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Original Article

The Assessment of Insulin Resistance and Triglyceride/Glucose Index in Nonalcoholic Fatty Liver Disease

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ABSTRACT

Objective: Insulin resistance is one of the most important risk factors for nonalcoholic fatty liver disease (NAFLD). Homeostasis Model Assessment-Insulin Resistance (HOMA-IR) is a marker used to show insulin resistance. Triglyceride/Glucose index (TgG index) is a parameter that can be used to predict NAFLD and is as important as HOMA-IR. In this study, we aimed to determine the value of the HOMA-IR score and TgG index in predicting NAFLD.

Methods: 986 patients who applied to University of Health Sciences Haseki Training and Research Hospital Internal Medicine Clinic between 2017–2018 and underwent an abdominal ultrasonography scan for any reason were included in the study retrospectively. All medical cases here were investigated in terms of all clinic and laboratory aspects in order to exclude other possible liver-related diseases before they were diagnosed with NAFLD. The patients were categorized and grouped in two different ways. The first is the group with or without NAFLD; the second group was categorized as the control group, prediabetic group and type 2 diabetic group.

Results: Our study was conducted with a total of 986 patients, including 470 patients with NAFLD and 516 patients without NAFLD. When the TgG index is calculated; a statistically significant increase was observed in the incidence of NAFLD at levels above 8.4 ($p<0.001$). The correlation analysis revealed a positive correlation between the TgG index and HOMA-IR ($r=0.438$). TgG index ($p<0.001$ OR=3.702), HOMA-IR ($p=0.003$, OR=1.143), ALT elevation ($p=0.001$, OR=1.020) were found to be the most effective risk factors when the Backward Stepwise method was used.

Conclusion: The TgG index was found to be a remarkable predictor-parameter for NAFLD. While HOMA-IR increases the risk of NAFLD by 1.1 times, the the TgG index increases it 3.7 times. In our study, it was also observed that the TgG index increased the risk of NAFLD, independent of HOMA-IR.

INTRODUCTION

Nonalcoholic fatty liver disease is one of the most common chronic liver diseases in the world. In fact, the definition covers a broad spectrum, from simple fatty liver (NAFL) to steatohepatitis (NASH) or even from cirrhosis to hepatocellular cancer (HCC).[1] Insulin resistance means that although there is insulin in circulation, it cannot show its biological properties. Defects occurring in many stages, from the binding of insulin to the cell receptor to the internal pathways, are thought to be responsible for this resistance. Apart from fat-muscle-liver tissues, many systems such as growth, immune and nervous systems are affected by this condition. Although there are many methods that can measure insulin resistance, the Homeostasis Model Assessment-Insulin Resistance (HOMA-IR) index is usedmost frequently in the clinic because of its simplicity and cheapness.[2] In recent years, the TgG index has also gained importance as a parameter that predicts insulin resistance, and many studies have been conducted on the usability of this index.[3,4]

In conclusion, insulin resistance is one of the important risk factors for NAFLD. HOMA-IR is a frequently used marker of insulin resistance. On the other hand, the TgG-index, is as significant, simple, and usable parameter as the HOMA-IR index in predicting NAFLD. In this study, we focused on revealing the significance of HOMA-IR and the TgG-indexes in NAFLD prediction.

MATERIALS AND METHODS

Study population

986 patients aged between 18 and 65 who had applied to University of Health Sciences Haseki Training and Research Hospital Internal Medicine Clinic between January 01th, 2017 and January 01th, 2018 and had abdominal USG for any reason were included in the study. A retrospective, cross-sectional study was performed. Biochemical parameters were evaluated together with abdominal USG and a diagnosis of NAFLD was made. Biochemical tests consisted of platelet count, fasting plasma glucose (FPG), urea, creatinine, uric acid, ALT, AST, HbA1c, triglyceride, HDL-cholesterol, LDL-cholesterol. These parameters were analyzed using the Abbott Architect Analyzer System (IL, USA) device.

In all cases, clinical findings and laboratory results were evaluated in order to exclude other possible liver diseases prior to the diagnosis of NAFLD. Patients with alcohol abuse, autoimmune hepatitis, other liver diseases causing hepatosteatosis, acute abdomen, end-stage renal failure, cirrhosis, sepsis, malignancy and neuropsychiatric diseases were excluded from the study.

Patients with Hba1c values of 6.5% and above, fasting plasma glucose above 126 mg/dl, or those with plasma glucose above 200 mg/dl at any time were defined as the diabetic group. Patients with Hba1c levels between 5.7% and 6.4%, impaired fasting glucose (fasting plasma glucose between 100 and 125 mg/dl and 2nd-hour plasma glucose below 140 mg/dl) or impaired glucose tolerance (fasting plasma glucose level below 100 mg/dl and 2nd-hour plasma glucose level between 140 and 199 mg/dl) were determined as the prediabetic group. The control group was defined as the patients who did not meet the diagnostic criteria for prediabetes and diabetes. The HOMA-IR index was calculated using the following formula: [fasting glucose (mg/dL) × fasting insulin (μIU/mL)] / 405, and values 2.5 and above were considered as significant. Triglyceride/Glucose index was calculated as ln [fasting glucose (mg/dL) x fasting triglyceride (mg/dL) / 2] and values of 8.4 and above were considered statistically significant.

Radiological assessment

The study was based on USG findings. The level of fattening in the liver was classified as Grade I, Grade II, and Grade III in ultrasonographic examinations:

- Grade I (Mildly ill patients): There is a minimal diffuse increase in hepatic echogenicity. The borders of intrahepatic vessels and the diaphragm are clearly visible.
- Grade II (Moderately ill patients): There is a moderately diffuse increase in hepatic echogenicity. The visibility of intrahepatic vessels and the diaphragm is slightly impaired.
- Grade III (Severely ill patients): Hepatic echogenicity is remarkably increased. The posterior segment of the right lobe of the liver, the intrahepatic vessels, and the diaphragm are either completely invisible or unclear.

Statistical analysis

All data obtained in the study were recorded on the computer and analyzed using the software of SPSS (Statistical Package for social sciences) for Windows 16.0. As descriptive statistics, continuous variables were defined as mean and standard deviation, and categorical variables were described as percentages. The distribution normality of the variables was assessed using the Kolmogorov-Smirnov test. In the comparison of the two groups, the numerical data with normal distribution were assessed via the Student T-test, and to compare numerical data with non-normal distribution; the Mann-Whitney U test was used. For comprasions of more than two groups in numerical variables; the One Way ANOVA test was performed when the variables were normally distributed, and the Kruskal-Wallis test was used when the variables were not normally distributed. Subgroup analyzes were interpreted according to Bonferroni correction in the parametric test. Categorical variables were analyzed using the chi-square test. Pearson Spearman correlation test was used to compare the two numerical data. The effect of the logistic regression model [TgG-index, HOMA-IR, age, uric acid, ALT, HDL, LDL, presence of diabetes], which was established by considering the variables that differed regarding the endpoint in univariate analyzes, on the presence of NAFLD was evaluated using the Backward Stepwise method. The results were considered statistically significant at a confidence interval of 95% or $p<0.05$.

RESULTS

Our study consisted of a total of 986 patients, including 470 patients with NAFLD and 516 patients without NAFLD. Of the patients without NAFLD, 113 were male, 403 were female. The patients with NAFLD consisted of 119 male and 351 female patients. Analysing these different groups in the study according to gender, no statistically significant difference was found between the groups, ($p=0.22$). The mean age of the group without NAFLD was 54.92±15.8 years, while it was 56.93±12.74 for the group with NAFLD, and the difference between the two groups was statistically significant, ($p=0.001$). Mean ALT and AST values were 18.90±13.87 U/L and 22.1±8.8 U/L in patients without NAFLD, 24.65±16.08 U/L and 24.03±10.7 U/L in patients with NAFLD, respectively. The difference between these groups was statistically significant ($p<0.001$ and $p=0.004$, respectively). Uric acid levels showed statistically significant variability among diabetic, prediabetic, control groups, and groups with and without NAFLD. In patients with diabetes and NAFLD, the uric acid levels were higher, ($p<0.001$), (Table 1, 3). The mean LDL level was found to be 127.63±37.38 mg/dL in the patient group without NAFLD, and 131.45±35.68 mg/dL in NAFLD patients, respectively. These differences were statistically significant ($p=0.001$). The mean TG level was found to be

Table 1. The general characteristics and biochemical parameters of the study groups

Parameter	Non-NAFLD	NAFLD	p
Gender F/M	403/113	351/119	0.22
Age	54.92±15.8	56.93±12.74	0.001
LDL (mg/dL)	127.63±37.38	131.45±35.68	0.001
Triglyceride (mg/dL)	128.5±65.28	170.36±97.02	<0.001
Urea (mg/dl)	31.78±11.22	31.75±10.06	0.47
Creatinine (mg/dL)	0.72±0,23	0.73±0,20	0.04
Uric acid (mg/dL)	4.90±1.59	5.48±1.35	<0.001
HDL (mg/dL)	52.30±12.26	49.53±9.99	0.003
ALT (U/L)	18.90±13.87	24.65±16.08	<0.001
AST (U/L)	22.1±8.8	24.03±10.7	0.004
HOMA-IR (pg/mL)	1.73±1.16	3.03±1.94	<0.001
TgG Index	8.65±0.54	9.06±0.62	<0.001
HbA1c (%)	5.87±1.06	6.35±1.31	<0.001
Glucose (mg/dL)	102.42±28.99	119.33±41.90	<0.001
Insulin (uIU/mL)	6.82±3.70	10.36±5.41	<0.001
Platelet (10^3 U/L)	268±70	278±71	0.284
Pre-DM, n (%)	197 (52.8)	176 (47.2)	<0.001
Type 2 DM, n (%)	76 (32.8)	155 (67.2)	<0.001

NAFLD: Nonalcoholic fatty liver disease; F: Female; M: Male; LDL: Low density lipoprotein; HDL: High density lipoprotein; ALT: Alanine transaminase; AST: Aspartate transaminase; TgG: Triglyceride/Glucose; DM: Diabetes mellitus.

Table 2. Evaluation of TgG-indexes between patients with and without NAFLD

Parameter	Non-NAFLD	NAFLD	p
TgG index <8.4, n (%)	173 (17.5)	59 (6)	<0.001
TgG index ≥8.4, n (%)	343 (34.8)	411 (41.7)	<0.001

TgG: Triglyceride/Glucose; NAFLD: Nonalcoholic fatty liver disease.

Table 3. Assessment of HOMA-IR values, TgG indexes, and uric acid levels in control, prediabetes and diabetes groups

Parameter	Control	Prediabetes	Diabetes	p-value
HOMA-IR	1.80±0.07	2.40±0.10	4.61±0.31	<0.001
TgG index	8.55±0.50	8.82±0.49	9.38±0.63	<0.001
Uric acid	4.99±0.08	5.21±0.06	5.43±0.09	<0.001

HOMA-IR: Homeostasis Model Assessment-Insulin Resistance; TgG: Triglyceride/Glucose.

Table 5. Correlation coefficients (r) between the parameters examined in study patients

Parameter	LDL	HDL	Triglyceride	Age
TgG index	0.130*	0.308*	0.859*	0.174*

*P<0.001; **P>0.05. LDL: Low density lipoprotein; HDL: High density lipoprotein; TgG: Triglyceride/Glucose.

128.5±65.28 mg/dL in those without NAFLD, while it was 170.36±97.02 mg/dL in those with NAFLD, and the difference between the two groups was statistically significant, (p<0.001). It was determined that the mean creatinine value was 0.72±0.23 mg/dL in the patient group without NAFLD, while it was 0.73±0.20 mg/dL in NAFLD patients, and the difference was statistically significant, (p=0.04). It was found that the mean HDL level was 52.30±12.26 mg/dL in those without NAFLD, while it was 49.53±9.99 mg/dL in those with NAFLD, and there was a statistically significant difference between the two groups, (p=0.003). The mean HOMA-IR was found to be 1.73±1.16 in the patient group without NAFLD, while it was 3.03±1.94 in the patient group with NAFLD, and the difference was statistically significant, (p<0.001). The mean TgG-index was found to be 8.65±0.54 in those without NAFLD, while it was 9.06±0.62 in those with NAFLD, and there was a statistically significant difference between the two groups and it was observed that the NAFLD incidence increased in patients with high Tg-G index, (p<0.001), (Table 2). The mean Hba1c was found to be % 5.87±1.06 in the patient group without NAFLD, while it was % 6.35±1.31 in the patient group with NAFLD, and the difference between the two groups was statistically significant, (p<0.001). The mean glucose level was determined to be 102.42±28.99 mg/dL in those without NAFLD, while it was 119.33±41.90 mg/dL in those with NAFLD, and the difference between the two groups was statistically significant, (p<0.001). The mean insulin level was found to be 6.82±3.70 uIU/mL in the patient group without NAFLD, while it was 10.36±5.41 uIU/mL in the patient group with NAFLD, and the difference between the two groups was statistically significant, (p<0.001). TgG-index was increased in prediabetic patients compared to the control group, and the index was higher in diabetic patients than the control and prediabetes groups, (Table 3). No statistically significant difference was not found among the biochemical parameters examined when the urea and platelet values were evaluated.

Table 4. Correlation coefficients (r) between the parameters examined in study patients

Parameter	Uric acid	ALT	AST	Insulin	HOMA-IR	Glucose	HbA1c
TgG index	0.200*	0.125*	0.030**	0.303*	0.438*	0.623*	0.557*

*P<0.001; **P>0.05. HOMA-IR: Homeostasis Model Assessment-Insulin Resistance; TgG: Triglyceride/Glucose; ALT: Alanine transaminase; AST: Aspartate transaminase.

Table 6. The evaluation of the effects of the determined factors on NAFLD in all patient groups using regression analysis

Parameter	ig.	Exp(B)	95% CI for EXP(B)		Parameter	ig.	Exp(B)	95% CI for EXP(B)	
			Lower	Upper				Lower	Upper
Step 1a					Step 3a				
TgG index	004	2.821	1.380	5.769	TgG index	004	2.808	1.396	5.651
HOMA-IR	004	1.135	1.040	1.238	HOMA-IR	004	1.138	1.043	1.241
Uric acid	328	0.998	0.993	1.003	Uric acid	345	0.998	0.993	1.003
Age	698	0.998	0.987	1.009	LDL	550	1.001	0.997	1.005
LDL	504	1.001	0.997	1.006	ALT	001	1.020	1.008	1.033
HDL	835	0.998	0.984	1.013	Presence of diabetes	348			
ALT	001	1.020	1.008	1.032	DM (Control-Prediabetes)	280	1.196	0.865	1.654
Presence of diabetes	312				DM (Control-DM)	172	1.406	0.862	2.295
DM (Control-Prediabetes)	250	1.215	0.872	1.693	Constant	000	.000		
DM (Control-DM)	150	1.450	0.874	2.406	Step 4a				
Constant	.000	.000			TgG index	003	2.853	1.421	5.729
Step 2a					HOMA-IR	004	1.135	1.041	1.237
TgG index	003	2.859	1.414	5.782	Uric acid	344	0.998	0.993	1.003
HOMA-IR	004	1.136	1.041	1.239	ALT	001	1.020	1.008	1.033
Uric acid	323	0.997	0.993	1.002	Presence of diabetes	.349			
Age	671	0.998	0.987	1.009	DM (Control-Prediabetes)	263	1.203	0.870	1.662
LDL	525	1.001	0.997	1.005	DM (Control-DM)	179	1.398	0.858	2.280
ALT	001	1.020	1.008	1.032	Constant	000	.000		
Presence of diabetes	319				Step 5a				
DM (Control-Prediabetes)	252	1.214	0.871	1.692	TgG index	000	3.702	2.096	6.538
					HOMA-IR	003	1.143	1.048	1.246
DM (Control-DM)	154	1.440	0.872	2.380	Uricacid	076	0.996	0.992	1.000
					ALT	001	1.020	1.008	1.033
Constant	.000	.000			Constant	000	.000		

NAFLD: Nonalcoholic fatty liver disease; HOMA-IR: Homeostasis Model Assessment-Insulin Resistance; LDL: Low density lipoprotein; HDL: High density lipoprotein; ALT: Alanine transaminase; AST: Aspartate transaminase; TgG: Triglyceride/Glucose; DM: Diabetes mellitus; CI: Confidence interval.

Results of the correlation analysis

A positive correlation was found between the triglyceride/glucose index and insulin, HbA1c, glucose levels, (r=0.303, r=0.557, r=0.623, respectively), (Table 4).

A positive correlation was found between triglyceride/glucose index and triglyceride, LDL levels, (r=0.859, r=0.130, respectively). However, there was a negative correlation between triglyceride/glucose index and HDL levels, (r=-0.308), (Table 5).

A positive correlation was found between the triglyceride/glucose index and uric acid, AST, ALT levels, (r=0.200, r=0.030, r=0.125, respectively), (Table 4).

There was a positive correlation between the TgG index and HOMA-IR (r=0.438), (Table 4). Between the TgG index and age; a positive correlation was found (r=0.174), (Table 5).

When the Backward Stepwise method was used, TgG index (p<0.001 OR=3.702), HOMA-IR (p=0.003, OR=1.143), ALT elevation (p=0.001, OR=1.020) were found to be the most effective risk factors, (Table 6).

DISCUSSION

In our study, the cut-off value of the TgG index was taken as 8.4, and it was observed that the frequency of NAFLD was significantly higher at values of 8.4 and above. As is known, insulin resistance is one of the important risk factors for NAFLD.[5–7] The HOMA-IR index is one of the important markers used in the evaluation of insulin resistance in the patient population.[8] In our study, a correlation was found between the risk of NAFLD and the HOMA-IR index, TgG index. The TgG index can also be considered as one of the indicators of insulin resistance.[9] Therefore, it is an expected result to be found statistically significant in NAFLD patients. In our study, it was observed that the risk of NAFLD increased by 1.1 times with the high HOMA-IR value and 3.7 times with the height of the TgG index. Therefore,

the TgG index can be considered a stronger predictor for NAFLD than HOMA-IR. In other words, patients with a high TgG index can be considered to have insulin resistance and NAFLD can be tested.[10–12]

The TgG index is cost-effective as it is less expensive than the HOMA–IR index. These results are similar to other studies on the same subject.[13,14]

Diabetes and abnormal glucose tolerance are important risk factors for NAFLD. In addition to insulin resistance, low-grade inflammation, oxidative stress, and activation of cytokines can be listed in the pathogenesis of this risk.[15,16] In addition, in our study, NAFLD was observed at a higher rate in diabetic patientsthan in prediabetes and control groups (Table 1). When the results of the regression analysis were examined, it was observed that the high TgG index increased the risk of NAFLD independently of insulin resistance (Table 6).

When the triglyceride/glucose index was examined in the control, prediabetes and diabetes groups, it was found that there was a statistically significant difference between the prediabetic and diabetic groups. It was found that the TgG index increased in prediabetic patients compared to the control group, and the index was higher in diabetic patients than in the control and prediabetes groups. In the correlation analysis, HbA1c, insulin levels were found to be correlated with the TgG index. In a study conducted in China, the TgG index was found to be an important indicator in identifying people at high risk of diabetes. As a result, it was observed that the elevation of TG increased lipolysis and decreased glucose-derived insulin secretion as a result of prolonged exposure of β cells to the released fatty acids. Subsequently, it was found that insulin gene expression was impaired and cell death increased due to this situation.[17,18] In another study, a significant increase in insulin secretion was found in patients who received fatty acid supplements.[19] In summary, it has been observed that the TG elevation impairs beta-cell function and therefore constitutes a risk factor for diabetes and insulin resistance.

There was no significant difference between the genders in our study. There are conflicting data in the literature about NAFLD and its relationship with gender. Age in patients with NAFLD was found to be statistically significantly higher compared to the control group, but no statistically significant increase in risk found in the regression analysis. It has been reported in the literature that this disease is more common between the ages of 50 and 60.[20–22]

Higher serum uric acid levels were observed in patients with nonalcoholic fatty liver disease. There are many studies on the relationship between uric acid and NAFLD. In these studies, it was seen that uric acid was effective in both the first and the second hits in the "double hit theory", which is one of the most accepted hypotheses in understanding the pathogenesis of NAFLD. Its role in the first hit is associated with insulin resistance and hyperinsulinemia. Insulin resistance both reduces uric acid excretion from the kidney and increases uric acid synthesis, hence causing hyperuricemia.[23,24] Its role in the second hit is related to pro-inflammatory processes. It has been associated with inflammation, as it increases IL-6 and TNF-alpha levels.[25] Uric acid is considered one of the independent risk factors for the development of FLD and is even considered to be one of the metabolic syndrome components.[26,27] In our study, it was found that uric acid levels showed statistically significant variability among diabetic, prediabetic, control groups, and groups with and without NAFLD (Table 1, 3).

In our study, serum ALT, AST, and LDL levels were higher, and HDL levels were lower in patients with NAFLD. These results are similar to those obtained in other studies.[28–30] Regression analysis results showed that ALT elevation increased the risk of NAFLD by 1.02 times. Previous studies have demonstrated that ALT levels in adipose tissue increase in people with insulin resistance, and the current situation has been found to be associated with oxidative stress and inflammation. ALT is considered a compensatory response to an impaired hepatic insulin signal and is one of the significant indicators of hepatic damage.

The strengths of our study can be considered as randomized population sampling and inclusion of individuals with normal glucose tolerance andt different stages of metabolic glucose disorders, thus reducing bias selection and increasing the validity of the diagnostic test. The limitations are that not all patients had anthropometric measurements due to retrospective research and radiodiagnostic methods other than USG were not available.

CONCLUSION

As a result, the TgG index has been evaluated as an important predictive parameter in terms of NAFLD. In daily practice, the HOMA-IR index is frequently used for the evaluation of insulin resistance and NAFLD. In our study, it was found that a high HOMA-IR index increased NAFLD risk by 1.1 times, while a high TgG index 3.7 times. It was also observed that the TgG index increased the risk of NAFLD, independent of HOMA-IR. Therefore, the TgG index is an important and promising index in terms of predicting NAFLD and insulin resistance, being economical and giving more effective predictive estimates compared to other tests.

Ethics Committee Approval

This study approved by the Haseki Training and Research Hospital Ethics Committee (Date: 19.11.2018, Decision No: 258).

Informed Consent

Retrospective study.

Peer-review

Internally peer-reviewed.

Authorship Contributions

Concept: H.E.A., M.Ç.; Design: S.A., E.H.; Supervision: M.Ç., E.H.; Materials: M.Ç., S.A.; Data: H.E.A., M.Ç.; Analysis: S.A., E.H.; Literature search: M.Ç., E.H.; Writing: M.Ç., E.H.; Critical revision: S.A., H.E.A., M.Ç.

Conflict of Interest

None declared.

REFERENCES

1. Milić S, Lulić D, Štimac D. Non-alcoholic fatty liver disease and obesity: biochemical, metabolic and clinical presentations. World J Gastroenterol 2014;20:9330–7.
2. Turkish Diabetes Association. Insulin Resistance Workshop Report; 2017. p. 10–21.
3. Navarro-González D, Sánchez-Íñigo L, Pastrana-Delgado J, Fernández-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. [CrossRef]
4. Irace C, Carallo C, Scavelli FB, De Franceschi MS, Esposito T, Tripolino C, et al. Markers of insulin resistance and carotid atherosclerosis. A comparison of the homeostasis model assessment and triglyceride glucose index. Int J Clin Pract 2013;67:665–72.
5. Samuel VT, Liu ZX, Qu X, Elder BD, Bilz S, Befroy D, et al. Mechanism of hepatic insulin resistance in non-alcoholic fatty liver disease. J Biol Chem 2004;279:32345–53. [CrossRef]
6. Angelico F, Del Ben M, Conti R, Francioso S, Feole K, Fiorello S, et al. Insulin resistance, the metabolic syndrome, and nonalcoholic fatty liver disease. J Clin Endocrinol Metab 2005;90:1578–82. [CrossRef]
7. Utzschneider KM, Kahn SE. Review: The role of insulin resistance in nonalcoholic fatty liver disease. J Clin Endocrinol Metab 2006;91:4753–61. [CrossRef]
8. McAuley KA, Williams SM, Mann JI, Walker RJ, Lewis-Barned NJ, Temple LA, et al. Diagnosing insulin resistance in the general population. Diabetes Care 2001;24:460–4. [CrossRef]
9. Guerrero-Romero F, Villalobos-Molina R, Jiménez-Flores JR, Simental-Mendia LE, Méndez-Cruz R, Murguía-Romero M, et al. Fasting triglycerides and glucose index as a diagnostic test for insulin resistance in young adults. Arch Med Res 2016;47:382–7. [CrossRef]
10. Zheng R, Du Z, Wang M, Mao Y, Mao W. A longitudinal epidemiological study on the triglyceride and glucose index and the incident nonalcoholic fatty liver disease. Lipids Health Dis 2018;17:262.
11. Khan SH, Sobia F, Niazi NK, Manzoor SM, Fazal N, Ahmad F. Metabolic clustering of risk factors: evaluation of Triglyceride-glucose index (TyG index) for evaluation of insulin resistance. Diabetol Metab Syndr 2018;10:74. [CrossRef]
12. Lim J, Kim J, Koo SH, Kwon GC. Comparison of triglyceride glucose index, and related parameters to predict insulin resistance in Korean adults: An analysis of the 2007-2010 Korean National Health and Nutrition Examination Survey. PLoS One 2019;14:e0212963.
13. Simental-Mendía LE, Rodríguez-Morán M, Guerrero-Romero F. The product of fasting glucose and triglycerides as surrogate for identifying insulin resistance in apparently healthy subjects. Metab Syndr Relat Disord 2008;6:299–304. [CrossRef]
14. Mazidi M, Kengne AP, Katsiki N, Mikhailidis DP, Banach M. Lipid accumulation product and triglycerides/glucose index are useful predictors of insulin resistance. J Diabetes Complications 2018;32:266–70. [CrossRef]
15. Leite NC, Salles GF, Araujo AL, Villela-Nogueira CA, Cardoso CR. Prevalence and associated factors of non-alcoholic fatty liver disease in patients with type-2 diabetes mellitus. Liver Int 2009;29:113–9.
16. Davì G, Guagnano MT, Ciabattoni G, Basili S, Falco A, Marinopiccoli M, et al. Platelet activation in obese women: role of inflammation and oxidant stress. JAMA 2002;288:2008–14. [CrossRef]
17. Mason TM, Goh T, Tchipashvili V, Sandhu H, Gupta N, Lewis GF, et al. Prolonged elevation of plasma free fatty acids desensitizes the insulin secretory response to glucose in vivo in rats. Diabetes 1999;48:524–30. [CrossRef]
18. Zhang M, Wang B, Liu Y, Sun X, Luo X, Wang C, et al. Cumulative increased risk of incident type 2 diabetes mellitus with increasing triglyceride glucose index in normal-weight people: The Rural Chinese Cohort Study. Cardiovasc Diabetol 2017;16:30.
19. Sawada T, Tsubata H, Hashimoto N, Takabe M, Miyata T, Aoki K, et al. Effects of 6-month eicosapentaenoic acid treatment on postprandial hyperglycemia, hyperlipidemia, insulin secretion ability, and concomitant endothelial dysfunction among newly-diagnosed impaired glucose metabolism patients with coronary artery disease. An open label, single blinded, prospective randomized controlled trial. Cardiovasc Diabetol 2016;15:121. [CrossRef]
20. Amarapurkar D, Kamani P, Patel N, Gupte P, Kumar P, Agal S, et al. Prevalence of non-alcoholic fatty liver disease: population based study. Ann Hepatol 2007;6:161–3. [CrossRef]
21. Vernon G, Baranova A, Younossi ZM. Systematic review: the epidemiology and natural history of non-alcoholic fatty liver disease and non-alcoholic steatohepatitis in adults. Aliment Pharmacol Ther 2011;34:274–85.
22. Angulo P. Nonalcoholic fatty liver disease. N Engl J Med 2002;346:1221–31.
23. Galvan AQ, Natali A, Baldi S, Frascerra S, Sanna G, Ciociaro D, et al. Effect of insulin on uric acid excretion in humans. Am J Physiol Endocrinol Metab 1995;268:E1–E5.
24. Modan M, Halkin H, Karasik A, Lusky A. Elevated serum uric acid--a facet of hyperinsulinaemia. Diabetologia 1987;30:713–8.
25. Johnson RJ, Kang DH, Feig D, Kivlighn S, Kanellis J, Watanabe S, et al. Is there a pathogenetic role for uric acid in hypertension and cardiovascular and renal disease? Hypertension 2003;41:1183–90.
26. Lonardo A, Loria P, Leonardi F, Borsatti A, Neri P, Pulvirenti M, et al; POLI.ST.E.N.A. Study Group. Policentrica Steatosi Epatica Non Alcolica. Fasting insulin and uric acid levels but not indices of iron metabolism are independent predictors of non-alcoholic fatty liver disease. A case-control study. Dig Liver Dis 2002;34:204–11.
27. Yoo TW, Sung KC, Shin HS, Kim BJ, Kim BS, Kang JH, et al. Relationship between serum uric acid concentration and insulin resistance and metabolic syndrome. Circ J 2005;69:928–33.
28. Klein BE, Klein R, Lee KE. Components of the metabolic syndrome and risk of cardiovascular disease and diabetes in Beaver Dam. Diabetes Care 2002;25:1790–4. [CrossRef]
29. Rogowski O, Shapira I, Bassat OK, Chundadze T, Finn T, Berliner S, et al. Waist circumference as the predominant contributor to the micro-inflammatory response in the metabolic syndrome: a cross sectional study. J Inflamm (Lond) 2010;7:35. [CrossRef]
30. Nakanishi N, Okamoto M, Yoshida H, Matsuo Y, Suzuki K, Tatara K. Serum uric acid and risk for development of hypertension and impaired fasting glucose or Type II diabetes in Japanese male office workers. Eur J Epidemiol 2003;18:523–30.

Non-alkolik Yağlı Karaciğer Hastalığında İnsülin Direnci ve Trigliserid/Glukoz İndekslerinin Öneminin Değerlendirilmesi

Amaç: İnsülin direnci, non-alkolik yağlı karaciğer hastalığı (NAYKH) için önemli risk faktörlerinden biridir ve Homeostazis Model Assesment-İnsulin Resistance (HOMA-IR) insülin direncini göstermede kullandığımız bir belirteçtir. Trigliserid/Glukoz indeksi (TgG indeksi) ise NAYKH'ı öngördürmede HOMA-IR kadar önemli, basit, kullanılabilir bir parametredir. Bu çalışmamızda HOMA-IR ve TgG indeksinin NAYKH öngördürmedeki değerini belirlemeyi amaçladık.

Gereç ve Yöntem: Çalışmaya Sağlık Bilimleri Üniversitesi Haseki Eğitim ve Araştırma Hastanesi İç Hastalıkları Kliniği'ne 2017–2018 yılları arasında başvuran ve herhangi bir nedenle Batın Ultrasonografisi (USG) çektirilmiş 986 hasta geriye dönük incelenerek alındı. Tüm vakalar NAYKH tanısı konulmadan önce diğer olası karaciğer hastalıklarını dışlamak amacıyla klinik ve laboratuvar yönünden değerlendirildi. Hastalara iki farklı gruplandırma yapıldı. Birincisi NAYKH olan ve olmayan grup; ikincisi kontrol, prediyabetik ve Tip 2 diyabetik grup olarak belirlendi. Grupları karşılaştırmak için normal dağılıma göre sayısal veriler Student t test veya Mann Withney u testi kullanılarak değerlendirildi. Univariate analizlerde sonlanım noktasına göre fark saptanan değişkenlerin (TgG indeksi, HOMA-IR, yaş, ürik asit, ALT, HDL, LDL, diyabet varlığı) NAYKH gelişimi üzerine etkisini belirlemek için lojistik regresyon yapıldı. P<0.05 veya %95 güven aralığı istatistiksel olarak anlamlı kabul edildi.

Bulgular: Çalışmamız NAYKH olan 470 hasta ve NAYKH olmayan 516 hasta olmak üzere toplam 986 hastadan oluşmaktadır. TgG indeksi hesaplanmış; 8.4 ve üzeri değerlerde p<0.001 istatistiksel açıdan anlamlı düzeyde NAYKH sıklığında artış görülmüştür. Yapılan korelasyon analizinde TgG indeksi ile HOMA-IR arasında pozitif korelasyon (r=0.438) bulunmuştur. Univariate analizlerde sonlanım noktasına göre fark saptanan değişkenlerden oluşturulan regresyon modelinin [TgG indeksi, HOMA-IR, yaş, ürik asit, ALT, HDL, LDL, diyabet varlığı] NAYKH gelişimi üzerine etkisi incelendiğinde; Backward Stepwise metodunda TgG indeksi (p<0.001, OR=3.702), HOMA-IR (p=0.003, OR=1.143), ALT yüksekliği (p=0.001, OR=1.020) en etkili risk faktörleri olarak saptandı.

Sonuç: Sonuç olarak TgG indeksi NAYKH açısından önemli öngördürücü bir parametre olarak değerlendirilmiştir. HOMA-IR NAYKH riskini 1.1 kat arttırırken, TgG indeksi 3.7 kat arttırmaktadır. Çalışmamızda TgG indeksinin HOMA-IR'dan bağımsız olarak da NAYKH riskini arttırdığı görülmüştür.

Anahtar Sözcükler: HOMA-IR; non-alkolik yağlı karaciğer hastalığı; trigliserid/glukoz indeksi.