

Review Article

Childhood obesity in Asian Indians: a burgeoning cause of insulin resistance, diabetes and sub-clinical inflammation

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Recent data indicate a rise in obesity both in children and adolescents in developing countries. The overall prevalence of overweight/obesity in urban children in New Delhi has shown an increase from 16% in 2002 to about 24% in 2006-2007. Our recent data show that the prevalence among adolescent children was 29% in private schools and 11.3% in government funded schools. While India already has highest number of patients with type 2 diabetes mellitus (T2DM) globally, rapid rise of obesity in children is the prime reason for increasing insulin resistance, the metabolic syndrome, dyslipidemia, polycystic ovarian syndrome and raised levels of C-reactive protein. Excess body fat, thick truncal subcutaneous fat, and abdominal adiposity are important predisposing factors for development of insulin resistance in Asian Indian children. As compared to other ethnic groups, children with ancestral origin in South Asia manifest adiposity, insulin resistance and metabolic perturbations earlier in life and these derangements are of higher magnitude than white Caucasian children. Since the metabolic syndrome and obesity track into adulthood, these clinical entities need to be recognized early for effective prevention of T2DM and coronary heart disease. Therapeutic lifestyle changes, maintenance of high levels of physical activity and normal weight are most important prevention strategies. Both high-risk surveillance and cost-effective population intervention programs are urgently needed. In this context, we have launched one of the largest program ("MARG", The Path) to curb childhood obesity in India.

Key Words: Childhood obesity, Asian Indians, diabetes, metabolic syndrome, subclinical inflammation

INTRODUCTION

Obesity has reached epidemic proportions globally. More than 1 billion adults are overweight, and at least 300 million of them are clinically obese. Significantly, obesity is increasing rapidly in developing countries undergoing rapid nutrition and lifestyle transition, and it often coexists with under-nutrition. The rising prevalence of obesity in developing countries is largely due to rapid urbanization and mechanization which has led to reduction in the energy expenditure along with an increase in energy intake due to increased purchasing power and availability of high fat, energy-dense fast foods. Obesity is associated with increased risk of the metabolic syndrome, type 2 diabetes mellitus (T2DM), hypertension, dyslipidemia, polycystic ovarian syndrome (PCOS), and coronary heart disease (CHD), and some of these metabolic derangements start in childhood.

PREVALENCE

Nearly 22 million children under the age of five are estimated to be overweight worldwide. The calculated global prevalence of overweight (including obesity) in children aged 5-17 y is 10%, and the prevalence varies from over

30% in America to <2% in sub Saharan Africa. Recent trends in Indian population indicate a rise in obesity both in children as well as adults. Almost 38-65% of adult urban Indians in Delhi fulfil the criteria for either overweight/obesity or abdominal obesity (Table 1). The nationally representative data on childhood obesity in developing countries are scarce, with very few reports on the prevalence of obesity among children (Table 2). The prevalence of overweight/obesity in urban children in Delhi has shown an increase from 16% in 2002 to about 24% in 2006. According to our recent data, the prevalence among adolescent children (14-17 y) was 29% in private schools and 11.3% in government funded schools in 2006-2007. (Table 3)

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Table 1. Obesity in Asian Indians (2003-2005)

Variables	Urban	Rural
Mean BMI (kg/m ²)	24.8	21.9
BMI >30 kg/m ²	13.0	2.0
BMI >23 kg/m ²	65.4	31.8
High WC (cm)	38.6	7.7

BMI, Body mass index, WC, Waist circumference
 Unpublished data based on a study funded by American Association of Physicians of Indian Origin and Texas A & M University, TX, USA, 2003-2005

OBESITY IN ASIAN INDIANS: RELATIONSHIP OF BODY COMPOSITION WITH METABOLIC ABERRATIONS

For any proposed value of body mass index (BMI), Asian Indians have a higher magnitude of adiposity, abdominal obesity and a lower muscle mass than white Caucasians. Due to these body composition attributes, Asian Indians develop insulin resistance, the metabolic syndrome and T2DM even with a BMI currently defined within normal limits. Importantly, we have shown that excess truncal subcutaneous fat is a major determinant of insulin sensitivity and is associated with a high prevalence of insulin resistance in post-pubertal urban Asian Indian children.² Interestingly, truncal skinfolds are thicker signifying increased subcutaneous fat mass in Asian Indian adolescents as compared to white Caucasians and blacks.

Table 2. Childhood Obesity in India

Author (y)	Age group (y)	N	Location in India	Prevalence (%)
Sharma <i>et al</i> ¹⁵ (2007)	4-17	4000	Delhi (North)	Overweight, 22; obesity 6.
Rao <i>et al</i> ¹⁷ (2006)	9-16	2223	Pune (West)	Overweight, boys, 27.5, girls, 20.9.
Mohan <i>et al</i> ¹⁹ (2004)	11-17	3326	Punjab (North)	Urban, overweight, 11.6, obesity, 2.4; rural, overweight, 4.7, obesity, 3.6.
Ramachandran <i>et al</i> ²⁰ (2002)	13-18	4700	Chennai (South)	Overweight, boys, 17.8, girls, 15.8.
Kapil <i>et al</i> ²¹ (2002)	10-16	870	Delhi (North)	Obesity, 7.4, boys, 8, girls, 6.
Gupta <i>et al</i> ^{‡, 22} (1990)	5-15	3861	Uttar pradesh (North)	Obesity, 7.6.

† Obesity was calculated by International Obesity Task Force method. ‡ Obesity was calculated using the criteria of BMI greater than or equal to 22.6 kg/m² as cut off point.

Table 3. Age and Gender-specific Prevalence of Overweight/obesity among Adolescents (14-17 y) in New Delhi, India

Age (y)	Gender	Private Schools Overweight/obesity n=2552 (%)	Overall Prevalence	Government Schools Overweight/obesity N= 941 (%)	Overall Prevalence N (%)
14	Male	196 (29.7)	307 (32.6)	35 (12.9)	55 (12.7)
	Female	111 (39.6)		20 (12.4)	
15	Male	81 (23.3)	179 (29.9)	15 (11.8)	23 (11.5)
	Female	98 (39.0)		8 (11.0)	
16	Male	119 (28.0)	180 (25.1)	11 (7.8)	19 (8.4)
	Female	61 (20.8)		8 (9.4)	
17	Male	54 (27.0)	75 (25.3)	5 (9.4)	9 (11.0)
	Female	21 (21.6)		4 (13.8)	
Total					
N = 3493 (%)		741 (29.0)		106 (11.3)	
Overall prevalence, 24.3%					

Figures in parenthesis denote percentages, Cut-offs for overweight based on 85th percentile of age- and gender specific BMI developed by us. Misra *et al*, unpublished data, 2006-2007. These data are based on interim analysis of surveys conducted on schoolchildren in CHETNA and MARG programs (see last paragraph of manuscript for details)

HEALTH CONSEQUENCES OF CHILDHOOD OBESITY WITH REFERENCE TO ASIAN INDIANS

1. **The Metabolic Syndrome:** About one-third of overweight or obese urban Asian Indian children have insulin resistance.² Interestingly, higher level of hyperinsulinemia and related metabolic derangements has been recorded in Asian Indian neonates and children as compared to white Caucasian neonates.³ Similar comparative data are available for young children indicating early occurrence of insulin resistance in Asian Indians.⁴
2. **T2DM:** Obesity, especially abdominal obesity, is among the strongest risk factors for T2DM. In children, T2DM has been increasingly reported globally. T2DM was reported exclusively in overweight or obese Asian children with ancestral origin in Pakistan, India or Middle-Eastern countries in UK.⁵ We have reported that generalized obesity and abdominal obesity were significantly higher in children and adolescents with T2DM in North India.⁶ Important independent risk factors for development of T2DM in Asian Indian adolescents and young adults were hypertriglyceridemia, high waist-to-hip ratio, and family history of diabetes.⁷
3. **Sub-clinical inflammation:** Obesity contributes to the development of vascular inflammation which raises markers of inflammation. High levels of C-reactive protein (CRP) levels denote future risk for development of T2DM and CHD. In Asian Indian adolescents, high CRP levels were seen in 13% subjects overall, in ~22% of overweight and in ~25% in those with excess body fat.⁶ CRP levels show an association with percentage of body fat, waist-hip ratio, waist circumference (WC), and triceps skin fold thickness in Asian Indian children.⁷ Interestingly, excess dietary intake of saturated fat was a strong correlate of high CRP levels in Asian Indian adolescents.⁸
4. **Polycystic Ovarian Syndrome:** Obese adolescent girls are more likely to suffer from PCOS, a syndrome of variable combinations of menstrual irregularity, hirsutism or acne, with obesity and insulin resistance. Higher prevalence of PCOS was reported in South Asian women than white Caucasians in a recent study.⁹ South Asians present and seek treatment of PCOS at a younger age than white Caucasians, have more severe symptoms, and higher fasting insulin concentrations and lower insulin sensitivity than white Caucasians.⁹

SOCIO-CULTURAL ISSUES AND CHILDHOOD OBESITY IN INDIA

1. There is a general misconception in parents in India and other developing countries that an obese child is a healthy child. And that if the child is fat, "baby fat" will go away with time. In an effort to keep child "healthy", he/she is fed in excess. Many of these children remain obese for life.
2. High burden of school work and academic competitiveness have led to decreased participation in sports and any other form of physical activity. This is particularly true for girls who are sedentary from school years.

Many of the studies from India show that females have more obesity and the metabolic syndrome as compared to males.

3. The lack of appropriate play area and limited open space around home makes it difficult for children to stay physically active.
4. Parents are often overworked and find it easy to let children order "fast foods" and hardly have any time to oversee balanced nutrition for children.
5. Lastly, children spend more time in front of television and computers at the expense of sports and physical activity.

COMMUNITY INTERVENTION PROGRAMS FOR CHILDHOOD OBESITY IN INDIA

Community based interventions are aimed at providing a conducive environment for children to follow a healthy lifestyle, promote healthy food alternatives, and bring awareness and need about an increase in physical activity. In India, we have initiated comprehensive programs aiming at childhood obesity, namely "CHETNA" (Hindi for "The Awareness") [Children Health Education through Nutrition and Health Awareness program], and "MARG" (Hindi for "The Path") [Medical Education for Children/Adolescents for Realistic Prevention of Obesity and Diabetes and for Healthy Ageing]. Children are given nutritional and physical activity education through lectures and leaflets, and with the help of debates, skits, and drama related to health topics. Parents and children also take part in making healthy recipes. These comprehensive programs initiated on a large scale for the first time in South Asia aim to cover 5, 00,000 children in 15 cities of North India. Further, we aim to impart education regarding diet and physical activity not only to children, but also to teachers and parents. The MARG program is the first large scale community intervention project in South Asia which focuses 100% on primary prevention of not only diabetes, but on non-communicable diseases in general.

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AUTHOR DISCLOSURES

Swati Bhardwaj, Anoop Misra, Lokesh Khurana, Seema Gulati, Priyali Shah and Naval K Vikram, no conflicts of interest.

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