REVIEW ARTICLE

Rising Incidence of Overweight and Obesity among Children and Adolescents in India

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ABSTRACT- The rising incidence of overweight and obesity among children and adolescents has become a cause of concern for India. Overweight/Obesity is an independent risk factor of cardiovascular diseases (CVDs) but it needs to be addressed seriously. Research has shown that modifiable and environmental factors along with genetics triggers the risk of cardiovascular diseases quite early in childhood threatening the health prospects of adults. It is crucial to address the causes of overweight/obesity like physical inactivity, unhealthy eating, lack of knowledge and awareness and impact of media and advertising. Clustering of cardiovascular risk factors like high blood pressure, hyperglycemia, abdominal obesity, high triglycerides in children and adolescents is an alarming sign. In order to dodge this serious public health crisis in near future we need to curb the prevailing risk factors of overweight/obesity. A holistic approach to tackle the obesity epidemic with an array of activities from policy making to program implementation, community education to individual knowledge and skill development is required. We need to promote healthy eating and lifestyle modifications in childhood and adolescents to prevent CVD risk in adulthood.

Key-words- Adolescents, Obesity, Overweight, Cardiovascular Diseases

INTRODUCTION

The overall trend of childhood obesity is increasing globally and the prevalence is expected to reach 9.1%, or 60 million globally by 2020[1]. The prevalence of obesity in India is increasing rapidly which form the major part of global population. Obesity has become the cause of serious public health concern in childhood as overweight or obese children will become obese adults with increased risk of cardiovascular diseases (CVDs). As obesity is an independent risk factor for CVDs, medical professionals and policy makers should try to address the childhood overweight and obesity to overt CVD in adulthood. The aim of this review is to synthesize epidemiological evidence for causes and consequences of overweight and obesity among children and adolescents of India, to promote healthy eating and lifestyle in childhood and to prevent CVD risk in adulthood.

We selected the most relevant published literature on the electronic databases (in English language only), namely, PubMed, Embase and Cochrane Library applying specific search terms such as "India" "adolescents"; "childhood"; "overweight"; "obesity"; "CVD"; "CHD"; "physical inactivity"; "Diabetes mellitus"; "hypertension"; "dyslipidemia"; "smoking";" nutrition" etc. We have also gone through abstracts of conference/meetings; consulting authors/experts in the field; text books; publications and data of governmental/ non-governmental organizations like National Nutrition Monitoring Bureau (NNMB) and National Family Health Survey (NFHS) of India.

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Prevalence of overweight and obesity among adolescents

India is a vast and diverse country with significant variation in overweight and obesity across the states in all age groups [2]. The percentage of overweight and obese children and adolescents has been increasing in India. Research studies done on children and adolescents by Kotian *et al.* (9.9%)[3]; Stigler (16.6%)[4]; Gupta *et al.* (11.7%)[5]; Raj (40%)[6] and Bharati *et al.* (3.1%)[7] reported varied prevalence rates of overweight and obesity in different parts of India. Based on data from the NFHS-3[8] and NFHS-4[9], the percentage of adolescents and adults between the ages of 15 and 49 who were overweight or obese has doubled from 9.3% to 18.6% among males and 12.6% to 20.7% among females. Socioeconomic trends in childhood obesity are also emerging in India. Childhood obesity prevalence of a study conducted in north India was 5.59% in the higher socioeconomic strata, compared to 0.42% in the lower socioeconomic strata. [10] Studies from different parts of

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India have reported varying prevalence rates of overweight and obesity in children and adolescents, suggesting massive progression of this epidemic economically, geographically and socially [10-18] (Table 1). The most important consequence of obesity in adolescence is its persistence into adulthood with associated health risks like cardiovascular diseases, diabetes, osteoarthritis, gallbladder disease, etc. Obesity is more likely to persist when its onset is in late childhood or adolescence.

Table 1: Prevalence of overweight/obesity among adolescents in India

S. No	Author Reported	Year and Region	Age Group (Years)	Overweight Prevalence %			Obesity Prevalence %		
				Boys	Girls	Overall	Boys	Girls	Overall
1.	Chhatwal *et al.* [19] #	2004, Punjab	9-15	15.7	2.9	-	12.4	9.9	-
2.	Sidhu *et al.* [20] #	2005, Punjab	10-15	9.9	12.0	10.9	5.0	6.3	5.6
3.	Gupta *et al.* [21] #	2006, Jaipur	11-17	-	10.9	10.9	-	5.5	5.5
4.	Rao *et al.* [17] #	2007, Pune	9-16	27.5	20.9	-		-	-
5.	Bhardwaj *et al.* [22] #	2008, New Delhi	14-17	-	-	-	-	-	24.3*
6.	Gupta *et al.* [5] #	2011, New Delhi	14-17	-	-	25.2	-	-	11.7
7.	Nawab *et al.* [23] #	2014, UP	10-16	-	-	9.8	-	-	4.8
8.	Jagadesan *et al.* [24] #	2014, Chennai	6-17	20.7*	21.3*	-	-	-	-
9.	Chaitali *et al.* [25] #	2014, Bangalore	6-17	54.4	45.6	-	65.8	34.2	-

***Overweight/obesity, #Various cut-offs used**

Causes of Overweight and Obesity

There are few large-scale studies on the causes for the increasing prevalence of overweight and obesity in India. Some authors suggest that the same causal factors (sedentary lifestyles, increase in caloric consumption) apply in developed countries as are applicable for high rates of overweight and obesity in developing countries; however, there is inadequate research to support causes and consequences of obesity in childhood and adolescents in India.

Physical Inactivity

In order to tackle overweight and obesity, physical activity is an important component that needs to be examined. Children and adolescents indulge in sedentary activities like watching TV, sitting in front of computers and video games resulting in higher risk of overweight and obesity.[26] Higher intakes of energy, fat, sweet and salty snacks and carbonated beverages in addition to reducing consumption of fruits and vegetables has been found to be associated with excessive TV viewing and low physical activity.[27-29] Galhotra [29] stated that physical activity and time spent outdoors is notably low among adolescents because greater stress is laid on academics at school. According to Rani and Sathiyasekaran [27], the prevalence of risk factors of obesity was high, but the children in their study had accurate perceptions of their body weight due to higher education and they were making efforts to modify risk factors such as unhealthy dietary habits, sedentary lifestyle, and television viewing.

Inadequate Food Consumption/Unhealthy Food Choice

In the multistate study in rural India, NNMB [30] assessed the diet of adolescents. The average daily intake of food and nutrients was assessed among 10-17-year-olds and showed that on average, the intake of cereals and millets and pulses was lower than the Recommended Dietary Allowances (RDA) for Indians as suggested by the Indian Council of Medical Research (ICMR) expert committee. [31] An increasing trend was noted in the consumption of fruits, green leafy vegetables, fats and oils over the years. Time trends of food consumption amongst adolescents and young adults showed a substantial reduction in intake of cereals, roots and tubers, milk and milk products, sugar and jaggery and certain vegetables over the last four decades. [30] These findings need further elucidation to understand the structural, familial, societal and individual factors that lead to changes in food choices and consumption among adolescents.

Many factors determine food choice and intake among adolescents, like socioeconomic status, culture, region, sex and age. In addition, adolescents' choice of foods is influenced by the media, family, peers and knowledge. Recent studies have indicated that faulty eating behaviour

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and dietary factors along with lack of physical activity can not only result in obesity among young adults, but can also lead to insulin resistance syndrome, hypertension, dyslipidemia, hypertriglyceridemia, and poor micronutrient status. [3-5, 23-24]

Chugh and Puri [32] conducted a study to compare eating and weight concerns among underweight, normal-weight and overweight adolescent girls (16-18 years) in New Delhi. Even normal weight and underweight girls reported concerns about excess weight. The level of satisfaction with body size decreased with increase in weight. Higher number of obese (76.6%) compared with normal-weight (38%) and underweight (14%) girls reported that they engaged in dieting. These adolescent girls were found to be missing meals, snacking and eating out. Johnson et al. [33] assessed the nutritional status and body image perception of adolescents in rural south India. It was found that 63% of the participants had normal BMI for age, 32% were under-nourished and 5% were overweight and obese. However, more than half (53%) of them wished they were thinner and 52% taller. Seventy nine percent of the participants were found to have body image dissatisfaction. Majority of undernourished adolescents (70.3%) perceived themselves to be normal, while 66.7% of overweight adolescents perceived themselves to be normal. Negative body image perception and body image dissatisfaction is very common in adolescence, and frequently leads to unhealthy eating habits like skipping meals, which in turn can exacerbate poor nutrition status and lead to eating disorders like bulimia and anorexia. [32-33]

Lack of Knowledge, awareness and Practices

Rani and Sathiyasekaran [27] assessed the knowledge and practices of high school students with respect to healthy diets before and after a nutrition education programme in Chennai, India. Post-nutrition education programme, dietary knowledge significantly improved from 37% to 67% and attitude towards healthy diet increased from 18% to 40%. The intake of soft drinks and fast food consumption also halved after the intervention suggesting that the provision of nutrition information can impact diet. Rao *et al.* [34] assessed the dietary habits and nutrition knowledge levels of adolescent girls and studied the efficacy of two different nutrition education tools in improving their nutrition knowledge in Hyderabad, India. Food frequency questionnaire data revealed more consumption of aerated drinks, bakery items, fast foods and less consumption of millets irrespective of their socioeconomic conditions. Consumption of vegetables, green leafy vegetables and fruits was moderate. Significant improvement in the nutrition related knowledge was observed among the experimental group after the education intervention (in two forms via traditional media and via audio-visual CD's) as compared to the baseline data. In a school based program conducted by Shah *et al.* [35] children and adolescents (8-18 years) were educated about health, nutrition, physical activity, non-communicable diseases and healthy cooking practices in three cities of North India. Baseline data revealed low nutrition knowledge scores in government (75-94%) and private (48-78%) schools. Despite the implementation of various National Nutrition Programmes at the community level, only 14% of the adolescent population had been exposed to nutrition education due to poor implementation of IEC in India. [30] There are major gaps in health and nutrition-related knowledge and behaviour of children, adolescents and young adults which needs to be addressed in order to overcome the ever-increasing obesity epidemic.

Impact of Media and Advertising

The Nutrition and Media Literacy report [36] revealed that children are exposed to around 7600 food commercials a year on television. Between 35 to 45% of the commercials on television are for food advertisements. Commercials increase preference for advertised foods and increase children's requests to parents for those foods. Out of the total food advertisements that are shown during television programmes, healthy food advertisements (e.g. milk and milk products, fortified wheat flour and biscuits, cereal based products/cornflakes) constitute only 4% while majority of the advertised products are high in fats and calories. Maheshwar, *et al.* [37] analyzed food advertisements on children's channels and found that 43% of foods advertisements were of chocolates and sweets, followed by fast food (11.6%), health/energy drinks (10.5%), and biscuits (10%). Many studies have observed that majority of food advertising content watched by young adolescents on television is related to calorie dense and micronutrient deficient foods and beverages. [38-39]

Family History and Ethnicity

Genetics plays a very crucial role in screening children's CVD risk as research has shown that CVD tends to cluster in families. [40-41] South Asians are genetically susceptible to CVD from early childhood.[42] Ethnic differences in CVDs begin early in childhood and are prevalent in adulthood. South Indians especially Indians demonstrate increased levels of CVD risk factors like increased insulin, blood pressure and lipid profile potentiated by environment and life style. [43-47] However, there is paucity of data regarding this from India.

Concerns

CVD Risk Profile in Children

Researchers have shown that CVD risk factors begin early in childhood and are influenced by environmental and genetic factors. Although modifiable risk factors like overweight and obesity during childhood paves the path for CVDs in adulthood. [14,48]

Prospective longitudinal studies have shown the impact of childhood BMI on the adolescent cardiovascular risk profile. The Avon longitudinal study of children aged between 9-16 years reported that odds of developing CVD risk later in life is more if the mean BMI was high during the childhood. [49]

Data from NFHS-4 highlights the increased CVD risk factors among different parts of rural and urban India.

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The prevalence of overweight/obesity, high blood sugar levels and hypertension was more in urban population in comparison to rural population. Females had higher BMI in comparison to males. Hypertension and high blood sugar was more prevalent among males in comparison to female population aged 15-49 years (Table 2).

Table 2: Nutritional Status of Adolescents and Adults according to NFHS-3 and NFHS-4

S. No	Indicators	NFHS-4 (2015-16) [9]			NFHS-3 (2005-06) [8]
#	Nutritional Status of adolescents and adults (Age 15-49 years)	Urban	Rural	Total	Total
	Overweight/Obese (BMI ≥ 25.0 kg/m^2) (%)				
1	Male	31.3	15.0	20.7	12.6
2	Female	26.3	14.3	18.6	9.3
	Blood Sugar Levels				
	Female				
3	High (>140 mg/dl) (%)	6.9	5.2	5.8	NA
4	Very High (>160 mg/dl) (%)	3.6	2.3	2.8	NA
	Male				
5	High (>140 mg/dl) (%)	8.8	7.4	8.0	NA
6	Very High (>160 mg/dl) (%)	4.4	3.5	3.9	NA
	Hypertension				
	Female				
7	Slightly above normal (Systolic 140-159 mm of Hg and/or Diastolic 90-99 mm of Hg) (%)	7.3	6.5	6.7	NA
8	Moderately high (Systolic 160-179 mm of Hg and/or Diastolic 100-109 mm of Hg) (%)	1.6	1.3	1.4	NA
9	Very high (Systolic ≥180 mm of Hg and/or Diastolic ≥110 mm of Hg) (%)	0.7	0.7	0.7	NA
	Male				
10	Slightly above normal (Systolic 140-159 mm of Hg and/or Diastolic 90-99 mm of Hg) (%)	11.4	9.8	10.4	NA
11	Moderately high (Systolic 160-179 mm of Hg and/or Diastolic 100-109 mm of Hg) (%)	2.7	2.0	2.3	NA
12	Very high (Systolic ≥180 mm of Hg and/or Diastolic ≥110 mm of Hg) (%)	1.0	0.8	0.9	NA

Metabolic Syndrome and Clustering of Cardiovascular Risk Factors

Metabolic syndrome (MS) is characterized by clustering of five diagnostic components i.e. hyperinsulinemia, obesity, hypertension, and hyperlipidemia. [50-51] MS is triggered by genetic factors as well as environmental factors.[52] Research has associated the cause of the MS in children with obesity, which leads to excess insulin production, increased BP and dyslipidemia. [53]

A study done on 1083 school going children (12-17 years) of India reported an overall prevalence of metabolic syndrome to be 4.2% (3.2% in boys, 5.5% in girls). [53] 36.6% of the overweight adolescents and 11.5% of at-risk-for-overweight adolescents met the criteria for metabolic syndrome. [53]

The prevalence of MS was found to be 3.5% according to ATP III criteria and 1.5% based on IDF criteria in a study conducted on 899 school going children aged between 10-18 years in India. No significant gender difference was observed in the distribution of MS. [54]

Another study done in India reported MS in 3.8% (boys: 3.9%, girls: 3.8%) and obesity in 9.9% (Boys: 9.9%, Girls: 10.6%) of children and adolescents. Obese children had the highest proportion of MS compared with those at risk for overweight and those with normal weight (30.7% vs. 2.5% and 0.5%, respectively; P = 0.000). [55] These

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findings support the dominant role of adiposity in cardiovascular risk clustering during childhood and adolescence.

Hypertension is the most common diseases among adults but recent data have verified association of blood pressure (BP) with childhood obesity. Data from a European pediatric cohort found that 35.4% of overweight children had high BP. [56] Studies done in India found that increase in BMI is more significant in influencing pediatric BP among school going children.[57-59] A study was conducted on 10,248 school children to evaluate the prevalence of hypertension in apparently healthy school children of Delhi, India. The children belonged to 5-16 years age group of both sexes. Prevalence of hypertension was much higher in children with increased waist circumference and high BMI. [58]

Insulin resistance, a well-known cardiovascular risk factor in adult life, has a strong association with childhood obesity. In a recent study on 208 obese children and adolescents, the rate of insulin resistance was 37% in boys and 27.8% in girls in the prepubertal period, while in the pubertal period the rates were 61.7% and 66.7%, respectively.[60] In another study of 710 obese children, Invitti et al. reported an overall prevalence of glucose intolerance of 4.5%.[61] Obesity and the associated insulin resistance have significant influence on glucose metabolism, with hypersecretion of insulin and chronic hyperinsulinemia in obese adults as well as obese children, both without diabetes.[62,63] This scenario frequently leads to the development of type 2 diabetes.[64] In a retrospective analysis of 1301 obese children, Jin *et al.* [65] reported the prevalence of type 2 diabetes as 2.2% and that of prediabetes as 19.6%. It is interesting to note that 52.2% of the prediabetic children had dyslipidemia and 20.8% had hypertension; this only reiterates the fact that there is clustering of cardiovascular risk factors in the setting of obesity.

Dyslipidemia

Epidemiological studies have established that lipid abnormalities in children indeed contribute to adult CVD. [66] However, such traditional lipid risk factors do not explain fully the increased susceptibility of Indians to CVD [67]. Obesity has a strong association with atherogenic dyslipidemia. In a large series of 26000 overweight children, concentrations of one or more of the lipids were abnormal in 32%: total cholesterol in 14.1%, LDL-C in 15.8%, HDL-C in 11.1%, and triglycerides in 14.3% of those in whom data were available. [53] In a series of 943 school-going adolescents, Musso *et al.* [68] reported significant differences in the levels of triglycerides (73 mg/dl vs 90 mg/dl; P<0.001), and HDL-C (52 mg/dl vs 47 mg/dl; P<0.001) between non-overweight and overweight groups.

Future CVD Risk

A consistent body of evidence from epidemiological, clinical and laboratory studies on cardiovascular risk factors among the younger populations, including children, adolescents, and youth exists worldwide. [40,69-70] However, such evidence is mainly confined to developed countries. [70] In India and the rest of South Asia, similar studies systematically evaluating cardiovascular risk factors across younger populations are generally inadequate. Such evidence synthesis is essential to help develop cost-effective screening and intervention programs in a specific population group.

Epidemiological studies from South Asia [70-73] provide reliable data regarding prevalence and trends of cardiovascular risk factors in children and youth. These studies have confirmed that the cardiovascular risk factors begin early, track through young age and tend to magnify and manifest in middle age in most societies. [74-75]

Suggestions

A holistic approach to tackle the childhood obesity epidemic needs an array of activities which includes steps like influencing policy makers and legislation, mobilizing communities, restructuring organizational practices, establishing coalitions and networks, empowering providers, imparting community education as well as enriching and reinforcing individual knowledge and skills.[76] Schools, child care facilities and primary health care centers are important settings for implementation of policies and programmes. Relevant attempts may involve specifying the nutrition composition of foods served in school canteens as well as other outlets, supporting requirements for physical education in schools, increasing the availability of physical activity options or the time available to utilize these options, implementing training programs to empower school teachers to provide nutrition or physical education, and providing financial as well as technical support for programmes and services related to weight control.[77]

Of the possible setting-based interventions, there is sufficient evidence to recommend multi component interventions aimed at diet[78], cardiorespirotary health[79], cognitive change which makes the approach a holistic and efficient one with demonstrable results. [77]

Adolescents and youth require further nutrition interventions, especially in the form of better designed IEC or education activities, besides proper health care, to improve their health and nutrition status. As is apparent from the data presented in this review, there is adequate epidemiological evidence on the nutrition status of adolescents. However, factors affecting food intake are poorly understood. In addition, the implementation of newer programmes for adolescents that includes nutrition components points to the fact that the government is cognizant of the necessity of focusing on this segment of the population.

Any attempt to contain the massive epidemic of childhood obesity will only be fruitful if it is supported by sufficient evidence garnered by appropriate research. Though the evidence is growing in this area, significant deficiencies exist in the areas of epidemiologic transitions in childhood obesity, correlations of obesity to cardiovascular risk factors in an Indian setting as well as efficacy of locally designed interventional programmes. Due importance should also be given to identification and

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assessment of population determinants of childhood obesity. Research in this field should be directed towards enabling early application of such evidence generated to bring in public health policy changes without delay.

CONCLUSIONS

Obesity in adolescents and children has raised to significant levels globally with serious public health consequences. In addition to cardiovascular, emotional and social issues, it poses a serious hazard to the basic health care delivery system. Unless this epidemic is contained the implications of this global phenomenon on future generations will be serious. The reversibility of this disease with suitable intervention strategies should be seen as an opportunity and efforts pursued with vigour.

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