



**A STUDY OF BODY MASS INDEX IN THE POPULATION AND ITS
ASSOCIATION WITH BLOOD PRESSURE AND SERUM
LEVELS OF GLUCOSE AND TRIACYLGLYCEROL**

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ABSTRACT

The prevalence of metabolic diseases in the urban and semi-urban population in India is high. Most people are unaware of the risks associated with obesity, diabetes mellitus, hypertension and dyslipidemia. This study was undertaken to find the association between Body Mass Index (BMI) and the fasting levels of blood glucose, triacylglycerol along with hypertension in the local population who were apparently healthy. One hundred and nine healthy people were segregated into four groups based on BMI- Lean, Normal, Overweight and Obese. The mean values of fasting and post-prandial blood sugar and fasting triglyceride and the range of systolic and diastolic blood pressure was found to increase with the increase in BMI in the four groups. Fifteen cases were found to have Metabolic Syndrome. A close association of the risk factors for cardiovascular diseases with increasing BMI was found to exist in the population studied during a routine health check-up.

KEYWORDS: Body Mass Index, Metabolic Syndrome, Dyslipidemia, Hypertension, Blood Glucose



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INTRODUCTION

The prevalence of metabolic diseases like obesity, diabetes mellitus and dyslipidemia is high in the Indian population and is continuing to increase unabated^(1,2). This is mainly brought about by the change in lifestyle in the urban and semi-urban population. People are largely unaware of the risk factors causing these diseases and also their consequences. The study was undertaken with the aim of determining the association of overweight/obesity and blood glucose and triglyceride along with blood pressure in an attempt to identify people at risk of developing metabolic diseases.

MATERIALS AND METHODS

One hundred and nine apparently healthy cases attending the Master Health Check Up unit, over a period of one month, at a tertiary care centre in Pondicherry were considered for the study. An informed consent was taken from all the patients. At this clinic a comprehensive health check-up is carried out for apparently healthy people. They were thoroughly examined by the clinicians. Cases found to have diabetes and hypertension were also included in the study. 5 ml of fasting venous blood sample was collected from the 109 cases and sent for analysis of glucose and triglyceride. A 2 hour post-prandial sample was also analysed for glucose. The following parameters were estimated in blood using IFCC (International Federation of Clinical Chemists) approved procedures;

- Serum fasting glucose
- Serum fasting triacylglycerol
- Serum post-prandial glucose

RESULTS

109 apparently healthy cases were included in the study and they were divided into four groups namely; Lean, Normal, Overweight, Obese, based on their BMI, as depicted in Table I. 55.9% of the study population had a BMI $\geq 25\text{kg/m}^2$ which is considered abnormal.

The analyses were carried out in a fully automated random access blood chemistry analyser. The blood pressure was recorded in all the subjects. The height and weight of all these subjects were noted and the Body Mass Index was calculated using the standard formula⁽³⁾,

$$\text{BMI} = (\text{Weight in kg}) / (\text{Height in m})^2$$

The cases were segregated into four groups based on their BMI namely; Lean, Normal, Overweight, and Obese.^(3, 4) The mean serum values of fasting and post-prandial glucose and fasting triacylglycerol were calculated in each group. The range of age, BMI, systolic and diastolic blood pressures in each of the groups was noted. The number and percentage of cases with abnormal values of the various parameters were noted. The number of cases having the Metabolic Syndrome was calculated based on the ATP III criteria modified to suit Indian population.⁽⁵⁾ Metabolic Syndrome was diagnosed if any three or more of the following were present:-

1. Hyperglycemia (fasting blood glucose $\geq 110\text{mg/dL}$)
2. Hypertension
3. Waist circumference $\geq 90\text{cm}$ for men and $\geq 85\text{cm}$ for women.
4. HDL – ($< 40\text{mg/dL}$ for men and $< 50\text{mg/dL}$ for women).

In this study, criteria 1, 2 and 4 were taken into consideration to identify cases with Metabolic Syndrome. BMI $\geq 25\text{kg/m}^2$ was considered abnormal.^(3, 4)

Table I
Various groups of cases based on BMI

Sl. No	BMI(kg/m ²)	Groups	Number	Age(in years)
1	< 18.5	Lean	5 (4.6%)	23-48
2	18.5- 24.9	Normal	43 (39.4%)	22-68
3	25- 29.9	Overweight	41 (37.6%)	24-72
4	>30	Obese	20 (18.3%)	32-83
			Total= 109	

It was found, that most (84, 77.06%) of the cases in the study group fell under the categories of Normal and Overweight while few (25, 22.93%) in the categories of Lean and Obese. The mean serum values of fasting and two hour post- prandial glucose and fasting triacylglycerol in the four groups in shown in Table II.

Table II
Mean Values of the various parameters in the different groups

Sl. No	Parameters Groups	Mean Fasting blood sugar mg/dL	Mean post- prandial blood sugar mg/dL	Mean triacylglycerol mg/dL
1	Lean	88.7± 8.7	107.6± 14.6	129.8± 41.9
2	Normal	93.3± 7.9	123.5± 9.9	131.1±38.6
3	Overweight	99.4±16.0	156.9±47.6	135.5±40.0
4	Obese	99.8±14.3	165.0±56.0	139.4±25.7

As seen above, the mean values of fasting blood sugar, post- prandial blood sugar and triacylglycerol is found to increase with the increase in BMI. The mean values of serum fasting blood sugar, post- prandial blood sugar and triacylglycerol in this study are 95.6mg/dL,143.2mg/dL and 132.3mg/dL respectively. The range of values of systolic and diastolic blood pressures and BMI in the various groups has been depicted in Table III.

Table III
Range of values of various parameters

Sl.No	Parameters Groups	BMI Kg/m ²	Systolic Blood Pressure mmHg	Diastolic Blood Pressure mmHg
1	Lean	14.1- 17.1	120- 130	70- 90
2	Normal	20.3- 24.8	100- 150	60- 98
3	Overweight	25.0- 29.8	110-190	60- 110
4	Obese	30.1- 35.0	110- 170	70- 110

The number and percentage of cases in each group with FBS≥ 110mg%, PPBS≥ 140mg% and TGL≥ 150mg%, Systolic Blood Pressure≥ 140mmHg, Diastolic Blood Pressure≥ 90mmHg are given in Table IV.

Table IV
Number and Percentage of abnormal values in each group

S.no	Parameters Groups	Fasting Blood Sugar≥ 110 mg/dL	Post- Prandial Blood Sugar≥ 140 mg/dL	Serum Triacylglycerol≥ 150 mg/dL	Systolic Blood Pressure≥ 140 mmHg	Diastolic Blood Pressure≥ 90 mmHg
1	Lean n=5	Nil (0%)	Nil (0%)	2 (40%)	Nil (0%)	1 (20%)
2	Normal n=44	3 (10.7%)	4 (14.2%)	16 (36.3%)	16 (36.3%)	10 (22.7%)
3	Overweight n=41	11 (26.8%)	16 (39%)	15 (36.5%)	12 (29.2%)	13 (31.7%)
4	Obese n=20	4 (20%)	10 (50%)	7 (35%)	6 (30%)	5 (25%)

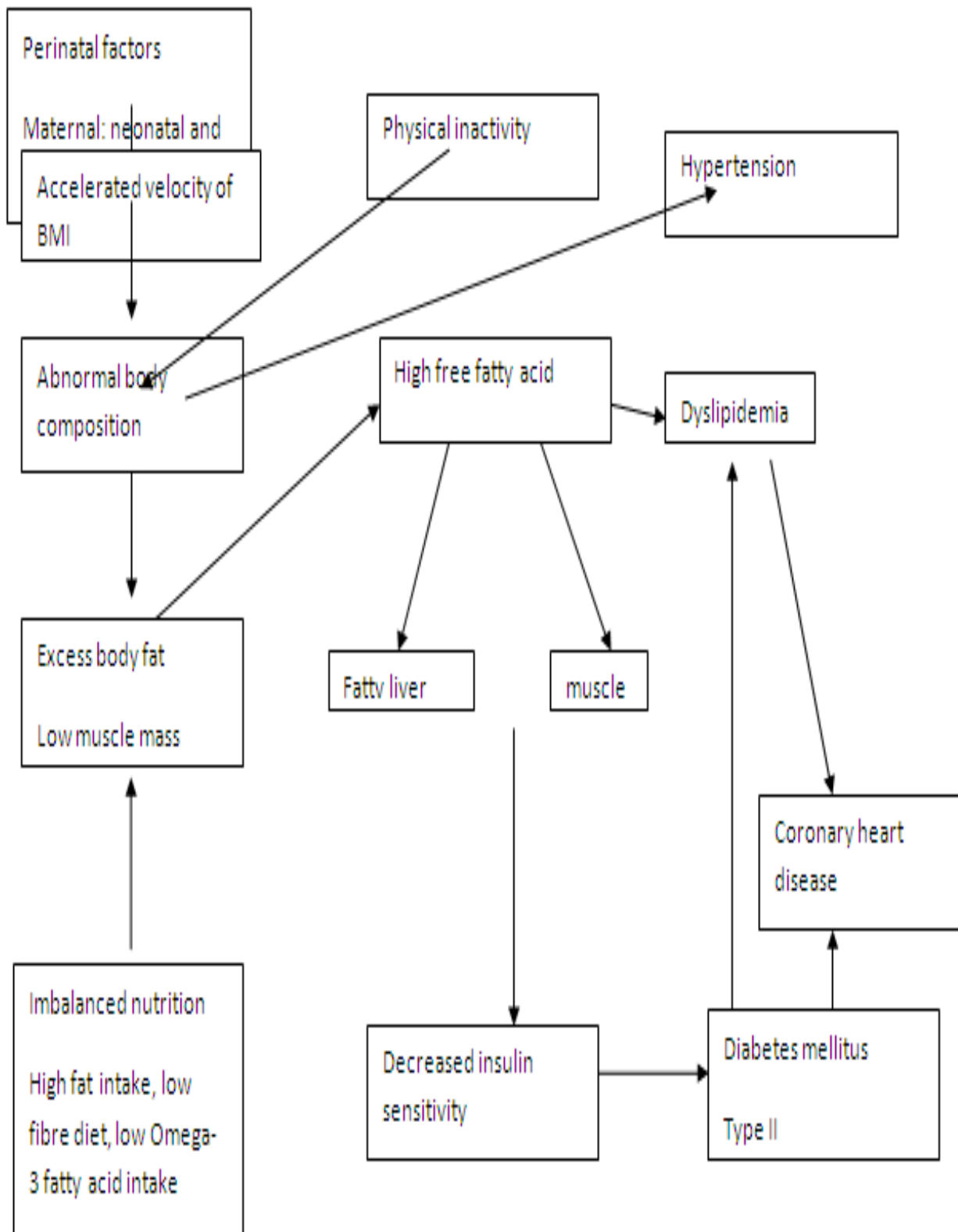
Of the 109 subjects, 13.7% (15 subjects) were found to have the Metabolic Syndrome, based on the ATP III criteria, modified to suit the Indian population.

DISCUSSION

109 apparently healthy subjects, who were included in this study, were segregated into four groups, Lean, Normal, Overweight and Obese based on their BMI. 55.9% of these subjects were found to have a BMI ≥ 25 kg/m², which is considered abnormal. This figure is higher than that in the study conducted by Ramachandra et al in Chennai, where 35.8% of men and 48.9% of women (total 43.4%) had BMI ≥ 25 kg/m².^(2, 5) The mean value of the serum triacylglycerol in each of the groups, Lean, Normal, Overweight, and Obese in the present study are 129.8 mg/dL, 129.7mg/dL, 133.9mg/dL and 139.4mg/dL respectively. The mean value of serum triacylglycerol in the study population as a whole was 132.3mg/dL. A study was conducted in Kolkata on healthy people in 2003 and the mean value of serum triacylglycerol was found to be 132 ± 42 mg/dL which is comparable with those of the present study.⁽⁶⁾ In a study conducted in Mumbai in 2008 to find the prevalence of dyslipidemia in the young adult Indian population, the mean level of serum triacylglycerol was 141.96mg/dL which was higher than the mean value of 132.3mg/dL in the present study.⁽⁷⁾ In the same study at Mumbai, the mean levels of fasting and post- prandial blood glucose were 100.96mg/dL and 115.39mg/dL respectively.⁽⁷⁾ In the current study, the corresponding values are 95.5mg/dL and 143.2mg/dL. While the fasting blood glucose values are very much comparable, the mean of post- prandial blood glucose values in this study are much higher than in the Mumbai study. The mean triacylglycerol in the study conducted at Chennai was 140 ± 88 mg/dL which is a little higher than the mean value 132.3mg/dL in the present study.⁽⁵⁾ The mean systolic and diastolic levels of blood pressure in the Chennai study was 120 ± 12 mmHg and 77 ± 8 mmHg respectively.⁽⁵⁾ In the present study, the ranges of blood of pressure varied among the different groups and were slightly on the higher side of normal. The prevalence of the Metabolic Syndrome among males and females respectively in the Chennai study are 36.2% and 22.9%.⁽⁵⁾ In the present study it was much less, at 15% only of the study population. In this study, it was observed that the mean values of fasting and post- prandial blood glucose and

triacylglycerol have increased with increase in BMI. Also, the percentage of cases with abnormal high values shows an increasing trend, in general with increasing BMI. (Table IV). All the above observations corroborate the fact that Indians in general have high levels of blood glucose and triacylglycerol, along with higher range of blood pressure. Quite a high percentage of people (55.9%) have BMI ≥ 25 kg/m². All these make them prone to develop diabetes mellitus, coronary heart disease and the Metabolic Syndrome. This is in accordance with the observation made by Misra et al in their study on the Indian population.⁽⁸⁾ It has been shown that south Asians have genetic predispositions to develop dyslipidemia, obesity and diabetes mellitus.⁽⁹⁾ Even factors like maternal and childhood obesity are important contributing factors. This increase in BMI leads to excess body fat accumulation and low muscle mass, leading to decreasing insulin sensitivity. This predisposes the individual towards impaired glucose tolerance and coronary heart diseases.⁽⁹⁾ In a recent study by Rao et al from Chennai on 338 children and adolescents there were as many as 97 overweight and 96 obese based on anthropometric measurements.⁽¹⁰⁾ This study also showed a significant positive correlation of BMI with total cholesterol, triacylglycerols, HDL-cholesterol and Lipoprotein(A) levels. These findings suggest that trends of dyslipidemia are also prevalent amongst Indian children.⁽¹⁰⁾ Thus there is a complex inter- relation between various factors, such as genetic, environmental and metabolic which result in a deranged metabolism and pose a risk towards the development of the metabolic diseases. These complex inter- relation is depicted in Figure I.⁽¹¹⁾ One of the contributing factors is the change in lifestyle in the society which has led to physical inactivity. The fast pace of life has brought in stress leading to raised levels of stress hormones. All these are known factors which affect the metabolism of the body. The modern food habits of people lead to consumption of food with high levels of refined sugar and fats, these go on to give rise to obesity and impaired glucose tolerance and dyslipidemia.

Figure I
Interplay of various factors leading to metabolic diseases



CONCLUSION

In this study, 109 cases were included, who were apparently healthy and were segregated into four groups namely, Lean, Normal, Overweight and Obese based on their BMI. Their blood samples were drawn to analyse fasting and post- prandial glucose and fasting levels of triacylglycerol. The blood pressure of these cases was also noted. It was found that 55.9% of the study population had BMI \geq 25 kg/m². This is considered abnormal. The mean values of serum triacylglycerol, fasting and post- prandial blood glucose are 137.5 mg/dL, 98.60 mg/dL and 142 mg/dL respectively. The mean values of these three parameters and the range of systolic and

diastolic blood pressures are found to have increased with the increase in BMI. There were more cases with abnormal high values in Overweight group. Serum triacylglycerol levels have been found to be high, even in Lean and Normal groups. 15% of the study population was found to have Metabolic Syndrome. The mean values of the parameters, though not alarming, are certainly high. What is more alarming is the fact that people are unaware of the metabolic derangements affecting them, which were detected during a routine health check-up. Therefore it is imperative to create awareness among people regarding healthy lifestyle changes and routine health checks to prevent the risk of developing the metabolic diseases and finally the Metabolic Syndrome.

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