

# Pattern of chronic diseases amongst adolescent obese children in developing countries

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**Overweight and obesity are among the most prevalent nutritional problems in developed and developing countries. The problem of obesity is confined not only to adults but also to children and adolescents. In many developing countries childhood obesity is associated with increased consumption of processed and fast food, dependence on television and computers for leisure and a less physically active lifestyle. Obesity has serious long-term consequences. Childhood obesity is not an immediately lethal disease itself, but has a significant risk factor associated with a range of serious non-communicable diseases in adulthood. Hypertension, hypercholesterolemia, type-2 diabetes mellitus, gall bladder disease, asthma, mental health concerns and orthopaedic disorders have been linked to obesity. Thus, there is an urgent need to address the problem and efforts should be made to prevent the epidemic of obesity and its associated health disasters. An attempt has been made in this article to review the data published on prevalence and mechanism of specific morbidity conditions in obese adolescent children in developing countries with special reference to India.**

OBESITY is a global nutritional concern. The increasing prevalence of overweight, obesity and its consequences prompted the World Health Organization to designate obesity as a global epidemic<sup>1</sup>. The problem of obesity is confined not only to adults but also to children and adolescents. Data from NHANES IV (National Health and Nutrition Education Survey) 1999–2000 indicate that 21% to 23% of children aged 6–17 years are overweight, based on the definition of  $\geq 85$ th to  $< 95$ th percentile of BMI, and 9 to 13% of children aged 6–17 years are obese, based on the definition of  $\geq 95$ th percentile of BMI<sup>2</sup>. Various studies also indicate that the prevalence of overweight and obesity amongst children of all ages is increasing in developing countries in the past few decades<sup>3,4</sup>. Figures on the global prevalence of childhood obesity have been compiled by the WHO where several developing countries such as Nicaragua, Brazil, Antigua, Zambia, Venezuela and Peru, show a prevalence rate of over 2%. Countries such as Barbados, Honduras, Lesotho, Bolivia, Trinidad, Iran and Mauritius have a  $> 4\%$  prevalence, while Jamaica and Chile top the list with 10% greater prevalence rate in school children<sup>5</sup>. Obesity

in children is gradually becoming a public health problem in many developing countries also<sup>6</sup>.

Various studies from India also showed the increased prevalence of obesity. Results of a study from Punjab revealed that children in the age group of 11–17 years residing in urban areas were more overweight (11.6%) compared to children from rural areas (4.7%). But more children were obese in rural areas (3.6%) compared to urban areas<sup>7</sup> (2.6%). Another study<sup>8</sup> done on 1228 boys at Pune in the age group of 10–15 years showed that the prevalence of obesity to be 5.7% whereas the prevalence of overweight was 19.9%. A cross-sectional study carried out on 2008 school children of age 9–15 years in Punjab, revealed the overall prevalence of obesity and overweight was 11.1% and 14.2% respectively<sup>9</sup>. A study<sup>10</sup> in Delhi on affluent school children showed the prevalence of obesity to be 7.4%. Another study conducted by the Nutrition Foundation of India found among 5000 children aged 4–18 years in a Delhi private school 29% were overweight<sup>11</sup>. A similar study done in South India showed<sup>12</sup> the prevalence of obesity to be 3.1% and overweight to be 16.8%. A study on 707 children in the age group of 10–15 years at Chennai revealed that 10% of the subjects were overweight and 6% of them were obese<sup>13</sup>. Data from NFHS II (1998–99) showed the prevalence of obesity as 0.1% in the age group of 15–19 years<sup>14</sup>.

The health consequences of obesity are many and varied, ranging from an increased risk of premature death to several non-fatal but debilitating complaints that have an adverse effect on the quality of life. Obesity is also major risk factors for Non-Communicable Diseases (NCDs) such as Non-Insulin-Dependant Diabetes Mellitus (NIDDM), Cardiovascular Disease (CVD) and cancer. In many industrialized countries, it is associated with various psychological problems also. Childhood obesity has a correlation with increased levels of lipids, lipoproteins, hypertension, insulin resistance and morbidity from coronary heart disease in adults<sup>15</sup>.

## Health consequences

### *Hypertension*

Hypertension is the most common and most potent universal contributor to cardiovascular mortality. Elevated blood pressure, labile or fixed, systolic or diastolic, at any

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age is a contributor to all forms of cardiovascular disease<sup>16</sup>. The relationship between obesity and cardiovascular risk factors has been reported<sup>17,18</sup>.

Hypertension in obese children may occur due to increased cardiac output, increased blood volume, excessive sodium intake, increased steroid production, and alteration in receptors for various pressor substances<sup>19,20</sup>. Hypertension in adolescents can be explained by biological maturation and hormonal changes<sup>21</sup>. Hypertension in obesity results in increased intravascular volume, increased sympathetic nervous system activity, sodium retention and hyperinsulinaemia<sup>22</sup>.

An epidemiological study on school children in Delhi found that prevalence of hypertension (systolic, diastolic or both) was 11.9% in boys and 11.4% in girls. BMI showed a positive correlation with systolic as well as diastolic blood pressure<sup>23</sup>. Similar correlation was established by other studies<sup>24,25</sup>. A study conducted in Texas, USA on children with mean age of  $13.5 \pm 1.7$  years showed the prevalence of elevated hypertension to be 4.5% after screening them thrice<sup>26</sup>. Table 1 shows other studies reporting the prevalence of hypertension.

These studies confirm an evolving epidemic of cardiovascular risk in children and adolescence, as evidenced by an increase in the prevalence of overweight and obesity.

#### *Diabetes mellitus and impaired glucose intolerance*

Type-2 diabetes mellitus typically is considered a disease of adults, known as 'adult diabetes' in the past; however, parallel to the epidemic of obesity in children, a second epidemic of type-2 diabetes is also emerging. The pathophysiology of the development of type-2 diabetes mellitus is complex and multifactorial.

Higher BMI and especially increased truncal or abdominal fat clearly is an important determinant of blood glucose levels, insulin resistance, and the development of diabetes<sup>27-29</sup>. Up to 50% of the variation in insulin sensitivity in populations can be explained by differences in body fat content of the individual<sup>30,31</sup>. A multi-ethnic cohort study on 167 obese children and adolescents revealed that pre-

valence of impaired glucose tolerance was found to be 25% in obese children and 21% in obese adolescents; and type-2 diabetes was found in 4% of obese adolescents<sup>27</sup>.

A study in Arkansas on African-American children revealed that before 1982, only 4% of children and adolescents were diagnosed with type-2 diabetes mellitus but by 1996, 16% had this diagnosis which is parallel with increase in prevalence of obesity<sup>32</sup>. Other studies indicating the prevalence of diabetes mellitus and impaired glucose tolerance are shown in Table 2.

Intra-abdominal fat accumulation has been implicated as an independent risk factor for type-2 diabetes mellitus and in some studies it has been shown to be an even stronger predictor of type-2 diabetes mellitus than overall fatness<sup>33</sup>.

#### *Dyslipidemias*

Universally, obesity has been found to be associated with increase in plasma triglycerides (TGs). The characteristic pattern observed consists of elevated serum low-density lipoprotein cholesterol (LDL-C) and triglycerides and lowered high-density lipoprotein cholesterol levels (HDL-C)<sup>34,35</sup>.

According to the NHANES II there was an approximately 100 mg/dl difference in TG levels between normal weight and obese males and 60 mg/dl difference in TG level in females<sup>36</sup>. Obesity also appears to be associated consistently with decrease in high-density lipoprotein cholesterol (HDL-C)<sup>37-39</sup>.

A study was done on 29 obese 14-year-old children and 32 obese 12-year-old children to identify anthropometric variables, which may affect lipoprotein concentration. It was found that abdominal obesity is associated with an unfavourable lipid profile in obese 12-14-year-old children<sup>34</sup>. Various studies on obese children and adolescents showed that Very Low Density Lipoprotein (VLDL) and LDL levels are positively correlated with BMI<sup>40-42</sup>. Table 3 shows other studies reporting the prevalence of dyslipidemias.

Unfavourable lipid levels were relatively common among obese children and adolescents, proving that obesity should be considered a risk factor for dyslipidemias.

**Table 1.** Prevalence of hypertension in children with obesity

Author	Year of study	Country	Sample size and age	Prevalence of hypertension
Gupta, A. K. <i>et al.</i> <sup>54</sup>	1990	India	3861 (5-15 yrs) 292 obese children 3569 non-obese children	0.34% of obese children 0.16% of non-obese children
Verma, M. <i>et al.</i> <sup>55</sup>	1994	India (Punjab)	2562 (5-15 yrs)	Obese children: 13.7% Non-obese children: 0.4%
Anand, N. K. <i>et al.</i> <sup>56</sup>	1996	India (Amritsar)	5000 (5-17 yrs)	Normal children: 0.23% Obese children: 3.5% Obese + family history of hypertension: 5.9%
Macedo, M. E. <i>et al.</i> <sup>57</sup>	1996	North Portugal	889 (5-18 yrs)	5.2% children
Sorof, J. M. <i>et al.</i> <sup>58</sup>	2002	USA (Texas)	5102	19.4% children

**Table 2.** Prevalence of diabetes mellitus and impaired glucose tolerance (IGT) in children with obesity

Author	Year of study	Country	Sample size	Prevalence of IGT and diabetes mellitus
Ripamonti, G. <i>et al.</i> <sup>59</sup>	1990	Italy	398 Obese children	11% (IGT)
Tresaco, B. <i>et al.</i> <sup>60</sup>	2003	Spain	95 Obese children (4–16 yrs)	7.4% (IGT) No prevalence of diabetes mellitus
Wabitsch, M. <i>et al.</i> <sup>61</sup>	2004	Germany	520 obese children	Type II DM: 1.5% Impaired glucose tolerance: 2.1%

**Table 3.** Prevalence of dyslipidemias in children with obesity

Author	Year of study	Country	Sample size and age	Prevalence of dyslipidemias
Valverde, M. A. <i>et al.</i> <sup>62</sup>	1998	Portugal	74 obese children + adolescent	67.6% elevated TG levels 93.6% lower HDL value
Fredlard, O. <i>et al.</i> <sup>63</sup>	2002	Texas	89 obese children (5–17 yrs) 53 non-obese children (5–14 years)	*52% of obese children elevated serum cholesterol level *37% of obese children had elevated serum cholesterol level *30% of obese subjects had elevated serum TG levels *16% of non-obese children had elevated cholesterol level *12% of non-obese children had elevated serum cholesterol level *12% of non-obese children had elevated serum TG levels

**Other health disorders**

*Psychosocial effects*

The most common consequence of obesity in children is poor psychological functioning. Pre-adolescent children associate the shape of an overweight body with poor social functioning, impaired academic success and reduced fitness and health<sup>43</sup>.

Among teenagers, cross-sectional studies have documented an inverse relationship between bodyweight and both self-esteem and body image<sup>44</sup>. A study conducted in the US has shown that women who were overweight during adolescence had lower family incomes and higher rates of poverty when compared to other women<sup>45</sup>.

*Hepatic and gastric disorders*

Hepatic disorders in obese children have been reported, particularly hepatic steatosis characterized by raised serum transaminase levels<sup>44</sup>. Obese children are at higher risk for the development of gallstones<sup>46</sup>. Gastro-oesophageal reflux and gastric emptying disturbances are also associated in a small percentage of obese children.

*Endocrine disturbances*

Fat cells (adiposities) function as endocrine cells, producing many locally and distantly acting hormones, affecting hormonal patterns in obese patients<sup>47,48</sup>. Other endocrinal disturbances include insulin resistance and increased insulin

secretion, decreased progesterone levels in women, decreased testosterone levels in men, increased cortisol production and decreased growth hormone levels<sup>49</sup>. Obesity is also associated with polycystic ovary syndrome in adolescent females<sup>50</sup>.

*Orthopedic disorders*

Obese children suffer from orthopaedic disorders. The more serious of these include slipped capital femoral epiphysis<sup>51</sup> and Blount disease<sup>52,53</sup>. It was estimated that 50–80% of children having Blount disease were obese. Other minor abnormalities observed are knock-knees, increased susceptibility to ankle sprains and flatfeet.

Childhood obesity may be seen as the marker of high-risk dietary and physical inactivity practices. Environmental and lifestyle factors are mainly responsible for promoting such practices. Childhood obesity is related to hypertension, altered insulin levels, diabetes mellitus, dyslipidemias to morbidity from coronary heart disease. Several longitudinal associations have also been documented with overweight children and adolescents having an increased risk of adult obesity and various risks associated with it. Thus, childhood obesity is the prelude to a public health disaster. There is an urgent need to address the problem and efforts should be made to prevent the epidemic of obesity and its associated health disasters.

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