Comparison of Obesity Indices and Triglyceride Glucose Related Parameters to Predict Type 2 Diabetes Mellitus Among Normal-Weight Elderly in China

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Original investigation

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Abstract

Background : Although a significant proportion of type 2 diabetes mellitus (T2DM) cases arose from normal-weight individuals, studies on indicators that can predict T2DM in normal-weight people are limited. Accordingly, this study aims to investigate the predictive value of obesity indices and triglyceride glucose related parameters (TyG-related parameters) in T2DM among normal-weight Chinese elderly.

Methods : A total of 24,215 normal-weight Chinese elderly (age ≥ 60 years) [body mass index–BMI (18.5–23.9 kg/m²)] were included. Obesity indices and triglyceride glucose related parameters (TyG-related parameters) included waist circumference (WC), waist-to-height ratio (WHtR), visceral adiposity index (VAI), lipid accumulation product (LAP), and TyG-related parameters (TyG, TyG-BMI, TyG-WC, and TyG-WHtR). Multivariate logistic regression analysis was performed to examine the associations between obesity-and TyG-related indices and T2DM. The areas under the curve (AUC) of the receiver-operating characteristic (ROC) curve analyses were used to evaluate and compare the predictive value of the different indices.

Results : The prevalence of T2DM was 14.2% in normal-weight individuals. Among the indices, TyG was significantly associated with T2DM among men and women, respectively (adjusted odds ratio–aOR 19.005; 95% CI 13.235–27.291) and (aOR 25.262; 95% CI 16.957–37.634). Compared with other indices, TyG had the highest AUC value for T2DM in men (AUC: 0.818, 95% CI 0.810–0.825) and women (AUC: 0.824, 95% CI 0.814–0.833).

Conclusions : TyG is an effective marker and outperforms than other indices when predicting T2DM in the normal-weight Chinese elderly population.

Full Text

This preprint is available for [download as a PDF](#).

Tables

Table 1 Demographic and clinical characteristics of the participants

Variables	Without T2DM(<i>n</i> =20,795)	T2DM(<i>n</i> =3420)	Total(<i>n</i> =24,215)	<i>p</i> -value
	Median±SD or <i>n</i> (%)	Median±SD or <i>n</i> (%)	Median±SD or <i>n</i> (%)	
Sex				0.001
Men	9281(38.33)	1380(5.70)	10,661(44.03)	
Women	11,514(47.55)	2040(8.42)	13,554(55.97)	
Mean age (years)	70.95±5.71	71.47±5.70	71.03±5.71	0.001
Age category				0.001
60-69 yrs	10,775(44.50)	1596(6.59)	12,37151.09	
70-79 yrs	8021(33.12)	1459(6.03)	948039.15	
80 yrs+	1999(8.25)	365(1.51)	23649.76	
BMI (kg/m ²)	21.75±1.44	21.96±1.40	21.78±1.44	0.001
SBP (mm Hg)	132.87±18.57	136.49±19.05	133.38±18.68	0.001
DBP (mm Hg)	76.67±10.73	77.11±10.57	76.73±10.70	0.001
TC (mmol/L)	5.13±1.11	5.20±1.22	5.14±1.13	0.001
TG (mmol/L)	1.45±0.97	1.87±1.36	1.51±1.04	0.001
HDL-C (mmol/L)	1.45±0.44	1.37±0.40	1.43±0.43	0.001
LDL-C (mmol/L)	3.01±0.95	3.05±1.01	3.02±0.96	0.001
FPG (mmol/L)	5.41±0.67	9.28±2.69	5.96±1.80	0.001
Obesity indices				
WC (cm)	81.26±6.27	82.73±6.16	81.47±6.27	0.001
WHtR	0.51±0.04	0.52±0.04	0.51±0.041	0.001
VAI	1.91±3.01	2.65±2.64	2.02±2.97	0.001
LAP	30.27±25.21	41.92±34.74	31.91±27.08	0.001
TyG-related parameters				
TyG	7.00±0.53	7.74±0.63	7.10±0.60	0.001
TyG-BMI	152.43±16.53	169.94±18.38	154.90±17.87	0.001
TyG-WC	569.38±65.76	640.19±73.04	579.38±71.24	0.001

TyG-WHtR	3.59±0.43	4.04±0.48	3.66±0.46	0.001
Lifestyle				
Current smoking	3063(12.65)	357(1.47)	3420(14.12)	0.078
Current drinking	2962(12.23)	458(1.89)	3420(14.12)	0.001
Frequency of physical activity				0.222
Low	13,094(54.07)	2140(8.84)	15,234(62.91)	
Moderate	2993(12.36)	529(2.18)	3522(14.54)	
High	4708(19.44)	751(3.10)	5459(22.55)	

Abbreviations: T2DM, Type 2 Diabetes Mellitus; BMI, Body Mass Index; SBP, Systolic Blood Pressure, DBP, Diastolic Blood Pressure; TC, Total Cholesterol; TG, Triglyceride; HDL-C, high-density lipid cholesterol; LDL-C, low-density lipid cholesterol; FPG, fasting plasma glucose; WC, Waist Circumference; WHtR, Waist Height-Ratio; VAI, Visceral Adiposity Index; LAP, Lipid Accumulation Product; TyG, Triglyceride Glucose; TyG-BMI, TyG related to BMI; TyG-WC, TyG related to WC; TyG-WHtR, TyG related to WHtR; Data are presented as means ± standard deviation, and interquartile range or frequencies. *p* values are from *t*-tests or Chi-square tests for analysis of variance for continuous variables and categorical variables

Table 2 aOR for T2DM in quartiles of each index

Categories	WC	WHtR	VAI	LAP
Men				
Q1	Ref.	Ref.	Ref.	Ref.
Q2	1.216(0.974,1.518)	0.991(0.819,1.201)	1.163(0.947,1.429)	1.224(0.972,1.542)
Q3	1.239(0.946,1.624)	0.876(0.965,1.103)	1.373(1.090,1.729)	1.227(0.927,1.624)
Q4	1.514(1.130,2.029)	1.095(0.842,1.425)	1.933(1.479,2.527)	1.553(1.099,2.094)
Women				
Q1	Ref.	Ref.	Ref.	Ref.
Q2	1.123(0.955,1.320)	0.879(0.732,1.056)	1.155(0.965,1.382)	1.315(1.088,1.589)
Q3	1.085(0.890,1.323)	0.952(0.781,1.159)	1.567(1.278,1.920)	1.428(1.136,1.793)
Q4	1.133(0.908,1.414)	0.989(0.789,1.240)	1.954(1.541,2.478)	1.754(1.337,2.300)
Categories	TyG	TyG-BMI	TyG-WC	TyG-WHtR
Men				
Q1	Ref.	Ref.	Ref.	Ref.
Q2	3.136(2.226,4.339)	0.966(0.735,1.270)	1.122(0.785,1.604)	1.593(1.166,2.177)
Q3	6.819(4.867,9.545)	0.783(0.585,1.048)	0.976(0.641,1.487)	1.572(1.080,2.089)
Q4	19.005(13.235,27.291)	0.968(0.705,1.329)	1.122(0.705,1.786)	2.356(1.557,3.566)
Women				
Q1	Ref.	Ref.	Ref.	Ref.
Q2	3.347(2.268,4.938)	0.809(0.628,1.041)	1.115(0.811,1.533)	1.075(0.745,1.550)
Q3	7.568(5.128,11.167)	0.775(0.601,1.000)	1.239(0.861,1.782)	1.247(0.822,1.892)
Q4	25.262(16.957,37.634)	1.024(0.785,1.335)	1.723(1.164,2.552)	1.264(0.809,1.974)

Abbreviations: aOR, adjusted Odds Ratio; Q, Quartile; Ref, Reference; WC, Waist Circumference; WHtR, Waist Height-Ratio; VAI, Visceral Adiposity Index; LAP, Lipid Accumulation Product; TyG, Triglyceride Glucose; TyG-BMI, TyG related to BMI; TyG-WC, TyG related to WC; TyG-WHtR, TyG related to WHtR;

Table 3 ROC curve analyses for each index in predicting T2DM

Parameters	WC	WHtR	VAI	LAP
Man				
AUC (95% CI)	0.586(0.570,0.602)	0.571(0.555,0.587)	0.620(0.604,0.636)	0.622(0.606,0.638)
<i>p</i> -value	0.001	0.001	0.001	0.001
Cut-off	≥84.3	≥0.49	≥1.50	≥25.08
Sens. (%)	50.22	70.80	48.55	51.52
Spec. (%)	62.57	39.19	69.67	66.53
Youden index	0.13	0.10	0.18	0.18
Women				
AUC (95% CI)	0.565(0.552,0.578)	0.556(0.543,0.570)	0.625(0.612,0.638)	0.630(0.617,0.643)
<i>p</i> -value	0.001	0.001	0.001	0.001
Cut-off	≥79.8	≥0.52	≥2.04	≥33.61
Sens. (%)	67.16	65.03	60.29	58.38
Spec. (%)	42.70	42.97	59.26	60.80
Youden index	0.10	0.09	0.19	0.19
Man	TyG	TyG-BMI	TyG-WC	TyG-WHtR
AUC (95% CI)	0.818(0.810,0.825)	0.760(0.752,0.768)	0.771(0.763,0.779)	0.768(0.760,0.776)
<i>p</i> -value	0.001	0.001	0.001	0.001
Cut-off	≥7.17	≥163.04	≥608.91	≥3.64
Sens. (%)	76.09	62.54	66.67	70.58
Spec. (%)	72.38	77.35	73.84	69.20
Youden index	0.48	0.40	0.41	0.40
Women				
AUC (95% CI)	0.824(0.814,0.833)	0.760(0.748,0.771)	0.766(0.755,0.777)	0.760(0.749,0.771)
<i>p</i> -value	0.001	0.001	0.001	0.001
Cut-off	≥7.40	≥162.68	≥592.40	≥3.88
Sens. (%)	73.87	68.24	73.13	70.98
Spec. (%)	75.90	70.84	66.16	68.36
Youden index	0.50	0.39	0.40	0.39

Abbreviations: ROC, Receiver Operating Characteristic Curve; AUC, Area Under Curve; 95% CI, 95% Confidence Interval; Sens, Sensitivity; Spec, Specificity; WC, Waist Circumference; WHtR, Waist Height-Ratio; VAI, Visceral Adiposity Index; LAP, Lipid Accumulation Product; TyG, Triglyceride Glucose; TyG-BMI, TyG related to BMI; TyG-WC, TyG related to WC; TyG-WHtR, TyG related to WHtR;

Table 4 Pairwise comparison of AUC of TyG

Index	Differences between AUC	95% CI	<i>p</i> -value
Men			
WC	0.232	(0.213,0.250)	≪0.001
WHtR	0.246	(0.268,0.265)	≪0.001
VAI	0.198	(0.188,0.207)	≪0.001
LAP	0.195	(0.185,0.260)	≪0.001
TyG-BMI	0.056	(0.048,0.066)	≪0.001
TyG-WC	0.046	(0.036,0.055)	≪0.001
TyG-WHtR	0.050	(0.040,0.059)	≪0.001
Women			
WC	0.259	(0.243,0.274)	≪0.001
WHtR	0.268	(0.252,0.284)	≪0.001
VAI	0.199	(0.191,0.206)	≪0.001
LAP	0.194	(0.186,0.202)	≪0.001
TyG-BMI	0.064	(0.056,0.072)	≪0.001
TyG-WC	0.058	(0.050,0.066)	≪0.001
TyG-WHtR	0.064	(0.055,0.073)	≪0.001

Abbreviations: AUC, Area Under Curve; 95% CI, 95% Confidence Interval; WC, Waist Circumference; WHtR, Waist Height-Ratio; VAI, Visceral Adiposity Index; LAP, Lipid Accumulation Product; TyG, Triglyceride Glucose; TyG-BMI, TyG related to BMI; TyG-WC, TyG related to WC; TyG-WHtR, TyG related to WHtR;

Figures

Figure 1

ROC curves for each indices as predictors of T2DM in men and women.