Higher weekly white rice consumption is associated with an increased risk of incident MCI : a two-year follow-up study of elderly people in Shanghai Community

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Research Article

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Abstract

Background: There have been no longitudinal studies of white rice consumption and cognitive impairment

Methods: This was a 2-year longitudinal follow-up study. Data were obtained from the cohort study on the brain health of the elderly in Shanghai. There were 620 (224 men and 396 women) subjects aged ≥ 60 years. Weekly white rice consumption was assessed using a quantitative food frequency questionnaire. Cognitive function was assessed using the Mini-Mental State Examination (MMSE) and Montreal Cognitive Assessment (MoCA) and the diagnosis of mild cognitive impairment (MCI) was based on the revised Petersen's diagnostic algorithm. The association between weekly white rice consumption and cognitive function was investigated by Cox regression analysis and the ROC curve.

Results: During a mean follow-up period of 2 years, 471 individuals without baseline cognitive impairment developed incident mild cognitive impairment. In the overall cohort, higher weekly white rice consumption was associated with an increased risk of MCI (p=0.019, HR=1.051, 95%CI:1.008~1.096) and was independent of age, education and drinking. The ROC curve indicated that weekly white rice consumption had a mild-to-moderate effect in predicting MCI (below the curve was 0.591, p=0.07, 95%CI:0.527~0.655).

Conclusions: higher weekly white rice consumption is associated with an increased risk of incident MCI

Key Messages

1. What is already known about this subject?

An increasing number of studies have shown that healthy dietary patterns may have a protective effect against dementia and cognitive decline，and brown rice is thought to have a cognitive protective effect.

2. What are the new findings?

White rice is a traditional staple of the Chinese people, but our current research shows that higher weekly white rice consumption is associated with an increased risk of incident mild cognitive impairment, which is the precursor stage of dementia.

3. How might these results change the focus of research or clinical practice?

In the future, large longitudinal studies will further investigate the effect of eating white rice on cognitive function and explore the possible mechanisms behind this phenomenon.

1. Introduction

The number of elderly people is growing rapidly due to longer life expectancy. As a result, the incidence of dementia and age-related diseases is also increasing rapidly. There are 47 million people suffer from dementia around the world, and the number is expected to rise to more than 131 million by 2050[1]. As the country with the largest elderly population in the world, China has one in four cases of dementia globally, and the national cost of dementia care in 2015 is $167.74 billion[2]. In the absence of effective treatments, intervention, and management of dementia in its early stages, such as mild cognitive impairment, is extremely important.

Among measures to prevent dementia and mild cognitive impairment, a "healthy" diet is recommended, and Mediterranean diet, dietary antioxidants, and mild-to-moderate alcohol consumption are considered protective factors for dementia[3]. Paddy rice is the staple food for nearly half the world's population, and the world consumes more than 440 million tons of rice a year[4]. Paddy rice is naturally a good source of vitamins, such as thiamine (vitamin B1), riboflavin (vitamin B2), and niacin (vitamin B3), however, as it undergoes several processing steps before consumption (such as dehulling, washing, milling, and cooking) that might lead to a significant loss of many minerals and vitamins[4]. So the high consumption of rice might also reflect a lack of dietary diversity at the same time, which might be a risk factor for developing micronutrient deficiencies.

The relationship between dementia and rice is ambiguous, and the results are inconsistent, for example, Uenobe M[5] et al confirmed that long-term consumption of dewaxed brown rice (DBR) might help prevent and reduce overall cognitive decline, especially in older adults with low cognitive function. Kuroda Y[6] et al found that a 2-y oral consumption of ultra-high hydrostatic pressurizing brown rice (UHHPBR) would increase information processing speed (as a measure of cognitive function) and improve apathy in the elderly, suggesting a protective effect of UHHPBR administration against age-related decline in motivation and brain cognition. Corpuz HM[7] et al proved that fermented rice peptides (FRPs) would play a role in preventing scopolamine-induced memory impairment in mice, and the underlying mechanism might involve regulation of the ERK/CREB/BDNF signaling pathway. Okuda M [8]et

al found that highly water pressurized brown rice would improve cognitive dysfunction in senescence-accelerated mouse prone 8 and reduce amyloid-beta in their brain. However, a cross-sectional study included 635 community-dwelling people aged 69-71 years indicated that rice and miso soup was not associated with cognitive function[9]. What's more, Kim J[10] et al also pointed out that the white rice only pattern (a rice-centered diet without well-balanced meals) would increase the risk of cognitive impairment.

However, although there have been many studies linking rice types to dementia, few studies have involved the relationship between frequency of white rice consumption and cognitive function. Since the overconsumption of rice can lead to diabetes or obesity[11], we hypothesized that a high frequency of white rice consumption might also be a risk factor for cognitive impairment[12]. Therefore, in the current study, we followed up a total of 620 old people with normal cognition for two years, and specifically explored the effect of weekly white rice consumption on their future cognitive function.

2. Methods

2.1 Data sources

Data were obtained from the cohort study on the brain health of the elderly in Shanghai (http://www.shanghaibrainagingstudy.org/). This project was launched in 2016, which was a prospective and observational cohort study. The specific content of this project includes understanding the mortality, prevalence, incidence, and population distribution characteristics of mild cognitive impairment and Alzheimer's disease among the elderly over 55 years old in Shanghai communities. The inclusion criteria were as follows[13] : 1) ≥55 years; 2) permanent population of Shanghai; 3) no evidence of serious mental illness, such as intellectual disability and schizophrenia; 4) no evidence of serious physical illness; 5) agreed to participate in the study. Exclusion criteria were as follows: 1)<55 years old; 2) floating population; 3) serious mental illness and physical illness or acute stress state, for example, acute medical disorders; and 4) the guardians or the participants or refused to participate in the study. Finally, A total of 1103 seniors entered the database, and 620 old people with normal cognition were included in the current study and were followed for two years. Figure 1 illustrates the research flow.

Ethical approval was obtained from the Ethics Committee of the Shanghai Mental Health Center, and all the participants had signed informed consent before the study.

2.2 Diet Assessment

Dietary intake was assessed at baseline using the food frequency questionnaire (FFQ)[14]. The question “how often do you eat white rice?” was used in the interview. Responses were recorded as monthly (for those who consumed white rice less than 1 time per week), weekly (for those who consumed white rice 1–6 times per week) or daily (for those who consumed white rice at least 1 time per day). White rice intake frequencies were calculated weekly (calculated from monthly, weekly, and daily recordings, e.g., green vegetables once/month = 0.25 times/week, green vegetables once/day, every day = 7 times/week;, etc.). By using the same method, we have also investigated data on the consumption of bread, red meat, white meat, tofu, fish, green vegetables, red vegetables, bean curd, fruit or juice, and ginger.

2.3 Clinical evaluations

All the participants would undergo a clinical and cognitive assessment at baseline and follow-up. The diagnosis of MCI was based on the revised Petersen’s diagnostic algorithm[15], and the diagnosis of dementia was based on the Diagnostic and Statistical Manual of Mental Disorders, fourth edition(DSM-IV). All the diagnoses were performed by trained and qualified medical clinicians. To improve the accuracy of the research, we also collected their body fluids (blood and urine) and head MRI. In addition, we also obtained their general demographic information, daily life information, and disease-related information through a questionnaire survey. What's more, the Mini-Mental State Examination (MMSE)[16]and Montreal Cognitive Assessment (MoCA)[17] were used to assess the subjects' overall cognitive function. Based on the result of the follow-up clinical evaluation (including the first year and the second year follow-up), these participants were classified as normal to normal group(NC-NC group) and normal to MCI group (NC-MCI group).

2.3.1 Diagnostic criteria for the cognitively normal elderly

All cognitively normal (NC) elderly people needed to meet the following criteria[18]: 1) under the cutoff scores of Mini-Mental State Examination (MMSE), higher than middle-school educated individuals ≥25; elementary school educated individuals≥21; and illiterate individuals ≥18; 2) without serious physical illness and mental illness[16]; 3) absence of dementia; 4) be able to complete all tests.

2.3.2 Diagnostic criteria for mild cognitive impairment

The diagnosis of MCI was based on Petersen's diagnostic criteria[19]: 1) self-reported or informant cognitive complaints;2) objective memory disorder;3) maintain the independence of functional ability; 4) no dementia.

2.3.3 Patient and Public Involvement statement

In this study, we publicize and introduce the project through the community neighborhood committee, and all subjects can decide whether to participate in this study according to their own wishes. All subjects will get a detailed physical examination report, as well as small gifts.

3. Statistical Analysis

Continuous variables were expressed as mean ±SD and categorical variables were expressed as frequencies (%). Independent sample t-test and Chi-square tests were used to compare the continuous variables and classification variables of the NC-MCI group and the NC-NC group, respectively. Next, we used the COX regression models to examine the association between the weekly consumption of white rice and MCI, treating whether to convert to MCI as the dependent variable, the transition time as the time variable and the weekly consumption of white rice as the independent variable. Model 1 did not control any variables; Model 2 controlled some variables, such as age and education; Model (3) furtherly controlled other variables, such as drinking. The ROC curve was used to explore the sensitivity and specificity of weekly rice consumption to predict MCI.

4. Results

4.1 Comparison of general demographic data between follow-up and lost follow up population

Of the 620 cognitively normal elderly subjects, 145 were lost during the 2-year follow-up, with a loss rate of 23.4%. Compared with the lost follow up participants, follow up participants were more likely to drink tea, combined with a higher proportion of hypertension, diabetes, coronary heart disease, hyperlipidemia, cerebral infarction, depression and their MOCA scores were higher ($p<0.05$). However, there were no statistically significant differences ($p>0.05$) in age, education, gender, smoker, drinker, take exercise, hobby, cerebral hemorrhage, eat rice weekly, eat bread weekly, eat fruits weekly, eat orange vegetables weekly, eat green vegetables weekly, eat fish weekly, eat tofu weekly, eat white meat weekly and eat red meat weekly between the two groups (Supplementary 1).

4.2 Comparison of general demographic data between high white rice consumption and low white rice consumpition

In the present study, we took the 14 times a week as the cut-off value to divide the low frequency and high frequency[20], and the elderly with the low white rice consumption were younger, less willing to eat fish and green vegetables, and had a higher MCI conversion rate ($p<0.05$), while there was no statistically significant differences ($p>0.05$) in education, gender, smoker, drinker, tea drinker, take exercise, hobby, hypertension, diabetes, coronary heart disease, hyperlipidemia, cerebral infarction, depression, cerebral hemorrhage, consumption of bread, fruits, orange vegetables, tofu, white meat and red meat between the two groups. Table 1 presents the results.

4.3 Comparison of general demographic data between the NC-MCI group and the NC-NC group

Of the 471 older adults who were followed, 91 converted to MCI, while 380 remained cognitively normal, resulting in a 2-year incidence of MCI of 19.3%. Compared with those who had transitioned to MCI, those who had not transitioned were younger, had fewer drinks, ate less white rice per week, but were more educated and had higher MOCA scores ($p<0.05$), however, there were no statistically significant differences ($p>0.05$) in gender, smoker, tea drinker, take exercise, hobby, hypertension, diabetes, coronary heart disease, hyperlipidemia, cerebral infarction, depression, cerebral hemorrhage, eat bread weekly, eat fruits weekly, eat orange vegetables weekly, eat green vegetables weekly, eat fish weekly, eat tofu weekly, eat white meat weekly and eat red meat weekly between the two groups. Table 2 presents the results.

4.4 The results of Cox regression analysis

Table 3 shows the results of Cox regression analysis(change to MCI as a dependent variable, change time as a time variable). Higher weekly rice consumption was a risk factors for MCI (model 1: $p=0.019$, HR=1.051, 95%CI:1.008~1.096); This relationship remained statistically significant after adjusting for age and education in model 2: ($p=0.041$, HR=1.044, 95%CI:1.002~1.089); Further adjustment for drinking in model 3 also did not change the results ($p=0.020$, HR=1.052, 95%CI:1.008~1.097). The ROC curve was used to determine the weekly rice consumption to predict the risk of MCI, and it was found that the area under the curve was 0.591 ($p=0.07$, 95%CI:0.527~0.655), suggesting that the weekly rice consumption had a mild-to-moderate effect in predicting MCI. Figure 2 presents the results.

5. Discussion

As a staple food, rice plays an important role in more than half of the world's population, especially in China[21]. Although many studies have shown that brown rice is a protective factor for cognitive function[6,8,22], few studies have involved the effect of white rice on cognitive function. To my knowledge, this was the first longitudinal study to examine the relationship between white rice consumption and cognitive function, and we had come to two interesting conclusions: 1)high weekly white rice consumption was a risk factor for MCI and was independent of age and education; 2) weekly white rice consumption had a moderate effect in predicting MCI.

In this study, we used FFD to investigate the effect of weekly consumption of white rice, green vegetables, meat, and other foods on the future cognitive function of the elderly in Chinese Communities, and we found that the consumption of rice per week of the elderly who converted to MCI was significantly higher than that of the non-transformants. After controlling for age, education, and alcohol consumption, weekly consumption of white rice had still been shown to be associated with poor memory performance. By using the ROC curve, we also explored the possibility of using the weekly consumption of white rice to predict the change of MCI in the future, and we found that the area under the curve was 0.591 ($p=0.07$, 95%CI:0.527~0.655), suggesting that weekly consumption of white rice had a mild-to-moderate effect in predicting MCI.

Since there was no previous study on the relationship between the weekly consumption of white rice and cognitive function, we could not judge whether our research was consistent with others. However, there were several mechanisms to explain why eating white rice would increase the risk of cognitive impairment, first, compared with low white rice consumption, high white rice consumption was significantly associated with a risk of weight gain of ≥3 kg[23], and obesity was a risk factor for cognitive impairment[24-26]; second, compared with black rice, white rice had a faster gastric emptying rate, so it had a greater impact on blood glucose[27]; In Chinese adults, higher carbohydrate intake, mainly from white rice, was associated with a higher incidence of coronary heart disease[28]; At the same time, rice consumption was also considered to be an important route of arsenic exposure in populations in non-arsenic endemic areas[29].

We admit that our research has some limitations, first, this study was conducted in The Shanghai area and could be extended to other parts of the country; second, based on the above research, we could not find the exact mechanism of white rice increasing cognitive risk; third, we did not distinguish specific types of MCI, so it was not possible to determine whether white rice had a greater effect on amnestic or vascular MCI; fourth, a 2-year follow-up was too short, and we would continue to follow up the above population.

6. Conclusion

High weekly white rice consumption is a risk factor for MCI and has a moderate predictive effect. However, these findings need to be validated in a national study.

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the principles of Declaration of Helsinki, and approved by the Research Ethical Committee of the affiliated mental health center of Shanghai Jiaotong University School of Medicine. All participants had signed the informed consent written informed consent before the start of the study.

Consent for publication

Not applicable.

Availability of data and materials

The data base generated and/or analyzed during the current study are not publicly available but are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Wei Li contributed to the study concept and design. Ling Yue acquired the data. Shifu Xiao and Guanjun Li analyzed the data and drafted the manuscript. All authors have read and approved the final manuscript.

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Tables

Table 1. comparison of general demographic data among different rice consumption frequency

Variables	≤ 14 times a week (n=96)	>14 times a week (n=375)	p
Age, y	67.29±6.922	69.38±7.312	0.012*
Education, y	11.30±3.202	11.55±3.513	0.527
Male, n(%)	35(36.5)	135(36.0)	1.000
Smoker, n(%)	25(26.0)	69(18.4)	0.115
Drinker, n(%)	19(19.8)	64(17.1)	0.549
Tea drinker, n(%)	57(59.4)	193(51.5)	0.171
Take exercise, n(%)	71(74.0)	269(71.7)	0.704
Hobby, n(%)	75(78.1)	286(76.3)	0.787
Hypertension, n(%)	55(57.3)	194(51.7)	0.360
Diabetes, n(%)	24(25.0)	71(18.9)	0.200
Coronary heart disease, n(%)	16(16.7)	60(16.0)	0.877
Hyperlipidemia, n(%)	34(35.4)	116(30.9)	0.394
Cerebral hemorrhage, n(%)	4(4.2)	5(1.3)	0.089
Cerebral infarction, n(%)	10(10.4)	48(12.8)	0.604
Depression, n(%)	1(1.0)	8(2.1)	0.694
Bread, n(%)	59(61.5)	248(66.1)	0.402
Fruits,n(%)	86(89.6)	351(93.6)	0.186
Orange vegetables,n(%)	87(90.6)	339(90.4)	1.000
Green vegetables,n(%)	93(96.9)	375(100)	0.008*
Fish,n(%)	86(89.6)	361(96.3)	0.016*
Tofu,n(%)	88(91.7)	338(90.1)	0.846
White meat,n(%)	76(79.2)	323(86.1)	0.111
Red meat,n(%)	84(87.5)	303(80.8)	0.137
MCI, n(%)	11(11.5)	80(21.3)	0.030*

Table 2. General demographic data of the subjects with different clinical outcomes

Variables	NC to MCI (n=91)	NC to NC (n=380)	p
Age, y	71.31±6.858	68.39±7.269	0.001*
Education, y	10.58±4.104	11.72±3.242	0.005*
Male, n(%)	40(44.0)	130(34.2)	0.090
Smoker, n(%)	21(23.1)	73(19.2)	0.465
Drinker, n(%)	23(25.3)	60(15.8)	0.045*
Tea drinker, n(%)	42(46.2)	208(54.7)	0.161
Take exercise, n(%)	59(64.8)	281(73.9)	0.091
Hobby, n(%)	63(69.2)	298(78.4)	0.073
Hypertension, n(%)	52(57.1)	197(51.8)	0.413
Diabetes, n(%)	23(25.3)	72(18.9)	0.191
Coronary heart disease, n(%)	19(20.9)	57(15.0)	0.203
Hyperlipidemia, n(%)	30(33.0)	120(31.6)	0.803
Cerebral hemorrhage, n(%)	2(2.2)	7(1.8)	0.687
Cerebral infarction, n(%)	14(15.4)	44(11.6)	0.374
Depression, n(%)	2(2.2)	7(1.8)	0.687
Eat rice weekly	15.77±4.619	13.97±5.058	0.002*
Eat bread weekly	7.00±0.000	7.12±1.442	0.727
Eat fruits weekly	8.40±3.464	8.12±3.001	0.564
Eat orange vegetables weekly	7.84±2.322	7.93±2.658	0.876
Eat green vegetables weekly	3.88±1.356	3.97±1.610	0.879
Eat fish weekly	2.78±1.216	2.73±1.160	0.708
Eat tofu weekly	1.97±1.095	2.19±1.172	0.167
Eat white meat weekly	1.93±1.079	1.93±1.156	0.989
Eat red meat weekly	2.22±1.332	2.31±1.313	0.667
MoCA	23.84±3.304	24.87±2.810	0.002*

Table 3. Results of Cox regression analysis (with MCI as dependent variable)

Variables	B	S.E	Wald	df	p	HR	95%confidence interval	
							Lower limit	Upper limit
Model 1								
Eat rice weekly	0.050	0.021	5.531	1	0.019*	1.051	1.008	1.096
Model 2								
Age	0.038	0.014	7.810	1	0.005*	1.039	1.011	1.067
Education	-0.072	0.028	6.731	1	0.009*	0.931	0.882	0.983
Eat rice weekly	0.044	0.021	4.166	1	0.041*	1.044	1.002	1.089
Model3								
Age	0.042	0.014	9.033	1	0.003*	1.043	1.015	1.072
Education	-0.068	0.028	5.927	1	0.015*	0.935	0.885	0.987
Drinker	0.498	0.253	3.866	1	0.049*	1.646	1.002	2.705
Eat rice weekly	0.050	0.022	5.446	1	0.020*	1.052	1.008	1.097

Figures

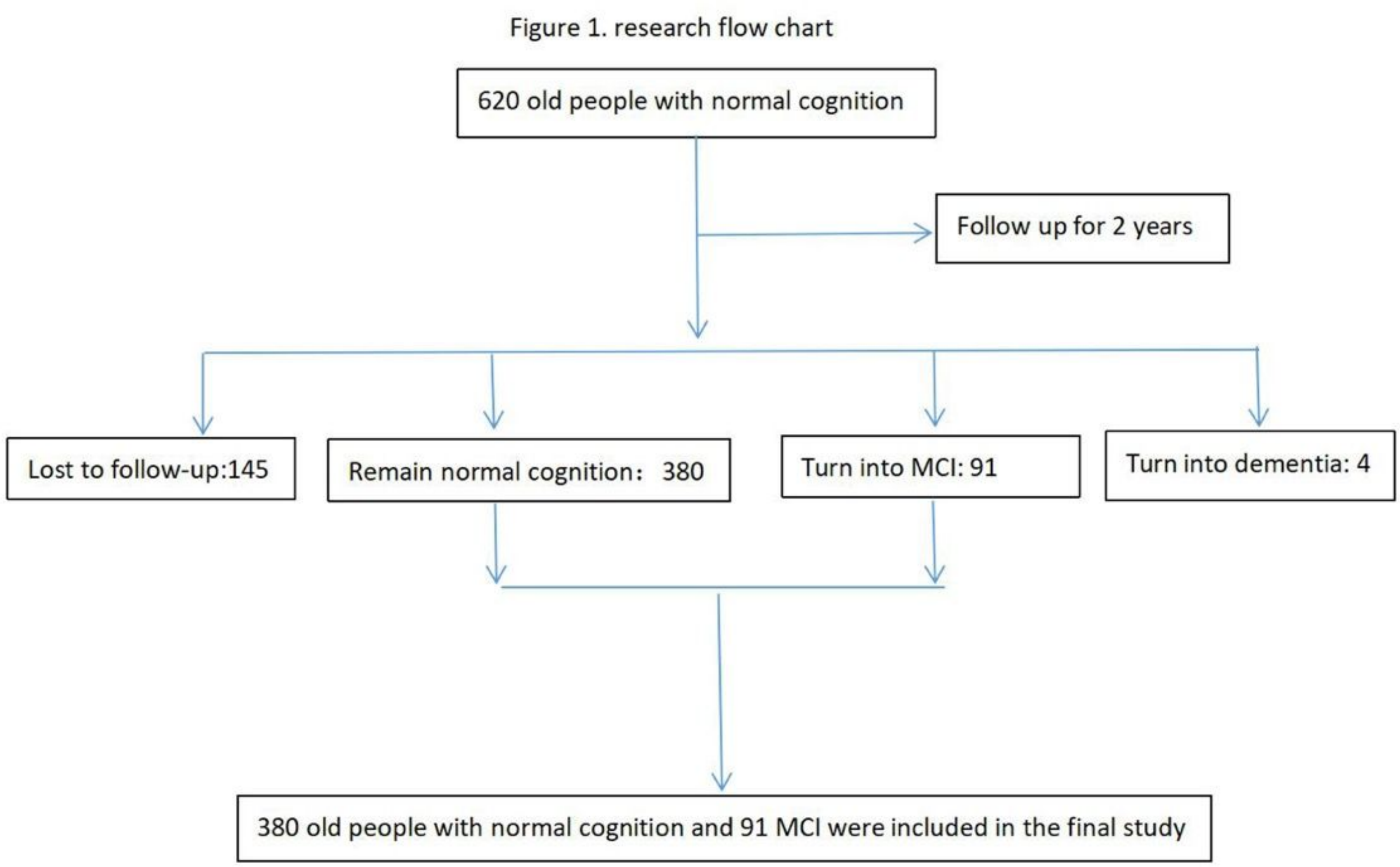

Figure 1

Research Flow Chart

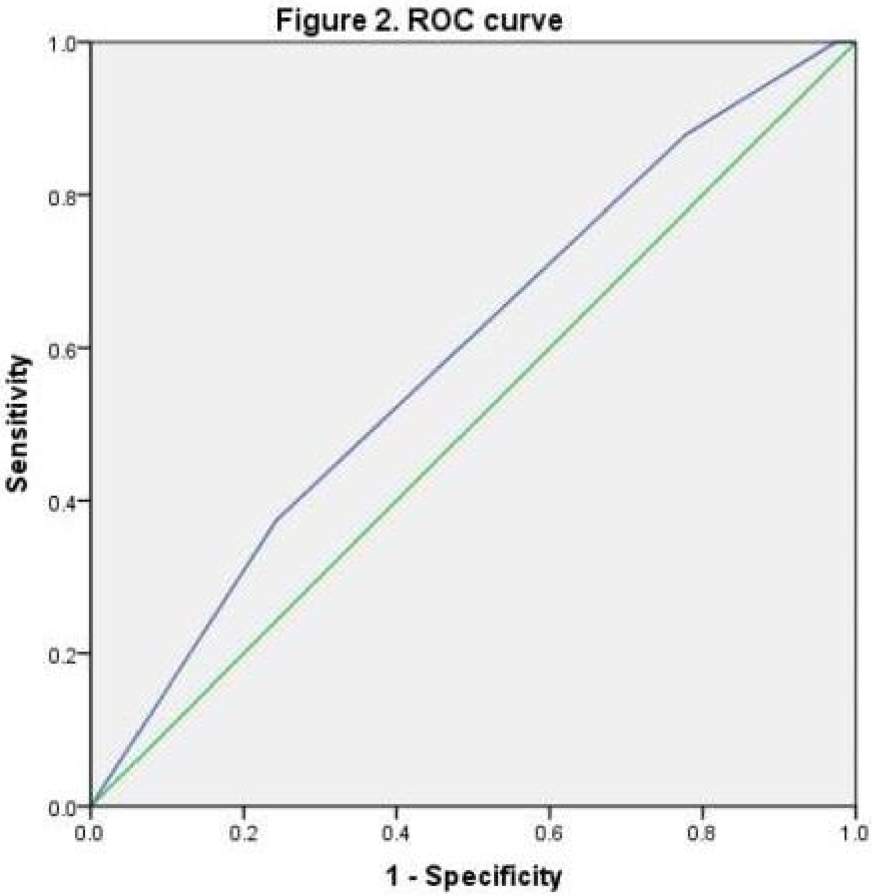

Figure 2

ROC Curve

Supplementary Files

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