TyG Index A Risk Assessment Tool For Early Diagnosis Of Prediabetic Individuals

Meraj Rahim[1], Muhammad Khalid Siddiqui[1], Nighat Mirza[2], Shaheen Sharafat[3], Masood Anwer Qureshi[1], Muhammad Adnan Kanpurwala[4]

[1] *Department of Physiology, Dow Medical College, Karachi, Pakistan.*
[2] *Department of Community Medicine, Dow Medical College, Karachi, Pakistan.*
[3] *Department of Pathology, Dow Medical College, Karachi, Pakistan.*
[4] *Department of Physiology, Karachi Institute of Medical Sciences, Karachi, Pakistan.*

ABSTRACT

Objective:
Type 2 diabetes mellitus has assumed a universal proportion.To predict future onset of diabetes, a simple routine test can be used as an innovative method to calculate the Triglyceride Index [TyG] – a product of fasting plasma glucose and serum triglyceride levels.

Methodology:
The study was designed as a cross sectional survey. The subjects were stratified on the presence of family history of Type 2 Diabetes Mellitus(T2DM). The Nutritional status and lipid profile were measured. The Roche Hitachi® Analyzer 902 calculates the analyst concentration of lipid profile for each sample. The blood glucose levels were estimated by Glucose oxidase method.

Results:
The study shows, age, diastolic blood pressure, glucose, cholesterol, triglyceride, HDL and TyG index have significant mean differences across TyG index quartiles. History of diabetes in mothers and in siblings shows significant association with TyG index quartiles, Group of diabetes and smoking shows significant association with TyG-index quartiles.

Conclusions:
High risk individuals with history of diabetes in their family can be assessed for future risk of type 2 diabetes mellitus by using this innovative method of calculating simple products of fasting triglycerides and fasting plasma sugar

Key words:
Diabetes, fasting plasma glucose, lipid profile, TyG index

***For Correspondence**

Meraj Rahim
Associate Professor
Department of Physiology,
Dow International Medical College, Karachi, Pakistan

Email:
meraj.rahim@duhs.edu.pk

INTRODUCTION

The prevalence of diabetes is rising throughout the world. In Pakistan, its prevalence was reported as 6.9 million cases in 2014; this is expected to rise to approximately 13 million in the year 2035, which would rank Pakistan at 8th position among the top 10 countries with increased prevalence of diabetes[1]

In Pakistani urban population the prevalence of diabetes and impaired fasting glucose is reported to be 6.0% in males and 3.5% in females.[2] Identification of subjects with impaired fasting glucose is important to overcome this burden of diabetes, therefore, proper aim of prevention to avoid this hazard is important.[3]

Testing the blood after twelve hours fasting for triglyceride level is an important marker for prediction of diabetes[4-7] The novel index, the Triglyceride index is simply a product of FPG and TG, which substitutes for foretells insulin resistance in subjects with no health issues.[8-9] It has been suggested that a population of individuals having normal body weight and BMI but have multiple obesity related abnormalities are called metabolically obese but normal body weight (MONW) and they prove to be having metabolic risk factors.[10 -12] Usually people with normal weight do not take it seriously to monitor their health indicators, as well as ignore the preventive measures for T2DM, but it is necessary for everyone to be vigilant and identify it before time.[13-14] Diet not only effect the individual himself or herself but it may have multiple impact on the

This article may be cited as: Rahim M, Siddiqui MK, Mirza N, Sharafat S, Qureshi MA, Kanpurwala MA. TyG Index A Risk Assessment Tool For Early Diagnosis Of Prediabetic Individuals. Adv Basic Med Sci. 2019;3(2):73-78

offspring. There are studies which have shown that diet and drugs do affect the fetus and placenta during pregnancy.[15]

The level of FPG (Fasting Plasma Glucose and TyG (triglycerides) has been proved to show increased risk of diabetes. The index of TyG is a surrogate to the insulin resistance, the result of triglycerides and Fasting Plasma Glucose is a modern index in healthy subjects.[16-18]

Objective of our study is to use this Triglyceride Index [TyG] which is simply the product of fasting triglyceride and fasting glucose and can be used to assess as a tool of preventing diabetes in young healthy adults of Karachi who have a positive family history of diabetes.

METHODOLOGY

Research was conducted in healthy young adults from 18 to 24 years of age. All these subjects belonged to different faculties of Dow University of Health Sciences Karachi, (DUHS) like Dow College of Pharmacy and Institute of Nursing and National Institute of Diabetes and Endocrinology (NIDE).

A Cross-sectional study was done and all the subjects were grouped according to their family history, as below:

Group I: Offspring of no diabetic parent (NDP)

Group II: Offspring of single diabetic parent (SDP)

Group III: Offspring of both diabetic parents (BDP)

Definition of the cohorts:

The sample size was 180 subjects estimated by taking into consideration prevalence of diabetes as 13.5% [19]

Sample technique: Non probability Purposive sampling

Instrument and data collection

The willing participants were asked to fill out a questionnaire/proforma and after the written consent was obtained; the demographic data was sought including their ages, gender and any family history of diabetes in single or both parents and their personal habits along with their past medical history. A detailed introductory session was given on DM to all the participants to motivate them to participate in this study.

In this study, those subjects were included who were healthy, young adults between the age groups of 18 to 24 years with no history of past and recent medical problems. The criteria for exclusion remained the subjects with history of diabetes or any other known endocrinopathies. The participants were instructed to observe a 12-hour fast and then report to Dow Diagnostic Research& Reference Laboratories (DDR&RL) Ojha Campus. The Asian Pacific criteria were used to categorize BMI into underweight, normal weight, overweight and obese range.[20] The Stadiometer was utilized to record the weight, and care was taken to place it on a hard floor. It was also ensured that the participants removed their heavy outer garments prior to the procedure. The participants were instructed to stand on center of platform so that the weight distribution stays even otherwise recorded weight would turn out to be falsely high. Anthropometry status was taken including their height, while asking them to remove shoes and advised to stand straight and upright. At a level between the lower rib margin and iliac crest, their waist circumference (cm) was measured in the horizontal position. Hip measurement was done at fullest point at buttocks in (cm) while the measurer was standing at the side of the participant.

The information about each subject with respect to his/her parents' history of T2DM was used to place him/her under respective group. Those showing no family history of T2DM (none of the parents as diabetics) were considered as NDP [21-23]. And the one with both parents having T2DM was placed under the group BDP, whereas the offspring with father or mother having T2DM was placed under group SDP. Biochemical parameters were assessed using the standard procedures. Fasting blood samples after collection were centrifuged in HERMLE 2323 for 10 minutes, the serum samples were analyzed for lipid profile and fasting glucose levels on automated analyzer HITACHI 902. Glucose was estimated using glucose oxidase method This research was approved ethically by the Institutional Review Board Reference No: [IRB-164/DUHS-10] of Dow University of Health Sciences, Pakistan.

STATISTICAL ANALYSIS

Data was stored and analyzed using IBM-SPSS version 23.0, mean and standard deviation were derived for age, height, weight, body mass index, waist circumference, hip circumference, WHR, and other quantitative studied parameters. One-way analysis of variance was done using F-test to compare these mean levels across quartiles. Since we have more than 2 groups to compare the mean levels, therefore, we have used the ANOVA to overcome type one error. Count and percentages were also given for qualitative data set. Pearson correlation and chi square tests were used to see the association of TyG index quartiles with these categorical set of data. P-values less than 0.05 were considered significant.

RESULTS

Table No 1 shows the baseline characteristics of subjects and their comparison, according to the TyG index quartile (Q1–Q4) groups. Each participant in the upper quartile of the population from these groups was more obese. The values for FPG and SC, TG, cholesterol-HDL ratio and TyG index increased in higher quartile.

Characteristic	Mean Age in Years	Mean BMI	Mean WHR	Mean SBP	Mean DBP	Mean Serum Cholesterol	Mean Serum triglycerides	Mean TyG–Index
Q1 (n=46)	20.74	20.79	.79	113.78	74.75	140.41	49.04	3880
Q2 (n=45)	20.36	22.51	.75	115.81	73.75	150.93	64.27	5302
Q3 (n=44)	21.09	21.69	.78	116.22	75.95	166.50	85.82	7216
Q4(n=45)	21.27	24.19	.81	117.64	75.00	171.47	161.22	14602
P Value	<0.01*	0.06	0.19	0.10	0.50	<0.01*	<0.01*	<0.01*

*P<0.05 Considered as significant usi ng ANOVA

Table 1:Baseline characteristics of subjects and their comparison with TyG Index Quartiles

Table 2 shows that, 71.7% females found in first quartile of TyG index, and 62.2% were found in fourth quartile, 52.2% subjects having diabetic father, fall in first quartile and 55.6% fall in fourth quartile, gender and history of diabetes in fathers shows no significant association with TyG quartiles.

History of diabetes in mothers gives significant association with TyG quartiles, 48.9% samples having diabetic mother fall in fourth quartile of TyG, all other parameters of table 2 were found statistically insignificant.

Characteristics		TyG Index Quartiles								p-valu
		Q1 (n=46)		Q2 (n=45)		Q3 (n=44)		Q4 (n=45)		
		n	%	n	%	n	%	n	%	
Gender	Male	13	28.3%	13	28.9%	13	29.5%	17	37.8%	0.73
	Female	33	71.7%	32	71.1%	31	70.5%	28	62.2%	
Father Diabetes	Yes	24	52.2%	18	40.0%	24	54.5%	25	55.6%	0.42
	No	22	47.8%	27	60.0%	20	45.5%	20	44.4%	
Mother Diabetes	Yes	11	23.9%	11	24.4%	14	31.8%	22	48.9%	0.03*
	No	35	76.1%	34	75.6%	30	68.2%	23	51.1%	
Paternal Grand Father Diabetes	Yes	9	19.6%	6	13.3%	12	27.3%	12	26.7%	0.65
	No	30	65.2%	34	75.6%	26	59.1%	28	62.2%	
	Don't Know	7	15.2%	5	11.1%	6	13.6%	5	11.1%	
Paternal Grand Mother Diabetes	Yes	13	28.3%	14	31.1%	15	34.1%	16	35.6%	0.96
	No	28	60.9%	27	60.0%	25	56.8%	23	51.1%	
	Don't Know	5	10.9%	4	8.9%	4	9.1%	6	13.3%	
Maternal Grand Father Diabetes	Yes	13	28.3%	5	11.1%	6	13.6%	12	26.7%	0.24
	No	28	60.9%	34	75.6%	30	68.2%	25	55.6%	
	Don't Know	5	10.9%	6	13.3%	8	18.2%	8	17.8%	
Maternal Grand Mother Diabetes	Yes	11	23.9%	13	28.9%	13	29.5%	17	37.8%	0.72
	No	30	65.2%	26	57.8%	28	63.6%	24	53.3%	
	Don't Know	5	10.9%	6	13.3%	3	6.8%	4	8.9%	
Diabetes in sibling (Brother)	Yes	2	4.3%	2	4.4%	4	9.1%	5	11.1%	0.40
	No	43	93.5%	43	95.6%	40	90.9%	38	84.4%	
	Don't Know	1	2.2%	0	.0%	0	.0%	2	4.4%	
Diabetes in sibling (Sister)	Yes	4	8.7%	1	2.2%	2	4.5%	8	17.8%	0.02*
	No	41	89.1%	44	97.8%	42	95.5%	34	75.6%	
	Don't Know	1	2.2%	0	.0%	0	.0%	3	6.7%	

Table 2: Association of Baseline characteristics of subjects with TyG Quartiles

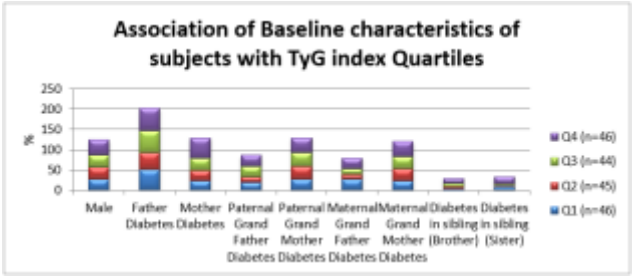

Fig: 1 Association of Baseline characteristics of subjects with TyG Quartiles

Table 3 shows that the association of TyG quartiles with study groups, and subjects' physical activity, results

show, 40% of both diabetes subjects are found in fourth quartile of TyG index, and 17.4% fall in first quartile, 41.3% of non-diabetics were in first quartile and 35.6% in fourth quartiles, there was significant association of TyG index quartiles with diabetes groups, in physical activity none of the parameter gives significant association with TyG quartiles, however there was significant association of life style , smoking and ex-smoker history with TyG quartiles.

Characteristics		TyG Index Quartiles								p-value
		Q1 (n=46)		Q1 (n=46)		Q1 (n=46)		Q1 (n=46)		
		n	%	n	%	n	%	n	%	
Groups	Both Diabetic	8	17.4%	2	4.4%	11	25.0%	18	40.0%	<0.01*
	Single Diabetic	19	41.3%	25	55.6%	16	36.4%	11	24.4%	
	Non Diabetic	19	41.3%	18	40.0%	17	38.6%	16	35.6%	
Student	School	0	.0%	0	.0%	1	2.3%	1	2.2%	0.40
	College	2	4.3%	1	2.2%	0	.0%	4	8.9%	
	University	43	93.5%	44	97.8%	43	97.7%	39	86.7%	
	Others	1	2.2%	0	.0%	0	.0%	1	2.2%	
Walking	Yes	37	80.4%	34	75.6%	40	90.9%	30	68.2%	0.06
	No	9	19.6%	11	24.4%	4	9.1%	14	31.8%	
Jogging	Yes	6	14.0%	7	15.6%	8	20.0%	6	13.6%	0.84
	No	37	86.0%	38	84.4%	32	80.0%	38	86.4%	
Swimming	Yes	6	14.0%	3	6.7%	5	12.2%	5	11.1%	0.72
	No	37	86.0%	42	93.3%	36	87.8%	40	88.9%	
Aerobics	Yes	11	25.6%	9	20.0%	8	19.0%	15	34.1%	0.34
	No	32	74.4%	36	80.0%	34	81.0%	29	65.9%	
Smoking	Yes	0	.0%	1	2.2%	2	4.5%	6	13.3%	0.02*
	No	46	100.0%	44	97.8%	42	95.5%	39	86.7%	
Ex Smoker	Yes	4	8.7%	0	.0%	0	.0%	7	16.3%	<0.01*
	No	42	91.3%	45	100.0%	42	100.0%	36	83.7%	

*P<0.05 Considered as significant using Chi Square test of Independence

Table 3: Association of Physical activities of subjects according to TyG Quartiles

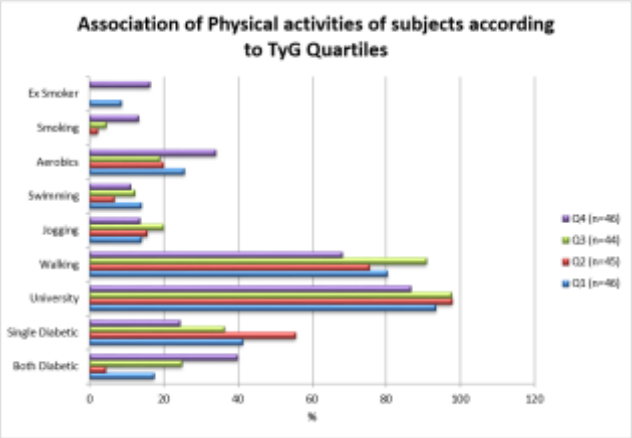

Figure 2: Association of Physical activities of subjects according to TyG Quartiles

DISCUSSION

In the Chungju Metabolic Disease Cohort (CMC) study it was found that TyG index was found to be associated with four-fold risk in developing diabetes as compared to those who were in the lowest quartile.[23]

In our study the participants characteristics were analyzed according to the TyG index quartile (Q1–Q4) groups. The participants in the upper quartile groups were more obese. The values for, serum cholesterol, triglycerides, cholesterol-HDL ratio, FPG, fasting insulin and TyG index increased in higher quartile. On gender analysis it was found that, female had higher values in first quartile, while on analysis of group difference, both diabetic parents had values in higher quartile in TyG index.

In a current study it was found that by Lee S-H et al that those participants who had a raised TyG Index had a highest quartile for developing the risk of diabetes. It was also seen that the predictive value of TyG was a better index than IR Index. Thus such a simple routine method can be utilized for identifying the future risk of diabetes.[23]

In our study the TyG Index was calculated by Fasting plasma glucose and serum triglycerides and it was found to be raised in off-springs of diabetic parents. In a Brazilian study it was found that their subjects had raised levels of triglycerides.[18] In our population, this is the first study interpreting the calculation of this index, we had limitations in our study that the off-springs were participating in fasting condition for the collection of samples but the best part was that our subjects were young people and did not have chronic diseases therefore their results were not interfered by the intake of drugs like lipid lowering drugs.

CONCLUSION

In the conclusion we would say that Serum triglycerides and Plasma glucose are routine tests, and by simply calculating the product, it gives a valuable index to predict onset of diabetes.

ACKNOWLEDGEMENT

We are thankful to the institutes of DUHS for facilitating in research by letting students to be our subjects for sample size.

REFRENCES

1. International diabetes federation. diabetes atlas. sixth edition 2013. [Cited on January 22, 2015.] Available from URL: http://www.idf.org/diabetes atlas

2. Shera AS, Jawad F, Maqsood A. Diabetes research and clinical practice 2007; 76:219-22.2.

3. Knowler WC, Barrett-Connor E, Fowler SE, Hamman RF, Lachin JM, et al. (2002) Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. N Engl J Med 346: 393–403.

4. Dallmeier D, Larson MG, Wang N, Fontes JD, Benjamin EJ, et al. (2012). Addition of inflammatory biomarkers did not improve diabetes prediction in the community: The Framingham heart study. J Am Heart Assoc 1: e000869.

5. Kashima S, Inoue K, Matsumoto M, Akimoto K (2013) Do non-glycaemic markers add value to plasma glucose and hemoglobin a1c in predicting diabetes? Yuport health checkup center study. PLos One 8: e66899.

6. Echouffo Tcheugui JB, Dieffenbach SD, Kengne AP (2013) Added value of novel circulating and genetic biomarkers in type 2 diabetes prediction: A systematic review. Diabetes Res Clin Pract 101: 255–269.

7. Schulze MB, Weikert C, Pischon T, Bergmann MM, Al-Hasani H, et al. (2009). Use of multiple metabolic and genetic markers to improve the prediction of type2 diabetes: the EPIC-Potsdam Study. Diabetes Care 32: 2116–2119.

8. Simental-Mendı´a LE, Rodrı´guez-Mora´n M, Guerrero-Romero F (2008) Theproduct of fasting glucose and triglycerides as surrogate for identifying insulinresistance in apparently healthy subjects. Metab Syndr Relat Disord 6: 299–304.

9. Guerrero-Romero F, Simental-Mendı´a LE, Gonza´lez-Ortiz M, Martı´nez-Abundis E, Ramos-Zavala MG, et al. (2010) The product of triglycerides and glucose, a simple measure of insulin sensitivity. Comparison with the euglycemic-hyperinsulinemic clamp. J Clin Endocrinol Metab 95: 3347–3351

10. Karelis AD, St-Pierre DH, Conus F, Rabasa-Lhoret R, Poehlman ET. Metabolic and body composition factors in subgroups of obesity: what do we know? J Clin Endocrinol Metab. 2004; 89:2569–75.

11. Soriguer F, Gutierrez-Repiso C, Rubio-Martin E, et al. Metabolically healthy but obese, a matter of time? Findings from the prospective Pizarra study. J ClinEndocrinolMetab. 2013;98:2318–25.

12. Hinnouho GM, Czernichow S, Dugravot A, et al. Metabolically healthy obesity and the risk of cardiovascular disease and type 2 diabetes: the Whitehall II cohort study. Eur Heart J. 2015;36:551–9.

13. Nazare JA, Smith JD, Borel AL, et al. Ethnic influences on the relations between abdominal subcutaneous and visceral adiposity, liver fat, and cardio-metabolic risk profile: The International Study of Prediction of Intra-Abdominal Adiposity and Its Relationship with Cardio-metabolic Risk/Intra-Abdominal Adiposity. Am J Clin Nutr. 2012; 96:714–26.

14. Gao H, Salim A, Lee J, Tai ES, van Dam RM. Can body fat distribution, adiponectin levels and inflammation explain differences in insulin resistance between ethnic Chinese, Malays and Asian Indians? Int J Obes. 2012; 36:1086–93.

15. Arshad R, Kanpurwala MA, Karim N, Hassan JA. Effects of Diet and Metformin on placental morphology in Gestational Diabetes Mellitus. Pakistan journal of medical sciences. 2016 Nov;32(6):1522.

16. Simental-Mendia LE, Rodriguez-Moran M, Guerrero-Romero F. The prod-uct of fasting glucose and triglycerides as surrogate for identifying insulin resistance in apparently healthy subjects. Metab Syndr Related Disord. 2008; 6:299–304.

17. Navarro-Gonzalez D, Sanchez-Inigo L, Pastrana-Delgado J, Fernandez-Montero A, Martinez JA. Triglyceride-glucose index (TyG index) in comparison with fasting plasma glucose improved diabetes prediction in patients with normal fasting glucose: the vascular-metabolic CUN cohort. Prev Med. 2016; 86:99–105.

18. Vasques AC, Novaes FS, de Oliveira Mda S, et al. TyG index performs better than HOMA in a Brazilian population: a hyperglycemic clamp validated study. Diabetes Res Clin Pract. 2011; 93: 98–100.

19. Shera AS, Rafique G, Khwaja IA, Ara J, Baqai S, King H et al. Pakistan national diabetes survey: prevalence of glucose intolerance and associated factors in Shikarpur, Sindh Province Diabet Med 1995.

20. World Health Organization. The Asia pacific perspective: redefining obesity and its treatment. Health communication Australia. Int Obesity Task Force 2000.

21. Rahim M, Rahim M, Rahim M, Sharafat S, Shaikh Z, et al. Maternal and paternal transmission of diabetes: influence of nutritional factors. J Diabetes Metab 2015; 6:504.

22. Rahim M, Rahim M, Qureshi MA, Sharafat S,Shaikh Z. Frequency of prediabetes, raised BMI and low plasma HDL-cholesterol in offspring of diabetes. J Dow Uni Health Sci 2014; 8:67-71.

23. Lee S-H, Kwon H-S, Park Y-M, Ha H-S, Jeong SH, et al. (2014) Predicting the Development of Diabetes Using the Product of Triglycerides and Glucose: The Chungju Metabolic Disease Cohort (CMC) Study. PLoS ONE 9(2): e90430. doi:10.1371/journal.pone.0090430.