoking, *n* (%)				χ^2 = 7.10	0.008
No	178 (60.34)	92 (68.66)	86 (53.42)		
Yes	117 (39.66)	42 (31.34)	75 (46.58)		
Drinking, *n* (%)				χ^2 = 0.10	0.750
No	190 (64.41)	85 (63.43)	105 (65.22)		
Yes	105 (35.59)	49 (36.57)	56 (34.78)		
Tea, *n* (%)				χ^2 = 3.32	0.069
No	232 (78.64)	99 (73.88)	133 (82.61)		
Yes	63 (21.36)	35 (26.12)	28 (17.39)		
Coffee, *n* (%)				χ^2 = 4.55	0.033
No	250 (84.75)	107 (79.85)	143 (88.82)		
Yes	45 (15.25)	27 (20.15)	18 (11.18)		
Spicy diet, *n* (%)				χ^2 = 0.11	0.735
No	204 (69.15)	94 (70.15)	110 (68.32)		
Yes	91 (30.85)	40 (29.85)	51 (31.68)		
High-sweet diet, *n* (%)				χ^2 = 0.05	0.815

No	236 (80.00)	108 (80.60)	128 (79.50)		
Yes	59 (20.00)	26 (19.40)	33 (20.50)		
High fried diet, *n* (%)				χ^2 = 0.67	0.413
No	236 (80.00)	110 (82.09)	126 (78.26)		
Yes	59 (20.00)	24 (17.91)	35 (21.74)		
High-salt diet, *n* (%)				χ^2 = 7.42	0.006
No	203 (68.81)	103 (76.87)	100 (62.11)		
Yes	92 (31.19)	31 (23.13)	61 (37.89)		
High cholesterol diet, *n* (%)				χ^2 = 4.69	0.030
No	220 (74.58)	108 (80.60)	112 (69.57)		
Yes	75 (25.42)	26 (19.40)	49 (30.43)		
High-vitamin diet, *n* (%)				χ^2 = 5.62	0.018
No	176 (59.66)	70 (52.24)	106 (65.84)		
Yes	119 (40.34)	64 (47.76)	55 (34.16)		
Edible oil type, *n* (%)				χ^2 = 0.47	0.494
Vegetable oil	192 (65.08)	90 (67.16)	102 (63.35)		
Animal oil	103 (34.92)	44 (32.84)	59 (36.65)		
Serological indicators					
RBC, mean ± SD	4.65 ± 1.02	4.83 ± 1.05	4.51 ± 0.96	*t* = 2.80	0.005
WBC, mean ± SD	7.17 ± 3.37	6.97 ± 3.45	7.33 ± 3.32	*t* = -0.91	0.362
NLR, mean ± SD	2.25 ± 0.61	2.02 ± 0.53	2.43 ± 0.61	*t* = -6.12	< 0.001
PLT, mean ± SD	168.71 ± 29.96	171.31 ± 31.69	166.54 ± 28.37	*t* = 1.36	0.174
IL-6 increases, *n* (%)				χ^2 = 2.18	0.140
No	219 (74.24)	105 (78.36)	114 (70.81)		
Yes	76 (25.76)	29 (21.64)	47 (29.19)		
TC, mean ± SD	5.01 ± 1.21	4.92 ± 1.17	5.10 ± 1.25	*t* = -1.27	0.204
TG, mean ± SD	1.29 ± 0.40	1.25 ± 0.36	1.32 ± 0.43	*t* = -1.31	0.191
HDL-C, mean ± SD	1.36 ± 0.25	1.41 ± 0.27	1.33 ± 0.21	*t* = 2.74	0.007
LDL-C, mean ± SD	3.29 ± 0.41	3.22 ± 0.31	3.35 ± 0.47	*t* = -2.96	0.003

NMCI: Non-mild cognitive impairment; MCI: Mild cognitive impairment; BMI: Body mass index; RBC: Red blood cell; WBC: White blood cell; NLR: Neutrophil lymphocyte ratio; PLT: Platelet; IL-6: Interleukin-6; TC: Total cholesterol; TG: Triglycerides; HDL-C: High-density lipoprotein cholesterol; LDL-C: Low-density lipoprotein cholesterol.

Difference analysis between MCI group and normal group

There were significant differences in the prevalence of hypertension (33.54% *vs* 22.39%, $P < 0.05$), diabetes (29.81% *vs* 14.18%, $P < 0.005$), hyperlipidemia (25.47% *vs* 15.67%, $P < 0.05$) and cardiovascular disease (28.57% *vs* 17.91%, $P < 0.05$) between MCI group and normal group (Table 1). In relation to dietary information, significant differences were observed between the two groups in the proportion of patients with smoking (46.58% *vs* 31.34%, $P < 0.05$), coffee (11.18% *vs* 20.15%, $P < 0.05$), high-salt diet (37.89% *vs* 23.13%, $P < 0.05$), high-cholesterol diet (30.43% *vs* 19.40%, $P < 0.05$), and high-vitamin diet (34.16% *vs* 47.76%, $P < 0.05$; Table 1). In addition, there were notable discrepancies between the two groups with regard to RBC ($P < 0.05$), NLR ($P < 0.05$), HDL-C ($P < 0.05$), and LDL-C ($P < 0.05$; Table 1). No statistical differences were found between the two groups in other factors.

Logistic regression analysis between MCI group and normal group

Univariate Logistic regression showed that old age, hypertension, diabetes, hyperlipidemia, cardiovascular disease, smoking, high-salt diet, high-cholesterol diet, decreased RBC, increased NLR, and elevated LDL-C were associated with increased risk of MCI (Table 2). These variables were included in multivariate Logistic regression analysis, and the results showed that advanced age was significantly correlated with an elevated risk of MCI (OR = 1.12, 95%CI: 1.08-1.17, $P < 0.05$; Table 2). Elderly patients with basic diseases, such as hypertension (OR = 3.28, 95%CI: 1.50-7.16, $P < 0.05$), diabetes

Table 2 Logistic regression analysis of demographic information, dietary information and serological information between the two groups

Variables	Univariate Logistic analysis					Multivariate Logistic analysis				
	β	SE	Z	*P* value	OR (95%CI)	β	SE	Z	*P* value	OR (95%CI)
Age	0.06	0.02	4.23	< 0.001	1.07 (1.03-1.10)	0.12	0.02	5.25	< 0.001	1.12 (1.08-1.17)
Hypertension										
No					1.00 (Reference)					1.00 (Reference)
Yes	0.56	0.27	2.10	0.036	1.75 (1.04-2.95)	1.19	0.40	2.98	0.003	3.28 (1.50-7.16)
Diabetes										
No					1.00 (Reference)					1.00 (Reference)
Yes	0.94	0.30	3.13	0.002	2.57 (1.42-4.64)	1.07	0.40	2.65	0.008	2.91 (1.32-6.40)
Hyperlipemia										
No					1.00 (Reference)					1.00 (Reference)
Yes	0.61	0.30	2.04	0.041	1.84 (1.02-3.30)	0.83	0.39	2.14	0.032	2.30 (1.07-4.92)
Cardiovascular disease										
No					1.00 (Reference)					1.00 (Reference)
Yes	0.61	0.28	2.13	0.033	1.83 (1.05-3.20)	0.55	0.38	1.42	0.154	1.73 (0.81-3.66)
Smoking										
No					1.00 (Reference)					1.00 (Reference)
Yes	0.65	0.24	2.65	0.008	1.91 (1.18-3.08)	0.70	0.32	2.19	0.029	2.02 (1.08-3.80)
Coffee										
No					1.00 (Reference)					1.00 (Reference)
Yes	-0.70	0.33	-2.11	0.035	0.50 (0.26-0.95)	-0.14	0.45	-0.31	0.758	0.87 (0.36-2.11)
High-salt diet										
No					1.00 (Reference)					1.00 (Reference)
Yes	0.71	0.26	2.70	0.007	2.03 (1.21-3.38)	1.25	0.36	3.45	< 0.001	3.47 (1.71-7.05)
High cholesterol diet										
No					1.00 (Reference)					1.00 (Reference)
Yes	0.60	0.28	2.15	0.031	1.82 (1.05-3.13)	0.88	0.37	2.37	0.018	2.41 (1.16-4.98)
High-vitamin diet										
No					1.00 (Reference)					1.00 (Reference)
Yes	-0.57	0.24	-2.36	0.018	0.57 (0.35-0.91)	-0.71	0.32	-2.18	0.029	0.49 (0.26-0.93)
RBC	-0.33	0.12	-2.74	0.006	0.72 (0.57-0.91)	-0.60	0.17	-3.59	< 0.001	0.55 (0.39-0.76)
NLR	1.25	0.23	5.48	< 0.001	3.50 (2.24-5.48)	1.95	0.34	5.78	< 0.001	7.05 (3.64-13.65)
HDL-C	-1.35	0.50	-2.73	0.006	0.26 (0.10-0.68)	-2.04	0.65	-3.14	0.002	0.13 (0.04-0.46)
LDL-C	0.84	0.30	2.77	0.006	2.31 (1.28-4.18)	0.76	0.38	1.99	0.047	2.14 (1.01-4.53)

OR: Odds ratio; 95%CI: 95% confidence interval; RBC: Red blood cell; NLR: Neutrophil lymphocyte ratio; HDL-C: High-density lipoprotein cholesterol; LDL-C: Low-density lipoprotein cholesterol.

(OR = 2.91, 95%CI: 1.32-6.40, $P < 0.05$), and hyperlipidemia (OR = 2.30, 95%CI: 1.07-4.92, $P < 0.05$), were also associated with an increased risk of MCI (Table 2). Smoking (OR = 2.02, 95%CI: 1.08-3.80, $P < 0.05$), high salt diet (OR = 3.47, 95%CI: 1.71-7.05, $P < 0.05$), high cholesterol diet (OR = 2.41, 95%CI: 1.16-4.98, $P < 0.05$) were associated with a high risk of MCI. High vitamin diet (OR = 0.49, 95%CI: 0.26-0.93, $P < 0.05$) were protective factors for MCI. Decreased RBC (OR = 0.55, 95%CI: 0.39-0.76, $P < 0.05$) and increased NLR (OR = 7.05, 95%CI: 3.64-13.65, $P < 0.05$) and increased LDL-C (OR = 2.14, 95%CI: 1.01-4.53, $P = 0.05$) in elderly patients may be risk factors for MCI and increased LDL-C (OR = 0.13, 95%CI: 0.04-0.46, $P < 0.05$) may be protective factors (Table 2).

Construction of clinical prediction model

A prediction model for MCI risk in the elderly was constructed based on Logistic regression. The nomograph was constructed using nine factors: Hypertension, diabetes, smoking, high-salt diet, age, NLR, TC, HDL-C and LDL-C (Figure 1). In the training set, the AUC of the ROC plotted by the prediction model was 0.86 (95%CI: 0.81-0.91; Figure 2A). Calibration curve results showed that the model fits well and there was no significant difference between predicted and observed values (Hosmer-Lemeshow $P > 0.05$; Figure 2B). The DAC curve showed that when the risk threshold exceeds 0.1, the corresponding intervention had a positive benefit (Figure 2C). When the cut-off value was 0.595, the model has the best prediction effect, and the accuracy was 0.80 (95%CI: 0.73-0.85), the sensitivity was 0.87 (95%CI: 0.80-0.94), the specificity was 0.73 (95%CI: 0.65-0.81), the PPV was 0.73 (95%CI: 0.65-0.81), and the NPV was 0.87 (95%CI: 0.80-0.84; Table 3).

Validation of clinical predictive models

In this study, internal validation was used to test the stability of the prediction model. Before internal validation, the balance check results showed no significant difference between the training set and the validation set (Supplementary Table 1). Moreover, the VIF values of the variables included in the prediction model were all less than 5, indicating that there was no multicollinearity between the variables (Supplementary Table 2).

In the validation set, the AUC was 0.79 (95%CI: 0.70-0.89; Figure 2D). The results of the calibration curve indicated that the model demonstrated a strong fit (Hosmer-Lemeshow $P > 0.05$; Figure 2E). The DAC results showed that when the risk threshold was greater than 0.1, the intervention can obtain a good return effect (Figure 2F). When the cutoff value was 0.595, the model of validation set had the best prediction effect. At this time, the accuracy was 0.73 (95%CI: 0.63-0.82), the sensitivity was 0.80 (95%CI: 0.68-0.92), the specificity was 0.67 (95%CI: 0.54-0.80), the PPV was 0.67 (95%CI: 0.53-0.80), and the NPV was 0.80 (95%CI: 0.68-0.93; Table 3).

DISCUSSION

MCI, as an intermediate state between normal aging and dementia, is characterized by a slight decline in cognitive functions (such as memory, language, attention, reasoning, *etc.*), but the decline is not large enough to affect an individual's ability to function in daily life[19]. MCI is relatively common in older people, especially in those over 65 years of age[20]. MCI may cause psychological disorders, social disorders, and impaired functional independence in elderly patients, and once it progresses to dementia, it will put a huge burden on the patient's family and society[21]. Since MCI is in an intervenable stage, early identification and treatment are important to delay the process of cognitive decline and avoid deterioration into dementia[22]. In this study, nutritional status, dietary factors and serological indicators were used to investigate their ability to predict the risk of MCI. The results showed that old age, combined with hypertension, diabetes or hyperlipidemia, smoking, high-salt diet, high-cholesterol diet, decreased RBC, increased NLR, and elevated LDL-C may be independent risk factors for the increased risk of MCI in the elderly. High vitamin diet and high HDL-C may be protective factors for MCI. The results of this study can provide theoretical support for more accurate identification of high-risk groups of MCI and timely implementation of targeted intervention measures.

The results of this study found that advanced age is an important risk factor for the onset of MCI. As we age, the brain undergoes a series of structural and functional changes[23]. For example, a decrease in the number of brain cells, decreased levels of neurotransmitter substances, and reduced blood circulation in the brain can all lead to a decline in cognitive function[24]. Previous studies have shown that aging leads to the accumulation of more neurofibrillary tangles and amyloid plaques in the brain[25]. These are key pathological features of AD and other forms of dementia, and are also associated with susceptibility to MCI[26]. In addition, this study also found that some underlying diseases in the elderly group are also risk factors for MCI. Previous studies have reported that high blood pressure, diabetes, and high blood lipids increase the risk of cognitive impairment, which is consistent with the findings of this study[27,28]. Long-term hypertension can lead to hardening of the small artery wall, especially the small blood vessels in the brain, and then lead to changes in the structure and function of cerebral vessels, such as thickening of the blood vessel wall, narrowing of the lumen, and decreased vascular elasticity[29]. The alterations lead to a reduction in cerebral blood supply, resulting in hypoxia and malnutrition of the brain tissue, thereby impacting the normal functioning of neurons and potentially leading to cognitive decline. This study also found that a high-salt diet was associated with an increased risk of developing MCI, possibly because of the strong association between a high-salt diet and high blood pressure, and because a high-salt diet itself can also affect inflammatory responses and oxidative stress levels in the body. Abnormal blood glucose metabolism in diabetic patients not only directly damages blood vessels, but also leads to systemic inflammation and oxidative stress through insulin resistance and hyperinsulinemia. These processes can promote brain microvascular disease, neuronal damage, and cognitive decline[30]. In addition, the results of the study also showed that hyperlipidemia is an important risk factor for the onset of MCI, which is similar to previous studies[31]. In addition, factors associated with hyperlipidemia, such as a high-cholesterol diet and high LDL-C, were also found to be associated with an increased risk of MCI. High levels of cholesterol and LDL-C are associated with an increased risk of atherosclerosis[32]. Atherosclerosis affects not only large blood vessels, but also small blood vessels in the brain, resulting in reduced blood flow to the brain and impaired cognitive function. In addition, dyslipidemia may damage neurons directly or indirectly by promoting inflammatory responses, oxidative stress, and apoptosis[33]. However, its specific mechanism and molecular principle are worthy of further investigation.

Table 3 Confusion matrix analysis of clinical predictive models

Data	AUC (95%CI)	Accuracy (95%CI)	Sensitivity (95%CI)	Specificity (95%CI)	PPV (95%CI)	NPV (95%CI)	Cut off
Train	0.86 (0.81-0.91)	0.80 (0.73-0.85)	0.87 (0.80-0.94)	0.73 (0.65-0.81)	0.73 (0.65-0.81)	0.87 (0.80-0.94)	0.595
Test	0.79 (0.70-0.89)	0.73 (0.63-0.82)	0.80 (0.68-0.92)	0.67 (0.54-0.80)	0.67 (0.53-0.80)	0.80 (0.68-0.93)	0.595

95%CI: 95% confidence interval; AUC: Area under curve; PPV: Positive predictive value; NPV: Negative predictive value.

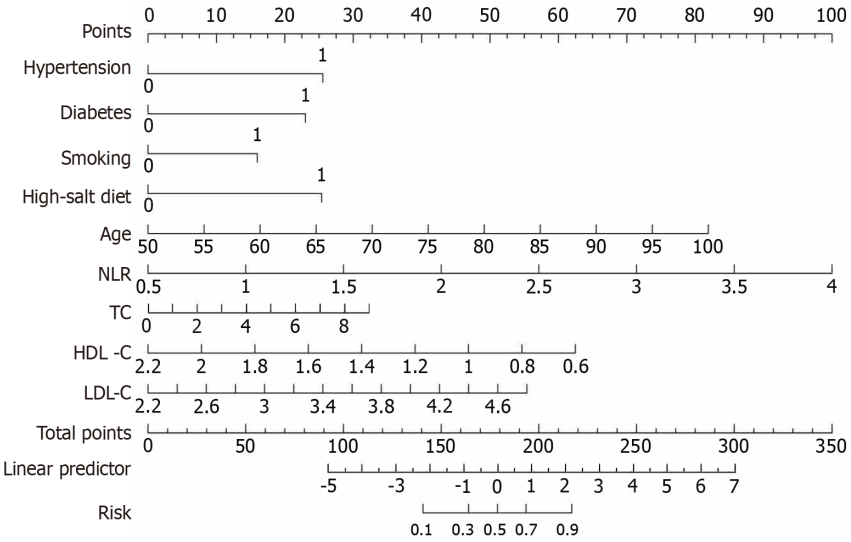

Figure 1 The nomogram model for predicting the risk of mild cognitive impairment onset. NLR: Neutrophil lymphocyte ratio; TC: Total cholesterol; HDL-C: High-density lipoprotein cholesterol; LDL-C: Low-density lipoprotein cholesterol.

In addition, this study found that smoking was associated with an increased risk of MCI. Smoking has been widely recognized to have a negative impact on cognitive function. Nicotine and other harmful chemicals can affect brain function through a variety of mechanisms, including promoting oxidative stress, inflammatory responses, and cerebrovascular dysfunction. These processes may accelerate neuronal degeneration and cognitive decline, thereby increasing the risk of MCI[34]. Long-term smoking may also cause hardening and narrowing of blood vessels, reduce the blood supply to the brain, affect the oxygen and nutrient supply to the brain, and further exacerbate the decline in cognitive function[35]. This study found that a high-vitamin diet and high levels of HDL-C were protective factors for MCI. Vitamin D strengthens the connections between neurons and is essential for maintaining normal cognitive function. Studies have shown that vitamin D deficiency makes neural networks more vulnerable to the effects of enzyme degradation, reducing the number and strength of connections between neurons in the hippocampus, which can lead to cognitive decline[36]. Vitamin E is an antioxidant that protects nerve cells from oxidative stress and has a protective effect on cognitive function[37]. And folic acid promotes the synthesis of neurotransmitters in the brain, such as dopamine and serotonin, which are essential for maintaining normal cognitive function. In addition, folic acid also helps reduce harmful substances that damage brain vessels, and assists in DNA synthesis and improves memory. Vitamin B2 (riboflavin) plays an important role in brain cell development and regeneration, and can activate brain function[38]. The decrease of RBC and the increase of NLR may be related to the inflammatory response in the body, which may aggravate the decline of neurological function in elderly patients. However, further research is needed to explore the specific mechanisms.

However, there are some limitations to this study. First of all, this study is a retrospective analysis, and there is a tendency of recall bias in the process of collecting patients' lifestyle and dietary habits. Second, the sample source of this study is single, resulting in limited extrapolation of results. Finally, changes in nutritional status and serological indicators in older adults are often influenced by multiple factors, including physiological aging, chronic disease, and drug use. In addition, the lack of in-depth research on the mechanism of the influence of the identified risk factors on MCI limits the clinical application value of the findings. At the same time, most of the existing studies were cross-sectional designs and failed to include longitudinal follow-up data, resulting in insufficient understanding of the evolution of risk factors over time and their impact on the progression of MCI. Moreover, the research is mainly focused on specific populations and environments, and the applicability of the model in different ethnic and regional populations is not fully tested, which may lead to the generality and accuracy of the model being questioned. Therefore, when evaluating the relationship between these indicators and cognitive function, it is necessary to consider a variety of factors in order to reach a more accurate conclusion.

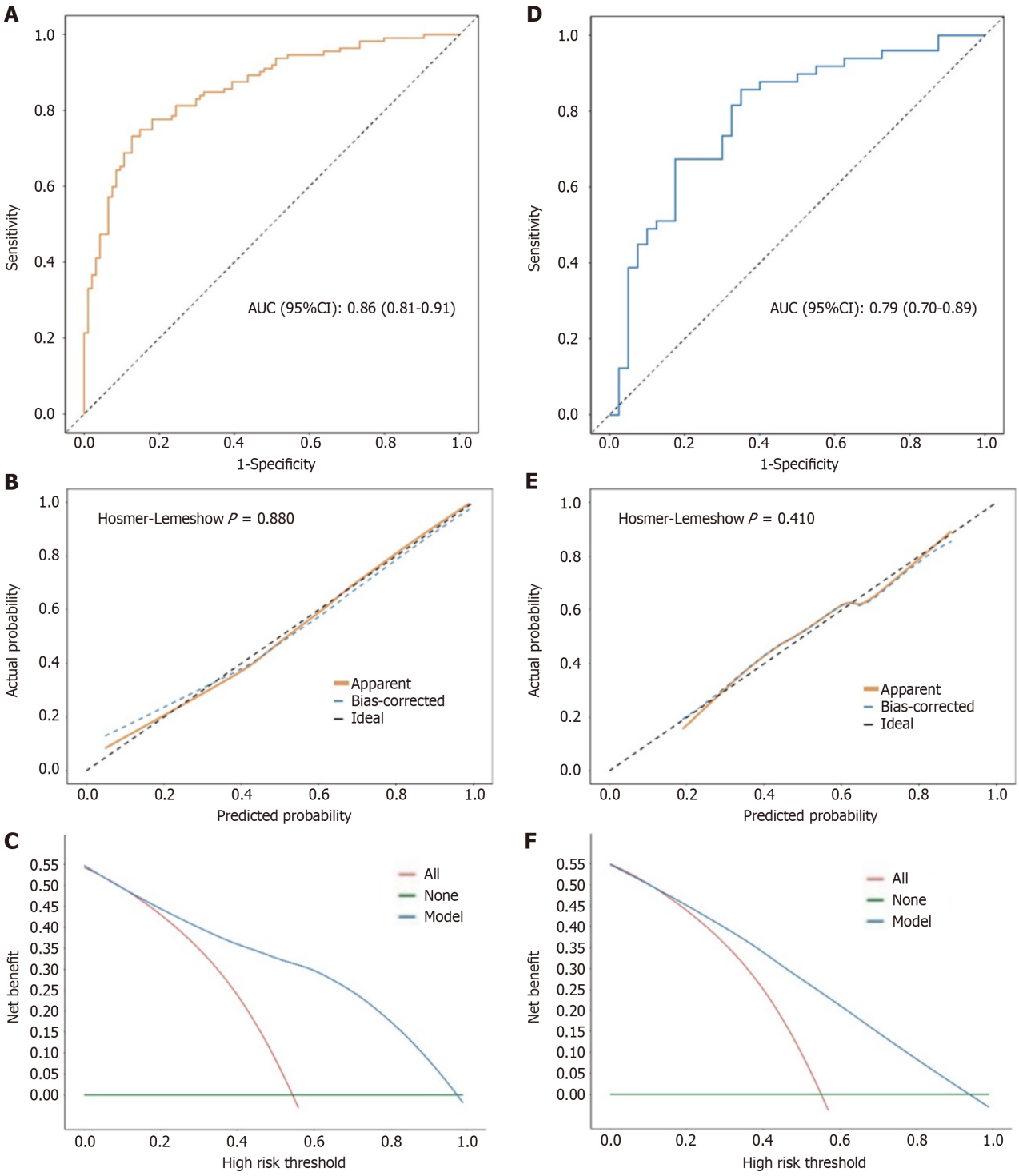

Figure 2 Receiver operating characteristic curves, calibration curves and decision acceptance curve analysis for training and testing sets. A-C: Receiver operating characteristic (ROC), calibration curve, and decision acceptance curve (DAC) for the training set; D-F: ROC, calibration curve, and DAC for the testing set. AUC: Area under curve.

CONCLUSION

Through comprehensive analysis of demographic information, dietary information and serological test results in the elderly population, this study discussed the risk factors of MCI in the elderly population, and built a prediction model for predicting the incidence of MCI in elderly patients. The results of the study showed that old age, hypertension, diabetes, hyperlipidemia, smoking, high-salt diet, high-cholesterol diet, decreased RBC, increased NLR and increased LDL-C were risk factors for the onset of MCI. High vitamin diet and elevated HDL-C were protective factors. In addition, the prediction model constructed in this study has good differentiation and calibration degree. The findings of this study uncover numerous risk factors contributing to the heightened susceptibility to MCI in the elderly population, offering crucial theoretical insights for etiological exploration and clinical management of MCI. Furthermore, leveraging the

predictive model enables accurate identification of high-risk cohorts for MCI, facilitating timely implementation of targeted interventions and averting further progression into dementia. The outcomes of this study hold significant clinical and practical implications for managing and preventing MCI in patients.

FOOTNOTES

Author contributions: Hong K designed research; Yang Y performed research; Lu SR, Xu Q and Yu J contributed new reagents or analytic tools; Wang Z analyzed data; Yang Y and Zhang BS wrote the paper.

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