ORIGINAL ARTICLE

# METABOLIC SYNDROME IN SCHOOL CHILDREN OF DERA ISMAIL KHAN, PAKISTAN

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**Background:** Childhood obesity has increased considerably in many regions of the world including Pakistan. The recent phenomenon of 'nutritional transition' with a westernisation of food so prevalent in developing countries, has caused a significant rise in obesity among population that were unaware of this problem in the recent past. The aim of this study was to find out the frequency of metabolic syndrome and cardiovascular risk factors in obese school children (6–11 years) in Dera Ismail Khan. **Methods:** Eighty-six children were included in this study with 61 (70.94%) obese and 25 (29.06%) normal weight children. Obese children comprised of 34 (39.53%) boys and 27 (31.40%) girls. Normal weight children included 15 (17.44%) boys and 10 (11.63%) girls. They were selected among 1,336 children from 8 primary schools of Dera Ismail Khan city. Anthropometric parameters of each subject were recorded, BMI determined and body mass status calculated. Children were categorized by the presence or absence of Obesity. Blood Pressure was also measured. Non-fasting venous blood samples were taken, analysed for lipids; Triglycerides (TG), Cholesterol (TC); Lipoproteins: High and Low Density Lipoprotein-cholesterol (HDL-C, LDL-C) and Plasma Glucose Concentration (PGC). Metabolic syndrome was identified in the presence of ≥3 of the followings with cut-off values: TG>170 mg/dl, HDL-C<35 mg/dl, WC>71 cm, BP >120/80 mm Hg, PGC>200 mg/dl. **Results:** Metabolic syndrome was identified in 22.95% of the obese children. It was 19.67% and 3.27% in obese boys and girls respectively. Metabolic syndrome was not found in normal weight children. Clustering of cardiovascular factors was abundantly present in obese and rare in normal weight children.

**Keywords:** Metabolic Syndrome, Cardiovascular Risk Factors, Obese School Children, Lipid Profile

## INTRODUCTION

Childhood obesity has increased considerably in many regions of the world including Pakistan. The recent phenomenon of 'nutritional transition' with a westernisation of food so prevalent in developing countries, has caused a significant rise in obesity among population that were unaware of this problem in the recent past.[1] Childhood obesity frequently tracks into the adulthood[2], thus representing a major contributor to the obesity epidemic and to the increased cardiovascular morbidity and mortality.

Obesity, type 2 diabetes mellitus, hypertension, lipid and cardiovascular disorders are common in western societies and are responsible for enormous burden of sufferings. An individual may have one, more than one or all of the conditions, leading to hypothesis that clustering of these conditions may not be coincidence but due to a common abnormality that allow them to develop. Some of the researchers suggested in 1988 that the basic defect was related to insulin, and the insulin resistance syndrome was first described by Reaven GM.[3] Insulin resistance (IR) is a state in which a given amount of insulin produces subnormal biological response.[4] Insulin resistance syndrome/metabolic syndrome (Met S) is characterised by a decrease in the uptake of glucose by muscles and adipose tissue; suppression of hepatic glucose production and output[5], resistance to the action of insulin on proteins and lipid metabolism and vascular endothelial dysfunction and suppression of genetic expression.[6]

Several defects in the insulin signalling cascade have been implicated in the pathogenesis of insulin resistance including reduction in the synthesis or increased degradation of the insulin receptors and components of the system.[5,7] Genetic as well as environmental factors are believed to be involved in its aetiology. Multiple genes have suggested as candidates.[5] Insulin sensitivity is also affected by several other factors including obesity; ethnicity, gender, puberty, perinatal factors, sedentary lifestyle and diet.[8] Insulin resistance/Hyperinsulinemia is an important link between obesity and associated metabolic abnormalities and cardiovascular risks.[9]

A number of attempts have been made to characterize the paediatric metabolic syndrome (Met S) or a related construct with a meaning similar to adult Met S.[10,11] Failure to adopt an accepted definition for children and adolescents include: use of adult cut-points or a single set of cut-points for all ages throughout childhood, the disturbances in the metabolic indicators in most children are quantitatively moderate, the lack of normal range of insulin concentration across childhood, the physiological insulin resistance of puberty, lack of

cut-points for central obesity linked to Met S for children and differences in baseline lipid levels among various races.[12]

The definitions of the WHO and European group for the study of insulin resistance includes measures of the insulin resistance[13] but definition used by the US National Cholesterol Education Programme[14] includes abnormalities in any three of the following factors: plasma glucose concentration (PGC), triglyceride level (TG), high density lipoprotein-cholesterol (HDL-C), systolic blood pressure and waist circumference (WC) (Insulin is not included). The new definition used by the International Diabetes Federation (IDF) requires central obesity plus two of the following four: raised TG, raised blood pressure, reduced HDL-C and raised plasma glucose level. Sex and ethnic specific cut-points for central obesity as measured by waist circumference are included for the first time.[15]

The metabolic syndrome has received significant attention because of its role in disease. In general, patients with this syndrome exhibit a pro-inflammatory state, and in addition to high levels of TG, low levels of HDL-C, they tend to have high levels of apoprotein B and elevations in small low density lipoprotein particles. All of these factors contribute to doubling the risk factors for the incident cardiovascular disease with in 5–10 years as well as 5 fold increase in the risk for incident type 2 diabetes mellitus.

The aim of the present study was to find out the frequency of metabolic syndrome and cardiovascular risk factors (CVD) in obese school children (6–11 years) at Dera Ismail khan according to modified NCEP-ATPIII criteria.

## SUBJECTS AND METHODS

Eighty-six children were included in this study with 61 (70.94%) obese and 25 (29.06%) normal weight. Obese children comprised of 34 obese boys (39.53%) and 27 (31.40%) obese girls. Normal weight children included 15 (17.44%) boys and 10 (11.63%) girls. They were selected from 1,336 children (865 boys and 471 girls) from 8 primary schools (from semi government, welfare and private sector) of Dera Ismail Khan. Thorough clinical examination excluded those suffering from chronic health ailments and endocrinological diseases. Written permission was obtained from their parents/ guardians.

Anthropometric parameters (body weight, height and waist circumference) of each child were recorded. Children were lightly dressed and barefooted. Body Mass Index (BMI) of the subjects was calculated according to Quatelet's Index. BMI number of each one was plotted on the CDC's age and gender specific growth charts 2000 to have percentile ranking. Body Mass Status was calculated according to WHO criteria.[16] A child was considered normal weight if his BMI-for-age percentile was between 5$^{th}$ and 85$^{th}$ percentile and obese if his BMI-for-age percentile was ≥95$^{th}$. Waist circumference (WC) was measured with a tape measure at a distance between lateral lower rib margin and uppermost lateral border of iliac crest in the standing position at the end of expiration.[17] WC is a proxy measure of central/abdominal adipose tissue, independent of total body fat. WC cut points indicative of adverse and normal risk profiles were ≥71 and <61 Cm respectively.

Non fasting venous blood sample was used for the measurement of Lipids: Triglycerides (TG), Total Cholesterol (TC), Lipoproteins: High and Low Density Lipoprotein Cholesterol (HDL-C, LDL-C) and Plasma Glucose concentration (PGC) casual. TG and TC were measured through Enzymatic method at 546 ηm, HDL-C through Non Enzymatic Immunological and LDL-C by CHOD-PAP method at 546 ηm and PGC (casual) through Glucose Oxidase method at 540 ηm. Micro lab 300 Merck (Germany) was used for measurement of all the parameters.

Modified NCEP-ATPIII criteria were used for the diagnosis of metabolic syndrome in the present study. However, cut points for the adverse levels of the TG (observed >170 mg/dl), and HDL-C (<35 mg/dl) were used according to the recommendations by the American Heart Association.[18] The adverse level for PGC (casual) without any symptoms for type 2 diabetes mellitus was taken as >200 mg/dl.[19]

Recently released guidelines of the NCEP, an individual would be classified as having metabolic syndrome if three of the five criteria were met. These risk factors are; increased levels of TG, systolic blood pressure, PGC, WC and reduced levels of HDL-C. This study has adopted the criteria with modified serum concentrations.

## RESULTS

Gender wise distribution of the sample according to the body mass status is given in Table-1. The sample (n=86) included 61 obese and 25 normal weight children. WC of the obese children was higher than normal weight children. TG is significantly higher ($p$<0.001) in obese boys as well as in obese girls. TC values were also found higher in obese boys ($p$<0.05) and girls ($p$<0.001). Subnormal values ($p$<0.001) for HDL-C were recorded in obese boys as compared to normal weight boys while it also decreased ($p$<0.05) in obese girls when compared to normal weight girls. As far as LDL-C in obese children is concerned, it was recorded at normal risk level (<110 mg/dl). None of the obese children was having elevated levels of systolic or diastolic blood pressure and hyperglycemia/type 2 diabetes mellitus (Table-2, 3).

Clustering of cardiovascular risk factors was abundantly present in obese children as compared to

normal weight children; 8.1% among obese children had no risk factor; however, 18.03%; 50.81% and 22.95% obese children had 1, 2 and 3 risk factors respectively for cardiovascular disease. The frequency of CVD risk factors in normal children was rare; 60% had none but the frequency of 1 and 2 risk factors was 36% and 4% respectively. The frequency of metabolic syndrome was 22.95% in obese children. It is important to note that obese boys had significantly higher frequency of metabolic syndrome (22.95%) than obese girls (3.27%). Metabolic syndrome was not observed in normal weight children (Table-3).

**Table-1: Sample Distribution According to gender and Body Weight Status (n=86)**

| | Normal Weight | | | | Obese | | | |
|---|---|---|---|---|---|---|---|---|
| **Gender** | **Boys** | | **Girls** | | **Boys** | | **Girls** | |
| | **n** | **%** | **n** | **%** | **n** | **%** | **n** | **%** |
| **Children** | 15 | 17.44 | 10 | 11.63 | 34 | 39.53 | 27 | 31.40 |
| **Total** | **25 (29.06%)** | | | | **61 (70.94%)** | | | |

**Table-2: Clinical and Laboratory Data of School Children**

| | Obese Boys | Normal Weight Boys | Obese Girls | Normal Weight Girls |
|---|---|---|---|---|
| **Age** | | | | |
| **BMI ($Kg/m^2$)** | 25.27±1.55 | 15.37±2.12 | 22.87±2.27 | 15.01±0.78 |
| **WC (Cm)** | 75.29±8.25 | 59.27±9.91 | 75.52±7.15 | 52.80±5.27 |
| **TG (mg/dl)** | 204.15±55.48 | 144.87±37.60 | 238.1±95.2 | 181.3±16.04 |
| **TC (mg/dl)** | 161.03±21.19 | 142.80±31.45 | 172.37±25.04 | 153.70±11.64 |
| **HDL (mg/dl)** | 33.794±5.151 | 42.73±6.95 | 42.63±7.33 | 52.20±4.61 |
| **LDL (mg/dl)** | 88.44±17.69 | 97.36±6.48 | 102.70±16.29 | 99.36±4.86 |
| **Systolic BP** | 89.41±7.36 | 77.67±5.94 | 88.15±6.81 | 72.50±7.55 |
| **Glucose (mg/dl)** | 85.52±7.08 | 77.83±4.91 | 93.30±4.47 | 72.66±10.90 |

**Table-3: Clustering of Risk Factors in Obese and Non-Obese Children (n=86)**

| **Body Mass Status** | **Obese** | | | | **Non-Obese** | | | |
|---|---|---|---|---|---|---|---|---|
| **Gender** | **Boys** | | **Girls** | | **Boys** | | **Girls** | |
| **Status of Risk Factor** | **n** | **%** | **n** | **%** | **n** | **%** | **n** | **%** |
| **00/No risk factor** | 1 | 2.94 | 4 | 14.81 | 9 | 60 | 6 | 60 |
| **+1 risk factor** | 5 | 14.70 | 6 | 22.22 | 5 | 33.33 | 4 | 40 |
| **+2 risk factor** | 16 | 47.05 | 15 | 55.55 | 1 | 6.67 | 00 | 00 |
| **+3 risk factor (Met S)** | 12 | 35.29 | 2 | 7.40 | 0 | 00.00 | 00 | 00 |
| **Total** | **34** | **100** | **27** | **100** | **15** | **100** | **10** | **100** |

Metabolic Syndrome (Met S) in Obese Children =22.95%, Metabolic Syndrome (Overall Children) =16.27%, Metabolic Syndrome in Obese Boys =19.67%, Metabolic Syndrome in Obese Girls =3.27%

## DISCUSSION

This study describes the frequency of metabolic syndrome and cardiovascular risk factors in obese children at primary schools of Dera Ismail Khan, Pakistan. To identify the metabolic syndrome in obese children of the study area, we used criteria analogous to NCEP-ATPIII with modifications in TG (observed >170 mg/dl), HDL-C (<35 mg/dl) and PGC, casual (>200 mg/dl). The frequency of metabolic syndrome in obese children was 22.95% and 16.27% in the sample. The gender difference was well marked. Met S was significantly common in obese boys (19.67%) as compared with the obese girls (3.27%). Risk factors for CVD were not identified in 8.19% of the obese children; however, 91.80% were having one, two or three of the risk factors. The number of obese children with two risk factors (50.81%) was significantly more common than those with three risk factors (22.95%). Sixty percent of the normal weight children were free from risk factor, however 40% had one or two risk factors and no subject was identified with three risk factors.

Frequency of Met S in obese children of the present study was noted higher (22.95%) than rest of the developing countries using the identical criteria. Kilshadi *et al*[20] in their Caspian study which included 4811 children 6–18 years, had found metabolic syndrome in 2–14% of Iranian children. Similar study, carried out in Tehran (Iran), reported a prevalence of 10.1% in adolescents 10–19 years. Gender wise prevalence was 10.3% in boys and 9.9% in girls.[21] Semiz Serap *et al*[22] had reported much lower frequency of Met S (2.1%) in Turkish obese children 6–16 years using the criteria analogous to ATP III. 286 (186 obese and 98 normal weight) children were included in their study. Seventy-nine percent of the obese children had one, two or more risk factors; 20% were having no risk factor. Normal weight children had much lower risk factors and no one had 3 risk factors or Met S. No significance gender difference was identified for the frequency of Met S. However, higher frequency of Met S (21% in obese children) was noted in another Turkish study by Agirbasli *et al*[23], using ATP III formula. The study investigated 1,385 children, 10–17 years of age with an overall frequency (2.2%) of Met S. Met S was ten times more common in overweight and obese children than healthy children.

Much higher rates for Met S had been quoted by a number of researchers in developed countries. Cruz *et al*[24] had reported prevalence of 30% in obese Hispanic children of USA, using modified ATPIII and WHO formula with fasting blood samples. The study involved 126 obese children, 8–13 years. Still higher rates for Met S (38.5%) had been noted by Weiss *et al*[25];

in 439 obese American children, having BMI >97$^{th}$ percentile, using modified ATPIII and WHO formula (Fasting sample). Met S was found 49.7% in severely obese children. Yoshinaga *et al*[26] had identified Met S as 17.7% in obese Japanese children; 6–11 years.

## CONCLUSION

The developing countries are facing double burden of malnutrition, under and over nutrition and Pakistanis is not an exception. The frequency of paediatric metabolic syndrome will increase with the increase in childhood obesity. Prevention of obesity and metabolic syndrome is important to reduce the frequency of cardiovascular risk factors by increasing the physical activity and intake of fibre: reducing the consumption of saturated fats and junk foods, starting in the childhood especially in obese children with positive family history of chronic diseases.

## RECOMMENDATIONS

Health Professionals and policy maker should focus on primary prevention of childhood obesity and metabolic syndrome especially in developing countries which are facing an epidemic of chronic diseases.

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