·论著·

TyG-WHtR指数与中青年急性冠脉综合征患者冠状动脉病变程度的相关性

刘欣然,马晶茹,华冰洋,苏晓港,李俊杰
(沈阳医学院附属第二医院心血管内科,沈阳 110035)

摘要 **目的** 探讨甘油三酯-葡萄糖-腰高比(TyG-WHtR)指数与中青年急性冠脉综合征(ACS)患者冠状动脉病变程度的相关性。**方法** 选取2024年1月1日至2024年12月31日间于沈阳医学院附属第二医院首次诊断为ACS的572例中青年患者作为研究对象,计算其TyG-WHtR指数、TyG指数、Gensini评分(GS)。采取三分位法将研究对象分为低、中、高TyG-WHtR组,比较组间临床资料差异,分析TyG-WHtR指数与冠状动脉病变程度的相关性。**结果** 高TyG-WHtR组的GS明显高于低TyG-WHtR组和中TyG-WHtR组。相关性分析显示,TyG-WHtR指数与GS呈正相关($r = 0.695$,$P < 0.001$)。调整混杂因素后构建多元线性回归模型,结果发现TyG-WHtR指数为GS升高的独立危险因素。TyG-WHtR指数每增加1个单位,GS将升高29.415分(β= 29.415,$P = 0.014$)。当TyG-WHtR指数>4.85时,其对GS具有较好的预测效能。**结论** TyG-WHtR指数与中青年ACS患者冠状动脉病变严重程度呈正相关,且是其独立危险因素。高水平TyG-WHtR指数对于中青年ACS患者冠状动脉病变程度有预测价值。

关键词 甘油三酯-葡萄糖-腰高比指数;中青年;急性冠脉综合征;冠状动脉病变
中图分类号 R541.4 **文献标志码** A **文章编号** 0258-4646(2026)01-0015-05
网络出版地址 https://link.cnki.net/urlid/21.1227.R.20260105.1555.020
DOI: 10.12007/j.issn.0258-4646.2026.01.003

Corrnelation between TyG-WHtR index and the severity of coronary artery lesions in young and middle-aged patients with acute coronary syndrome

LIU Xinran, MA Jingru, HUA Bingyang, SU Xiaogang, LI Junjie
(Department of Cardiovascular Medicine, Second Hospital Affiliated to Shenyang Medical College, Shenyang 110035, China)

Abstract **Objective** To explore the correlation between the triglyceride-glucose-waist-to-height ratio (TyG-WHtR) index and the severity of coronary artery lesions in young and middle-aged patients with acute coronary syndrome (ACS). **Methods** A total of 572 young and middle-aged patients diagnosed with ACS at Second Hospital Affiliated to Shenyang Medical College from January 1, 2024 to December 31, 2024 were enrolled. The TyG-WHtR index, TyG index, and Gensini score (GS) were calculated, and the samples were divided into three groups (low, moderate, and high TyG-WHtR) using the tertile method. Differences in clinical data among the groups were compared, and the correlation between TyG-WHtR index and severity of coronary artery lesions was analyzed. **Results** The GS was significantly higher in the high TyG-WHtR group than in the low and moderate TyG-WHtR groups. Notably, the TyG-WHtR index positively correlated with the GS ($r = 0.695$, $P < 0.001$). In the multiple linear regression model constructed after adjusting for confounding factors, the TyG-WHtR index was identified as an independent risk factor for elevated GS; each 1-unit increase in the TyG-WHtR index was associated with a 29.415-point increase in GS (β=29.415, $P = 0.014$). A TyG-WHtR index of >4.85 indicated good predictive efficacy for GS aggravation. **Conclusion** The severity of coronary artery lesions in young and middle-aged patients with ACS positively correlated with the TyG-WHtR index, which serves as an independent risk factor for GS aggravation. A high TyG-WHtR index has predictive value for the severity of coronary artery lesions in young and middle-aged patients with ACS.

Keywords triglyceride-glucose-waist-to-height ratio index; young and middle-aged; acute coronary syndrome; coronary artery lesions

近年来,中青年急性冠脉综合征(acute coronary syndrome, ACS)的发病率呈逐年上升趋势[1]。冠状动脉病变程度直接影响ACS患者的治疗方案选择与远期预后[2-3]。因此,寻找能够有效评估和预测其冠状动脉病变程度的指标对疾病的早期干预和管理具有重要意义[4]。

基金项目:辽宁省科学技术计划(2023JH2/101300086);辽宁省教育厅基本科研项目(LJKMZ20221778);沈阳医学院硕士研究生科技创新基金(Y20240544)
作者简介:刘欣然(1997-),女,医师,硕士.
通信作者:马晶茹,E-mail:majingru1218@163.com
收稿日期:2025-08-28
网络出版时间:2026-01-06 09:33:16

甘油三酯–葡萄糖（triglyceride- glucose，TyG）指数作为一种反映胰岛素抵抗和代谢紊乱的简易指标，已被证实与冠状动脉粥样硬化性心脏病等心血管疾病的发生和发展密切相关[5-6]；而腰高比（waist-to-height ratio，WHtR）能较好地反映中心性肥胖情况，其与心血管疾病的关联也得到了诸多研究的支持[7]。然而，将TyG指数与WHtR相结合形成的TyG-WHtR指数在评估中青年ACS患者冠状动脉病变程度中的作用尚未明确，因此，本研究拟探讨二者之间的相关性。

1　材料与方法

1.1　研究对象

选取2024年1月1日至2024年12月31日间于沈阳医学院附属第二医院首次诊断为ACS的572例中青年患者作为研究对象。参考中华医学会心血管病学分会、中华心血管病杂志编辑委员会经皮冠状动脉介入治疗指南（2025年）[8]的年龄划分标准，本研究将中青年人群年龄界定为17~59岁。572例中青年ACS患者中，男330例，女242例。纳入标准：均符合《2023 ESC急性冠脉综合征治疗指南》[9]中ACS的诊断标准；病历资料完整；均行冠状动脉造影检查。排除标准：有ACS既往史；有其他心脏疾病（包括重度先天性心脏病、瓣膜病、心肌病、心肌炎）；入院时合并严重的其他系统疾病（包括血液系统疾病、消化系统疾病、脑血管疾病、肿瘤等）；入院前接受过糖皮质激素、免疫抑制剂治疗。本研究经沈阳医学院附属第二医院医学伦理委员会批准（2025–沈医二院伦理–fs060）。所有患者签署知情同意书。

1.2　方法

1.2.1　资料收集：通过我院电子病历系统采集临床数据，计算相关指标。TyG指数=ln[甘油三酯（mg/dL）× 空腹血糖（mg/dL）/2]；WHtR=腰围（cm）/身高（cm）；TyG-WHtR指数=TyG指数 × WHtR；冠状动脉病变程度的评估指标Gensini评分（Gensini score，GS）=病变节段的狭窄评分 × 病灶部位系数之和。

1.2.2　分组：根据TyG-WHtR指数值，采用三分位数法将患者分为低TyG-WHtR组（TyG-WHtR指数≤4.559，n = 190）、中TyG-WHtR组（TyG-WHtR指数>4.559~5.025，n = 191）、高TyG-WHtR组（TyG-WHtR指数>5.025，n = 191）。

1.3　统计学分析

采用SPSS 29.0软件进行统计分析。计量资料用$M(P_{25}\sim P_{75})$表示，采用Kruskal-Wallis非参数检验进行组间比较。计数资料用率（%）表示，采用χ^2检验进行组间比较。计算Spearman相关系数，用多元线性回归分析影响因素。绘制受试者操作特征（receiver operating characteristic，ROC）曲线，计算曲线下面积（area under the curve，AUC）。所有检验为双侧检验，$P<0.05$为差异有统计学意义。

2　结果

2.1　3组患者基线特征比较

如表1所示，低、中、高TyG-WHtR组GS、糖尿病史、服降糖药物史、高血压病史、腰围（waist circumference，WC）、臀围（hip circumference，Hip）、WHtR、体重指数（body mass index，BMI）、高密度脂蛋白胆固醇（high-density lipoprotein cholesterol，HDL-C）、N末端脑钠肽前体（N-terminal pro-brain natriuretic peptide，NT-proBNP）、甘油三酯、空腹血糖（fasting plasma glucose，FPG）、TyG指数、ST段抬高型心肌梗死（ST-segment elevation myocardial infarction，STEMI）等14项指标比较，差异均有统计学意义（均$P<0.05$）。3组年龄、性别、体重、低密度脂蛋白胆固醇（low-density lipoprotein cholesterol，LDL-C）、不稳定型心绞痛和非ST段抬高型心肌梗死比较，差异无统计学意义（$P>0.05$）。

2.2　各指标与GS的相关性

将存在组间差异的变量及TyG-WHtR指数等指标设为自变量，计算Spearman相关系数，分析其与GS的关系。如表2所示，糖尿病史、服降糖药史、WC、Hip、甘油三酯、FPG、WHtR、BMI、TyG指数、TyG-WHtR指数、STEMI例数与GS呈正相关（$P<0.05$）。HDL-C与GS呈负相关（$P<0.05$）。此外，TyG-WHtR指数与GS的相关性（$r=0.695$）高于TyG指数（$r=0.428$）和WHtR（$r=0.423$）。

2.3　冠状动脉病变的独立危险因素

以GS为因变量，纳入TyG-WHtR指数为主要自变量，调整性别、年龄等混杂因素后构建多元线性回归模型。结果如表3所示，TyG-WHtR指数为GS升高的独立危险因素，TyG-WHtR指数每增加1个单位，GS升高29.415分（β=29.415，$P=0.014$）。

表1　低、中、高TyG-WHtR组ACS患者基线临床特征比较

Tab.1　Comparison of baseline clinical characteristics of ACS patients in the low，medium，and high TyG-WHtR groups

Variable	Low TyG-WHtR group (n = 190)	Medium TyG-WHtR group (n = 191)	High TyG-WHtR group (n = 191)	H/χ^2	P
Age (year)	54.00 (49.50–69.00)	57.00 (50.25–71.00)	55.00 (50.50–70.00)	3.21	0.201
Male [n (%)]	100 (52.6)	103 (54.0)	127 (66.5)	2.43	0.297
Gensini score	23.00 (9.50–59.00)	50.00 (22.50–67.50)	90.00 (63.50–102.00)	54.23	<0.001
History of diabetes [n (%)]	37 (19.5)	72 (38.0)	86 (45.0)	7.84	0.020
Diabetes medication [n (%)]	37 (19.5)	69 (36.1)	82 (42.9)	6.72	0.035
History of hypertension [n (%)]	29 (15.3)	45 (23.6)	56 (29.3)	6.56	0.044
Weight (kg)	67.00 (60.00–78.50)	69.00 (61.50–75.00)	72.00 (65.00–80.50)	2.38	0.096
WC (cm)	82.00 (79.00–90.00)	89.00 (84.50–91.00)	92.00 (90.00–95.50)	42.59	<0.001
Hip (cm)	101.00 (98.00–103.50)	101.00 (98.25–105.00)	104.00 (101.50–109.00)	14.65	<0.001
HDL-C (mmol/L)	1.300 (1.170–1.560)	1.270 (1.083–1.505)	1.210 (1.040–1.315)	10.12	0.006
LDL-C (mmol/L)	2.09 (1.630–2.885)	2.34 (1.855–2.893)	2.50 (1.950– 3.020)	2.54	0.281
NT-proBNP (pg/mL)	123.25 (62.550–182.400)	142.70 (121.938–408.100)	81.20 (60.150–240.950)	6.81	0.033
TG (mg/dL)	79.713 (59.342–113.369)	114.255 (92.334–144.148)	180.683 (142.155–253.310)	65.5	<0.001
FPG (mg/dL)	107.28 (99.090–116.370)	113.31 (99.405–131.535)	117.18 (105.840–150.300)	13.06	0.002
WHtR	0.500 (0.481–0.523)	0.525 (0.514–0.542)	0.561 (0.530–0.584)	54.98	<0.001
BMI (kg/m^2)	24.741 (22.485–27.615)	24.990 (22.290–27.495)	26.037 (24.195–28.770)	4.55	0.012
TyG	8.292 (8.102–8.759)	8.807 (8.575–8.963)	9.371 (9.041–9.726)	71.18	<0.001
UAP [n (%)]	100 (52.6)	98 (51.3)	77 (40.3)	3.26	0.087
NSTEMI [n (%)]	68 (35.8)	61 (31.9)	71 (37.2)	4.33	0.347
STEMI [n (%)]	22 (11.6)	32 (16.8)	43 (22.5)	7.65	0.035

WC, waist circumference; Hip, hip circumference; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; NT-proBNP, N-terminal pro-brain natriuretic peptide; TG, triglyceride; FPG, fasting plasma glucose; WHtR, waist-to-height ratio; BMI, body mass index; TyG, triglyceride-glucose; UAP, unstable angina pectoris; NSTEMI, non-ST-segment elevation myocardial infarction; STEMI, ST-segment elevation myocardial infarction.

表2　各指标与GS的Spearman相关性分析结果

Tab.2　Results of Spearman correlation analysis between each indicator and GS

Variable	Spearman (r)	P
History of diabetes	0.235	0.004
Diabetes medication	0.265	0.001
History of hypertension	0.260	0.451
WC	0.447	<0.001
Hip	0.342	<0.001
HDL-C	−0.515	0.006
NT-proBNP	0.082	0.335
TG	0.359	<0.001
FPG	0.310	<0.001
WHtR	0.423	<0.001
BMI	0.213	0.008
TyG	0.428	<0.001
TyG-WHtR	0.695	<0.001
STEMI	0.597	<0.001

2.4　TyG-WHtR指数、TyG指数和WHtR预测冠状动脉病变的效能

采用GS中位数（37.00）作为二分类界值（GS≥37.0分为高病变组，GS< 37.0为低病变组）绘制ROC

曲线，比较TyG-WHtR指数、TyG指数和WHtR这3项指标预测冠状动脉病变程度的效能。结果显示，TyG-WHtR指数的AUC（0.797）高于TyG指数（0.782）和WHtR（0.759），差异有统计学意义（$P < 0.05$）。TyG-WHtR指数的最佳截断值为4.85，灵敏度为0.812，特异度为0.883，因此，TyG-WHtR指数对冠状动脉病变程度的预测效能优于TyG指数和WHtR。见表4、图1。

表3　以TyG-WHtR指数为主要自变量的多元线性回归分析结果

Tab.3　Results of multiple linear regression analysis with TyG-WHtR index as the main variable

Variable	β	*SE*	*t*	*P*
TyG-WHtR	29.415	12.136	2.284	0.014
WC	0.125	0.750	0.167	0.868
FPG	3.305	2.050	1.612	0.109
TG	2.380	3.717	0.640	0.523
HDL-C	−1.478	9.747	−0.152	0.880
History of diabetes	−26.782	15.083	−1.776	0.078
Diabetes medication	−27.352	15.055	−1.676	0.058
NT-proBNP	0.000	0.001	0.425	0.672
Age	−0.156	0.234	−0.665	0.507
Male	13.152	7.081	1.857	0.065

表4　TyG-WHtR指数、TyG指数和WHtR预测冠状动脉病变程度的效能比较

Tab.4　Comparison of the efficacy of TyG-WHtR index，TyG index，and WHtR in predicting GS

Variable	AUC	95%*CI*	Optimal cut-off value	Sensitivity	Specificity	*P*
TyG-WHtR	0.797	0.711–0.873	4.85	0.812	0.883	0.002
TyG	0.782	0.698–0.868	831.21	0.802	0.728	0.004
WHtR	0.759	0.679–0.857	0.54	0.790	0.707	0.025

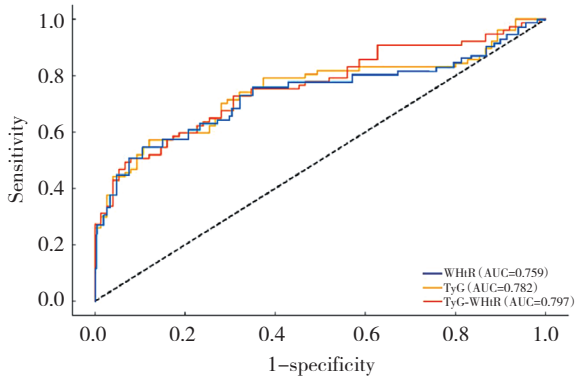


图1　TyG-WHtR指数、TyG指数和WHtR预测冠状动脉病变程度的ROC曲线

Fig.1　ROC curves for predicting the severity of coronary artery lesions by the TyG-WHtR index，TyG index，and WHtR

3　讨论

随着医学技术的不断发展，ACS的循证管理已取得显著进展，但在全球范围内仍有较高的致残率和致死率[10]。根据全球ACS注册研究[11]数据显示，ACS患者1年内死亡率约为15%，5年累积死亡率可达20%，其中中青年人群中占比已达20%~30%[12]。因此，识别并干预中青年ACS患者的高危因素具有重要的临床意义。

本研究发现，TyG-WHtR指数与中青年ACS患者冠状动脉病变程度（以GS衡量）呈显著正相关（$r = 0.695$），且相关性高于TyG指数、WHtR等单一指标。TyG-WHtR指数整合了糖脂代谢异常（通过TyG指数反映甘油三酯与血糖的交互影响）与中心性肥胖（通过WHtR体现腰围与身高的比例，更精准刻画内脏脂肪堆积）[13]。中青年患者ACS中，糖脂代谢紊乱易引发血管内皮损伤，脂质沉积形成动脉粥样硬化斑块[14-15]；中心性肥胖则通过炎性细胞因子释放、胰岛素抵抗加剧等加速斑块进展与血管狭窄[16-17]，二者协同作用使TyG-WHtR指数成为冠状动脉病变程度更敏锐的“监测器”，解释了其与GS高相关性的病理生理基础。随着心血管-肾脏综合征分期进展，

TyG-WHtR指数与动脉僵硬度同步升高。以上均提示TyG-WHtR指数可能是冠状动脉损伤的早期潜在标志物。

本研究根据TyG-WHtR指数值将患者按照三分位法分组，结果发现，高TyG-WHtR组中STEMI的例数约为低TyG-WHtR组的2倍。说明TyG-WHtR指数所反映的胰岛素抵抗和中心性肥胖二者协同能进一步加剧血管损伤和血栓的风险，因此，STEMI的例数也增加。本研究还发现，糖尿病史、降糖药使用、WC、Hip、甘油三酯、FPG、BMI等与GS均呈正相关，反映了糖代谢异常、肥胖表型对冠状动脉病变的推动作用；HDL-C则与GS呈负相关，因HDL-C具备逆向转运胆固醇、抗炎抗氧化功能，其水平降低削弱了对冠状动脉的保护，这也从侧面验证了TyG-WHtR指数关联分析的合理性。

中青年ACS患者往往对疾病重视不足、危险因素控制不佳。TyG-WHtR指数简便易测（结合FPG、甘油三酯、身高、WC数据），可作为ACS的早期筛查工具。同时，本研究提示需综合管控多重危险因素，针对糖尿病、肥胖等进行多维度干预，为中青年ACS患者的二级预防提供了方向。本研究结果未来仍需在更大样本、更多人群中进一步验证，并结合纵向随访及其他代谢及炎症指标，验证TyG-WHtR指数对冠状动脉病变进展的预测价值；还可深入探究其与新型危险因素（如肠道菌群、遗传标志物）的交互作用，进一步完善中青年ACS发病机制与防控策略体系。

参考文献：

[1] KAUL U, SETHI R, ROY S, et al. Morphological characterization of coronary plaques in young Indian patients with acute coronary syndrome: a multicentric study [J]. Indian Heart J, 2024, 76 (6): 370-375. DOI: 10.1016/j.ihj.2024.11.001.

[2] STILES SL, STACEY I, KATZENELLENBOGEN JM, et al. Trends in acute coronary syndrome hospitalisation, incidence and mortality rates in young adults: an Australian linked data study [J]. J Epidemiol Community Health, 2025, 79 (8): 580-587. DOI: 10.1136/jech-2024-223615.

[3] ZHENG J, LI JY, LI TT, et al. Development and validation of an in-hospital major adverse cardiovascular events risk model for young patients with acute coronary syndrome: a retrospective cohort study [J]. PeerJ, 2025, 13: e19513. DOI: 10.7717/peerj.19513.

[4] ZHANG KD, WANG FD, YU Q, et al. Clinical characteristics and biomarkers feature analysis using a proteomics platform in young patients with acute coronary syndrome [J]. Front Cardiovasc Med, 2024, 11: 1384546. DOI: 10.3389/fcvm.2024.1384546.

[5] QU N, LI Q, BAI X, et al. Evaluation of the association of the total cholesterol-to-high-density lipoprotein cholesterol ratio and triglyceride-glucose index with coronary artery disease and their diagnostic utility [J]. Br J Hosp Med, 2025, 86 (6): 1-16. DOI: 10.12968/hmed.2024.1038.

[6] BAI SR, CHEN TL, LI YR, et al. Comparison of prognostic value of triglyceride-glucose index and atherogenic index of plasma in patients with acute coronary syndrome: a retrospective study [J]. JRSM Cardiovasc Dis, 2025, 14: 20480040251341155. DOI: 10.1177/20480040251341155.

[7] NIU RD, WANG H, QIU GK, et al. Metabolomic profiles of body shapes and their associations with the risks of incident cardiovascular diseases in Chinese adults [J]. Nutr Metab Cardiovasc Dis, 2025, 35 (9): 104031. DOI: 10.1016/j.numecd.2025.104031.

[8] 中华医学会心血管病学分会，中华心血管病杂志编辑委员会. 经皮冠状动脉介入治疗指南 [J]. 中华心血管病杂志，2025，53 (7)：717-745. DOI：10.3760/cma.j.cn112148-20250422-00302.

[9] BUSKE M, FEISTRITZER HJ, JOBS A, et al. Management of acute coronary syndrome: ESC guidelines 2023 [J]. Herz, 2024, 49 (1): 5-14. DOI: 10.1007/s00059-023-05222-1.

[10] GRIES JJ, VIRK HUH, BIRNBAUM Y, et al. Understanding gastrointestinal bleeding in patients with cardiac disease: an interdisciplinary approach [J]. Expert Rev Cardiovasc Ther, 2025, 23 (5): 197-207. DOI: 10.1080/14779072.2025.2520831.

[11] KIATCHOOSAKUN S, CHAMNARNPHOL N, WONGWIPAPORN C, et al. Performance of the GRACE and the ACTION risk model in the prediction of in-hospital mortality: external validation, model revision and updating in the Thai Percutaneous Coronary Intervention Registry [J]. Open Heart, 2025, 12 (1): e003027. DOI: 10.1136/openhrt-2024-003027.

[12] GALE CP, STOCKEN D, NADARAJAH R, et al. Effectiveness of the GRACE risk score according to troponin elevation in patients admitted with non-ST elevation acute coronary syndrome: a post hoc analysis of the UKGRIS parallel group cluster randomised controlled trial [J]. Open Heart, 2025, 12 (1): e003213. DOI: 10.1136/openhrt-2025-003213.

[13] CHEN LL, YIN LX. Associations of novel triglyceride- and triglyceride-glucose-derived obesity indices with hypertension in non-obese US adults (NHANES 1999: 2020) [J]. Am J Hypertens, 2025: hpaf146. DOI: 10.1093/ajh/hpaf146.

[14] BERGAMI M, FABIN N, CENKO E, et al. microRNAs as potential biomarkers in coronary artery disease [J]. Curr Top Med Chem, 2023, 23 (6): 454-469. DOI: 10.2174/1568026623666221221124530.

[15] RALLIDIS LS, PAPATHANASIOU KA, TSAMOULIS D, et al. Newly detected diabetes mellitus patients with acute coronary syndrome have an adverse cardiometabolic profile similar to patients with prior diabetes and a more extensive ischemic myocardial insult [J]. Diabetes Res Clin Pract, 2024, 211: 111664. DOI: 10.1016/j.diabres.2024.111664.

[16] KAJIKAWA M, MARUHASHI T, KISHIMOTO S, et al. A body shape index as a simple anthropometric marker of abdominal obesity and risk of cardiovascular events [J]. J Clin Endocrinol Metab, 2024, 109 (12): 3272-3281. DOI: 10.1210/clinem/dgae282.

[17] ZHAO LH, LIU Y, XIAO JY, et al. Prognostic value of metabolic syndrome in patients with non-ST elevated myocardial infarction undergoing percutaneous coronary intervention [J]. Front Cardiovasc Med, 2022, 9: 912999. DOI: 10.3389/fcvm.2022.912999.

（编辑　王又冬）