RESEARCH ARTICLE

# Prevalence of Insulin Resistance and its Association with Obesity and Alcoholism in Male Medical Students of Bhopal

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**ABSTRACT- Background:** Obesity is rising in medical students due to their stressful academic calendar and sparse time for sports. Obesity is aggravated by the regular drinking of alcohol, a recreational and stress-busting activity, particularly for male students. Obesity leads to insulin resistance. Homeostasis model assessment-estimated insulin resistance (HOMA-IR) >2 has been reported to independently predict cardiovascular risk. Although many studies are there on obesity of medical students, few studies exist in Central India on the prevalence of insulin resistance in medical students. Therefore, the prevalence of insulin resistance and its association with obesity and alcoholism was investigated in the first year male medical students of the LN Medical College, Bhopal, India.
**Methods:** The 50 male medical students of the first year were investigated and considered overweight/obese, if BMI>=23 or centrally obese if waist circumference (WC)>=90cm. Alcohol intake of more than 20 gm per day was considered as a high alcohol intake. HOMA-IR was calculated from fasting glucose and fasting insulin, whereas HOMA-IR>=2 was regarded as high.
**Results:** Insulin resistance measured by HOMA-IR>=2 was found in 40%, central obesity as per waist circumference in 20%, overall obesity/overweight as per BMI with 60% and alcoholism in 42%. A significant association was found between insulin resistance and central obesity measured by waist circumference (p value 0.001), but not with BMI and alcoholism.
**Conclusion:** Prevalence of insulin resistance in first year male medical students were high and insulin resistance was significantly associated with central obesity.

**Key-words-** Alcoholism, BMI, HOMA-IR, Insulin resistance, Waist circumference

## INTRODUCTION

Medical students have a rigorous academic calendar, which leaves less time for sports and exercise. Prevalence of overweight and obesity is rising in medical students worldwide.[1] Studies from various parts of India have agreed on this rising trend to varying degree. [2,3]
It is compulsory for first year medical students of our institution to reside in the college hostel. Regular drinking of alcohol is a recreational and stress-busting activity for the male students.

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They are at risk of being overweight as alcohol prevents oxidation of fatty acids by contributing 7 kcal/gm of energy.[4] Increased central obesity is reported to lower physical fitness index and cardiovascular efficiency, especially during exercise, due to lower utilization of oxygen per unit of body mass. [5]
Obesity in general is associated with increased risk of metabolic syndrome and cardiovascular disease.[6] Many endocrine, inflammatory, neural, and cell-intrinsic pathways get dysregulated in obesity, which independently and in interdependent ways leads to insulin resistance.[7] HOMA-IR>2 has been reported to independently predict future risk of developing cardiovascular disease (CVD).[8] HOMA-IR>2.5 has been reported to identify a large number of adolescents as having metabolic syndrome in different categories of Body Mass Index (BMI).[9]
High prevalence of insulin resistance in the general school and college population has been reported.[10] However,

 

studies on medical students is mostly restricted to obesity. There have been few studies in medical students, particularly in Central India on the prevalence of insulin resistance. This study was there therefore carried out in the first year male medical students of our institute in Bhopal to estimate the prevalence of insulin resistance and determine whether insulin resistance was significantly associated with obesity and alcoholism.

## MATERIALS AND METHODS

This study was carried out as an Indian Council of Medical Research-Short Term Studentship (ICMR-STS) project on 50 first year male medical students, studying at the LN Medical College, Bhopal, India. Out of the total 150 students admitted every year, about half were male. The students included in the study were 18 to 25 years of age of 2015-16 batch. Those unwilling to give consent were excluded from the study. Four students declined to give their alcoholic and smoking status, even though they filled all other informations. The sample size was adequate to fulfil the primary objectives at the 5% level of significance. Permission of Institutional Ethical Committee was taken prior to commencing the study.

A questionnaire was given to the students for information regarding their name, age, and address, history of high alcohol intake, high calorie intake, level of physical exercise, socio-economic status, and personal history of smoking, diabetes or hypertension. Alcohol intake of more than 20 gm per day was considered as high alcohol intake.[11] Smoking more than five sticks per day was considered frequent. Heavy physical exercise (gymming, running or playing games like football for 30 minutes or more per day) was considered physically active. Calorie consumption of more than 3000 per day was considered high. Information was also collected about their parents being affluent (>=12 lakhs per annum) or having moderate income.

Obesity in general was measured by BMI and central obesity was measured by waist circumference. The weight in kg and height in metres of the students was noted by wall mounted stadiometer to calculate BMI. The waist circumference of the students was measured keeping the tape horizontally at just above the hip bone. Students were categorised on the basis of central obesity and BMI as per Asian criteria. The student was normal, if BMI 18.5–22.9, overweight if BMI 23-24.9 and obese if BMI>=25. These were dichotomised into two categories-normal and overweight/obese. Based on central obesity, student was obese, if waist circumference (WC) was >=90 cm, else normal. Systolic and diastolic blood pressures of the students were recorded. Systolic and/or diastolic equal to or more than 130 and 85 respectively were considered high, following the criteria set for detecting metabolic syndrome.[12]

Overnight fasting samples were collected for estimating plasma glucose and insulin. Samples for glucose were collected in fluoride oxalate while samples for insulin estimation were collected in EDTA tubes and frozen at -20 degrees, when processing got delayed by more than 24 hours. Plasma glucose was estimated by GOD-POD method on automated clinical chemistry analyser. Plasma insulin was estimated by ELISA.

Homeostasis model assessment-estimated insulin resistance [13] was calculated from fasting glucose and fasting insulin as follows:

$$\text{HOMA-IR} = \frac{\text{Glucose (mg/dl) X Insulin (mU/L)}}{405}$$

HOMA-IR>2 was regarded as high. [8] Statistical Analysis was carried out using IBM SPSS version 16. Students with high insulin resistance were counselled on improving their dietary pattern, substance abuse and life style to prevent future risk of CVD.

## RESULTS

The characteristics of the students were as follows:- their mean age was 21.16 years (range 18–25 years), mean BMI was 23.36 Kg/m$^2$ (range 17–32 Kg/m$^2$), mean WC was 83.12 cm (range 75–100 cm), systolic blood pressure was 120.80 mm (range110–140 mm), diastolic blood pressure was 80.72 mm (range 70–90), fasting plasma glucose was 80.78 mg/dl (range 65–110 mg/dl) and fasting plasma insulin was 11.35 mU/L (range 2.76–40.17 mU/L).

The distributions of student characteristics are shown in Table 1. As per BMI, two third students were either overweight or obese, while as per their waist circumference, one fifth was obese. One fifth of the students had blood pressure equal to or more than either systolic 130 or diastolic 85 mm. The fasting plasma glucose was less than 100 mg/dl in all but two students, while plasma insulin was equal to or higher than 20 mU/L in seven students. Insulin resistance measured by HOMA-IR$\geq$2 was found in 20 students (40%). Twenty one students were alcoholic (42%) and twenty four students were frequent smoker (48%). Inadequate physical activity and high calorie intake was present in about two third. Twenty percent of the students had parental income higher than twelve lakhs per annum.

The association of HOMA-IR with BMI wasn't statistically significant (Table 2). The percentage of overweight or obese students with HOMA-IR$\geq$ 2 was 43.3%, while the percentage of students with normal BMI and HOMA-IR$\geq$ 2 was slightly lower at 35% (p value 0.556). The crude odds ratio of having HOMA-IR$\geq$ 2 in students with BMI$\geq$23 as compared to those with BMI<23 was 1.41.

A significant association was found between HOMA-IR and waist circumference (Table 3). The percentage of obese students with HOMA-IR$\geq$ 2 was 90%, while the percentage of students with normal WC and HOMA-IR$\geq$ 2 was significantly lower at 27.5% (p value 0.001). The crude odds ratio of having HOMA-IR$\geq$2 in students with WC>=90 cm as compared to those with WC<90 cm was 23.7.

 

**Table 1:** Distribution of Student Characteristics

| Characteristic | Total No. (%) | Characteristic | Total No. (%) |
|---|---|---|---|
| BMI ≥ 23 (overweight/obese) | 30 (60%) | Alcohol > 20gm/day | 21 (42%) |
| < 23 | 20 (40%) | < 20gm/day or nil | 25 (50%) |
| Waist ≥ 90 cm | 10 (20%) | Not willing to inform | 04 (08%) |
| < 90cm | 40 (80%) | Smoking ≥ 5 sticks/day | 24 (48%) |
| BP ≥ 130/85 | 10 (20%) | < sticks/ day | 22 (44%) |
| < 130/85 | 40 (80%) | Not willing to inform | 04 (08%) |
| Pl. Glucose(F) ≥ 100 mg/dl | 02 (04%) | Calorie intake ≥ 3000/ day | 30 (60%) |
| < 100 mg/dl | 48 (96%) | < 3000/ day | 20 (40%) |
| Pl. Insulin ≥ 20mU/L | 07(14%) | Physical activity ≥ 30 mins | 16 (32%) |
| < 20mU/L | 43(86%) | < 30 mins or Nil | 34 (68%) |
| HOMA-IR ≥ 2 | 20 (40%) | Income ≥ 12 lakhs per annum | 10 (20%) |
| < 2 | 30 (60%) | < 12 lakhs per annum | 40 (80%) |

**Table 2:** Association of HOMA-IR with BMI

| BMI Category | HOMA-IR Category | | Total | p-value |
|---|---|---|---|---|
| | HOMA-IR < 2 | HOMA-IR ≥ 2 | | |
| BMI < 23 | 13 (65%) | 07(35%) | 20 (100%) | 0.556 (NS) |
| BMI ≥23 (overweight/ obese) | 17 (56.7%) | 13 (43.3%) | 30 (100%) | |
| Total | 30 (60%) | 20 (40%) | 50 (100%) | |

**NS: Not significant**

**Table 3:** Association of HOMA-IR with Waist Circumference

| WC Category | HOMA-IR Category | | Total | p-value |
|---|---|---|---|---|
| | HOMA-IR < 2 | HOMA-IR ≥ 2 | | |
| WC < 90 | 29(72.5%) | 11(27.5%) | 40 (100%) | 0.001 (S) |
| WC ≥90 (obese) | 01 (10%) | 09 (90%) | 10 (100%) | |
| Total | 30 (60%) | 20 (40%) | 50 (100%) | |

The association of HOMA-IR with alcoholism was not statistically significant (Table 4). The percentage of alcoholic students with HOMA-IR≥ 2 was 52.4%, while the percentage of non-alcoholic students with HOMA-IR≥ 2 was lower at 32%, but the difference was statistically insignificant (p value 0.162). The crude odds ratio of having HOMA-IR≥ 2 in alcoholic students as compared to non-alcoholic students was 2.3.

 

**Table 4:** Association of HOMA-IR with Alcoholism

| Alcohol Intake | HOMA-IR Category | | Total | p-value |
|---|---|---|---|---|
| | HOMA-IR < 2 | HOMA-IR ≥ 2 | | |
| Alcohol ≥20gm/day | 10(47.6%) | 11(52.4%) | 21 (100%) | 0.162 (NS) |
| Alcohol< 20 gm/day or Nil | 17 (68%) | 08 (32%) | 25 (100%) | |
| Total | 27(58.7%) | 19 (41.3%) | 46* (100%) | |

**NS: Not significant, *Four students did not reveal whether they were alcoholic**

## DISCUSSION

The findings of this study highlight the problems of obesity, alcoholism and insulin resistance in male medical students. In our study, 60% of the male students were either overweight or obese, more than half of which (34%) were obese. Central obesity (WC>=90cm) was 20%, 68% had poor physical activity, 60% had high calorie intake, 42% were alcoholic, 48% were smokers and 20% came from the very affluent background.

Khan *et al*. [14] also reported high rate of obesity in males from a medical college of Lahore. They reported 30.5% of males had BMI>=25, 46% of males had central obesity based on waist to hip ratio and overall, 80.7% played no sport. In India, Gupta *et al*. [15] reported from a government medical college that 21.4% male students were either overweight or obese, but the figures were similar for females as well. Our result's values of overweight/obesity prevalence are higher but that may be due to better socio-economic class of the students of our private college. Mean WC found in our study (83.12 cm) is similar to that reported from a private college in Ujjain (79.2cm), although their higher prevalence (80%) of central obesity is due to a lower cut-off (WC>=78 cm).[16] Obesity in medical students is increased by alcoholism, but many other contributing factors exist like genetic predisposition, higher stress of medical education, lack of exercise, irregular sleep pattern, irregular dietary habits, snacking, taking high calorie food and positive family history.[17]

Medical students were often initiated to drinking following their admission. Despite knowing its ill effects, students take up alcoholism and other substance abuse for reasons like relief from psychological stress, celebration, to reduce tiredness, peer pressure, experimental use and easy availability. [18] Garg *et al.* [19] reported 71.9% students started alcohol consumption after admission to a medical college, a third of which developed regular frequency. Goel *et al*. [20] reported 16.7% alcoholism in medical students with higher prevalence in males. Prevalence of alcoholism found in our study was higher and could be a reflection of the higher socio-economic status of the students.

Ethanol consumption leads to mechanisms like inhibition of AMP-Protein Kinases that not only block fatty acid oxidation, but also promote fatty acid synthesis, leading to obesity. [21] Insulin resistance in obesity results from many mechanisms. Elevated fatty acids impair protein kinases, resulting in the induction of insulin resistance. The brain integrates the signals from fatty acids with adiposity signals from leptin and insulin. Various biomarkers of inflammation, such as tumor necrosis factor alpha, Interleukin-6 and C-reactive protein also have been found to be elevated in the insulin resistant obese individual. Complex interplay between endocrine, inflammatory, neural, and cell-intrinsic pathways that get dysregulated leads to insulin resistance in obesity. [7]

Different authors have used different methods to measure insulin resistance. Although, the euglycemic clamp or the oral glucose tolerance test is the most desirable methods of determining insulin resistance, but they are difficult to carry out. Hence, methods like HOMA-IR, fasting glucose/insulin ratio (FGIR) and quantitative insulin-sensitivity check index (QUICKI) are more frequently used. HOMA-IR is more reliable than FGIR and QUICKI. [22] and has good correlation with euglycaemic clamp, even though its relatively low precision puts limits on its use. [23]

In our study, although most students had apparently normal plasma glucose and plasma insulin, prevalence of insulin resistance by HOMA-IR cutoff >=2 was high at 40%. Out study chose a lower cut-off of HOMA-IR based on report by Ray *et al.* [8] that it predicts future risk of cardiovascular disease. There was, however, no consensus on the cut-off for HOMA-IR. Singru *et al.* [3] has preferred a HOMA-IR cut-off of 2.5 in adults as it predicts risk of metabolic syndrome. Their study on adolescents found 34.5% insulin resistance with mean HOMA-IR increasing with sexual maturity and obesity. John *et al.* [12] reported 14.4% insulin resistance in their study on students of a medical college in South India, but they chose to measure insulin resistance by triglycerides to HDL-cholesterol ratio instead of by HOMA-IR.

 

In our study, HOMA-IR showed statistically significant association with central obesity measured by waist circumference, but not with overweight/obesity measured by BMI. There has been a shift in focus to central obesity rather than overall obesity in relation to prediction of future mortality. Waist circumference is therefore now considered better than Body Mass Index as an index of obesity. [24] Henderson et al even reported that waist circumference was the best predictor of insulin resistance. [25] But even in terms of BMI, there were 7.3% more students having HOMA-IR>=2 in the overweight/obese category as compared to students in the normal category. Likewise, Lim *et al* reported positive association of HOMA-IR, with both the obesity indices-BMI and WC. [26]

In our study, there was no statistically significant association of alcoholism with HOMA-IR. Since our study was on first year students, the duration of alcoholism was short and may not have had a significant effect. A multi-centric study across eight medical colleges of India showed the prevalence of alcohol consumption increased from 16.7% in undergraduate medical students to 31.5% in postgraduates, rate being higher in males. [20] However, even in our study, the alcoholic category had 20.4% more students with HOMA-IR>=2 as compared to non-alcoholic or abstaining students.

The study was limited by its sample size, which prevented a more detailed stratified or re-gressional analysis of the cofounders. The association between alcohol and insulin resistance can be influenced by smoking. Physical activity and calorie intake can influence the association of waist circumference and insulin resistance. While the distributions of these third factors were obtained, the sample size was calculated for the crude association and not for detailed analysis keeping in mind that this was a summer project for undergraduate student.

The counselling given to obese students with high HOMA-IR might motivate them to improve their dietary pattern, lifestyle and habits. There are different therapies which are being used in India and across the world for the treatment and prevention of obesity [27], which can also be practised to prevent future complications. Students should be screened for their WC and all students, in particular those with high WC, should be encouraged by the institute to make sports and exercise a part of their life. Follow-up studies can be done on a larger sample of these medical students, performing oral glucose tolerance tests and lipid profile for a comprehensive assessment of insulin resistance, metabolic syndrome and risk of CVD.

## CONCLUSIONS

The male medical students of first year showed lack of balance in their life style, reflected by their lower physical activity, higher calorie intake, higher prevalence of obesity/ overweight and alcoholism. The prevalence of insulin resistance in these students was high (40%), which makes them prone to future development of metabolic syndrome and cardiovascular complications. Central obesity measured by WC>=90cm was significantly associated with insulin resistance measured by HOMA-IR cut-off >= 2, but not with BMI or alcoholism. WC>=90cm is therefore a strong indication for screening students for insulin resistance to prevent future complications. Besides, medical colleges need to make sports activities a regular feature of campus life right from the first year, particularly for students with higher WC.

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