# Assessing Insulin Resistance and Metabolic Syndrome Prevalence Among Rural and Urban Adolescents in South India Using HOMA-IR

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**ABSTRACT:**

**INTRODUCTION:** Insulin resistance is a metabolic condition marked by decreased cell sensitivity to insulin, which impairs the uptake and utilization of glucose. It plays a major role in the emergence of a number of metabolic illnesses, such as metabolic syndrome, a collection of risk factors that includes dyslipidemia, high blood pressure, abdominal obesity, and poor glucose metabolism. Teenagers who have metabolic syndrome or insulin resistance should have these conditions identified as soon as possible to avoid long-term health issues and facilitate early treatments. Evaluation of Insulin Resistance and Metabolic Syndrome Prevalence in South Indian Adolescents, Both in Rural and Urban Settings Employing HOMA-IR could provide a number of unique benefits, like as Put Adolescents First. Although a large body of research has been conducted on adult metabolic syndrome and insulin resistance, relatively few studies have focused explicitly on adolescents. This study closes a significant gap by concentrating on teenagers and offering HOMA-IR cut-off values that are particular to their age. This innovative method acknowledges the distinct physiological traits and metabolic profiles of this age group.

**Aim:** The present study was planned Assessing Insulin Resistance and Metabolic Syndrome Prevalence Among Rural and Urban Adolescents in South India Using HOMA-IR

**Methodology:** This study, which was conducted in Sree Balaji Medical College and Hospital in

Chennai between October 2023 and December 2023, employs the homeostatic model assessment for insulin resistance approach. Each participant's parents gave written informed consent for their ward to participate in the study at the time it was started. Children's consent was also acquired prior to taking blood samples. Every participant had their blood pressure, height, and weight measured. To determine plasma glucose and serum insulin values, blood was collected both before and after the glucose load. BMI was computed. By using the Tanner & White approach, SMR was found. (22,23).

**Result:** Adolescents with any component of MS had significantly higher HOMA-IR values than those without. When both techniques (definition of MS by IDF or HOMA-IR cut-off of 2.5) were combined, the yields for MS were higher:37.5%,68.7%, and 100% in normal, overweight, and obese group, respectively.

**Conclusion:** In south Indian adolescents, HOMA-IR increased with sexual maturity and with progression from normal to obese. A HOMA-IR cut-off of 2.5 provided the maximum sensitivity and specificity in diagnosing MS in both genders as per IDF criteria.

**KEYWORDS:** Insulin resistance, metabolic syndrome, HOMA IR, South Indian Adolescents, dietary pattern, life style

## INTRODUCTION:

Adults and older adults with metabolic syndrome (MS), type 2 diabetes mellitus (T2DM), and cardiovascular disease (CVD) have all been linked to insulin resistance (IR) and the metabolic abnormalities associated with IR. The diagnosis of MS in children and adolescents is growing in popularity (1,2). It is commonly known that childhood obesity, which is on the rise globally, is linked to IR (3).Insulin-mediated glucose disposal and inhibition of hepatic glucose production are two examples of the metabolic actions of insulin that are typically defined as decreased sensitivity or responsiveness in IR. Insulin sensitivity and resistance can be measured using a variety of methods, both directly (using hyperinsulinemic euglycemic glucose clamping and insulin suppression tests) and indirectly (using the homeostasis model of assessment-IR (HOMA), frequently sampled intravenous glucose tolerance test, oral glucose tolerance test, and meal tolerance test). (4). Insulin resistance (IR) is thought to be the primary mechanistic basis of obesity in a context of dysmetabolic status, a pathophysiology shared by a number of conditions (5). The development of IR is influenced by a decreased tissue response to insulin-mediated cellular actions, lipolytic action in adipose tissue, and accumulation of free fatty acids (FFA) in the liver. The inflammation linked to insulin resistance is also mediated by the inflammatory cytokines produced by malfunctioning adipocytes (6). This IR, which is linked to beta-cell dysfunction brought on by ectopic fat deposition, is more common in obese children (7). With a similar degree of adiposity and glycemic status, it is more common in adolescents than in adults, and it is associated with a faster rate of decline in beta-cell function. Among this age group, children's IR is partly caused by puberty, a physiological condition (8). Since there is no accepted definition for insulin sensitivity in children and fasting plasma insulin is a subpar indicator, insulin sensitivity (IR) is a significant problem that clinicians must deal with in pediatric patients (9). Insulin resistance (IR) impacts the insulin's downstream signaling pathways, preferring the

MAPK pathway over the Pi3K-Akt pathway. This can result in a variety of unfavorable metabolic consequences, including CVD, diabetes, and hypertension. IR is therefore a significant precursor to MetS [10]. The hyperinsulinemic-euglycemic clamp method, which is laborious and requires technical expertise, is the gold standard for measuring infrared [11].The Homeostasis Model Assessment of Insulin Resistance (HOMA-IR), which requires the measurement of fasting plasma Insulin levels—which may not be widely available and inaccurate due to improper standardization—is an easier, albeit less accurate, method of measurement. [12]. A useful tool that provides a non-invasive way to measure insulin resistance is the Homeostatic Model Assessment for Insulin Resistance, or HOMA-IR. However, despite its usefulness, little is known about the precise applicability and cut-off values for HOMA-IR in the teenage population of South India. This study aims to close this gap by thoroughly examining the relationship between the prevalence of metabolic syndrome in South Indian adolescents and insulin resistance as measured by HOMA-IR. [13–15].This work sheds light on the possible socioeconomic implications of insulin resistance and metabolic syndrome in addition to addressing the scientific curiosity surrounding these conditions. Adolescents' metabolic health is essential to the prosperity of communities because they will comprise the workforce of the future and contribute to the well-being of society. Our objective is to provide healthcare professionals, educators, and policymakers with the necessary knowledge to develop tailored strategies that are in line with the local realities of South India by illuminating the factors that contribute to insulin resistance in this population. Furthermore, the rise in metabolic disorders worldwide emphasizes how critical it is to identify the underlying causes in a variety of populations.This research adds to the global dialogue on metabolic health, within the particular context of South Indian adolescents. This acknowledges the need for evidence-based and culturally sensitive solutions in order to develop a thorough understanding of insulin resistance and metabolic syndrome. In the end, we hope that this research will contribute to a healthier future for South Indian adolescents by broadening the scientific discourse and encouraging positive changes in healthcare practices and policies.

**AIM:** The present study was planned to Assessing Insulin Resistance and Metabolic Syndrome Prevalence Among Rural and Urban Adolescents in South India Using HOMA-IR

## MATERIALS AND METHODS

Between October 2023 and December 2023, the Homeostatic Model Assessment for Insulin Resistance Method was used in this study at Hicare Scanners and Lab in Chennai. Both the Institutional Research Committee and the Institutional Human Ethical Committee approved the project.. The Declaration of Helsinki's guidelines were followed in the conduct of the study, and each subject or patient provided written informed consent. Both the parents and the patients gave their prior consent for the study. Each participant's parents gave written informed consent for their ward to participate in the study at the time it was started. Children's consent was also acquired prior to taking blood samples. With the subject standing upright and his or her head held in the Frankfurt horizontal plane, the subject's height was measured with a stadiometer, accurate to within 0.1 cm. Using an electronic digital weighing machine, the subject's weight was recorded to the nearest 0.1 kg while they were wearing light clothing and no shoes.
Measurements of weight and height were made twice, and BMI was computed using the mean of the two readings. The blood pressure was measured using the protocol outlined in the Joint

National Committee's Seventh Report (16). On the morning of the test, the subjects and their parent(s) were interviewed to determine compliance with the written instructions that the adolescents were given to fast for 12 hours. After a 12-hour overnight fast, venous blood samples were drawn, and the participants were given the glucose load. Samples were collected two hours after loading to measure serum insulin and plasma glucose levels. The kids were kept fasting in the exam room during this time, and they weren't allowed to engage in any physically demanding activities. The day of the assay, the post-load plasma glucose levels and fasting levels were estimated, and the remaining aliquots were kept refrigerated at -20˚C.Plasma glucose was measured using the glucose oxidase–peroxidase method (Clonital, Italy). With the use of commercial kits and an automated analyzer (Hitachi-902 fully automated biochemistry analyzer; Roche, Manheim, Germany), the levels of total cholesterol, HDL cholesterol, and triglycerides (TG) in fasting serum were measured. Commercial kits and an electrochemiluminescence device (Elicsys, Roche Diagnostics) were used to measure the serum insulin level. The measurement range was 3.5-2083.5 pmol/L, with a normal value of 14.6-152.8 pmol/L provided. The coefficients of variation for the intra- and inter-assays were 3.4% and 4.3%, respectively. The HOMA model [HOMA-IR = fasting insulin (µIU/mL)*fasting glucose (mmol/L)/22.5] was utilized to compute IR (17).BMI is defined as the square of body height times body weight, expressed in kilograms per square meter. WC cut-offs as suggested by Kuriyan and associates. A systolic (SBP)/diastolic blood pressure (DBP) greater than the 90th centile for age and sex (18) was considered hypertension. Tanner & White's method was used to calculate SMR (22, 23). The International Diabetes Federation (IDF) criteria (61) [WC >90th percentile with any two of the parameters (TG ≥1.69 mmol/L, HDL <1.03 mmol/L, FPG>5.6 mmol/L, and BP >130/85 mmHg] were used to define metabolic syndrome in adolescents.[19,20]. Unless otherwise indicated, the data are shown as mean ± standard deviation or as a number (%). The independent student's t-test was used to analyze all parametric data in categorical groups. The chi-square test was used to analyze all non-parametric data. To evaluate the strength of the relationship between lipid HOMA-IR and other parametric variables, Pearson's correlation coefficient was computed. HOMA-IR was used to plot receiver operator characteristic (ROC) curves in relation to the presence or absence of metabolic abnormalities. Plots of HOMA-IR and the presence or absence of metabolic abnormalities were made using the highest value of Youden's index, which was used to determine the cut-off value of HOMA-IR. A p-value of less than 0.05 was deemed statistically significant. Youden's index was calculated as follows: sensitivity - (1-specificity), which was obtained from the curve's coordinates.

**INCLUSION CRITERIA**

1. **Age Range:** Inclusion of participants within a specific age range (12 – 19) relevant to adolescence, ensuring that the study focuses on the target population.
2. **Geographic Location:** Selection of participants from South Indian regions to maintain homogeneity and relevance to the regional demographic.
3. **Body Mass Index (BMI):** Specifying a BMI range to include a diverse group of participants while ensuring a focus on the adolescent age group.

**EXCLUSION CRITERIA**

1. **Age Limit:** Excluding participants outside the defined age range to maintain the study's focus on adolescents.

2. **Geographic Exclusion:** Excluding participants from regions outside South India to maintain the study's regional relevance.
3. **Chronic Medical Conditions:** Excluding individuals with chronic medical conditions (e.g., diabetes, cardiovascular diseases) that may independently influence insulin resistance.
4. **Medication Use:** Excluding participants on medications that may impact insulin sensitivity to isolate the effects of insulin resistance.
5. **Pregnancy:** Excluding pregnant participants due to the potential impact of pregnancy on metabolic parameters.
6. **Severe Mental Health Conditions:** Excluding participants with severe mental health conditions that may impact their ability to participate or comply with study requirements.

**Extreme BMI:** Excluding individuals with extremely low or high BMI to avoid outliers that may skew the results.

## SAMPLE COLLECTION:

Under aseptic precautions, by venepuncture venous blood (5ml) was drawn from all the subjects after overnight fasting of 10-12hours. From that serum was separated for analyzing of serum lipid profile, **Fasting glucose , Fasting Insulin levels**

## STUDY PARAMETERS:

1. Serum cholesterol
2. Serum Triglycerides
3. High density lipoprotein (HDL)
4. Fasting Glucose

5. Fasting Insulin 6.HOMA-IR

## STATISTICAL ANALYSIS:

The collected data would undergo statistical analysis to determine the relationship between HOMA-IR and the presence of metabolic syndrome components. Regression analysis, correlation analysis, or logistic regression models may be employed to assess the association. Receiver operating characteristic (ROC) curve analysis can be used to determine the optimal cut-off value of HOMA-IR for identifying metabolic syndrome in adolescents.

## RESULTS:

After appropriate screening with , lipid profile and Blood Glucose of Normal, overweight, and obese patients were selected for this study. The mean and standard deviation of biochemical parameters of Normal, overweight, obese patients are shown in following table 1.

**Table 1: Mean And Standard Deviation Of Biochemical Parameters Normal,Over weight and obese**

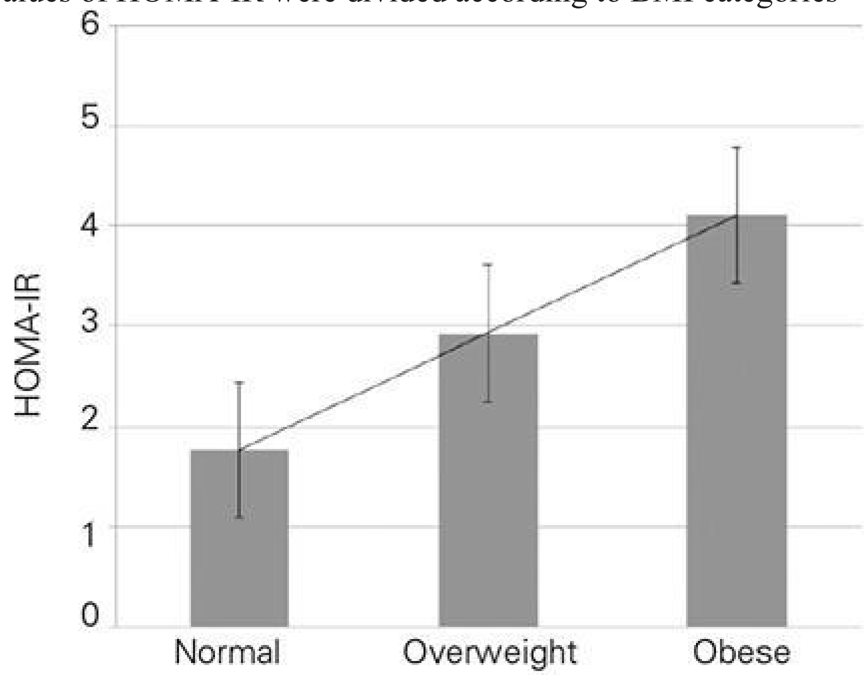
| Variables | BMI | | | | | | |
|---|---|---|---|---|---|---|---|
| | Normal n = 40 | | Over weight n = 25 | | Obese n = 5 | | |
| | Mean | Standard Deviation | Mean | Standard Deviation | Mean | Standard Deviation | p value |
| AGE | 16.60 | 2.23 | 16.72 | 2.07 | 16.20 | 1.64 | 0.883 |
| SYSTOLIC PRESSURE | 117.3 | 7.7 | 128.6 | 8.02 | 137.6 | 5.73 | <0.001 |
| DIASTOLIC PRESSURE | 68.18 | 7.51 | 77.8 | 7.22 | 83.8 | 7.01 | <0.001 |
| TOTAL CHOLESTEROL | 148 | 18.24 | 186.84 | 29 | 230.2 | 20.04 | <0.001 |
| TRIGLYCERIDE | 112.43 | 18.31 | 153.28 | 35.91 | 190 | 10.3 | <0.001 |
| HDL-CHOLESTEROL | 67.15 | 8.13 | 57.68 | 10.3 | 43 | 3.94 | <0.001 |
| FASTING GLUCOSE | 93.38 | 7.9 | 105.8 | 10.59 | 112.8 | 3.7 | <0.001 |
| FASTING INSULIN | 5.71 | 2.54 | 11 | 3.16 | 15.43 | 1.34 | <0.001 |
| HOMA-IR | 1.3 | 0.69 | 2.88 | 1.02 | 4.3 | 0.38 | <0.001 |

**Table 5.2:**

| Variables | Categories | BMI_Recode | | | p value |
|---|---|---|---|---|---|
| | | Normal n (%) | Over weight n (%) | Obese n (%) | |
| Sex | Male | 22 (55%) | 18 (72%) | 3 (60%) | 0.367 |
| | Female | 18 (45%) | 7 (28%) | 2 (40%) | |
| HOMA_IR_Recode | < 2.9 | 37 (92.5%) | 13 (52%) | 0 (0%) | <0.001 |
| | >=2.9 | 3 (7.5%) | 12 (48%) | 5 (100%) | |

***p value < 0.005 is considered to be significant**

The HOMA-IR values increased progressively from normal weight to obese from the figure 5.1. The mean values of HOMA-IR were divided according to BMI categories



The prevalence of MS in normal BMI, overweight, and obese adolescents was 28.5%,16%,100% respectively,using the IDF definition. The HOMA-IR cut-off value for MS was determined by il6curve.

Although the HOMA-IR value of 2.0 showed maximum sensitivity for diagnosing MS as defined by IDF (86.3%) and it had low specificity (46.4% and 47.7%, respectively). A sensitivity of >70% and specificity of >60% was indicated by HOMA-IR value of 2.5. According to this cut-off, the number of adolescents with IR in different BMI categories would be 4 (10%) in normal weight, 17 (68%) in overweight, and 5 (100%) in obese groups, respectively. When both techniques (definition of MS by IDF or HOMA-IR cut-off of 2.5) were combined, the yields for MS were higher:37.5%,68.7%, and 100% in normal, overweight, and obese group, respectively. Adolescents with any component of MS had significantly higher HOMA-IR.

**DISCUSSION:**

There's a good chance that the global obesity epidemic has contributed to the rise in the incidence and prevalence of type 2 diabetes and its cardiovascular complications. Concern should be expressed over the rising rate of obesity in South Indian children and adolescents (21- 23) as this increases the risk of detrimental health effects in addition to being a risk factor for adult obesity (24). The prevalence of IR and MS in this population is rising in tandem with the trend of rising adolescent obesity (25). However, there are currently no data defining the HOMA-IR cut-off values for adolescents in South India. A study conducted in southern India found a link between glucose intolerance and HOMA-IR (26). This study is the first to examine HOMA-IR values in adolescents of both sexes who are obese, overweight, or normal weight while also accounting for age and metabolic abnormalities linked to metabolic syndrome.In contrast to boys, who displayed lowest levels at 13 years old and peak HOMA-IR values at 19 years old, girls in our study showed no significant differences in mean HOMA-IR values according to age groups. In healthy Spanish children, HOMA-IR increased with age in both boys and girls, according to a study (27). A few years before puberty, in mid-childhood (~ 7 years), the Early Bird Diabetes study from the UK had prospectively evaluated HOMA-IR in healthy children aged 5-14 years and found that IR started rising from that point on.As predicted, both boys and girls in the current cross-sectional study, which included teenagers between the ages of 10 and 19, demonstrated a progressive increase in mean HOMA-IR values with rising BMI. The HOMA-IR values of adolescents who were normal weight, overweight, and obese differed significantly from one another. A large study conducted among adolescents in the United States of America confirmed that obese subjects had higher HOMA-IR values than normal adolescents (28).The HOMA-IR cut-off values for diagnosing MS in teenagers are up for debate. A HOMA-IR cut-off of 2.5 in the current study offered sufficient sensitivity and specificity for MS and IDF criteria diagnosis. No prior research from south India has attempted to determine HOMA-IR cut-offs to identify MS within this population subset. Numerous studies (29), which used small samples of obese children and adolescents, reported HOMA-IR values ranging from 2.22 to 3.16 as the cut-off for identifying IR. Consequently, it is likely that these studies reported higher cut-off values. Because our study's cut-off values were obtained from a sizable cohort of adolescents who were evenly distributed among normal weight, overweight, and obese, they have a higher chance of being applicable.Given that IR has been linked to MS, it is possible that long-term IR is what leads to the metabolic abnormalities connected to MS. The current study's results support this further, as the HOMA-IR cut-off identified several overweight and normal-weight adolescents with IR who would not have been detected by the ATP III criteria. A Turkish study made a similar observation. (30). These kids could eventually develop multiple sclerosis. Given that children and adolescents from the Indian subcontinent were found to be more insulin resistant than their Caucasian counterparts (31) this assumes significance for them. This is further supported by our research, which found that 100% of obese teenagers had IR, compared to roughly 52% in a study of teenagers in the US. Therefore, MS development may be avoided by providing intervention to the group of teenagers with underlying IR who do not have metabolic abnormalities. Future research must, however, validate this tactic.(32)In this investigation, there were strong correlations between HOMA-IR and WHR and BMI, but not between HOMA-IR and WHR. The strongest correlation between HOMA-IR and WC was also noted in other studies, one of which was conducted in India (33). In our research, WHR has also demonstrated a strong correlation with HOMA-IR. A sizable European study revealed a similar outcome. According to all of these studies, WC and WHtR can be used to identify people who are at risk for IR in adolescents and are strong predictors of IR. Elevated TG was correlated with HOMA-IR among the different biochemical parameters, while HDL did not exhibit a significant correlation. HOMA-IR was considerably higher in teenagers who tested positive for MS-related components.(34). high ferritin levels in CAD patients may be an additional risk factor for atheromatous plaque formation and subsequent CAD development. Low vitamin D levels are also linked to an increased risk of CAD (35).The quantity of teenagers in the sample with a comparable distribution across all BMI categories is our study's strongest point. Its shortcoming is the lack of a long-term follow-up.According to this study, HOMA-IR is a useful method for identifying MS in teenagers. According to IDF criteria, a HOMA-IR cut-off of 2.5 offered the highest level of sensitivity and specificity for diagnosing MS in both genders.

## CONCLUSION

In south Indian adolescents, HOMA-IR increased with sexual maturity and with progression from normal to obese. A HOMA-IR cut-off of 2.5 provided the maximum sensitivity and specificity in diagnosing MS in both genders as per IDF criteria.

## AUTHORS CONTRIBUTION:

This study was done by Mr. E.Vasudevan under the guidance of Dr. B. Shanthi and Mrs Kalaiarasi ,Mr.Nambiarasan ,Dr. Mary Chandrika Anton. Dr.Chaganti Sridevi, contributed in review of literature and discussion.

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## ETHICAL STANDARDS

The study involved human participants following the ethical standards of the tertiary health care institution where the study was conducted.

## CONFLICT OF INTEREST

Declared none by the authors.

## LIMITATIONS OF THE STUDY

The study population shall be enlarged as it was relatively less.

## FUNDING:

The principal investigator did not get fund from any agencies for carrying out this project.

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