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Association between Modified Cardiometabolic Index and Incident Cardiovascular Disease in Middle-Aged and Elderly Chinese Individuals with Abnormal Glucose Metabolism

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Abstract

Background: The cardiometabolic index (CMI) was developed ten years ago as a composite indicator combining measures of obesity (waist-to-height ratio) and dyslipidemia (triglyceride/HDL-C ratio). Prior studies have demonstrated its ability to predict both the occurrence and mortality of cardiovascular disease. Extending this line of inquiry, the current investigation examines how a modified cardiometabolic index (MCMI) with CVD risk specifically among middle-aged and older individuals exhibiting abnormal glucose metabolism. **Methods:** A total of 3420 participants from the China Health and Retirement Longitudinal Study (CHARLS) were included. MCMI levels were measured at baseline and categorized into quartiles. Cox proportional hazards models were used to estimate hazard ratios (HRs) and 95% confidence intervals (CIs) for the association between MCMI and incident CVD, with adjustment for demographic, socioeconomic, and clinical confounders. Restricted cubic spline analysis was employed to examine the dose-response relationship. **Results:** During a median follow-up of 10 years, 705 incident CVD cases were documented. Kaplan-Meier analysis showed significantly higher cumulative incidence of CVD with increasing MCMI quartiles (log-rank $P < 0.01$). In fully adjusted models, each unit increase in MCMI was associated with a 21% higher risk of CVD (HR = 1.21, 95% CI: 1.09 - 1.34, $P < 0.001$). Participants in the highest MCMI quartile (Q4) had a 40% increased risk compared to those in the lowest quartile (Q1) (HR = 1.40, 95% CI: 1.12 - 1.77, $P = 0.004$). Restricted cubic spline analysis revealed a linear relationship (P for nonlinear = 0.778). The positive association remained consistent across subgroups. **Conclusions:** Higher MCMI levels are independently associated with an increased

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risk of incident CVD in a dose-response manner. These findings highlight the importance of monitoring and managing MCMI for CVD prevention in middle-aged and older adults.

Keywords

CVD, CMI, MCMI, CHARLS, Abnormal Glucose Metabolism

1. Introduction

With the improvement of global living standards, the impact of CVD on human health is increasing [1]-[3]. Over the past two decades, the number of cases has risen from 271 million to 523 million, nearly doubling, and the number of deaths from CVD has also increased significantly [2] [4]. Despite significant advancements in medical technology, the incidence and mortality rates of CVD remain the highest globally, placing a substantial burden on public health systems. Therefore, early identification of populations at high risk for CVD is of great significance for controlling disease progression.

The cardiometabolic index (CMI) is a comprehensive metabolic indicator that reflects both visceral fat distribution and dyslipidemia. It was first proposed by Wakabayashi *et al.* [5], in 2015, calculated as the product of the triglyceride-to-high-density lipoprotein cholesterol ratio and the waist-to-height ratio, and is primarily used for the auxiliary diagnosis of diabetes and the assessment of visceral adipose tissue dysfunction. Recent studies have shown that CMI is closely associated with cardiovascular diseases, renal dysfunction, acute pancreatitis, and various metabolic abnormalities [6]-[8]. More recent research has further proposed the modified cardiometabolic index (MCMI), which incorporates fasting blood glucose on the basis of CMI, making it a comprehensive assessment tool that simultaneously covers insulin resistance, central obesity, and dyslipidemia [9]. Existing studies have indicated that MCMI is positively correlated with the risk of non-alcoholic fatty liver disease (NAFLD) and can effectively predict the occurrence of NAFLD and liver fibrosis [9]. Studies have shown that insulin resistance, obesity, and dyslipidemia are closely associated with the occurrence of CVD [10]-[14].

However, the association between MCMI and CVD risk in middle-aged and elderly populations with dysglycemia remains unclear. To address this research gap, this study, based on the CHARLS database, aims to investigate the relationship between MCMI levels and the risk of CVD in individuals aged 45 years and older with abnormal glucose metabolism.

2. Methods

This study utilized data from the China Health and Retirement Longitudinal Study (CHARLS), a nationally representative longitudinal survey of individuals aged 45 years and above in China. Using a multistage probability sampling method, the baseline survey was conducted between 2011 and 2012 (Wave 1). To date, multiple follow-up waves have been made publicly available, including those in 2013 (Wave 2), 2015 (Wave 3), 2018 (Wave 4), and 2020 (Wave 5) [15].

Initially, 11,847 participants who had undergone complete blood count testing were included. A total of 8427 participants were excluded based on the following criteria: 1) Age < 44 years; 2) Missing data on triglycerides, high-density lipoprotein cholesterol, fasting blood glucose, height, or waist circumference; 3) No follow-up data on cardiovascular disease from Wave 1 to Wave 5 years; 4) History of cardiovascular disease before 2011; 5) Normal glucose metabolism. Ultimately, 3420 participants were included in the analysis (**Figure 1**).

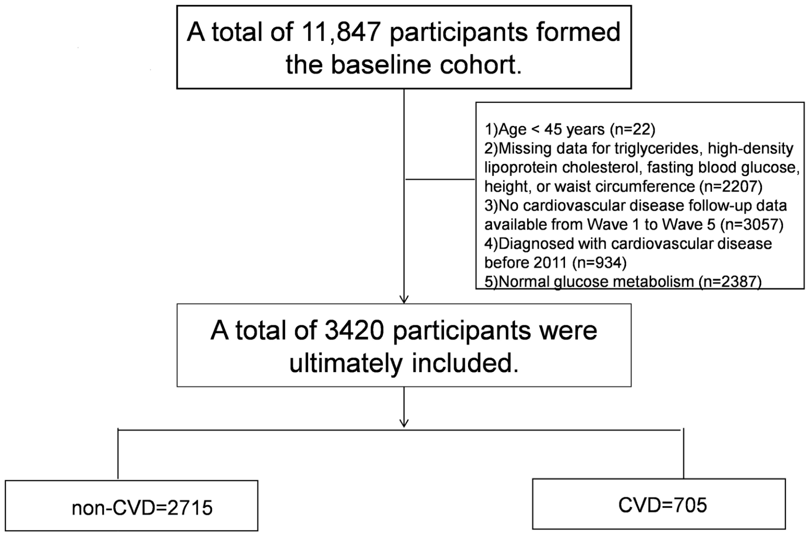

Figure 1. Flow diagram of study participants.

2.1. Definition of Participants with Abnormal Glucose Metabolism

Abnormal glucose metabolism primarily includes two categories: diabetes and prediabetes. According to the diagnostic criteria of the American Diabetes Association (ADA) [16], prediabetes is defined as a fasting plasma glucose level of 100 - 125 mg/dL or a glycosylated hemoglobin A1c (HbA1c) level of 5.7% - 6.4%. Diabetes is diagnosed if any of the following criteria are met: fasting plasma glucose ≥ 125 mg/dL, HbA1c ≥ 6.5%, a self-reported history of diabetes, or the use of glucose-lowering medications [17].

2.2. Assessment of Cardiovascular Disease and Calculation of the Metabolic Comorbidity Index

CVD was the primary outcome in this study. Heart disease was determined based on whether the participant reported that a doctor had informed them of a diagnosis of myocardial infarction, angina pectoris, coronary heart disease, heart failure, or other heart conditions. Stroke was determined based on whether the participant reported that a doctor had informed them of a diagnosis of stroke. In this study, CVD was defined as self-reported presence of either or both of the above conditions.

MCMI = ln[Triglycerides (TG, mg/dL) × Fasting Blood Glucose (mg/dL)/ High-Density Lipoprotein Cholesterol (HDL-C, mg/dL)] × Waist Circumference (cm)/Height (cm) [9].

Covariates:

To reduce confounding bias, this study first identified potential confounding variables based on previous literature, and subsequently included them as covariates in the model for statistical adjustment. Covariates covered the following categories: Demographics: age, gender, hukou (rural/other), marital status (married/ other); Lifestyle: drinking status (yes/other), smoking status (yes/other); Clinical indicators: hypertension (hypertensive/non-hypertensive), LDL-C (mg/dL).

Statistical Analysis:

Based on the presence or absence of coronary heart disease, participants were divided into two groups. First, Kaplan-Meier curve analysis was used to examine the relationship between MCMI levels and the risk of cardiovascular disease (CVD). Subsequently, a multivariate Cox proportional hazards regression model (fully adjusted for confounders) was employed to further evaluate the association between MCMI and CVD. To further explore the pattern of this association, MCMI was categorized into quartiles and analyzed using the same fully adjusted model, and restricted cubic splines (RCS) were applied to fit the dose-response relationship between MCMI and CVD risk. In addition, subgroup analyses were conducted to assess the consistency of this association across different population characteristics.

3. Results

Table 1. Baseline characteristics of the study participants.

Variables	Total (n = 3420)	0 (n = 2715)	1 (n = 705)	P value[2]
AGE, Mean ± SD	58.63 ± 8.37	58.25 ± 8.45	60.08 ± 7.90	**<0.001**
SEX, n (%)				**0.005**
Female	1880 (55.02)	1459 (53.80)	421 (59.72)	
Male	1537 (44.98)	1253 (46.20)	284 (40.28)	
Hukou, n (%)				0.974
Rural	2919 (85.35)	2317 (85.34)	602 (85.39)	
Other	501 (14.65)	398 (14.66)	103 (14.61)	
Marital Status, n (%)				0.725
Married	3078 (90.00)	2446 (90.09)	632 (89.65)	
Other	342 (10.00)	269 (9.91)	73 (10.35)	
Drinking Status, n (%)				**0.014**
NO	2525 (73.83)	1979 (72.89)	546 (77.45)	
YES	895 (26.17)	736 (27.11)	159 (22.55)	

Continued

Smoking Status, n (%)				**0.010**
NO	2438 (71.29)	1908 (70.28)	530 (75.18)	
YES	982 (28.71)	807 (29.72)	175 (24.82)	
Hypertension Status, n (%)				**<0.001**
No Hypertension	2038 (59.59)	1689 (62.21)	349 (49.50)	
Hypertension	1382 (40.41)	1026 (37.79)	356 (50.50)	
Glu, Mean ± SD	121.22 ± 38.42	120.23 ± 34.83	125.01 ± 49.73	**0.017**
Tg, Mean ± SD	150.57 ± 135.67	148.64 ± 133.33	158.02 ± 144.18	0.102
HDL-C, Mean ± SD	50.53 ± 15.84	50.70 ± 15.74	49.86 ± 16.21	0.209
LDL-C, Mean ± SD	118.53 ± 37.06	117.68 ± 36.85	121.81 ± 37.69	**0.008**
HbA1c, Mean ± SD	5.41 ± 0.91	5.38 ± 0.84	5.53 ± 1.12	**<0.001**
SBP, Mean ± SD	130.70 ± 20.56	129.92 ± 20.35	133.71 ± 21.08	**<0.001**
DBP, Mean ± SD	76.01 ± 11.56	75.56 ± 11.37	77.74 ± 12.13	**<0.001**
Height, Mean ± SD	157.75 ± 8.47	157.86 ± 8.42	157.36 ± 8.66	0.162
WC, Mean ± SD	85.23 ± 12.35	84.70 ± 12.11	87.27 ± 13.02	**<0.001**
BMI, Mean ± SD	23.87 ± 3.88	23.70 ± 3.82	24.52 ± 4.07	**<0.001**
Heart Disease, n (%)				**<0.001**
No	2927 (85.58)	2715 (100.00)	212 (30.07)	
Yes	493 (14.42)	0 (0.00)	493 (69.93)	
Stroke, n (%)				**<0.001**
No	3149 (92.08)	2715 (100.00)	434 (61.56)	
Yes	271 (7.92)	0 (0.00)	271 (38.44)	
CVD, n (%)				**<0.001**
No	2715 (79.39)	2715 (100.00)	0 (0.00)	
Yes	705 (20.61)	0 (0.00)	705 (100.00)	

Abbreviations: Glu, Fasting Blood Glucose; Tg, Triglycerides; HDL-C, High-Density Lipoprotein Cho, Cholesterol; LDL-C, Low-Density Lipoprotein Cholesterol; HbA1c, Glycated Hemoglobin A1c; SBP, Systolic Blood Pressure; DBP, Diastolic Blood Pressure; WC, Waist Circumference; BMI, Body Mass Index; SD, Standard Deviation. P value estimated using chi-square for categorical variable and t-tests for continuous variables.

Table 1 shows a total of 3420 participants were included in this study, among whom 705 (20.61%) developed new-onset cardiovascular disease during the follow-up period. The mean age of the participants was 58.63 ± 8.37 years, and 1537 (44.98%) were male. Inter-group comparisons showed statistically significant differences ($P < 0.05$) in the distribution of the following variables: blood glucose, low-density lipoprotein cholesterol, glycated hemoglobin, systolic blood pressure, diastolic blood pressure, waist circumference, body mass index, drinking status, smoking status, hypertension status, new-onset heart disease, new-onset stroke, and new-onset cardiovascular disease.

3.1. The Association between MCMI Levels and CVD Risk

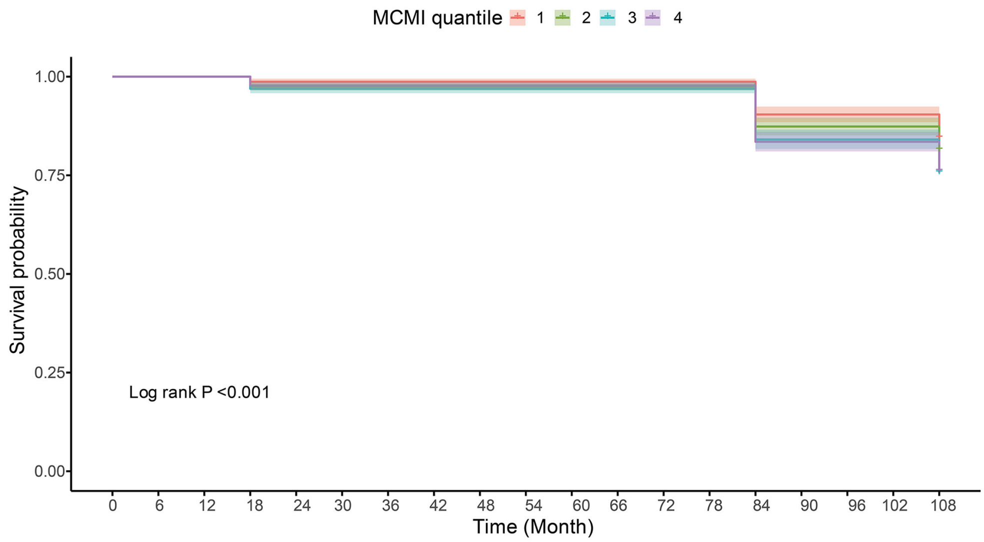

Figure 2. Kaplan-Meier survival curves for CVD risk stratified by MCMI quartiles.

Figure 2 presents the Kaplan-Meier survival curves stratified by MCMI quartiles. The results show a significant difference in cumulative survival rates among the four MCMI quartile groups (Log-rank $P < 0.001$). Over the follow-up period, the group with the highest MCMI level (quartile 4) exhibited the most pronounced decline in survival probability, whereas the group with the lowest MCMI level (quartile 1) maintained the highest survival probability throughout. This indicates that elevated MCMI levels are associated with an increased risk of future CVD.

Table 2. MCMI and risk of cardiovascular disease: results from adjusted cox models.

Variables	Model 1		Model 2		Model 3	
	HR (95% CI)	P	HR (95% CI)	P	HR (95% CI)	P
MCMI	1.27 (1.16 - 1.40)	**<0.001**	1.26 (1.14 - 1.39)	**<0.001**	1.21 (1.09 - 1.34)	**<0.001**
MCMI						
Q1	1.00 (Reference)		1.00 (Reference)		1.00 (Reference)	
Q2	1.22 (0.97 - 1.53)	0.094	1.20 (0.95 - 1.51)	0.120	1.16 (0.92 - 1.46)	0.206
Q3	1.62 (1.30 - 2.01)	**<0.001**	1.59 (1.28 - 1.98)	**<0.001**	1.46 (1.17 - 1.83)	**<0.001**
Q4	1.59 (1.28 - 1.98)	**<0.001**	1.55 (1.24 - 1.93)	**<0.001**	1.40 (1.12 - 1.77)	**0.004**

HR: Hazard Ratio, CI: Confidence Interval

Model 1: Crude

Model 2: Adjust: SEX, AGE

Model 3: Adjust: SEX, AGE, LDL-C, Hukou, marital status, drinking status, smoking status, hypertension status

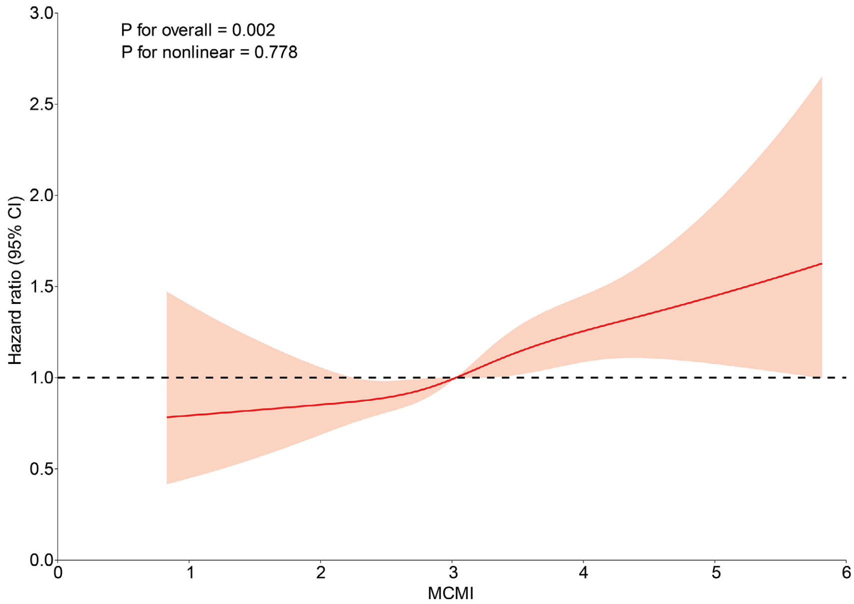

Figure 3. Dose-response relationship between MCMI and CVD risk.

As shown in **Table 2**, a significant statistical association was observed between MCMI and the incidence of cardiovascular disease in the fully adjusted model (Model 3), with a hazard ratio (HR) of 1.21 (95% CI: 1.09 - 1.34, P < 0.001). This association remained significant when MCMI was categorized into quartiles: compared to the lowest quartile (Q1), the highest quartile (Q4) exhibited a hazard ratio of 1.40 (95% CI: 1.12 - 1.77, P = 0.004) for cardiovascular disease. Restricted cubic spline (RCS) analysis further confirmed a positive dose-response relationship between MCMI and CVD risk (**Figure 3**).

3.2. Subgroup Analysis

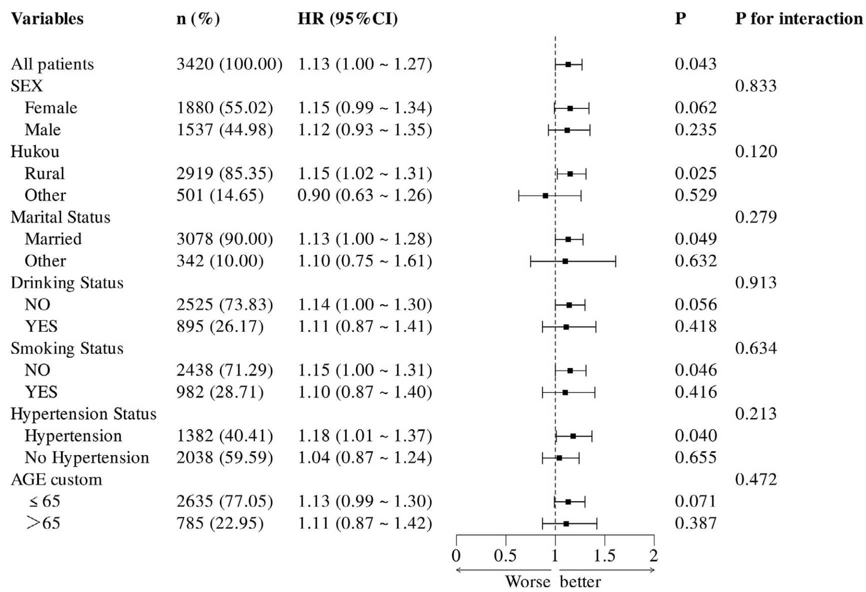

Figure 4. Subgroup analyses of the association between MCMI and cardiovascular disease risk.

To enhance the generalizability of the study findings, we performed subgroup analyses (**Figure 4**) across variables including sex, household registration type, marital status, alcohol consumption, smoking status, hypertension status, and age group (≥65 years and <65 years). Interaction tests indicated generally consistent trends of association across all subgroups (all P-values for interaction >0.05), suggesting that the main findings of this study are broadly applicable across populations with different characteristics.

4. Discussion

This study included 3450 middle-aged and elderly patients with dysglycemia. After 10 years of follow-up, 705 participants developed cardiovascular disease (CVD), with a cumulative incidence of 20.61%. Survival analysis indicated that as MCMI levels increased, the incidence of CVD showed an upward trend. In the fully adjusted model (Model 3), compared with the lowest quartile (Q1), the highest quartile (Q4) had a significantly increased risk of CVD, with a hazard ratio (HR) of 1.40 (95% CI: 1.12 - 1.77, P = 0.004).

The CMI is a metabolic indicator that combines features of dyslipidemia and abdominal obesity [5]. Since its proposal a decade ago, multiple studies have confirmed its close association with diseases such as NAFLD, CVD, and infertility [6]-[8]. Recently, Guo *et al.* further proposed the MCMI based on CMI [9]. This index adds fasting blood glucose parameters to CMI, thereby integrating multiple metabolic risk factors including insulin resistance, dyslipidemia, and obesity. Existing studies have demonstrated a significant correlation between MCMI and NAFLD as well as liver fibrosis.

This study is the first to reveal a significant positive correlation between the MCMI and the risk of CVD in middle-aged and elderly populations with dysglycemia. Although the exact pathophysiological mechanisms remain to be further elucidated, existing theories on metabolism and cardiovascular disease may provide potential explanatory pathways for this phenomenon: insulin resistance reduces the uptake and utilization efficiency of glucose in peripheral tissues, leading to a chronic hyperglycemic state and secondary dyslipidemia (such as elevated triglycerides and decreased high-density lipoprotein cholesterol). These metabolic abnormalities collectively act on the vascular system and can accelerate the formation and progression of atherosclerotic plaques through multiple pathways, including promoting oxidative stress, low-grade inflammatory responses, and endothelial dysfunction, ultimately increasing the risk of CVD events [18]-[20]. Furthermore, obesity, as a key driver of insulin resistance, is often associated with chronic low-grade inflammation, abnormal adipokine secretion, and elevated free fatty acid levels [21]-[24]. These changes can collectively exacerbate vascular endothelial dysfunction, promote plaque destabilization, and accelerate the progression of atherosclerosis, thereby further increasing the risk of cardiovascular disease.

Future research could focus on the following directions to systematically elucidate the pathophysiological link between MCMI and CVD: at the metabolic regulation level, investigating whether MCMI contributes to CVD development by affecting key pathways in glucose and lipid metabolism (such as insulin signal transduction and fatty acid oxidation); in terms of inflammatory mechanisms, analyzing the association between MCMI and systemic inflammatory markers (e.g., IL-6, TNF-α, CRP) as well as local vascular inflammatory responses; and from the perspective of vascular function, further exploring the impact of MCMI on vascular endothelial function, arterial elasticity, and microcirculatory status. Through integrated multidimensional mechanistic studies, a more robust theoretical foundation may be established for MCMI as a predictive and interventional target for CVD.

5. Limitations

This study has several limitations. First, due to the limited sample size, the sampling error is relatively large, which may affect the accuracy and statistical stability of the estimated association between MCMI and incident cardiovascular disease in populations with dysglycemia. Second, all study participants were from China; although the findings may have broader population-level relevance, their applicability to other ethnic groups and regions requires validation through cross-population, multicenter prospective studies before they can inform revisions to global clinical guidelines. Furthermore, the determination of cardiovascular disease events relied primarily on self-reported physician diagnoses, lacking a unified standard for re-evaluating reported events, and recall bias could lead to an underestimation of CVD incidence, which might mean the observed association is even stronger than reported. This may introduce information bias and compromise the precision of outcome definitions. Future research could enhance the reliability of the conclusions by expanding the sample size, conducting multinational cohort comparisons, and employing objective clinical and imaging indicators for endpoint verification.

6. Conclusion

Higher levels of the modified cardiometabolic index exhibit an independent and dose-response positive correlation with the risk of cardiovascular disease incidence. These findings suggest that the modified cardiometabolic index can serve not only as an effective predictor of cardiovascular disease risk in middle-aged and elderly populations but also indicate that systematic monitoring and proactive intervention targeting this index hold significant clinical and public health importance for reducing the occurrence and progression of cardiovascular disease in this demographic. Therefore, when formulating cardiovascular disease prevention strategies for middle-aged and elderly populations, it is recommended to incorporate the modified cardiometabolic index into routine risk assessments, given that it can be calculated from simple, commonly available clinical measurements and represents a cost-effective screening tool. Effective management of this index should be achieved through lifestyle interventions and metabolic regulation, thereby providing a robust foundation for early prevention and control of cardiovascular disease.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] GBD 2019 Diseases and Injuries Collaborators (2020) Global Burden of 369 Diseases and Injuries in 204 Countries and Territories, 1990-2019: A Systematic Analysis for the Global Burden of Disease Study 2019. *The Lancet*, **396**, 1204-1222.

[2] Roth, G.A., Mensah, G.A., Johnson, C.O., Addolorato, G., Ammirati, E., Baddour, L.M., *et al.* (2020) Global Burden of Cardiovascular Diseases and Risk Factors, 1990-2019: Update from the GBD 2019 Study. *Journal of the American College of Cardiology*, **76**, 2982-3021. https://doi.org/10.1016/j.jacc.2020.11.010

[3] Chen, M., Xiong, S., Zheng, J., Zhang, J., Ye, D., Xian, Y., *et al.* (2025) Association between Cardiometabolic Index and Gestational Diabetes Mellitus: A Cross-Sectional Study. *Endocrine*, **87**, 569-577. https://doi.org/10.1007/s12020-024-04045-2

[4] GBD 2019 Risk Factors Collaborators (2020) Global Burden of 87 Risk Factors in 204 Countries and Territories, 1990-2019: A Systematic Analysis for the Global Burden of Disease Study 2019. *The Lancet*, **396**, 1223-1249.

[5] Wakabayashi, I. and Daimon, T. (2015) The "Cardiometabolic Index" as a New Marker Determined by Adiposity and Blood Lipids for Discrimination of Diabetes Mellitus. *Clinica Chimica Acta*, **438**, 274-278. https://doi.org/10.1016/j.cca.2014.08.042

[6] Tang, C., Pang, T., Dang, C., Liang, H., Wu, J., Shen, X., *et al.* (2024) Correlation between the Cardiometabolic Index and Arteriosclerosis in Patients with Type 2 Diabetes Mellitus. *BMC Cardiovascular Disorders*, **24**, Article No. 186. https://doi.org/10.1186/s12872-024-03853-8

[7] Dong, T., Lin, W., Zhou, Q., Yang, Y., Liu, X., Chen, J., *et al.* (2024) Association of Adiposity Indicators with Cardiometabolic Multimorbidity Risk in Hypertensive Patients: A Large Cross-Sectional Study. *Frontiers in Endocrinology*, **15**, Article ID: 1302296. https://doi.org/10.3389/fendo.2024.1302296

[8] Song, J., Li, Y., Zhu, J., Liang, J., Xue, S. and Zhu, Z. (2024) Non-Linear Associations of Cardiometabolic Index with Insulin Resistance, Impaired Fasting Glucose, and Type 2 Diabetes among US Adults: A Cross-Sectional Study. *Frontiers in Endocrinology*, **15**, Article ID: 1341828. https://doi.org/10.3389/fendo.2024.1341828

[9] Guo, Y., Su, W., Tao, L., Zhang, G. and Wang, K. (2025) The Association between Modified Cardiometabolic Index with Non-Alcoholic Fatty Liver Disease and Liver Fibrosis: A Cross-Sectional Study. *BMC Gastroenterology*, **25**, Article No. 265. https://doi.org/10.1186/s12876-025-03876-1

[10] Zhang, Q., Xiao, S., Jiao, X. and Shen, Y. (2023) The Triglyceride-Glucose Index Is a Predictor for Cardiovascular and All-Cause Mortality in CVD Patients with Diabetes or Pre-Diabetes: Evidence from NHANES 2001-2018. *Cardiovascular Diabetology*, **22**, Article No. 279. https://doi.org/10.1186/s12933-023-02030-z

[11] Dang, K., Wang, X., Hu, J., Zhang, Y., Cheng, L., Qi, X., *et al.* (2024) The Association between Triglyceride-Glucose Index and Its Combination with Obesity Indicators

and Cardiovascular Disease: NHANES 2003-2018. *Cardiovascular Diabetology*, **23**, Article No. 8. https://doi.org/10.1186/s12933-023-02115-9

[12] Li, W., Shen, C., Kong, W., Zhou, X., Fan, H., Zhang, Y., *et al.* (2024) Association between the Triglyceride Glucose-Body Mass Index and Future Cardiovascular Disease Risk in a Population with Cardiovascular-Kidney-Metabolic Syndrome Stage 0-3: A Nationwide Prospective Cohort Study. *Cardiovascular Diabetology*, **23**, Article No. 292. https://doi.org/10.1186/s12933-024-02352-6

[13] Liu, C., Liang, D., Xiao, K. and Xie, L. (2024) Association between the Triglyceride–glucose Index and All-Cause and CVD Mortality in the Young Population with Diabetes. *Cardiovascular Diabetology*, **23**, Article No. 171. https://doi.org/10.1186/s12933-024-02269-0

[14] Li, F., Wang, Y., Shi, B., Sun, S., Wang, S., Pang, S., *et al.* (2024) Association between the Cumulative Average Triglyceride Glucose-Body Mass Index and Cardiovascular Disease Incidence among the Middle-Aged and Older Population: A Prospective Nationwide Cohort Study in China. *Cardiovascular Diabetology*, **23**, Article No. 16. https://doi.org/10.1186/s12933-023-02114-w

[15] Zhao, Y., Hu, Y., Smith, J.P., Strauss, J. and Yang, G. (2012) Cohort Profile: The China Health and Retirement Longitudinal Study (Charls). *International Journal of Epidemiology*, **43**, 61-68. https://doi.org/10.1093/ije/dys203

[16] Marx, N., Federici, M., Schütt, K., Müller-Wieland, D., Ajjan, R.A., Antunes, M.J., *et al.* (2023) 2023 ESC Guidelines for the Management of Cardiovascular Disease in Patients with Diabetes. *European Heart Journal*, **44**, 4043-4140. https://doi.org/10.1093/eurheartj/ehad192

[17] American Diabetes Association (2020) 2. Classification and Diagnosis of Diabetes:*standards of Medical Care in Diabetes—2021. Diabetes Care*, **44**, S15-S33. https://doi.org/10.2337/dc21-s002

[18] Tao, L., Xu, J., Wang, T., Hua, F. and Li, J. (2022) Triglyceride-Glucose Index as a Marker in Cardiovascular Diseases: Landscape and Limitations. *Cardiovascular Diabetology*, **21**, Article No. 68. https://doi.org/10.1186/s12933-022-01511-x

[19] Kosmas, C.E., Bousvarou, M.D., Kostara, C.E., Papakonstantinou, E.J., Salamou, E. and Guzman, E. (2023) Insulin Resistance and Cardiovascular Disease. *Journal of International Medical Research*, **51**, 1-49. https://doi.org/10.1177/03000605231164548

[20] Rao, X., Xin, Z., Yu, Q., Feng, L., Shi, Y., Tang, T., *et al.* (2025) Triglyceride-Glucose-body Mass Index and the Incidence of Cardiovascular Diseases: A Meta-Analysis of Cohort Studies. *Cardiovascular Diabetology*, **24**, Article No. 34. https://doi.org/10.1186/s12933-025-02584-0

[21] Elagizi, A., Kachur, S., Carbone, S., Lavie, C.J. and Blair, S.N. (2020) A Review of Obesity, Physical Activity, and Cardiovascular Disease. *Current Obesity Reports*, **9**, 571-581. https://doi.org/10.1007/s13679-020-00403-z

[22] Salama, M., Balagopal, B., Fennoy, I. and Kumar, S. (2023) Childhood Obesity, Diabetes, and Cardiovascular Disease Risk. *The Journal of Clinical Endocrinology & Metabolism*, **108**, 3051-3066. https://doi.org/10.1210/clinem/dgad361

[23] Chartrand, D.J., Murphy-Després, A., Alméras, N., Lemieux, I., Larose, E. and Després, J. (2022) Overweight, Obesity, and CVD Risk: A Focus on Visceral/Ectopic Fat. *Current Atherosclerosis Reports*, **24**, 185-195. https://doi.org/10.1007/s11883-022-00996-x

[24] Tutor, A.W., Lavie, C.J., Kachur, S., Milani, R.V. and Ventura, H.O. (2023) Updates on Obesity and the Obesity Paradox in Cardiovascular Diseases. *Progress in Cardiovascular Diseases*, **78**, 2-10. https://doi.org/10.1016/j.pcad.2022.11.013