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TRIGLYCERIDE-TO-HDL-CHOLESTEROL RATIO AS A MEASURE OF INSULIN RESISTANCE IN OBESE CHILDREN AND ADOLESCENTS

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Summary: Childhood obesity is associated with insulin resistance, type 2 diabetes, and metabolic syndrome. [1] [2] Although accurate, traditional insulin measurement techniques are not practical for routine clinical usage in pediatric populations [3]. This study investigates whether the ratio of triglycerides to HDL cholesterol can be used as a straightforward indicator of insulin resistance in obese children and adolescents. A retrospective study of 123 obese people aged 5 to 19 years discovered a moderate but substantial positive relationship between this ratio and insulin resistance, as evaluated by HOMA-IR. Higher ratios were associated with higher HOMA-IR readings and insulin levels. The triglyceride-to-HDL ratio may therefore provide a useful substitute for evaluating insulin resistance in clinical contexts, although more investigation is needed to validate its applicability in larger populations.

Keywords: *Childhood obesity, Insulin resistance, Triglyceride-to-HDL-cholesterol ratio, HOMA-IR, Metabolic syndrome.*

1. INTRODUCTION

Childhood obesity is rising globally, increasing the risk of insulin resistance, type 2 diabetes, and cardiovascular diseases. Therefore, there is an increasing need to identify accessible markers for insulin resistance, which is crucial for early intervention. While HOMA-IR and the hyperinsulinemic-euglycemic clamp are standard tools, their time-consuming and expensive nature makes them impractical for routine clinical use. [2] The TG/HDL ratio has emerged as a potential alternative marker, but its use in pediatric populations remains under-researched. This study investigates the relationship between the TG/HDL ratio and insulin resistance in obese children and adolescents. By assessing the correlation between the TG/HDL ratio and HOMA-IR, aiming to determine whether this marker can help identify children at risk for metabolic complications.

2. MATERIALS AND METHODS

2.1. Study Population

Data were collected from 123 obese children (aged 5–19 years) from the database of Department of Paediatrics and Adolescent Medicine, UPJS Kosice, Slovakia and the study was approved by the Ethics Committee of the University.

2.2. Data Collection

Clinical and laboratory parameters were analyzed, including age, sex, glucose, insulin, triglycerides, HDL, BMI, blood pressure, liver enzymes, and lipid profiles, TG/HDL ratio using as a cut off value the mean 1.0.

2.3. Definition of Obesity

Obesity was defined using BMI:

- ≥ 95th percentile for children under 14 years
- BMI ≥ 30 for children older than 14

2.4. Insulin Resistance Assessment

In order to access insulin resistance, HOMA-IR was calculated as:

$$\text{HOMA-IR} = \frac{\text{Fasting Insulin (mIU/L)} \times \text{Fasting Glucose (mmol/L)}}{22.5}$$

2.5. Statistical Analysis

Correlation analysis was used to assess associations between HOMA-IR and biochemical, laboratory parameters and the correlation between TG/HDL ratio and HOMA-IR. Furthermore multiple regression analysis was performed to evaluate independent predictors of insulin resistance. As a dependent variable HOMA has been used. As an independent insulin level, total cholesterol, triglycerides, HDL, and GGT. The significance level was set as $p < 0.05$.

3. RESULTS

3.1. Correlation between laboratory and anthropometric parameters with HOMA

As a result of correlation analysis between the different parameters and HOMA. A moderate positive association between the triglyceride-to-HDL-cholesterol ratio and HOMA-IR is observed. Additionally, the highest positive correlation was seen with insulin levels. On the other hand, there were weak negative correlations between HOMA-IR and HDL and LDL cholesterol *(Table 1)*.

Table 1

Correlation of parameters with HOMA-IR

Parameters	Correlation with HOMA-IR	P value
TG/HDL ratio	0.2343	0.00000
AGE years	0.0254	0.00000
GLUCOSE mmol/L	0.2901	0.10988
UREA mmol/L	–0.0679	0.54855
INSULIN mIU/L	0.9853	0.00000
BMI kg/m^2	0.1470	0.00000
SYSTOLIC BP mmHg	0.1121	0.00000
DIASTOLIC BP mmHg	0.1855	0.00000
TC mmol/L	–0.0099	0.51066
TG mmol/L	0.2552	0.00000
LDL mmol/L	–0.0213	0.00000
HDL mmol/L	–0.0654	0.00000
AST mIU/L	0.0057	0.00000
ALT mIU/L	0.1857	0.00000
GGT mIU/L	0.2134	0.00000

(BMI: body mass index, BP: blood pressure, TC: total cholesterol, TG : triglycerides, LDL: low density lipoprotein, HDL: high density lipoprotein, AST: aspartate aminotransferase, ALT: Alanine aminotransferase, GGT: gamma-glutamyl-transferase. HOMA-IR: Homeostatic Model Assessment for Insulin Resistance)

3.2. Group Comparisons

Participants were divided into two categories based on the mean value 1.00 of TG/HDL ratio. Children with TG/HDL > 1.00 showed higher insulin levels, HOMA-IR, LDL cholesterol, and total cholesterol. Evidence that suggests that patients with a higher TG/HDL ratio exhibited a higher HOMA ratio, indicating that individuals with a higher TG/HDL ratio tend to have greater insulin resistance *(Table 2)*.

Table 2

Clinical parameters: TG/HDL ratio>1 compare to TG/HDL ratio <1.00

PARAMETERS	TG/HDL >1.00	TG/HDL <1.00	P VALUE
GENDER	32M/24 F	38M/29F	0.96
AGE years	13.00 ±3.31	13.64 ±3.13	0.33
GLUCOSE mmol/L	4.58 ±0.44	4.58 ±0.40	0.91
UREA mmol/L	3.97 ±0.79	4 ±0.83	0.53
INSULIN mIU/L	24.12 ±14.83	17.15 ±10.49	0.003
BMI kg/m^2	31.25 ±6.2	29.80 ±6.23	0.2
SYSTOLIC BP mmHg	124.66 ±15.31	124.149 ±15.56	0.85
DIASTOLIC BP mmHg	78.75 ±8.86	76.94 ±10.11	0.29
TC mmol/L	4.58 ±0.79	4.15 ±0.79	0.004
TG mmol/L	1.72 ±0.57	0.84 ±0.22	0.00
LDL mmol/L	2.99 ±0.66	2.48 ±0.72	0.0001
HDL mmol/L	1.15 ±0.15	1.51 ±0.54	0.00
AST mIU/L	1.24 ±6.22	0.41 ±0.12	0.94
ALT mIU/L	0.46 ±0.23	0.46 ±0.25	0.9
GGT m/IUL	0.45 ±0.41	0.33 ±0.19	0.05
HOMA-IR	4.95 ±3.19	3.53 ±2.15	0.05
% high blood pressure	35(62.5%)	40(59.7%)	0.13

(BMI: body mass index, BP: blood pressure, TC: total cholesterol, TG : triglycerides, LDL: low density lipoprotein, HDL: high density lipoprotein, AST: aspartate aminotransferase, ALT: Alanine aminotransferase, GGT: gamma-glutamyl-transferase. HOMA-IR: Homeostatic Model Assessment for Insulin Resistance)

3.3. Correlation between TG/HDL and other clinical parameters

During the correlation analysis between the TG/HDL ratio and other clinical parameters, there was found a notable positive association between the TG/HDL ratio and HOMA-IR, total cholesterol, LDL cholesterol and gamma-glutamyl transferase (GGT). However, significant negative correlations were observed with glucose and urea *(Table 3)*.

Table 3

Correlation between TG/HDL and other clinical parameter

Parameters	Correlation with TG/HDL	P value
HOMA-IR	0.23	0.05
AGE years	–0.05	0.33
GLUCOSE mmol/L	–0.12	0.91
UREA mmol/L	–0.12	0.53
INSULIN mIU/L	0.27	0.003
BMI kg/m^2	0.08	0.2
SYSTOLIC BP mmHg	0.06	0.85
DIASTOLIC BP mmHg	0.18	0.29
TC mmol/L	0.22	0.004
TG mmol/L	0.93	0.00
LDL mmol/L	0.39	0.0001
HDL mmol/L	–0.48	0.00
AST mIU/L	0.05	0.94
ALT mIU/L	0.07	0.9
GGT mIU/L	0.32	0.05

(BMI: body mass index, BP: blood pressure, TC: total cholesterol, TG: triglycerides, LDL: low density lipoprotein, HDL: high density lipoprotein, AST: aspartate aminotransferase, ALT: Alanine aminotransferase, GGT: gamma-glutamyl-transferase. HOMA-IR: Homeostatic Model Assessment for Insulin Resistance)

3.4. Multiple Regression Analysis.

During data analysis using multiple regression analysis, where the dependent variable is HOMA-IR and the independent variables are insulin level, total cholesterol, triglycerides, HDL, and GGT, it was found that insulin levels had the strongest positive effect on HOMA-IR and triglycerides had a significant negative impact on HOMA-IR, while HDL cholesterol had no effect *(Table 4)*.

Table 4

Multiple regression analysis results

Predictor (Independent Variable)	Coefficient Effect on HOMA-IR	Std.error	t-value	P-value
Insulin	0.210042	0.00342	61.42198	<0.0001
TC	–0.03303	0.059849	–0.55186	0.582
TG	–0.2053	0.088782	–2.31239	0.022
HDL	0.007334	0.103366	0.070955	0.943
GGT	0.142723	0.144219	0.989627	0.324

Multiple R value is 0.9863, and its **R^2 is 0.9728** (This means that approximately 97% of the variation in HOMA-IR is explained by the predictors in this model.) **Dependent Variable:** HOMA-IR (Homeostatic Model Assessment for Insulin Resistance) **Independent Variables:** Insulin, Total Cholesterol (TC), Triglycerides (TG), HDL Cholesterol (HDL), Gamma-Glutamyl Transferase (GGT)

4. DISCUSSION

Previous researches have established a strong correlation between the TG/HDL ratio and HOMA insulin resistance, aligning with our findings. These studies suggested mean TG/HDL ratio thresholds for assessing insulin resistance: Olson et al. proposed 2.0 [4], Behiry et al. 1.36 [5], and Iwani et al. 1.11 [6]. In our study, we used a threshold of 1.0 to differentiate between higher and lower TG/HDL ratios. These small differences between the different studies may suggest that there is still not a clear cut off value that can be used for assessing children with insulin resistance using the TG/HDL ratio, further broader studies can help differentiate and establish cut off values for universal use as insulin resistance assessment.

Furthermore our results also confirm the negative association between the TG/HDL ratio and HDL cholesterol, with a correlation coefficient of $r = –0.48$, consistent with findings by Demiral M. [7] and Olson et al. In addition, we observed a positive connection between the TG/HDL ratio and other metabolic indicators such as triglycerides, insulin, and total cholesterol, supporting its significance as a metabolic marker. Moreover Katsa et al. [8] highlighted the positive correlation between the TG/HDL ratio and LDL cholesterol, linking it to increased cardiovascular risk. Our study supports this association but missing detailed cardiovascular assessments, limiting direct conclusions. Future research should explore this relationship further with comprehensive cardiovascular evaluations.

Comparing this study's results with the ones of Krawczyk et al. [9], there were observed differences and similarities. Unlike their findings, we found no significant relation between weight and the TG/HDL ratio, suggesting population-specific variations. However, both studies confirmed a positive association between the TG/HDL ratio and triglycerides. Furthermore, while we observed a negative correlation between the TG/HDL ratio and HDL cholesterol, Krawczyk et al.

reported a positive connection, potentially due to differences in population characteristics. These findings emphasize the complexity of lipid metabolism and the necessity for further research in diverse populations to clarify these associations. Furthermore, to analyze how the borderline significant and significant data affected the HOMA-IR, a different method of statistical analysis was used, the multiple regression analysis which indicated a strong predictive model for HOMA-IR, with insulin and triglycerides appearing as the most significant predictors. The model had an excellent fit ($R^2 = 0.9728$), explaining nearly 97% of the variance in insulin resistance as evaluated by HOMA-IR. Insulin revealed a strong positive connection with the independent variables, implying that greater insulin levels contribute considerably to increased insulin resistance. Interestingly, triglycerides were also statistically significant in this model, although they linked negatively with HOMA-IR, a finding that needs further exploration. However, despite their biological significance, additional parameters including total cholesterol, HDL, and GGT did not exhibit significant individual impacts. These results underline the importance of triglyceride and insulin levels in regulating insulin resistance in the population under study and support the necessity of taking these factors into account when determining metabolic risk. In conclusion, our study provides strong evidence that the TG/HDL ratio serves as a valuable alternative for assessing insulin resistance. Children with higher TG/HDL ratios showed significantly elevated HOMA-IR levels, confirming its reliability as an alternative method for insulin resistance assessment. However, this research faced some limitations. Firstly the age-related metabolic differences were not analyzed separately. In addition potential measurement errors in laboratory data may affect accuracy. Moreover the study lacked cardiovascular health assessments, limiting conclusions on long-term risks.

5. CONCLUSION

The TG/HDL ratio offers a simpler and more cost-effective alternative to HOMA-IR for assessing insulin resistance, particularly in pediatric populations. Unlike HOMA-IR, which requires both fasting glucose and insulin levels and needs specialized laboratory tests and careful timing, the TG/HDL ratio can be calculated from a standard lipid profile that is commonly ordered in routine clinical practice. This makes it more accessible, especially in resource-limited settings where insulin specific evaluation tests may not be easily available or affordable. Because elevated triglyceride levels and low HDL cholesterol are both key components of dyslipidemia associated with insulin resistance, the TG/HDL ratio serves as an indirect but practical marker for identifying children at increased risk for metabolic syndrome. Its advantage lies in its simplicity, availability, and its ability to detect early metabolic abnormalities, helping in earlier intervention and potentially preventing progression to more serious conditions such as type 2 diabetes and cardiovascular disease. However, while this study has demonstrated a significant association between the TG/HDL ratio and HOMA-IR, the strength of the correlation

was moderate, so further research is needed to validate its predictive value across larger, more diverse populations.

REFERENCES

[1] Tagi, V. M., Giannini, C. and Chiarelli, F. (2019). Insulin Resistance in Children. *Front. Endocrinol*., 10, 342. https://doi.org/10.3389/fendo.2019.00342

[2] Power, A. C. (2015). *Harrisons endocrinology: Diabetes mellitus: diagnosis, classification, and pathophysiology.* In: Kasper, D. L., Fauci, A. S., Hauser, S. L., Longo, D. L., Larry Jameson, J. and Loscalzo, J. (eds.). *Harrison's Principles of Internal Medicine*. Vol. 2, 19th Edition, McGraw-Hill, New York, 2399–2407.

[3] Vandhna R., Sharma, Samantha T. Matta, Morey W. Haymond, Stephanie T. Chung (2020). Measuring Insulin Resistance in Humans. *Horm. Res. Paediatr*., 93, 577–588. https://doi.org/10.1159/000515462

[4] Olson, Karen et al. (2022). *The Triglyceride to HDL Ratio and Its Relationship to Insulin Resistance in Pre- and Postpubertal Children: Observation from the Wausau SCHOOL Project*. 2012 (794252), 1–4. https://doi.org/10.1155/2012/794252

[5] Behiry, Eman G. et al. (2019). Evaluation of TG-HDL Ratio instead of HOMA Ratio as Insulin Resistance Marker in Overweight and Children with Obesity. *Endocrine, Metabolic & Immune Disorders – Drug Targets*, 19 (5), 676–682. https://doi.org/10.2174/1871530319666190121123535

[6] Zati Iwani, N. A. K. et al. (2017). Triglyceride to HDL-C Ratio is Associated with Insulin Resistance in Overweight and Obese Children. *Sci. Rep*., 7, 40055. https://doi.org/10.1038/srep40055

[7] Demiral M. (2021). A novel diagnostic tool in determining insulin resistance in obese children: Triglyceride / HDL ratio. *J. Surg. Med*., 5 (11), 1144–1147.

[8] Maria Efthymia Katsa et al. (2019). The Roles of Triglyceride/High-Density Lipoprotein Cholesterol Ratio and Uric Acid as Predisposing Factors for Metabolic Syndrome in Healthy Children. *Annals of Pediatric Endocrinology & Metabolism*, 24 (3), 172–179. https://doi.org/10.6065/apem.2019.24.3.172

[9] Krawczyk, Monika et al. (2018). Usefulness of the Triglycerides to High-Density Lipoprotein Cholesterol Ratio (TG/HDL-C) in Prediction of Metabolic Syndrome in Polish Obese Children and Adolescents. *Acta Biochimica Polonica*. https://doi.org/10.18388/abp.2018_2649