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Research Article

Contribution of the Triglycerides-Glucose Index (TyG) in the Assessment of Insulin Resistance in Pregnant Women During an OGTT Test

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Abstract

The Triglyceride-Glucose (TyG) index is a marker used to assess insulin resistance which is associated with the occurrence of gestational diabetes. The aim of this study is to determine the benefit of the TyG within the diagnosis of insulin resistance in pregnant women in an orally induced hyperglycaemia test. This study was conducted at the Department of Biochemistry, at Aristide le Dantec University Hospital in collaboration with the department of gynaecology. Women with fasting blood glucose < 0.92 g/L at 12 weeks of age benefited from the OGTT 75 test following the WHO protocol. The TyG index was calculated using the formula: Ln [fasting triglyceridemia (mg/dL) × fasting blood glucose (mg/dL)]/2. Data were analysed using SPSS v.26 and a p< value of 0.05 was considered statistically significant. A total of 102 patients were included in the study with a mean age of 29±to 5.9 years. The OGTT 75 test was positive in 24 women (23.5%) with a predominance in the third trimester (19.4%). TyG values were significantly higher in women with gestational diabetes (8.76, ±0.5vs8.2±, 0.5; p<0.0001), in contrast to the HOMA index (6.43, ±16.8, ±1.15±, 0.9; p=0.138). The AUC of the ROC curve for the TyG-H0, TyG-H1 and TyG-H2 indices were 0.808 (95% CI)=0.70-0.92), 0.808 (95% CI)=0.698-0.918), 0.818 (95% CI)=0.70-0.93, respectively. For the HOMA-IR index, the AUC was 0.799 (95% CI = 0.69-0.91). The cut-off value for the TyG-H_1 index was 9.5 with a sensitivity and specificity of 79.2% and 71.8%, respectively. The TyG index is a better way to assess the level of insulin resistance in pregnant women than using the HOMA index, especially after the first hour of a glucose load of 75g.

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Keywords

TyG Index, HOMA-IR, Insulin Resistance, OGTT 75g, Gestational Diabetes

1. Introduction

Gestational diabetes mellitus (GDM) is defined as a carbohydrate intolerance of varying severity that first appears during pregnancy. It is a common condition affecting 2 to 3% of pregnant women. [1] Its prevalence varies from one country to another, with a clearer expansion in developing countries. In Senegal, the hospital prevalence is 34.5% [2] while at the national level, it remains unclear.

The pathophysiological mechanism is thought to be a disturbance of carbohydrate homeostasis underpinned by insulin resistance at the origin of various metabolic disorders. Insulin resistance (IR) is characterized by hyperinsulinemia secondary to a decrease in insulin sensitivity on target organs and tissues. [3] It is responsible for several types of complications during intra-uterine development. [4, 5]. The evaluation of this IR is not easy in clinical practice due to the lack of standardization of insulin dosage [6] and especially because of the cost of its dosage in developing countries, thus making it difficult to evaluate the IR using the HOMA index (HOMA-IR).

The biological follow-up of pregnancy often involves the measurement of fasting blood sugar and lipid profile, including triglyceridemia. The TyG index is derived from fasting blood glucose and fasting triglyceridemia. This is a simple and reliable parameter in the evaluation of the IR [7]. Many studies have reported a good correlation between the HOMA-IR index and the Triglyceride-Glucose Index (TyG) [6, 8] in the assessment of IR.

The aim of this study is to determine the performance of the TyG index in the diagnosis of insulin resistance during pregnancy.

2. Materials and Methods

This is a retrospective and analytical study conducted at the Biochemistry Department of the Aristide le Dantec Hospital in collaboration with the Gynaecology Department. Women with fasting blood glucose < 0.92 g/L at 12 weeks of amenorrhea (WA) benefited from the OGTT 75 test according to the WHO protocol. [9].

The data collected were age, age of pregnancy, a laboratory assessment with FBG, insulin and lipid profile with the determination of total cholesterol, its HDL and LDL fractions and triglycerides.

Assays were performed on Abbot's Architect Ci4100. Blood glucose, urea, total cholesterol, HDL cholesterol and triglycerides were determined by enzymatic method. LDL cholesterol by Friedewall's formula [10] and insulin by chemiluminescence.

The TyG index was calculated using the formula: Ln [fasting triglyceridemia (mg/dL) × fasting blood glucose (mg/dL)]/2 [11]. The TyG index was calculated for the 3 blood glucose measurements, namely at H_0 (TyG-H_0), H1 (TyG-H_1) and H2 (TyG-H_2). The HOMA-IR was calculated by the formula: [GAJ (mmol/L)*Insulin (IU/mL)]/22.5 [12].

The statistical analysis was done using SPSS v.26 software. Bivariate analysis was performed with Spearman correlation and Fisher test allowed analysis of distribution parameters. The performance of the TyG index was assessed by the ROC curve. A value of $p<0.05$ was considered significant.

3. Results

The present study included 102 patients with a mean age of 29±5.9 years and extremes of 18 and 45 years. 62.7% of the women were in the third quarter of pregnancy.

The prevalence of gestational diabetes was 23.5% (N=24/102) (Table 1) and was higher in women under 30 years of age (n=14; 13.7%) and in women in the third trimester of pregnancy (n=18; 17.6%) (Table 2).

Table 1. *Characteristics of the study population.*

Characteristics		Number	Percentage
Age (years)	< 30	51	50
	< 30	51	50
OGTT Test Period	2nd quarter	29	28,4
	3rd quarter	64	62.7
	Not determined	9	8.8
OPGH 75 Test	Positive	24	23.5
	Negative	78	76.5

Table 2. *Distribution of the study population by age and period of pregnancy.*

		Gestational diabetes	
		Yes (n=24)	**No (n=78)**
Age (years)	< 30	19 (18.6)	28 (27.5)
	> 30	5 (4.9)	50 (49)
Test period	2nd quarter	18 (17.6)	20 (19.6)
	3rd quarter	6 (5.9)	58 (56.9)

The table shows that blood glucose values are significantly higher in women with gestational diabetes as are the TyG index values for all three times (H0 (8.8±0.5vs8.2±0.5), H1 (9.6±0.3vs9.2±0.4) and H2 (9.1±0.4vs8.6±0.4); p< 0.001). There was no significant difference for the HOMA-IR index (6.4±16.8vs1.2±0.9, p=0.138) despite a higher mean value in women with gestational diabetes (Table 3).

Table 3. *Variation in parameters by gestational diabetes.*

Characteristics	**General population**	**Gestational diabetes**		
		Yes	**No**	**p**
Age (years)	29.1±5.9	29.9±6.4	28.8±5.7	0,480
H0 blood glucose (g/l)	0.8±0.2	1±0.2	0.7±0.1	< 0.0001*
H1 blood glucose (g/l)	1.4±0.3	1.8±0.3	1.2±0.2	< 0.0001*
H2 blood glucose (g/l)	1.2±0.4	1.7±0.4	1.1±0.2	< 0.0001*
Total cholesterol	1.9±0.6	2±0.8	1.8±0.6	0.340
HDL cholesterol	0.7±0.2	0.7±0.3	0.7±0.2	0.896
LDL cholesterol	1.1±0.5	1.2±0.6	1±0.4	0.265
Triglycerides	1.2±0.6	1.4±0.7	1.1±0.5	0.019*
Insulin	9.7±22.6	21.1±44.7	6.1±4.4	0.115
HOMA-IR	2.4±8.4	6.4±16.8	1.2±0.9	0.138
TyG_H0	8.3±0.5	8.8±0.5	8.2±0.5	< 0.0001*
TyG_H1	9.3±0.4	9.6±0.3	9.2±0.4	< 0.0001*
TyG_H2	8.7±0.5	9.1±0.4	8.6±0.4	< 0.0001*

*=p < 0.05, HDL=high-density lipoprotein, LDL=low-density lipoprotein, HOMA-IR=Homeostasic model assessment of insulin resistance

The TyG indices are not correlated with the age and its weakly correlated with the HOMA-IR index for the evaluation of insulin resistance, especially for TyG at the first hour of intake of the 75g glucose solution.

Table 4. *Result of the bivariate analysis of the TyG indices and other parameters.*

	TyG-H_0		**TyG-H_1**		**TyG-H_2**	
	r	**p**	**r**	**p**	**r**	**p**
Age	0.214	0.031	0.110	0.273	0.027	0.785
H_0 blood glucose (g/l)	0.463	< 0.0001	0.386	< 0.0001	0.250	0.008
H_1 blood glucose (g/l)	0.400	< 0.0001	0.725	< 0.0001	0.448	< 0.0001
H_2 blood glucose (g/l)	0.419	< 0.0001	0.566	< 0.0001	0.613	< 0.0001
Total cholesterol	0.612	< 0.0001	0.534	< 0.0001	0.793	< 0.0001
HDL cholesterol	0.353	< 0.0001	0.497	< 0.0001	0.480	< 0.0001
LDL cholesterol	0.555	< 0.0001	0.458	< 0.0001	0.796	< 0.0001
Triglycerides (g/l)	0.885	< 0.0001	0.504	< 0.0001	0.631	< 0.0001
Insulin	0.223	0.025	0.206	0.038	0.171	0.151
IR-HOMA	0.314	0.001	0.405	< 0.0001	0.330	0.001

The analysis of the Receiver Operating Characteristic (ROC) curve shows a larger IR (AUC) with 0.818 () with the TyG index for a cut-off of 9.50 with a sensitivity and specificity of 79.2% and 71.8% respectively (Table 5, Figure 1).

Table 5. *Distribution of performance indices for the evaluation of insulin resistance.*

Clues	**Cut-off**	**Se**	**Sp**	**AUC (CI)**	**p**
TyG-H_0	8.37	83.3	64.1	0.808 (0.70 – 0.92)	0.000 <1
TyG-H_1	9.50	79.2	71.8	0.818 (0.70 – 0.93	
TyG-H_2	8.88	70.8	83.3	0.799 (0.69 – 0.91)	
HOMA-IR	1.63	62.5	79.5	0.746 (0.63 – 0.86)	

Se=Sensibility; Sp=Specificity.

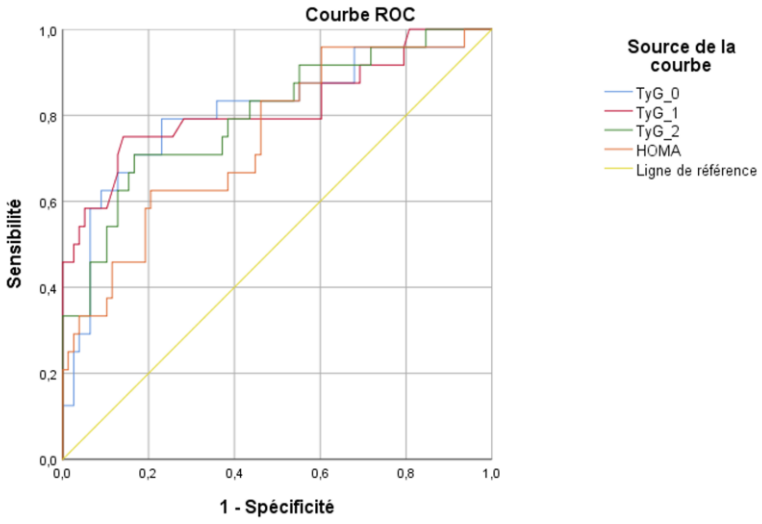

Figure 1. *ROC curve.*

Table 6 shows that all the indicators show the presence of insulin resistance in women with gestational diabetes with risk levels ranging from 6 to 10. During the index, the TyG-H2 index at the 8.88 threshold seems to better predict the risk of insulin resistance occurring during gestational diabetes.

Table 6. *Association of insulin resistance with the occurrence of gestational diabetes.*

		Gestational diabetes			
		Yes (n=24)	**No (n=78)**	**OR (IC)**	**p**
TyG-H0	Yes	19 (18.6)	28 (27.5)	6.79 (2.3 – 20.1)	< 0.0001*
	No	5 (4.9)	50 (49)		
TyG-H1	Yes	18 (17.6)	20 (19.6)	8.7 (3 – 25)	< 0.0001*
	No	6 (5.9)	58 (56.9)		
TyG-H2	Yes	16 (15.7)	13 (12.7)	10 (3.5 – 28.2)	< 0.0001*
	No	8 (7.8)	65 (63.7)		
HOMA-IR	Yes	8 (7.8)	6 (5.9)	6 (1.8 – 19.7)	0.004
	No	16 (15.7)	72 (70.6)		

4. Discussion

This study was designed to evaluate insulin resistance in pregnant women with TyG indices obtained during an oral induced hyperglycaemia (OGTT) test of 75g.

A total of 102 pregnant patients with a mean age of 29 ±5.9 years (18-45 years) were included in the study. The prevalence of gestational diabetes was 23.5% (n=24). This prevalence is lower than the Leye et al study (34.3%) with patients whose average age is similar to this study (29.8 ± 6.2 years). Ozyildirim et al reported comparable results to the Leye et al study with a mean age of 33.1 ±4.9 when assessing cardiovascular risk in women with gestational diabetes. [13] These results show that pregnancies generally occur at a very young age with the onset of earlier gestational diabetes, as we reported in this study with 79.17% of gestational diabetes cases occurring in women under 30 years of age.

Gestational diabetes occurs during an episode of insulin resistance with a decrease in glucose tolerance [12, 14]. To evaluate insulin resistance, several algorithms are proposed, including the TyG index, which takes into account both carbohydrate and lipid metabolism, including triglycerides. [8, 11, 12]. The TyG index is a marker that correlates perfectly with other insulin resistance assessment algorithms such as the HOMA-IR. [12, 15].

The correlations found were positive but relatively weak ($r(TyG\text{-}H_0)=0.314$; $r(TyG\text{-}H_1)=0.405$; $r(TyG\text{-}H_2)=0.330$) with the HOMA-IR. This moderate correlation is also reported by Nachimuthu et al (r=474; p<0.0001), Wu et al (r=51) as well as in Yoon's study in diabetic children and adolescents (r=0.189). [15-17].

The study of the performance of the TyG indices during the OGTT test showed that the index at the 1st hour ($TyG\text{-}H_1$) with an AUC=0.818 (0.7 – 0.93) and a cut-off of 9.50 had a sensitivity and specificity of 79.2% and 71.8% respectively which were better. However, the TyG-H0 index shows a higher sensitivity of 83.3% with a cut-off of 8.37 and the TyG-H2 index shows a higher specificity of 83.3% with a cut-off of 8.88. Zeng et al reported a lower AUC=0.57 (CI=0.5 – 0.62) and performance (Se=40.34% and Sp=74.54) with a cut-off of 9.07 [18]. Other authors have reported lower performance of the TyG index for RI assessments during gestational diabetes. This is the case of the study by Guo et al (AUC=0.641(0.611-0.671); Se=61.7% and Sp=61.7%) and Selvi et al (AUC=0.802 (0.73-0.875)) [15, 19].

Women with gestational diabetes had significantly higher blood glucose, triglyceride and TyG values at the various times of the OGTT 75 test. Zeng et al [18] also reported significantly higher blood glucose (0.81vs1 g/L; p<0.001) and TyG index (8.68vs8.82; p=0.023) in women with gestational diabetes. However, in Zeng's study, women with gestational diabetes had lower triglyceride values (1.65vs1.61 g/L) as well as for other lipid parameters [18]. In the Ozyildirim study, lipid parameters as well as blood glucose levels are more disturbed in women with gestational diabetes compared to control [13].

5. Conclusion

The Triglycerides-Glucose Index (TyG) is a good marker

for the assessment of insulin resistance in gestational diabetes. It is most interesting when determined at the first of an orally induced hyperglycaemia test with 75g of glucose.

Abbreviations

AUC	Area Under the Curve
CI	Confidence Interval
FBG	Fasting Blood Glucose
GDM	Gestational Diabetes Mellitus
HDL	High-Density Lipoprotein
HOMA-IR	Homeostasic Model Assessment of Insulin Resistance
LDL	Low-Density Lipoprotein
OGTT	Ora Glucose Tolerance Test
ROC	Receiver Operating Characteristic
Se	Sensitivity
Sp	Specificity
TyG	Triglycerides-Glucose Index
WHO	World Health Organization
WA	Weeks of Amenorrhea

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Conflicts of Interest

The authors declare no conflicts of interest.

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