

中文摘要

TyG 相关指数、肥胖指数和脂质比中老年人人群

糖尿病发病的预测价值

目的:

在全球范围内,糖尿病及其并发症已成为了全球重大公共卫生问题,对人类健康造成了严重威胁。糖尿病的早期治疗可有效降低糖尿病不良结局的风险。因此需要有效的筛查策略和早期检测指标预测糖尿病的发病风险。胰岛素抵抗(IR)在糖尿病和其他代谢相关疾病的发病机制中起着关键作用,并且在糖尿病确诊之前就已经出现。有研究指出甘油三酯-葡萄糖(TyG)相关指数、肥胖指数和脂质比等指标与 IR 相关,可能有助于识别糖尿病。目前关于各指标与糖尿病发病风险关系的研究结果并不一致,并且尚无研究系统的评估和比较 TyG 相关指数、肥胖指数和脂质比在中国中老年人中对糖尿病发病的预测价值,同时尚无研究探索上述指标的预测价值与糖尿病患者基线血糖状态的关系。在本研究中,我们将通过一项针对中国中老年人队列研究,评估 TyG 指数与糖尿病风险的相关性,并比较在不同血糖状态下 TyG 相关指数、肥胖指数和脂质比对糖尿病发病风险的预测能力,以便能及时筛选出糖尿病发病的高危人群,为糖尿病的早期预防和管理工作提供理论支持。

方法:

本研究使用的数据来源于中国健康与养老追踪调查(CHARLS)中 2011 年基线及 2013、2015、2018 年的随访数据,以 45 岁以上的中老年人人群为研究对象。根据基线血糖状态分为正常空腹血糖(NFG)组和空腹血糖受损(IFG)组。采用 Kaplan-Meier 法和 log-rank 检验观察和比较不同组间发病时间的差异。采用 Cox 比例风险模型评价 TyG 指数与糖尿病发病风险之间的关联。通过限制性立方样条探讨 TyG 指数与糖尿病发病风险之间的剂量-反应关系。为比较不同指标对糖尿病发病的预测价值,以 TyG-体重指数(BMI)、TyG-腰围(WC)、TyG-腰高比(WHtR)、内脏脂肪指数(VAI)、脂质蓄积产物(LAP)、甘油三酯(TG)/高密度脂蛋白胆固醇(HDL-C)、总胆固醇(TC)/HDL-C 四分位数分组为自变量,计算对于新

发糖尿病的 HR 和 95%CI。受试者工作特征曲线(ROC)下面积(AUC)用于检测基线时各指标对随访时糖尿病发病风险的预测能力。本研究采用 R 4.1.1 软件进行统计分析, 双侧 $P < 0.05$ 定义为差异有统计学意义。

结果:

1. 本研究共纳入研究对象 6258 人。按照基线血糖状态分组, NFG 组为 2970 人, IFG 组为 3288 人, IFG 组人群的年龄中位数较大($P < 0.001$), 高血压(23.8%)和心脏病史(11.3%)人口比例较高($P < 0.05$)。NFG 组人群 HDL-C 水平较高, 其他体检及血液指标水平较低($P < 0.05$)。在总人群中, 糖尿病发病率为 13.7%, 其中 NFG 组糖尿病发病率为 9.4%, IFG 组人群糖尿病发病率为 17.6%。糖尿病累积发病率在基线不同血糖状态之间差异有统计学意义($P < 0.001$)。

2. 在总人群和不同血糖状态人群中, 糖尿病发病风险与基线 TyG 水平呈正相关($P < 0.05$)。限制性立方样条结果显示, TyG 指数与糖尿病发病风险之间呈线性相关。

3. 在调整了年龄、饮酒、教育程度、高血压和心脏病史等协变量后, NFG 组中, TyG-BMI、TyG-WHtR、TyG-WC 的 Q4 组新发糖尿病的 HR 分别为对应 Q1 组的 1.84、1.61 和 1.82 倍, VAI、LAP、TG/HDL-C 和 TC/HDL-C 的 Q4 组新发糖尿病的危险度分别为 Q1 组的 2.04、1.57、1.67 和 1.41 倍。IFG 组中, TyG-BMI、TyG-WHtR、TyG-WC 的 Q4 组新发糖尿病的危险度分别为 Q1 组的 2.53、2.27、2.45 倍, VAI、LAP、TG/HDL-C 和 TC/HDL-C 的 Q4 组新发糖尿病的危险度分别为 Q1 组的 2.01、2.02、1.83 和 1.86 倍。

4. 根据调查对象的各指标水平与糖尿病发病风险的关系绘制 ROC 曲线。在总人群和 NFG 组中, TyG-WHtR 对糖尿病发病风险的预测价值最高, AUC 值分别为 0.658 和 0.613。在 IFG 组中, TyG-BMI 预测糖尿病发病风险的能力强于其他指标, AUC 值为 0.643。

5. 按年龄分层, 分析各指标对糖尿病发病风险的预测价值。结果显示, 在 65 岁以下人群中, 各指标中 TyG-WHtR 对糖尿病发病风险的预测价值最高, 在 65 岁及以上人群中, 在 NFG 组中各指标对糖尿病发病风险的预测价值均降低。在 IFG 组中, TyG-BMI 对新发糖尿病的预测价值最高。

结论:

1. 在中国中老年人群中, TyG 指数与糖尿病发病风险之间呈正相关, 且相关性呈线性。TyG 相关指数、肥胖指数和脂质比与中国中老年人群中糖尿病发病存在关联。

2. TyG 相关指数、肥胖指数和脂质比在不同人群中预测糖尿病的发病能力存在差异, 在总人群和 NFG 组人群中, TyG-WHtR 预测糖尿病发病风险的能力相对较好, 在 IFG 组人群中, TyG-BMI 预测糖尿病发病风险的能力相对较好。

关键词:

糖尿病, TyG 指数, 肥胖, 血脂比, CHARLS

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Abstract

Predictive value of TyG-related indices, obesity indices, and lipid ratios on the onset of diabetes in middle-aged and elderly populations

Objective:

On a global scale, diabetes and its complications have become a major public health problem worldwide, posing a serious threat to human health. Early and timely treatment of diabetes can effectively reduce the risk of adverse outcomes of diabetes. Therefore, effective screening strategies and early detection indicators are needed to predict the risk of diabetes. Insulin resistance (IR) plays a pivotal role in the pathogenesis of diabetes and other metabolic-related diseases and occurs before the diagnosis of diabetes. Indicators such as triglyceride-glucose (TyG) correlation index, adiposity index, and lipid ratio are associated with IR and may be helpful in identifying diabetes. The research results on the relationship between various indicators and the risk of diabetes were not consistent, and there was no systematic evaluation and comparison of the TyG-related parameters, obesity indices, and lipid ratios in the middle-aged and elderly Chinese population for the prediction value of new-onset diabetes. No study explored the relationship between the predictive value of the above indicators and the baseline blood glucose status of patients with new-onset diabetes. In this study, we evaluated the correlation between the TyG index and the risk of diabetes through the middle-aged and elderly people in China, and compared the predictive ability of the TyG-related indices, obesity indices, and lipid ratios on the risk of diabetes in different blood glucose states, so as to screen out the high-risk population of diabetes in time, and provide new data support for the early prevention and management of diabetes.

Methods:

The data used in this study was based on the 2011 baseline and 2013, 2015, and 2018 follow-up data of the China Health and Retirement Longitudinal Study

(CHARLS), and the middle-aged and elderly people over 45 years old were selected as the research objects. According to the baseline blood glucose status, they were divided into normal fasting glucose (NFG) group and impaired fasting glucose (IFG) group. The Kaplan-Meier method and log-rank test were used to observe and compare the differences in onset time between different groups. Cox proportional hazards model was used to evaluate the association between TyG index and the risk of diabetes. The dose-response relationship between the TyG index and the risk of new-onset diabetes after adjusting for potential confounding factors was explored by restricted cubic spline fitting. In order to compare the diagnostic value of different indicators for new-onset diabetes, TyG-body mass index (BMI), TyG-waist circumference (WC), TyG-waist height ratio (WHtR), visceral fat index (VAI), lipid accumulation product (LAP), triglyceride (TG)/high-density lipoprotein cholesterol (HDL-C), and total cholesterol (TC)/HDL-C quartiles were used as independent variables, and the HR and 95%CI for new-onset diabetes were calculated. The area under the receiver operating characteristic curve (ROC) was used to detect the predictive ability of each index at baseline to the risk of new-onset diabetes at follow-up. In this study, R 4.1.1 software was used for statistical analysis, and bilateral $P < 0.05$ was defined as a statistically significant difference.

Results:

1. A total of 6258 subjects were included in this study. According to the baseline blood glucose status, there were 2970 people in the NFG group and 3288 people in the IFG group. The average age of the people in the IFG group was older, and the proportion of people with high blood pressure history (23.8%) and heart disease history (11.3%) was higher ($P < 0.05$). The HDL-C level of the NFG group was higher, and the levels of other physical examination and blood indicators were lower ($P < 0.05$). In total population, the incidence of diabetes was 13.7%, among which the incidence of diabetes in NFG group was 9.4%, and the incidence of diabetes in IFG group was 17.6%. The cumulative incidence of diabetes was significantly different among different glycemic states at baseline ($P < 0.001$).

2. In the general population and populations with different blood glucose status, the risk of diabetes was positively correlated with the baseline TyG level($P<0.05$). Restricted cubic spline results showed that there was a linear correlation between TyG index and the risk of new-onset diabetes.

3. After adjusting covariates such as age, alcohol consumption, education level, history of hypertension, and history of heart disease, in the NFG group, the risk of new-onset diabetes in the Q4 group of TyG-BMI, TyG-WHtR, and TyG-WC was 1.84, 1.61, and 1.82 times that of the Q1 group, respectively. The risk of new-onset diabetes in Q4 group of VAI, LAP, TG/HDL-C and TC/HDL-C was 2.04, 1.57, 1.67 and 1.41 times that of Q1 group, respectively. In the IFG group, the risk of new-onset diabetes in the Q4 group of TyG-BMI, TyG-WHtR, and TyG-WC was 2.53, 2.27, and 2.45 times that of the Q1 group, respectively. The risk of new-onset diabetes in Q4 group of VAI, LAP, TG/HDL-C and TC/HDL-C was 2.01, 2.02, 1.83 and 1.86 times that of Q1 group, respectively.

4. ROC curve was drawn according to the relationship between the level of each index and the risk of diabetes. In the general population and the NFG group, TyG-WHtR had the highest predictive value for the risk of diabetes, with AUC values of 0.658 and 0.613, respectively. In the IFG group, the ability of TyG-BMI to predict the risk of diabetes was stronger than other indicators, with an AUC value of 0.643.

5. The predictive value of each index to diabetes risk was analyzed by age stratification. The results showed that when the age was <65 years old, the predictive value of TyG-WHtR for the risk of diabetes was the highest among all indicators, and when the age was ≥ 65 years old, the predictive value of all indicators for the risk of diabetes in the NFG group decreased. In the IFG group, TyG-BMI had the highest predictive value for new onset diabetes.

Conclusion:

1. In the middle-aged and elderly population in China, there was a positive correlation between TyG index and the risk of diabetes, and the correlation was linear. TyG-related parameters, obesity indices, and lipid ratios were associated with the

incidence of diabetes in middle-aged and elderly Chinese population.

2. TyG-related indices, obesity indices, and lipid ratios had different predictive abilities of diabetes onset in different populations. In the general population and NFG group, the ability of TyG-WHtR to predict the risk of diabetes was relatively better. In the IFG group, the ability of TyG-BMI to predict the risk of diabetes was relatively better.

Keywords:

diabetes mellitus, Triglyceride glucose index, obesity, lipid ratios, CHARLS

目 录

中文摘要	I
Abstract.....	IV
第 1 章 绪 论.....	1
1.1 糖尿病的流行病学特征.....	1
1.2 TyG 相关指数、肥胖指数和脂质比与糖尿病相关研究.....	3
1.2.1 TyG 相关指数与糖尿病.....	3
1.2.2 肥胖指数与糖尿病.....	4
1.2.3 脂质比与糖尿病.....	5
1.3 研究目的及意义.....	6
第 2 章 材料与方法	7
2.1 研究对象.....	7
2.1.1 数据来源.....	7
2.1.2 研究对象.....	7
2.2 研究变量及定义.....	8
2.2.1 糖尿病定义及分组.....	8
2.2.2 其他变量定义.....	8
2.3 评价指标计算公式.....	9
2.4 统计学方法.....	10
2.5 质量控制.....	10
第 3 章 结 果.....	11
3.1 研究对象的基本情况.....	11
3.1.1 研究对象的一般人口学情况.....	11
3.1.2 研究对象的体检及血液指标情况.....	12
3.2 研究对象糖尿病发病情况.....	13
3.2.1 总人群的糖尿病发病情况.....	13
3.2.2 不同血糖状态人群的糖尿病发病情况.....	15

3.3 研究对象 TyG 指数与糖尿病发病的关系.....	18
3.3.1 总人群中 TyG 指数与糖尿病发病的关系.....	18
3.4 TyG 相关指标与糖尿病发病的关系.....	22
3.4.1 TyG-BMI 与糖尿病发病的关系.....	22
3.4.2 TyG-WHtR 与糖尿病发病的关系.....	23
3.4.3 TyG-WC 与糖尿病发病的关系.....	24
3.5 肥胖指标与糖尿病发病的关系.....	25
3.5.1 VAI 与糖尿病发病的关系.....	25
3.5.2 LAP 与糖尿病发病的关系.....	26
3.6 脂质指标与糖尿病发病的关系.....	27
3.6.1 TG/HDL-C 与糖尿病发病的关系.....	27
3.6.2 TC/HDL-C 与糖尿病发病的关系.....	28
3.7 ROC 曲线分析不同指标对糖尿病发病风险的预测价值.....	30
3.7.1 总人群中 ROC 曲线分析不同指标对糖尿病发病风险的预测价值.....	30
3.7.2 不同糖代谢人群中 ROC 曲线分析不同指标对糖尿病发病的预测价值.....	31
3.8 不同指标对糖尿病发病预测价值的亚组分析.....	33
3.8.1 不同年龄的不同指标对糖尿病发病预测价值.....	33
第 4 章 讨 论.....	35
4.1 研究对象糖尿病发病情况.....	35
4.2 研究对象 TyG 指数与糖尿病发病的相关性.....	36
4.3 TyG 相关指标、肥胖指标和脂质指标与糖尿病发病的相关性.....	37
4.3.1 TyG 相关指标与糖尿病发病的相关性.....	37
4.3.2 肥胖指标与糖尿病发病的相关性.....	38
4.3.3 脂质指标与糖尿病发病的相关性.....	39
4.4 TyG 相关指标、肥胖指标和脂质指标对糖尿病预测能力的比较.....	40
4.5 不同指标对糖尿病发病预测价值的亚组分析.....	41
4.6 研究的临床及公共卫生意义.....	42
第 5 章 结 论.....	43

参考文献	44
作者简介及在学期间所取得的科研成果	59
致谢.....	62

英文缩略词表

英文缩写	英文全称	中文全称
DM	Diabetes Mellitus	糖尿病
IR	Insulin Resistance	胰岛素抵抗
IDF	International Diabetes Federation	国际糖尿病联合会
COVID-19	Corona Virus Disease 2019	新型冠状病毒肺炎
T2DM	Type 2 Diabetes Mellitus	2 型糖尿病
preDM	Prediabetes Mellitus	糖尿病前期
IFG	Impaired Fasting Glucose	空腹血糖受损
IGT	Impaired Glucose Tolerance	糖耐量受损
HIEC	The Hyperinsulinemic-Euglycemic Clamp Technique	高胰岛素-正常血糖钳夹试验
HOMA-IR	Homeostasis Model Assessment-IR	稳态模型评估胰岛素抵抗指数
TyG	Triglyceride-Glucose	甘油三酯-葡萄糖
TG	Triglyceride	甘油三酯
FPG	Fasting Plasma Glucose	空腹血糖
BMI	Body Mass Index	体重指数
WC	Waistline Circumference	腰围
WHtR	Waist-to-Height Ratio	腰高比
MRI	Magnetic Resonance Imaging	磁共振成像
CT	Computed Tomography	计算机断层扫描
LAP	Lipid Accumulation Product	脂质蓄积产物
VAI	Visceral Adiposity Index	内脏脂肪指数
HDL-C	High Density Lipoprotein Cholesterol	高密度脂蛋白胆固醇
TC	Total Cholesterol	总胆固醇
LDL-C	Low Density Lipoprotein Cholesterol	低密度脂蛋白胆固醇

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