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Prevalence of Metabolic Syndrome in school going children in the age group 8-18 years

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Abstract- *Metabolic syndrome comprises a cluster of cardiovascular risk factors (hypertension, altered glucose metabolism, dyslipidemia and abdominal obesity). Childhood obesity has reached epidemic levels in developed and developing countries as a result of lack of physical activity and unhealthy dietary habits and can be a harbinger of future health disorders. Studies show that the process of atherosclerosis starts at an early age and is linked to obesity and other components of the MS in childhood. As there is no clear definition for Pediatric MS, our study aims to evaluate the prevalence of MS in 8-18 year old school going children. This Rationalized Random Sampling cross sectional study was conducted involving students from two different schools in Guntur and Krishna district, Andhra Pradesh. A total of 150 students were included in the study. The study group was grouped into two groups (those with MS and those without MS) and clinical, anthropometric (height, weight, waist circumference) and biochemical parameters (FPG, TG) were estimated and MS was diagnosed using ATP III criteria. Statistically significant result was obtained for Blood Pressure, Triglycerides and Fasting Plasma Glucose. The study showed a prevalence of 4.0 % of MS in school going adolescents.*

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I. Introduction

Metabolic syndrome is defined as a cluster of risk factors which includes abdominal obesity, dyslipidemia, glucose intolerance and hypertension. These are the most important risk factors for cardiovascular disease and type 2 diabetes mellitus. According to Adult treatment panel III (ATP III) Metabolic syndrome (MS) is the presence in an individual of at least three of the following five risk factors central or abdominal obesity, hypertriglyceridemia, hypertension, low HDL cholesterol and high fasting glucose levels. MS in pediatric and adolescent population is not lagging far behind as obesity has permeated to all strata of life and age groups and there is evidence that these risk factors accelerate the development of early atherosclerosis beginning in childhood. The studies conducted in developed countries have reported the overall prevalence of pediatric MS to be between 3.1% and 24%. Cook et al who studied children and adolescents 12-19 years of age reported a prevalence of 4.2%. Investigators from Bogalusa heart study reported a prevalence of 3.6% in youth 8-17 years of age. However researchers reported much higher rates in children who are overweight and obese. National Health and Nutrition Examination Study (NHANES) (1988-1994) demonstrated that the prevalence of MS increases proportionally to BMI, the prevalence of MS was 28.7% in overweight adolescents (BMI $\geq 95^{th}$ percentile), compared to 6.1% in adolescents at risk for overweight (BMI $\geq 85^{th}$ percentile but lower than the 95^{th} percentile) and 0.1% in those below the 85^{th} percentile. Subrahmanyam et al have reported that the prevalence of overweight and obesity among the affluent adolescent school children in Chennai, TN was 15%.

Obesity is escalating as a global epidemic due to change in lifestyle characterized by the lack of physical activity and an energy rich diet. According to CDC (Centre for Diabetes control and prevention) Obesity has more than tripled over the past 30 years and is a significant problem now even in developing countries. The high prevalence of insulin resistance in Asian Indian children who are undergoing nutritional and lifestyle modification rapidly is a worrisome feature. Pediatric obesity is accompanied by various conditions orthopedic, respiratory, metabolic (hyperglycemic, dyslipidemia), hepatic (non alcoholic fatty disease) and cardiovascular disease [5]. The chronic evolution of obesity generates devastating consequences that are associated with long periods of physical incapacity and early mortality. The long term complications can be prevented by early diagnosis, healthy dietary habits and therapeutic lifestyle modification.

Hence in view of increasing prevalence of Obesity and Type II Diabetes in children and adolescents and as there are no standards existing for diagnosing this syndrome. It is also difficult to understand the pattern of prevalence of MS in children across nations and studies. This study was taken up to understand the prevalence of MS in South Indian School going children and to compare the clinical, anthropometric and biochemical characteristics between children with MS and without MS.

II. Review Of Literature

Previous studies have indicated that the process of atherosclerosis starts at an early age and is already linked to obesity and other components of the MS in childhood [4]. MS is a defect in the biochemical processes and pathways in the body. Enzyme defect, as a result of genetic mutation leads to problems in these pathways. Acetyl CoA is the connecting link between all the major metabolic pathways for proteins, carbohydrates and lipids. A genetic defect in any part of the major metabolic pathway is known as an inborn or congenital error of metabolism [2]. In recent studies, the cause has been narrowed to insulin resistance and obesity [10]. It has been found that individuals with high insulin levels over a long period of time are 36 times more overweight, have 2.5 times more hypertension and 3 times more dyslipidemia than those with low insulin levels [11]. In obese patients, insulin sensitivity is reduced as a result of the detrimental effect of inflammatory molecules on the insulin signaling pathways [3]. The Cardiovascular risk in Young Finns study was one of the first groups to explore the childhood predictors of the MS, and their study showed that insulin resistance precedes the development of MS in childhood [12]. Distribution of body fat has a pivotal role in the determination of insulin sensitivity and its consequences. The relation of obesity and peripheral insulin resistance depends more on the lipid distribution rather than on the absolute amount of fat per se [8]. Waist circumference is considered an independent predictor of insulin resistance and intra abdominal fat independent of BMI in obese adolescents [13]. Also, waist circumference has been shown to be highly linked to systolic and diastolic blood pressure and to triglyceride and HDL concentrations in this age group. According to these observations, the International Diabetes Federation task force has chosen waist circumference as the best anthropometric tool for correlation of intra abdominal fat and obesity in defining MS [8]. Muscle and liver are the two major tissues and fat deposition in them determines the sensitivity of these tissues to the metabolic effect of insulin. Intramyocellular lipid deposition is inversely correlated with peripheral insulin sensitivity and has been demonstrated to be increased in offspring of type 2 diabetic patients and in obese children with impaired glucose tolerance [14]. The normal adaptive response consists of increased insulin secretion along with reduced insulin clearance leading to increased circulating insulin levels. Other insulin sensitive tissues that do not depend on lipid deposition i.e kidney, ovary maintain their baseline insulin sensitivity, are now exposed to hypeinsulinemia. Inflammatory mediators have been suggested to be the primary insult leading to the development of insulin resistance and future atherogenesis in patients with MS [4]. In healthy adolescents C-reactive protein, interleukin-6, tumor necrosis factor were significantly associated with indices of insulin resistance and components of the syndrome, have been shown to be increased in adolescents with the MS reflecting the subclinical inflammatory process that is activated in these individuals. Decreased levels of adiponectin and increased inflammatory cytokines are non traditional factors accompanying the classic components of the syndrome. Also Endothelial dysfunction which is early marker of atherogenesis is been associated with the presence of the MS in adults and only few studies have been done on endothelial dysfunction in children showing comparable findings in children manifesting the syndrome [15].In summary central obesity coupled with increased susceptibility to Insulin resistance contributes to the development of the MS in Childhood [4].

III. Aims And Objectives

1. Many studies are done on MS in adults but there is no clear definition for paediatric MS so we aimed to evaluate the prevalence of MS in 8-18 year old school going children and to compare the clinical, anthropometric and biochemical characteristics between children with MS and without MS
2. To spread awareness about its prevalence and screening so as to prevent its future complications i.e Diabetes, CAD

IV. Material And Methods

Study design- Rationalised Random Sampling cross sectional study among school going children (age group 8-18 years)

Study setting- Department of Biochemistry, NRI medical college and general hospital, Chinnakakani

Study period- August 5th-October 5th 2014

Study population- 150 randomly selected students from two different schools in Krishna and Guntur districts, Andhra Pradesh respectively who were asked to come overnight fasting for 12 hours

Inclusion Criteria

Randomly selected 150 school children aged 8-18 years who were present on that day.

Exclusion Criteria

1. children who were not fasting
2. children suffering from any medical illness
3. children who are on hypolipidemic or hypoglycemic drugs

4. children who did not give consent

Study tools- Predesigned questionnaire, consent form, case record form, Measuring inch tape, Sphygmomanometer, Digital weighing machine , Blood collecting devices and Vacutainers .
Study variables- age, sex, birth, family history, diet, and lifestyle
Data collection- Predesigned questionnaire was given to all students participating in the study and the details were taken into consideration. Height was measured without shoes using inch tape in upright position. Weight was measured in upright position with minimal clothes and without shoes using digital weighing machine. BMI was calculated as weight in kilograms divided by height in meters squared. Waist circumference was measured in centimeters using non stretchable measuring tape at narrowest level from the lower border of rib cage and iliac crest. 3ml of fasting blood samples were collected by phlebotomists in respective Grey (Oxolate Fluoride tube) and
Red(No additive plain tube) vacutainers allowed to clot and centrifuged at 3000 rpm for 10 minutes and plasma / serum was separated for estimation of Fasting plasma glucose and Serum Triglycerides . Fasting plasma glucose was estimated by Glucose oxidase peroxidase (GOD-POD) method and serum Triglycerides was measured by peroxidase method, on Dade Dimension Auto Analyzer. Before analyzing the samples appropriate standardization and quality control protocols were followed.
Data analysis- The study group was divided into two groups Group I without MS and Group II with MS. Subjects with three or more of the following metabolic components were characterized as MS. Stastical Analysis was described as Mean ± SD and percentage, intergroup comparisons was done by 'student t' test and chi square test using MS Excel and SPSS software.
Definition- Subjects with three or more of the following metabolic components were characterized as MS.
1. Abdominal Obesity (≥ to age and sex specific 90^{th} percentile)
2. Elevated blood pressure (≥ to age, sex and height specific 90^{th} percentile)
3. Elevated Serum triglycerides (TGL ≥ 110 mg/dl)
4. Elevated Fasting Plasma Glucose (≥ 110 mg/dl)

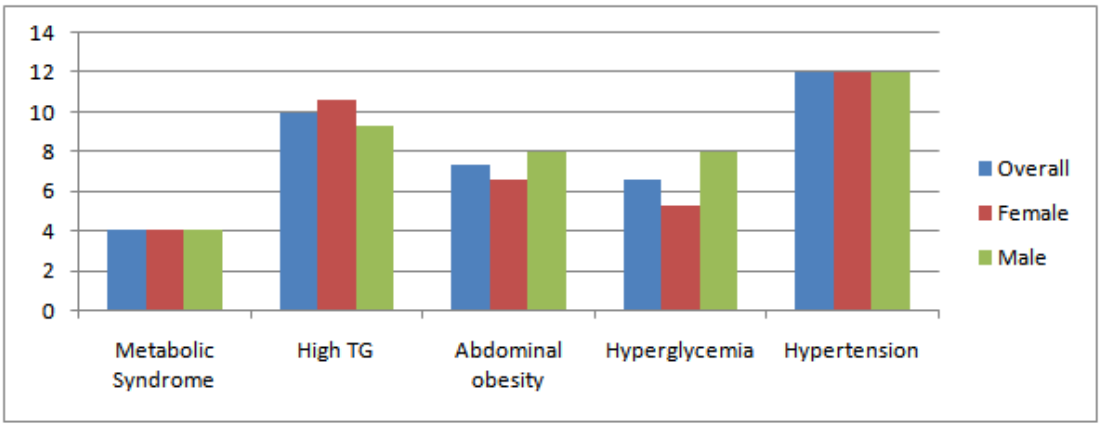
Ethical consideration- Study was undertaken after due clearance from the institutional ethical committee. Informed consent was taken from the participants after explaining the principle of study.

V. Results

Total 150 school children were studied for the prevalence of MS between the ages 8-18 years. Among the study group, 75 (50%) were females and the other 75 (50%) males, indicating equal representation of males and females In our study the prevalence of MS was seen in 6, i.e 4% of the studied children, [males=3(4%) and females=3 (4%)] Among the study group waist circumference was abnormal (≥90^{th} percentile) in 11 (7.3%) children (males-5 [6.6%] and females 6 [8%]) without any statistical significance (p-value ≤0.12). Abnormal Fasting Plasma Glucose (FPG) (≥ 110 mg/dl) was present in 10 (6.6%) of the studied population (males- 6 [8%] and females 4[5.3%]) with significant statistical difference (p-value≤ 0.002) between the two groups. Serum Triglycerides were abnormal in 15 (10%) among the study group with (males 7[9.3%] and females 8 [10.6%] with (p-value≤0.0001) statistically significant and Hypertension was present in 18 (12%) with males 9 [12%] and females 9 [12%] with (p-value≤0.001) statistically significant. (Table 1,Graph 1)

	Overall (n=150)	Female (n=75)	Male (n=75)
Metabolic syndrome	6 (4%)	3 (4%)	4(4%)
High TG	15 (10%)	8 (10.6%))	7 (9.3%)
Abdominal obesity	11 (7.3%)	5 (6.6%)	6 (8%)
Hyperglycemia	10 (6.6%)	4 (5.3%)	6 (8%)
Hypertension	18 (12%)	9 (12%)	9 (12%)

TABLE 1 The Presence of MS and its components in the study population by sex

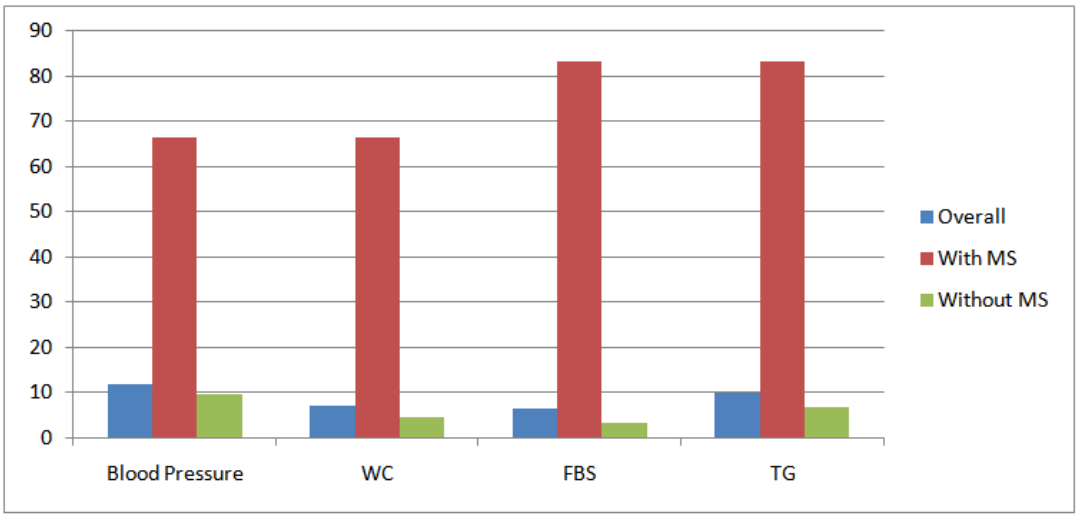


Graph 1.

Among 18 students with high blood pressure, 4 of them had MS (22.2%). Among 17 obese children MS was present in 1 of them (5.8%). Among 11 students with abnormal waist circumference, MS was seen in 4 of them (36.3%). Among the 10 children with abnormal FPG, MS was seen in 5 of them (50%) and among the 15 students with high Triglyceride level, MS was seen in 5 of them (33.3%). [Table 2,Graph 2]

		Female (n= 75)		Male (n = 75)	
	Overall (n=150)	Without MS (n=71)	With MS (n=4)	Without MS (n=70)	With MS (n=5)
Clinical Female Male	 75 (50%) 75 (50%)				
Age 13 years 14 years 15 years 16 years	 13 65 61 11	 7 42 21 3	 2 1 0 0	 4 22 38 8	 0 0 3 0
Blood pressure	18	7	2	7	2
Anthropometric BMI Normal Overweight Obese	 122 11 17	 58 2 11	 1 2 1	 60 7 5	 3 0 0
Waist circumference	11	2	3	5	1
Biochemical FPG	 10	 2	 2	 3	 3
Triglyceride	15	6	2	4	3

TABLE 2 Clinical, anthropometric and biochemical characteristics of the study population grouped by sex and the presence.

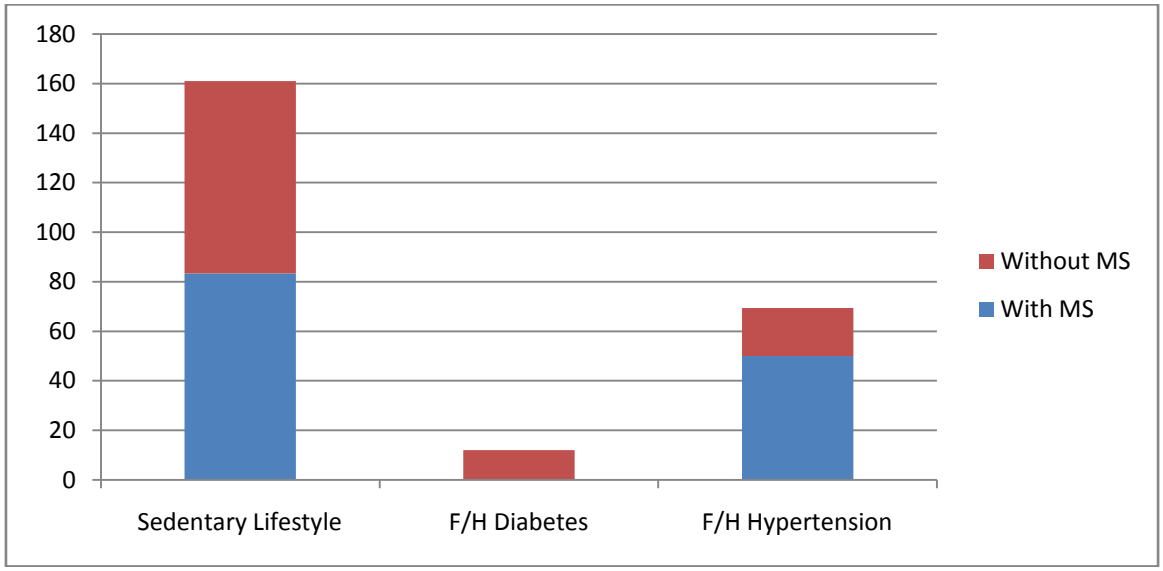


Graph 2.

Among the study group comprising of 150 students, 17 had a family history of diabetes (11.3%) and 31 had a family history of hypertension (20.6%). Among the 9 students with MS, none had a positive family history of diabetes and 3 had a positive family history of hypertension (50%). In the study group 113 students (75%) have a positive history of sedentary lifestyle and and among the students with MS, 5 (83.3%) have a sedentary lifestyle. [Table 3,Graph 3].

		Overall (n=150)	With MS (n= 6)		Without MS (n=144)	
			n	%	n	%
Sedentary lifestyle	Yes	113	5	83.3	112	77.7
	No	37	1	16.6	32	22.2
Famlily history of Diabetes		17	0		17	12
Family history of Hypertension		31	3	50	28	19.4

TABLE 3- Family history and lifestyle of the study population grouped by the presence of MS



Graph 3.

	CASES (With MS)		CONTROLS (Without MS)		
	Mean	SD	Mean	SD	P-value
BMI	20.7	3.9	18.94	3.73	0.07
WC	69.8	10.2	69.75	7.80	0.12
SBP	103.66	9.7	78.74	7.04	0.01
DBP	82.5	14.0	70.38	26.27	0.001
FPG	114.0	6.8	104.99	9.61	0.002
TGL	139.5	44.9	73.87	8.05	0.0001

TABLE 4- anthropometric and biochemical characteristics of the study population by the presence of metabolic syndrome with inter-group comparisons

VI. Discussion

The study was carried out on an urban population in Andhra Pradesh South India, showing a prevalence of 4.0 % of MS in school going adolescents.

The study shows the prevalence of childhood MS even in developing countries like India. Also the study indicates high percentage of overweight children. MS refers to a cluster of risk factors for CAD like insulin resistance, abdominal obesity, impaired glucose, elevated blood pressure, elevated triglycerides and reduced high density lipoproteins.

The study was conducted as a Rationalised Random Sampling cross sectional study in Guntur and Krishna districts in two different schools. The study shows the prevalence of MS in all age groups of children with reference to different parameters.The overall prevalence rates of overweight, obesity and normal weight were 7.3% , 11.3% and 81.3% respectively. ATP III definition with age modified standard cut off values was considered for the diagnosis of MS in the current study. The overall prevalence of MS in the study was 4.0% (males=4% , females= 4 %). Similar results were found by Syed M.S. Andrati et al a study in Kashmir [1], India

and A.Annapurna Reddy et al a study in Nellore, Andrapradesh [2]. Also by studies of Panmota et al (in Thailand,),Cook et al [9], Sing et al[10] from north India- was 4.2% without any sex difference [1]. Even in our study there is 4% prevalence and without any sex difference in accordance with Sing et al[10] , Kelisha et al and Lambert et al. Similarly, Duncan et al [16] reported the prevalence of MS in 12-19 year old U.S. adolescents as 4.2% in NHANES. There is certainly a dramatic rise in prevalence of MS even in developing countries. Some children did not show any components of MS, even though their BMI values indicated the presence of obesity. However Central obesity was significantly more common in MS group, supporting the observation that WC (waist circumference) is better predictor of MS than BMI, which is in accordance with study of Fernandeez et al [17]

Acording to Lee et al, there is a strong correlation between WC, dyslipidemia and hypertension [13]. This correlation is associated with increased abdominal fat. The prevalence of hypertriglyceridemia in children with MS was very high 83.3 % and presence of hypertension in MS is 66.6%. Studies have proven that hypertension in obese children is a factor responsible for atherosclerosis, CVD, vascular dysfunction [5, 12]. When we consider fasting blood glucose, it is 83.3% in children with metabolic syndrome.

However in our studies children with increased BMI had upper normal FPG, indicating impaired glucose tolerance in them and they may develop other features of MS. Also it is observed that 12% of the total study population had high Blood pressure and among the children with MS the high blood pressure was 66.6%. This could be due to high salt intake dietary habits, sedentary life style and also these children had positive family history for hypertension.

VII. Conclusions

Our study shows the prevalence of MS is high in central obesity children. High Fasting plasma glucose, High triglycerides and hypertension is common. In the coming years this will lead to increased incidence of Coronary Artery disease and Type 2 Diabetes in MS children. Timely treatment for obesity will decrease the incidence of MS and also its consequences. Screening of school children for prevalence of MS and advising about dietary and lifestyle modification will certainly play a role in avoiding a worrisome future due to MS.

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