ANTHROPOMETRIC STATUS AND OBESITY IN ADOLESCENT SCHOOL BOYS OF LOWER AND HIGHER SOCIOECONOMIC STRATA, BHUBANESWAR, ORISSA, 2003

- A cross-sectional study

by

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Dissertation project submitted in partial fulfillment of the requirements for the of Master of Applied Epidemiology (M.A.E) of

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CERTIFICATION

This is to certify that this dissertation, entitled **'Anthropometric status and obesity in adolescent school boys of lower and higher socio-economic strata, Bhubaneswar, Orissa, 2003 - A cross-sectional study'**, submitted by Dr. Madan Mohan Pradhan, in partial fulfillment of the requirements for the degree of Master of Applied Epidemiology, is the original work done by him and has not been submitted earlier, in part or whole, for any other (Publication or degree) purpose.

Date: 29.1.04

DIRECTOR

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ABSTRACT

Background: As the result of economic transition, India is facing the dual burden of under nutrition and overweight/obesity. Limited studies using international standards on adolescence anthropometry are available in India. No such study has been conducted in Orissa.

Objective: The primary objectives were to 1) assess the nutritional status of adolescent school boys in both higher and lower socio-economic strata in Bhubaneswar 2) estimate prevalence of overweight and obesity in these boys.

Methods: A cross sectional survey was conducted among 1077 school boys aged 11 to 16 years out of which 46.8% of boys were from affluent and 53.8 % were from non-affluent schools. Student's age was determined from the school register. Anthropometric measurements were carried out using standard techniques. Recently published international cutoff values of body mass index were used to estimate and compare age specific prevalence of overweight/obesity and under-nutrition between the two groups. A semi structured Questionnaire was used to obtain data on knowledge and awareness on obesity among study subjects. Data generated were analyzed using Epi-Info 6.

Results: Overall prevalence of thinness (<5th percentile BMI) among non-affluent and affluent school boys was 36% and 14% respectively. Overall prevalence of overweight / obesity was 16% in affluent and 4% non-affluent boys. The likelihood of gaining overweight was very high in affluent schoolboys: Odds Ratio (OR) for combined overweight and obesity at age 13 was 11.8 (p=0.001), at 12 (OR= 6.8 and p=0.02) and at 14 (OR, 5.06 and p=0.003).

Conclusion: Prevalence of under-nutrition and overweight are very much prevalent in non-affluent and affluent schoolboys in Bhubaneswar. Further studies are needed to assess the adolescence nutritional status and obesity among different strata in urban Orissa, to address the problem.

1.INTRODUCTION

1.1Global problem: The burden of chronic diseases is rapidly increasing worldwide [1]. In 2001, chronic diseases contributed approximately 60% of the 56.5 million reported deaths in the world and approximately 46% of the global burden of the disease. Contrary to the widely held belief, developing countries are increasingly suffering from high levels of public health problems related to chronic diseases. Deaths caused by chronic diseases dominate the mortality statistics in five out of six regions [1] of World Health Organisation (WHO).

The rapidity of the changes in developing countries is such that a double burden of disease may often coexist. India for example, at present faces a combination of communicable diseases and chronic diseases, with the burden of chronic diseases just exceeding that of communicable diseases [1].

Popkin and colleagues indicated that due to rapid industrialization the shifts of nutrition transition are advancing rapidly in Southeast Asian countries [2]. In some of these countries changes in disease structure through epidemiological transition has been reported and these changes mainly occur in urban areas while the traditional health problems still remain in rural areas. For many non-communicable diseases (NCDs) obesity is now considered as one of the root causes.

The WHO has described occurrence of obesity as a Global Epidemic and the growth in the number of severely overweight adults is expected to be double that of underweight during 1995-2025 [3].

Obesity affects all age groups including adolescents. Adolescence occupies a crucial position in human life characterized by an exceptionally rapid rate of growth [4]. The world's adolescent population is 1200 million persons in ages 10-19 years i.e. about 19% of the total population. This population faces a series of serious nutritional challenges, which affects their growth, development and also their livelihood as adults. The health consequences of

obesity in adult life are mainly due to the burden of obesity during childhood and adolescence [5]. The prevalence of overweight and obesity among children has been increasing rapidly worldwide [3]. During the past 20 years prevalence of obesity among children and adolescents has doubled in America [6]. Studies of developing countries like India [7-10], Thailand [11] and Pakistan [12] reported that prevalence of obesity in adolescence is increasing. It is estimated that over 115 million people in developing countries suffer from obesity-related problems [13].

Childhood obesity is positively correlated with eventual adult obesity and the obesity related co-morbidities in adult life. There is an increased risk of coronary heart disease, hypertension, diabetes mellitus, gallstones, osteoarthritis, some form of cancers sensitive to sex hormone, and decreased longevity [13-15].

1.2. Indian problem: The Scientific Report [9] of Nutrition Foundation of India (1999) highlighted the growing problem of obesity in India. It indicated that nearly one third of the males and more than half of females belonging to what may be termed the 'upper middle class' in India are currently overweight as per Body Mass Index (BMI) more than 25. The abdominal obesity in this group is even higher.

The steering committee on nutrition [16] of the tenth five year plan (Government of India) documented that, number of adolescents (10-19 years) will increase from 20 crore in 1996 to 21.53 crore in 2016 in India. Theses adolescents who are undergoing rapid growth and development are one of the nutritionally vulnerable groups who have not received the attention they deserve. Data from National Nutrition Monitoring Bureau (NNMB) of India also shows that over the period there has been some increase in obesity among affluent adolescent groups both in urban and rural areas [16]. There are evidences to suggest that there is increase in prevalence of overweight among children and adolescents of affluent families

than in the past possibly because of decreased physical activities, sedentary lifestyles, altered eating pattern and increased fat content in the diet [9-10].

Recent cover story in a popular news magazine [17], reported as follows: one in every six adolescents in the metros is overweight. Adolescents dominate the Indian cityscape. There are 250 million adolescents in India between 10 to19 years of age. From obesity to diabetes to depression, Indian teenagers are susceptible to a range of diseases that were earlier the bane of adults. In Chennai 17 % teen-agers between 13 to 18 years were overweight. A WHO backed survey at Delhi public schools revealed that 53 % of children between 10 to 14 years and 43% between 15 and 19 years snack on junk food everyday.

Currently only integrated data available that give an overview of the Global prevalence of obesity during childhood are those compiled by the WHO Programme of Nutrition [18]. Hence there is an urgent need to evaluate existing and future data sources concerning children and adolescents from across the world based on a standardized obesity classification system [19].

2.JUSTIFICATION

Obesity is considered as one of the major emerging health problem among adolescents. The obesity epidemic among adolescents is troubling because of the tremendous public health implications. The steering committee on Nutrition of Government of India for tenth five year plan says that currently India is facing a potential [illegible] epidemic due to increasing longevity, stress, changing lifestyle and altered dietary intake resulting in obesity, and this has to be addressed immediately [16].

- There are only limited prevalence data available
- Comparative studies between different socioeconomic strata on overweight/obesity are lacking.
- Various studies have been conducted on nutritional status in developing countries particularly in India, but these have generally been on under nutrition and on selected population group. Generally, these studies have not used the WHO classification of obesity [19].
- Orissa is a known poorer state in India. But, recently more number of urban setups is coming up and industrialization process is gaining momentum. Overweight/obesity seems to be rising in urban adolescents but to the best of investigator's knowledge no study has been conducted across the state.

Hence, to assess the burden of overweight/ obesity among adolescents the present study was conducted in Bhubaneswar, the state capital of Orissa with the following objectives.

3. OBJECTIVES

A. Primary Objectives

1. To assess the anthropometric status of adolescent school boys studying in affluent and non-affluent schools in Bhubaneswar, Orissa
2. To estimate the prevalence of overweight and obesity in these boys using BMI

B. Secondary objectives

1. To assess the knowledge and awareness on overweight/ obesity and the health implications among adolescent school boys of affluent and non-affluent schools
2. To describe the type of food consumed out side home and the life styles of the adolescent schoolboys belonging to both types of schools.

4.LITERATURE REVIEW

4.1.Background:

Since ages overweight/ obesity is commonly perceived as overt manifestation of body weight gain. Overweight/obesity in children and adolescents have been considered as signs of health, an indicator of wealth and prosperity of the family. Increase in body weight and girth have been often perceived as being attractive. Presence of plump children in the family reflects that the parents are well to do and good providers. Only recently these perceptions are changing, as overweight / obesity related health problems are increasing in young adults. Clinical evidence of obesity can be dated as far back as Graeco- Roman times, but little scientific progress was made towards understanding the condition until the 20th century. In 19th century, the work of Lavoisier and others indicated that metabolism was similar to slow combustion, and that obese and lean humans obeyed the laws of thermodynamics. Also, the discovery that fat is stored in "cells", the basic unit of biology, led to the idea that obesity could be caused by the process of too many fat cells. Interestingly, the 19th century also saw the publication of the first diet book, entitled 'Letter on corpulence addressed to the public', by W. Banting. In 20th century, analysis of life insurance data indicated that obesity was associated with an increased death rate [18].

Regardless of different methods used to classify overweight and obesity, studies have shown that since mid 1960s the rate of prevalence in adolescence of overweight/obesity continues to rise dramatically [6][20]. Due to the emergence of adolescence obesity and its health consequences in adult life particularly in developed countries there is renewed interest in the subject.

4.2.Definition of overweight/obesity:

Nancy [5] in 2003 said that the terms obesity and overweight are often used interchangeably, but they are two distinct conditions. Obesity refers to excess adipose tissue, while excess overweight refers excess weight for height. The normal processes of growth, pubertal development and body composition complicate defining overweight/obesity in children and adolescents [5].

Obesity is often defined as a condition of abnormal or excessive fat accumulation in adipose tissue, to the extent that health may be impaired [13]. Stated in simple terms, overweight/obesity is the result of an energy imbalance due to energy intake having exceeded energy expenditure over a period of time. As the modern civilization advances with more industrialization and urbanization processes there are powerful societal and environmental influences, which tend to overwhelm and upset the physiological mechanisms that balance the intake with expenditure to maintain stable body weights.

Till date no uniform international standard has been followed to assess overweight/obesity in different parts of the world. Among all indicators BMI is now mostly used in anthropometric assessment worldwide.

4.2.1.Concept of BMI and its use: Quetlet in 1869 was the first person to observe that among adults of normal built but different height, weight was roughly proportional to height square and he developed the Quetlet's Index *(weight in kg / Height in meter^2)* which was later renamed as *BMI* by Keys et al in 1972.

BMI provides the most useful, albeit crude, population-level measure of obesity. It can be used to estimate the prevalence of obesity within a population and the risks associated with it. Many studies have been conducted on anthropometric assessment of nutritional status in preschool children [21] but much less information can be obtained about older children and adolescents. One reason for this gap in knowledge is the lack of internationally agreed upon

methods for assessing nutritional status of adolescents. The WHO in 1995 made provisional recommendations for the interpretations of anthropometric data during adolescence using the National Health Examination Survey (NHES) reference data.

Due to various limitations for estimating overweight and obesity in adolescents, BMI for age was recommended as the best indicator for use in this age group. It incorporates the required information on age; it has validity as an indicator of total body fat at the upper percentile [22] as it provides continuity with recommended adult indicators. Although BMI has not been fully validated as an indicator of thinness, or under nutrition in adolescents, it provides a single index of body mass applicable at both extremes [3].

Usefulness in international epidemiological studies: According to Malina RM et al [24], the overall efficiency of BMI in predicting percentage body fat as measured by skin fold thickness or densitometry in adolescents of different ethnic origin was >0.8, suggesting that BMI could be useful in international epidemiological studies.

Recently Mary C Bellizz and William H Dietz (23) described that the measurement derived by BMI as an assessment of adiposity in children and adolescents are reliable and non intrusive; furthermore, BMI has been validated against measures of body density. Many countries have published BMI for age charts for their populations, and some have also defined cutoff points on theses charts to define overweight and obesity.

An additional function of gender allows for children to be categorized according to these international cut-off points.

Limitations of BMI: Although weight was considered one indicator of fatness, children of same weight but at different stages of height can have widely different level of adiposity. BMI partially adjusts weight for stature by using the square power for height. One effect of this correlation between BMI and height is that taller populations will appear to have higher prevalence of obesity [24]. Use of BMI in a clinical setting requires additional measures to confirm that a high BMI reflects excess body fat and not height.

4.2.2.Other anthropometric measures to assess overweight/obesity:

Before BMI was introduced anthropometrics variable like weight, height, skin fold thickness, mid upper arm circumference (MUAC), waist and hip circumferences were measured to assess the degree of overweight and obesity of an individual. Most of the present information on the health effects of obesity is derived from data on weight and height. Due to the simplicity and ease for data collection on these anthropometric variables, they are the most commonly employed measures of nutritional status in epidemiological studies. When using combination of weight and height to assess obesity, BMI is as strongly correlated with overall body fat as alternative indices and provides considerable advantages of comparability across studies. Despite the widespread use of obesity indices based on weight and height, their error in representing percent body fat is considerable, not because of failure to measure weight and height accurately but because the lean body mass can vary considerably among persons of the same height.

4.3.WHO recommendations for assessment of nutritional status in adolescents:

The WHO expert committee (1995) recommended BMI for age cut off values for adolescents to be considered "at risk of overweight" [21] because BMI is an inexact measure of total body fat, use of term obesity was limited to those who are at risk of overweight and have high level of subcutaneous fat. Designating individuals as at risk for overweight favours efforts to prevent obesity and provide guidance on weight control. Adolescents who are at risk of overweight may show other risk factors for future obesity related disease, e.g high blood pressure, elevated serum lipoproteins, and elevated insulin and glucose. In the absence of these risk factors, adolescents at risk of overweight should not require additional therapy or advice.

Table:1. WHO-recommended cut-off values for adolescents for nutrition assessment are as follows [21].

Indicators	Anthropometric variable	Cut-off values
Stunting or low height for age	Height-for-age	$< 3^{rd}$ percentile or <-2 Z scores
Thinness or low BMI for age	BMI-for age	$< 5^{th}$ percentile
At risk overweight	BMI-for age	$\geq 85^{th}$ percentile
Obese	BMI- for age	$\geq 85^{th}$ percentile BMI and
	*TRSKF- for age	$\geq 90^{th}$ percentile TRSKF and >=
	**SSKF for age	90^{th} percentile SSKF

* TRSKF= Triceps skin fold thickness ** SSKF= Sub scapular skin fold thickness

Now there are recent international studies available to establish a standard definition for childhood overweight and obesity based on BMI. Tim J Cole et al (2000) recommended international cut-off points by body mass index (BMI) for overweight and obesity by sex between 2 to 18 years, defined to pass through BMI of 25 and 30kg / m2 at age 18 obtained by averaging data from Brazil, Great Britain, Hong Kong, Netherlands, Singapore, and United States [25]. The cut-off points are given in the annexure II.

4.4.Global scenario overweight/obesity:

The world is facing a global epidemic of obesity. Evidence is emerging now to suggest that prevalence of overweight and obesity is increasing worldwide at an alarming rate. Both developed and developing countries are affected [19].

As of 2000,the number obese adult has increased to over 300 million, which is more than seven percent of the world's adult population. A recent analysis of the National Health and Nutrition Examination Survey (NHANES) data (1988-1994) using BMI $\geq$ 30 to classify obesity showed that around 20% of all men and 25% of all women are obese [19]. The 2000 WHO technical report series [19] has mentioned that obesity in developing countries coexists with under nutrition (BMI<18.5). In economically advanced regions of the developing world, prevalence may be as high as industrialized countries.

4.5.Overweight/oesity scenario in Southeast Asian Region:

Good quality, nationally representative, secular trend data for countries in South-Asia Region are not available [19]. However, data from two studies conducted in Thailand suggest that diet related chronic diseases, including obesity are increasing in affluent populations. Prevalence of overweight (BMI 25 -29.9) was considerably higher (15.2 % in men and 23.2 5 in women)[26]. The 2003 cross-sectional study conducted by N Krishna Reddy and his team in Andhra Pradesh showed that obesity was prevalent in 36 % of the population [27].

4.6.Overweight/obesity among adolescents:

Adolescence is the crucial period in the individual's life. Adolescents represent about 20 % of the world's population and around 85% of them are found in developing countries [28]. Although the world is facing a global epidemic of obesity little attention has been given to the nutrition of adolescents and there is not much published literature on the subject.

It becomes difficult to give an overview of the global prevalence of obesity in younger age groups, as there is lack of consistency and agreement between different studies in classifying obesity in this age. Irrespective of the classification system used different studies have reported that prevalence of childhood and adolescence obesity has increased [19].

World scenario: In the USA the prevalence of overweight defined by the 85th percentile of weight-for-height among 5-24 years old from biracial community of Louisiana increased approximately two fold between 1973 and1994. Further the yearly increases in relative weight and obesity during the latter part of the study period (1983-1994) were approximately 50% greater than those between 1973 and 1982 [29]. Similar trend has been observed in Japan; the frequency of obese school children by > 120% Standard body weight (SBW) aged 6-14 years increased from 5% to 10 %, and that of extremely obese (>140 % SBW) children from 1 % to 2 % during the 20 years between 1974 and 1993. The increase was most prominent in male students aged 9-11 years. Early obesity leads to an increased

likelihood of obesity in later life, as well as to an increased prevalence of obesity-related disorders. In the Japanese study, approximately one third of obese children grew into obese adults [28]

The third National Health and Nutrition Examination Survey (NHANES III) in United States reported that there is rise of overweight among adolescents aged 12-17 years(Table.2) as follows.

Table: 2. Prevalence of overweight among different ethnic group by sex in America (NHANES III)

Characteristics	Males (%)	Females (%)
White, non-Hispanic	11.6	9.6
Black-non-Hispanic	12.5	16.3
Mexican American	15.0	14.0
Total	12.3	10.7

Here the overweight is defined as a BMI (kg/m^2) at or above gender and age specific 95^{th} percentile BMI cut-of points calculated at 6 months interval, derived respectively from NHES, cycles 2 and 3. Broussard and colleagues reported that prevalence of overweight in 1990-91, by BMI >= 85^{th} percentile was remarkably high among the adolescents of Native Americans, which is around 40 %[30]. The cross-national comparison study on childhood obesity conducted by Youfa Wang in 2001[31] revealed that the prevalence of obesity and overweight was 11.1 % and 14.3 %, respectively, in the US, 6.0 % and 10.0 % in Russia, and 3.6 % and 3.4 % in China. Obesity was more in higher socio-economic status in China and Russia, but in the US low- socioeconomic groups were at a higher risk. Obesity was more prevalent in urban areas in China but in Russia it is more in rural areas. Thus it was concluded that childhood obesity is becoming a public health problem worldwide, but the prevalence of obesity varies remarkably across countries with different socioeconomic development levels. Data from National Longitudinal Survey of Youth has showed that there is an overweight prevalence of 21.5% among African American children, 21.8 % among Hispanic children and 12.3% among Non-Hispanic whites. This represents a 12% increase in the prevalence of overweight among African American and Hispanic children

and a 50% increase among whites from 1980 to 1998.In Australia at least one in five children and adolescents are overweight or obese [32].

In developing countries: High rates of childhood obesity are already evident in many developing countries. The prevalence of obesity among school children aged 6-12 years in Thailand, as diagnosed by weight for height exceeding 120 % of the Bangkok reference, rose from 12.2 % in 1991 to 15.6 % in 1993 [11]. In a recent study of 6-18 years old male schoolchildren in Saudi Arabia, the prevalence of obesity was found to be 15.8% [33]. A recent cross-sectional study conducted in secondary schools of Pakistan (Karachi) showed adolescent overweight to be 18% [12].

India: Limited data are available from India on prevalence of obesity among children and adolescent group. In India like many other developing countries overweight and obesity coexist with under nutrition. This constitutes a double burden for the country. Following few studies give an overview of the rising prevalence of overweight/obesity in India.

The study conducted by Umesh Kapil et al, (2001) reveals that prevalence of obesity amongst affluent adolescent school children in Delhi is 7.4 % (8 % in boys and 6% in girls) [7].

Ramachandran and his co-workers (2002) conducted a study among Indian adolescent school children (13 to 17 years n= 4700, M: F 2382:2318), and used BMI for assessing overweight/obesity. The study showed the age-adjusted prevalence of overweight as follows: 17.8 % boys and 15.8 % girls were overweight [8].

Gupta AK and colleagues in 1990 conducted a study amongst 3861 school children and reported the prevalence of obesity as 7.5% [10].

4.7.Consequences of childhood and adolescent obesity:

As described by Lee Yung Seng [34] obesity is now considered as a chronic disorder and root of many other chronic diseases. Unfortunately, there is no uniform consensus on the

definition of adolescence overweight/obesity. The consequences of childhood/adolescent obesity can be classified as: a) Medical and b) Psychosocial

a) Medial consequences: medical complications can be broadly classified into mechanical and metabolic complications.

Mechanical complications:- i). Obstructive sleep apnea syndrome and ii). Orthopedic problems.

Metabolic syndromes:-Insulin resistance, hypertension, dyslipidemia, and visceral obesity. Central obesity and insulin resistance are believed to be the chief abnormalities. Visceral fat depot enters the portal system and the free fatty acids induce significant insulin resistance at the liver and muscles, and abnormal insulin secretion by the islets cells. These metabolic complications lead to early cardiovascular disease and premature death and aggressive intervention can reduce the risk of life threatening events.

For most overweight children, the complications do not become apparent till years later, but the metabolic consequences of obesity may be already evident in some, even in young children. The more severely obese will be at higher risk of serious morbidity.

The medical consequences of childhood and adolescent obesity include:

- Glucose intolerance
- Hperlipidemia
- Hepatic steatosis or steahepatitis.
- Hypertension
- Obstructive sleep apnea
- Gallstones
- Orthopedic-blount disease, slipped capital femoral epiphysis
- Pseudotumour cerebri

As per Nacy E. Sherwood [5] there are evidences to suggest that there is long-term morbidity due to medical complications. Whether childhood-onset obesity leads to an increase likelihood of obesity in later life is an important issue with clinical implications. The likelihood of persistence of obesity from childhood to adulthood is related to the degree and duration of obesity, family adiposity and age of the child. The likelihood of an overweight

infant becoming overweight adolescent or adult is small. Less than 15 % of overweight infants and only about 25 % overweight preschool children will remain overweight into adulthood. Obesity is more likely to persist if it is present during the adolescent years. In general the later into adolescence overweight persists, the more severe the degree of obesity, and the presence of parental obesity, increases the likelihood that obesity will persists in adulthood. A recent study by Whitaker et al [(ref)] (1997) in Washington State tracked 850 infants over 21 -29 years. Among obese 6 years olds about 50 % remained obese. By the age of 10-14 years 80% of obese children with at least one obese parent remained obese [(35)]. A study conducted by Maffeis and colleagues in 2002 reported that 43% of obese children persisted to be obese adults, and another 29% were overweight as adults. The severity of obesity in childhood increases this likelihood and childhood BMI and insulin resistance that are significant predictors of subsequent development of metabolic syndrome X [(36)].

b) Psycho-social consequences: The 1998 WHO report [(3)] says that many obese individuals face psychological distress due to stigma attached to obesity. Psychological and social consequences are probably more prevalent than medical complications in overweight/obese persons. Childhood obesity has significant impact on the emotional development of the child or adolescent, who suffer from discrimination and stigmatization, as the obese individuals are commonly regarded as glutton and greedy, weak minded and ill disciplined. They may have fewer opportunities in school, at work, and social circle. As a consequence many obese individuals have less schooling, lower income, and higher poverty rates. Obese children were unfortunately uniformly ranked by other children as least desired friends [(34)]. Montello and colleagues in 1963[(37)] reported that individuals who were obese in childhood are more likely to have poor body image, and low esteem and confidence, even more so than those with adult onset obesity, as mid childhood is the critical period of development of body image and self esteem. A case- control study matched by gender and age conducted by

Sunita et al at St.John's Medical College Hospital showed that proportion of pre obese and obese adults (as per WHO definition by BMI) were significantly higher among the psychiatric patients (29% vs 5%) admitted to the hospital than the controls [38].

4.8.The public health burden:

Rising prevalence of adolescent overweight/obesity is public health burden. The cost attributable to obesity is high not only in terms of premature death and health care but also in terms of disability and diminished quality of life. Guijing Wang and his colleague reported [39] that in the past 20 years (1979-1999) among all hospital discharges, the proportion of discharges with obesity-associated diseases has increased dramatically. This increase has led to significant growth in economic cost. Center for Disease Control (CDC) researchers found that obesity related annual hospital costs increased three-fold over the 20 year period from 1979 to 2000. During that time, annual hospital costs for obesity related conditions in youths aged 6-17 increased from 35 million US dollar to 127 million US dollar (in 2001 dollar)[40].

India is undergoing rapid economic transition and is burdened by both communicable and non-communicable diseases. Heema Shukla in 2002 reported "The World Bank estimates that malnutrition costs India 10 billion US dollars each year due to lost productivity, illness and death. But the results of the largest ever survey of urban adults in India show there is also a significant level of obesity. Health policy makers must develop a dual approach to tackle these problems"[41].

4.9.Prevention:

Obesity and overweight are multi-determinant chronic problems resulting from complex interactions between genes and environment characterized by energy imbalance due to sedentary lifestyles and ready access to an abundance of food. Research suggests that

obesity runs in families and some individuals are more vulnerable than others to weight gain and developing obesity. Genetic susceptibility towards overweight has been proposed to occur through several mechanisms, including low resting metabolic rate, low level of lipid oxidation rate, low fat free mass, and poor appetite control[42-43]. Genetic research holds considerable promise for understanding the development of obesity and identifying those at risk for obesity. However, the rapid increases in rates of obesity and overweight have occurred over too brief a time through out the globe for there to have been significant genetic changes in the population. Although body weight regulation is primarily regulated by series of physiological processes, it is also influenced by behavioural and environmental factors [44]. Recent epidemiological trends in obesity have been linked to behavioural and environmental changes that have occurred in recent years. The increasing proportion of calories from fat and increase in calories of diet in combination with reduction in physical activity levels and increase in sedentary behaviour have been implicated as significant contributors to the obesity epidemic [27].

Nutritional Foundation of India (NFI) reported that greater consumption of fat, oils and sugar and lower consumption of fiber in the diet is the cause of overweight and obesity. Fast food centers are multiplying in the urban areas of India and these find increasing clientele, particularly from adolescent children. The change in dietary habits accompanied by a sedentary life style like watching television for prolonged periods by children compounds the issue. Technological improvements add to this by replacing manual labour by machines in several areas of life [9].

It is important that to adopt preventive measures, health policy makers need to know the burden of childhood obesity. International experiences would help in tackling this emerging health problem at local level. For international comparison internationally acceptable standard definition for overweight and obesity is very much essential. WHO mentions: "the value of estimating the prevalence of, and secular trends in overweight and obesity cannot

be overemphasized [ ]. Knowledge of the level and changing distribution of overweight and obesity can be:

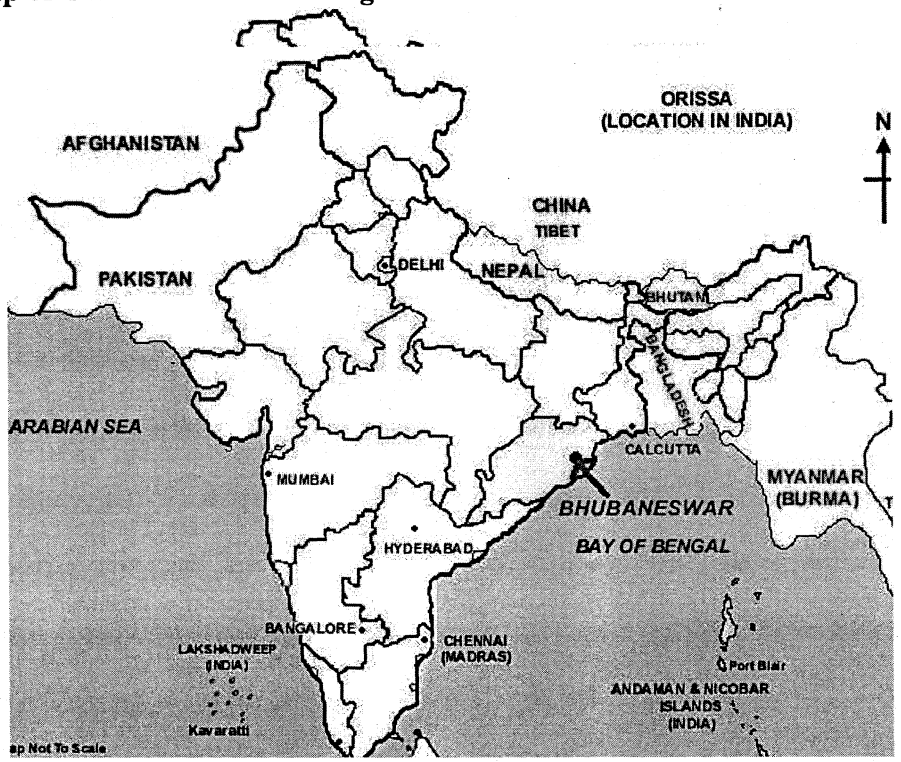
- Used to identify populations at particular risk of obesity and its associated health and economic consequences.
- Used by Health policy makers and public health planners in the mobilization and reallocation of resources for the control of diseases.
- Used to provide baseline data for monitoring the effectiveness of nutritional programmes for the control of obesity.

Since little research has been conducted on the primary prevention of obesity there is an urgent need for studies in this area particularly with subgroups at high risk of obesity [5].

5. METHODS

A cross sectional study was conducted in middle and secondary schools of Bhubaneswar,(Fig 1), the state capital of Orissa in the months of August and September 2003.

Fig:1 Map of Orissa in India Showing Bhubaneswar



5.1.Selection of Schools:

Two types of schools were selected.

(1).Affluent schools (2).Non-affluent schools

The definition affluent and non-affluent schools is as follows:

Affluent schools:

Schools catering to students from affluent sections of the society who can afford to pay admission and tuition fee of the school. In these schools the average admission fee is Rs. 5000 and average monthly tuition fee is more than Rs. 200.

Non-affluent schools:

The State Government run middle and secondary schools were considered as non-affluent schools. Here students from lower middle class and poor socioeconomic strata get the opportunity to study, as the admission and tuition fee in these schools are very minimal.

Schools were selected purposively taking into consideration the time constraints and feasibility. The study was conducted in following schools.

Affluent schools: - (i) St.Xavier school situated at Khandagiri,Bhubaneswar

(ii) Stewart school situated near CRP square,Bhubaneswar.

Affluent school: (i) Government Boys High school, Unit 8, Bhubaneswar

ii) Tapoban High school, Khandagiri, Bhubaneswar

School consent:

Before conducting the study Principal / Headmaster of the concerned schools were appraised about the study and verbal consents were obtained.

5.2.Subjects:

Only boys between 11 years to 16 years of age who were between 7^{th} and 10^{th} standards were included in the study.

5.3.Sample size:

Considering other urban studies in India the sample size for prevalence of overweight/obesity in Bhubaneswar was calculated. Assuming that the prevalence of overweight/obesity among adolescent schoolboys in Bhubaneswar be 10 % and allowing 20% error in the estimate (20 % of 10% = 2 %) the sample size was calculated as follows

$$n = \frac{1.96^2 \text{ X P X } (100 - P)}{\text{Precision}}$$

$$n = \frac{1.96^2 \times 10 \times 90}{2^2} = 864.$$

5.4.Study team: A three-member team was constituted to conduct the study. The team members were as follows.

(1) Scholar of Master in Applied Epidemiology, National Institute of Epidemiology, Chennai as Principal investigator

(2) One Senior Doctor, MD Community Medicine (Chief Medical Officer CRPF, Bhubaneswar) who was under refresher training at Community Medicine Department of SCB Medical College, Cuttack.

(3) One volunteer who deals with students of both affluent and general Government schools for his private tuition.

In each school the respective class teachers assisted the team as per the instruction of the school principal / headmaster. They helped in verification of date of birth of the students from school registers and arranging the examination room.

5.5Training of the study team:

As per the request of the principal investigator, the Director of Regional Medical Research Center (RMRC), Bhubaneswar provided training support and required instruments like Fat Fold Thickness slide calipers. The Research Officer of Clinico-epidemiological Division of RMRC trained the members at the school setting on anthropometric measurements by demonstration method.

5.6.Data Collection:

A data collection format was designed which contained anthropometric measures, semi-structured questionnaires for knowledge assessment on overweight /obesity, as well as lifestyle and food habits. The questionnaire was pre-tested with 30 students in two schools and after appropriate modification adequate number of copies were xeroxed for data collection. For each student one form was used to record his anthropometric measurements and information colleted from him.

Age was determined from the school register and calculated in years. The mean age was taken to round up the age in years. As for example if the age of a student falls between 11years 6 months to 12 years 6 months the age is taken as 12 years.

With the help of semi-structured questionnaires boys were interviewed individually. Information on caste, religion, parental education, occupation, knowledge & awareness on overweight/obesity, life style and type of food preferences and consumption were collected. During interview local language was used so that students could comprehend easily.

Each student was interviewed separately for collection of information on his knowledge and awareness about overweight/obesity, his lifestyle and food habits with the help of the semi structured questionnaires.

5.8.The cross sectional survey: All apparently healthy boys of a particular section of a class from standard 7^{th} to standard 10^{th} attending the school on the day and time of our survey were included in the study. Efforts were made to examine the students of the section who were absent on the day during the next three repeat visits.

5.7.Benefiting the schools:

After completing the study in a particular school interactive discussion sessions were conducted to make the teachers and students aware about the implications of overweight and obesity in adolescents. Information sheet on weight, height and desirable weight to the students who were examined was provided.

5.8.Anthropometric measurements:

Standard protocols were followed to record age, measure weight, height, mid-upper arm circumference (MUAC), waist circumference, hip circumference & triceps skin fold thickness (TSFT). To avoid embarrassing situation for the students for their partial nudity during anthropometric measurements, separate room was arranged in each school to keep privacy.

Weight: Lever beam balance scale (platform type weighing machine) was used to measure weight in kg. While measuring weight the boys were asked to remove their garments except pant.

Height: Standing heights of each boy were measured in centimeter. The steel scale attached to the lever beam-weighing machine was used for measuring the height. Students were asked to remove footwear and stand with heels together. The head of the student was positioned so that the line of vision was perpendicular to the body. The movable iron bar fixed to the scale was brought to rest on the top most point of the scalp. Height was recorded to the nearest millimeter (i.e. 0. x cm).

Mid-upper Arm Circumference (MUAC): The MUAC was measured at the midpoint between the acromion and olecranon process. Non-stretchable fiberglass tape was used to measure the mid upper arm circumference in cm (to the nearest 0.1 cm). The MUAC was measured in left upper arm.

Waist circumference: The waist circumference was measured using non-stretchable fiberglass tape taking bony landmarks into consideration (e.g. half way between the lower rib margin and iliac crest)

Following procedures were followed for waist measurement:

Participants were asked to remove clothes, around their waist. Tight clothing, including the belt were loosened and the pockets were emptied.

The measurer was to stand at the front side of the student to have a clear view. A full mirror could not be used for this purpose.

Participants were instructed to stand with their feet fairly close together (about 12-15 cm) with their weight equally distributed to each leg. Participants were advised to breathe normally. The reading of the waist circumference measurement was taken at the end of gentle exhaling. This was to prevent subjects from contracting their abdominal muscles or from holding their breath.

The measuring tape was held firmly, ensuring its horizontal position. Care was taken to see that the tape position was horizontal all around the waist. The tape was kept loose only to allow the observer to place one finger between the tape and the subject's body.

Measurements were recorded to the resolution of the tape (nearest millimeter)

Hip circumference: Hip circumference was measured, at the maximal circumference over the buttock. Tape position was kept horizontal all around the body.

For hip circumference measurement all procedures were followed as it was done for waist circumference.

Triceps skin fold thickness (TSFT): By Harpendon's calipers the triceps skin fold thickness was measured. One of the team members was specially trained to measure the triceps skin fold thickness by the RMRC Research officer working in clinico-epidemiological division having experience in anthopometry. The concerned team member was engaged to measure the TSFT in all boys to minimize human error.

TSFT was determined as follows: The midpoint between the acromion and olecranon process on the posterior surface of the left arm was measured by the tape and it was marked by ink pen. With the patient's arm relaxed, the skin fold was grasped ~1 cm above the midpoint, taking care to exclude muscle from the grasp. Triceps skin fold thickness was measured with the calipers at the midpoint. The measuring was repeated thrice.

Quality control measures: To maintain good quality anthropometric measurements, we were checking and re-calibrating the equipments and monitoring the performance of the measurers. After examining 30 students the measures had breaks to avoid fatigue.

The checking and re-calibrating of equipment was done at each break. A logbook was maintained for checking and recalibration.

For monitoring the performance of the measurers we checked the following information routinely:

- Distribution of terminal digit for weight, height, mid upper arm, waist, and hip circumference measurements.
- Distribution of terminal digits for full kilograms of weight.
- Recording of reasons for measurements that were not performed.
- Daily workload, to avoid fatigue.

If any problem was detected with the individual measurer it was discussed immediately which helped in correcting the errors.

After the survey the overall quality of anthropometric measurements was checked. The retrospective quality assessment enabled the team to discover problems that might have slipped through the control measures during the survey. It was also needed to ensure for accurate results.

5.9.Data analysis:

Data entry and analysis was done in Epi-Info version-6.04d [45] and Epi-2002. "Istat" was used to calculate independent 't' and modified 't' test. Tests of significance (chi-square, trend, t test), significance at 5%, Odds Ratios and 95% Confidence Intervals were calculated.

BMI was computed by using the formula weight (kg)/ height^2 in metre. International cut-off points for BMI were used for classifying adolescent children as over weight and obese. The study results were compared with the international reference standards: 2000 CDC Growth chart [46] and NHANES (1988-1994) reference data* and Cole's BMI international cut-off values for adolescents**[40] .The two groups of schoolboys were compared by:

1.Means and standard deviations (SD) of weight (kg), Height (cm), MUAC (cm), TSFT (cm), Hip circumference (cm) Waist circumference (cm), waist and hip ratio

2.Means +/-2SD with 2000 CDC Growth Chart / NHANES reference data (wherever appropriate) with all the above anthropometry 2000 CDC Growth Chart/ NHANES

3.Percentile of triceps and body mass index (BMI) with reference to NHANES data

Socio-demographic characteristics and their association with nutrition status, knowledge awareness, and food and lifestyle pattern between the two groups of students compared

**2000 CDC Growth Chart: The National Center for Health Statistics (NCHS) charts that have been in use since 1977 have been revised. The revised version, known as the Center For Diseases Control and Prevention (CDC) Growth Charts. These normalized charts are recommended by WHO for use in international applications and some times these are called as NCHS/ CDC charts, CDC/ WHO charts or NCHS/CDC/WHO charts. United States released CDC growth Charts in 2000, is now recommended for use in clinical practice and research to assess size and growth in U.S. infants, children and adolescents. NHANES Data: National Health and Nutrition Examination Survey and National Health Examination Survey (NHES) are two sources of data for developing CDC growth Charts. US expert panels recommended these data for use in clinical evaluation of obesity and epidemiological application. ** Cole's (BMI) international cut-offs: Tim J Cole and his colleagues have derived BMI cut-off points by age and sex for international use in anthropometry in children and adolescents in 2000 by conducting international survey of six nationally representative cross sectional growth studies. The six countries were: Brazil, Great Britain, Hong Kong, The Netherlands, Singapore, and the United States. The age and sex specific cut-off points are given in the annexure (annex-II).*

6. RESULTS

A total of 1077 schoolboys, 11 to 16 years of age were included in the present study. Out of this 46.2% were from affluent sections of the population (affluent schools) and 53.8% were from lower middle and poor sections (non-affluent schools). The proportion of boys absent during three repeat visits was approximately 2% in affluent and 3% in non-affluent schools. The result section has been described under following sections.

Section I: Socio-demographic profile

Section II: Means and Standard deviation: Comparison of means and standard deviations of anthropometric measurements (weight, height, waist circumference, hip circumference, mid-arm circumference and triceps skin fold thickness) of the study participants were compared with 2000 CDC Growth Chart / NHANES reference data (year 1988-1994) wherever appropriate.

Section III: Comparison of nutritional status by mean ± 2SD of collected anthropometric data (based on NHES/NHANES data)

Section IV:Ccomparison of nutritional status by using percentiles of collected anthropometric data (based on NHES / NHANES data).

Section V: Comparison of thinness, overweight and obesity by BMI as per the international cut-offs defined by WHO and Cole by age and sex.

Section V. Socioeconomic factors and prevalence of overweight

Section VI. Knowledge and awareness

Section VII. Food and life styles

6.1. Socio-demographic profile

The Table:3 shows the age wise distribution of the schoolboys. Number of boys were very few at the two extremes in non-affluent schools (11 and 16 years), the number was also small at 16-year in affluent schools.

Table:3. Distribution of adolescent school boys by age, Bhubaneswar, Orissa 2003

Age (Years)	Non-affluent schools		Affluent schools	
	(n= 579)	(%)	(n= 498)	(%)
11	20	3.5	55	11.0
12	166	28.7	65	13.1
13	179	30.9	131	26.3
14	137	23.7	117	23.5
15	65	11.2	117	23.5
16	12	2.1	13	2.6

In both types of schools the age distribution of boys was similar at age 13,14 and 16 years. At ages11 and 15, the percentage of boys in affluent schools was substantially higher compared to the non-affluent schools. At age 12 this contrast was reversed.

Table:4 shows that in affluent schools proportion of upper caste and non-Hindu boys were more than the non-affluent schools. About 17% of boys in non-affluent schools

Table: 4. Distribution (%)of adolescent schoolboys by caste and religion, Bhubaneswar, Orissa 2003

Characteristic	Non-affluent schools (n=579)	Affluent schools (n=498)
Caste		
Upper caste	80.4	87.9
Scheduled caste	9.8	2.6
Scheduled tribe	7.6	3.8
Others	1.7	5.6
Religion		
Hindu	96.5	94.4
Muslim	1.5	2.6
Christian	2.0	3.0

belonged to scheduled caste and scheduled tribes, which was about one third (34.4%) in case of affluent schools. Majority of boys (95%) of both types of schools belonged to Hindu families.

Table:5 shows that the difference in the level of parental education between the two categories of schoolboys was striking as would be expected. The difference was found to be statistically significant (mother's education: $p < 0.001$ and father's education: $p < 0.001$)

Table: 5. Distribution (%)of adolescent schoolboys by parental education, Bhubaneswar, Orissa 2003

Education level	Non-affluent Schools (n=579)	Affluent Schools (n=498)
Mother's Education		
No education	14.3	0.6
Primary	13.8	0.8
Middle	19.2	2.2
Secondary	28.2	11.2
Higher secondary	28.2	19.5
Above higher secondary	10.4	65.7
Father's Education		
No education	4.8	0.2
Primary	11.6	0.2
Middle	10.0	0.8
Secondary	26.6	3.4
Higher secondary	16.1	6.6
Above higher secondary	30.9	88.8

Mothers' education: A little over 75 % of mothers of non-affluent schoolboys had education below higher secondary level. However, more than 72% of mothers in affluent group had education at or above higher secondary level. In non-affluent group about 48% were within the level of no education to middle school education, whereas the proportion was very low (<4%) at this level of education incase of mothers of affluent schoolboys. The proportion of

mothers having education level above higher secondary in affluent group was about three times of that in the non-affluent group.

Fathers' education: In case of fathers more than 95% hade education up to or above higher secondary level in affluent schools, which is only about half (47%) in non-affluent schools.

Table: 6.shows that Occupational distribution of fathers also showed striking difference between the two groups. In affluent schools about 73 % fathers were working in professional and managerial position, whereas in non-affluent group only about 6 %

Table: 6. Distribution (%) of schoolboys by occupation of fathers Bhubaneswar, Orissa 2003

Father's occupation	Non-affluent schools (n=579)	Affluent schools (n=498)
Professional	0.9	25.5
Managerial	4.7	47.8
Skilled (manual and non- manual)	20.7	21.1
Partly skilled	50.1	4.6
Unskilled	23.7	1.0

had equivalent occupations. On the other hand about 74 % of fathers of boys in non-affluent schools were in partly skilled or unskilled occupations as compared with only about 6% in such occupations in case of affluent schools. Equal proportion (21%) in each section were working in skilled manual and non-manual categories i.e., clerical, typist, computer operator, mechanics, small trade / business, transport etc.

Mothers' occupation: In both groups more than 80 % of mothers (90 % in non affluent and 84 % in affluent group) were not working outside home.

6.2.Means and Standard deviations

Anthropometric measurements taken were: weight, height, mid-arm circumference, hip circumference, waist circumference and triceps skin fold thickness. Besides presenting the collected anthropometric data by means and standard deviations (SD) comparison has been made by mean plus 2 SD, waist-hip ratio (WHR), percentile of weight, height, triceps and BMI with reference to NCHS / NHANES data. BMI by age has been derived as per

thinness.

The means of above mentioned anthropometric measurements were compared using independent 't' test and modified 't'test where ever appropriate.

6.2.1.Weight:

Table:7.shows that at ages 11 and 16 in non-affluent schools numbers were small. At age 16 this was also so in affluent schools. In all ages affluent schoolboys had more weight than non-affluent boys

Table:7. Mean and SD of weight (kg) of adolescent schoolboys by age in Bhubaneswar, Orissa 2003

Age (Years)	Non-affluent schools (n=579)		Affluent schools (n=498)		t	P
	Mean	SD	Mean	SD		
11	31.66	5.97	35.50	7.61	2.04	0.075
12	32.72	6.71	38.61	7.51	5.79	0.001
13	39.64	8.78	46.09	10.70	31.91*	0.001
14	43.12	8.24	48.41	10.10	4.52*	0.001
15	45.85	10.99	55.03	11.77	6.42	0.001
16	47.61	10.80	52.85	10.04	1.26	0.221
Over all	39.07	9.67	46.77	11.94	11.51	0.001

*** Modified 't'test**

There was steady increase in weight up to age 16 in non-affluent group with sharp increase at age 12 to 13. In affluent section, the increase was similar up to age 14.Between 14 and 15 years there was a sharp increase. The number of boys at 16 was too small to make a valid comment on the apparent decrease in the mean weight. The variability (SD) in the affluent schools was slightly higher in all ages (12 to 15).The mean weight at ages 12 to 15 differed between affluent and non affluent schools ($p = 0.001$).

6.2.2.Height:

Table: 8. shows that in affluent schoolboys gain in height was steady from 11 to 15 years. In the non- affluent schoolboys an apparent sharp spurt in height is seen between 1 to 13 years.

Table: 8. Mean and SD of height (cm) of adolescent schoolboys by age, Bhubaneswar, Orissa 2003

Age (Years)	Non-affluent schools (n=579)		Affluent schools (n=498)		t	P
	Mean	SD	Mean	SD		
11	140.77	10.69	144.25	6.52	1.37*	0.184
12	143.91	8.62	149.15	7.91	0.65*	0.519
13	153.46	9.58	154.34	7.56	0.58*	0.566
14	156.78	8.12	160.34	8.74	3.34	0.001
15	158.86	11.32	164.59	6.69	3.74*	0.001
16	163.30	9.10	165.59	5.36	0.75*	0.458
Over all	151.88	11.03	156.65	10.12	7.38*	0.001

* Modified 't' test

In all ages the mean height of affluent schoolboys were more than that in the non-affluent schoolboys. The variability (SD) was higher in non-affluent schoolboys in all ages except 14 and highest at age 15 followed by 11 and 16. At age 14 the variability was slightly higher in affluent section than non-affluent section. The mean height at ages 14 and 15 differed between affluent and non-affluent schools.

6.2.3.Hip circumference

As observed in Table:9 the mean of hip circumference (cm) was more than 3 to 5 cm higher in affluent boys than the non-affluent boys in all age groups except at age 15 and 16. In 15 years the hip circumference was about 4 cm higher among non-affluent boys and in 16 year this was reverse i.e. affluent boys had more than 8 cm of mean hip circumference than the non-affluent boys.

Table: 9.Mean and SD of hip circumference (cm) of adolescent schoolboys by age, Bhubaneswar, Orissa 2003

Age Years	Non-affluent schools (n=579)		Affluent schools (n=498)		t	p
	Mean	SD	Mean	SD		
11	70.25	6.25	74.57	7.13	3.94	0.019
12	71.05	6.76	74.94	6.95	3.85	0.001
13	76.35	7.18	81.44	8.12	5.83	0.001
14	78.78	6.80	83.17	11.34	3.66*	0.001
15	91.27	8.37	86.91	8.29	3.38	0.001
16	77.33	20.27	85.11	8.31	1.24*	0.236

* Modified 't' test

The pattern of increase in hip circumference was similar in both groups in all ages except at the age of 15 year in non-affluent group. The variability (SD) was on higher side in affluent school boys from ages 11 to 14.The mean hip circumference ratio differed between the two groups of students in ages 11 to 15 (p= 0.01)

6.2.4 Waist circumference

Table:10 shows that the means of waist circumference of affluent boys were more in all age groups. At the age of 11,12 and 14 years the difference were 3 to 4 cm where as in 13 and 15 years it was about 7 cm. But at the upper extreme i.e. at 16 year there was equal proportion (about 68%)in both the groups. The numbers at 16 were however were small.

Table: 10. Mean and SD of waist circumference (cm) of adolescent school boys by age, Bhubaneswar, Orissa 2003

Age (Years)	Non-affluent schools (n=579)		Affluent schools (n=498)		t	p
	Mean	SD	Mean	SD		
11	57.45	5.74	60.86	7.70	1.80	0.075
12	58.51	6.83	61.71	9.22	2.54*	0.013
13	61.64	6.80	68.51	9.55	7.03	0.001
14	63.75	7.08	67.96	9.16	4.04	0.001
15	65.07	8.27	72.46	10.49	5.23*	0.001
16	67.18	9.34	68.32	9.70	0.29	0.768

*Modified 't' test

The variability (SD) was on higher side in affluent schoolboys in all ages. The mean waist circumference differed between the two groups of students in ages 12 to 15 (p = 0.01)

6.2.5.Waist-hip ratio (WHR)

In the Table: 11 it is found that he waist-hip ratio in both affluent and non-affluent group shows that there was no difference of WHR at any age except at 16 year.

Table: 11. Mean and SD of waist-hip ratio (WHR) of adolescent school boys by age , Bhubaneswar, Orissa 2003

Age (Years)	Non-affluent schools (n=579)		Affluent schools (n=498)		t	p
	Mean	SD	Mean	SD		
11	0.82	0.05	0.82	0.05	46.66*	0.001
12	0.82	0.06	0.82	0.09	0.00	1.000
13	0.81	0.05	0.84	0.06	4.66	0.001
14	0.81	0.05	0.82	0.08	1.17*	0.243
15	0.84	0.10	0.82	0.08	1.38*	0.169
16	1.05	0.80	0.81	0.05	1.04*	0.322

* Modified 't' test

At age 16 in non-affluent group a very small proportion exceeded 1, indicating central obesity as per classification in adults. But as the sample was very small no firm conclusion can be drawn. The variability (SD) was on higher side in affluent schoolboys in ages 12 to

14. The mean waist circumference differed between the two groups of students in ages 11 to 13 (p = 0.001)

6.2.6.Mid-arm circumference (MUAC)

In the Table:12 it is seen that in all age groups the mean of MUAC (cm) was more than 2 cm higher in affluent schoolboys than the non-affluent boys. The increase in MUAC was consistent in both the groups along with the advancement of age.

Table: 12.Mean and SD of MUAC (cm) of adolescent school boys by age, Bhubaneswar, Orissa 2003

Age Years	Non-affluent schools (n=579)		Affluent schools (n=498)		t	p
	Mean	SD	Mean	SD		
11	18.45	2.50	20.08	7.16	1.46*	0.148
12	19.16	2.65	21.24	3.00	5.16	0.001
13	20.93	5.23	23.74	3.77	5.508*	0.001
14	21.89	6.02	23.72	3.72	5.49*	0.001
15	22.14	3.30	25.69	4.87	5.83*	0.001
16	22.63	3.73	25.69	3.89	2.00	0.057

* Modified 't' test

The variability (SD) was on higher side in affluent schoolboys in all ages except 13 to 14. The mean MUAC differed between the two groups of students in ages 12 to 15 (p= 0.001).

6.2.7.Triceps skin-fold thickness

In the Table:13 it is shown that the triceps skin fold thickness was higher in affluent schoolboys in all age groups except at 16 year. In non-affluent schoolboys, it remained almost within the range of 9 to 10 from age 11 to 15. But this was fluctuating within 10 to 12 in affluent boys.

Table: 13.Mean and SD of triceps skin fold thickness (cm) of adolescent schoolboys by age, Bhubaneswar, Orissa 2003

Age (Years)	Non-affluent schools (n=579)		Affluent schools (n=498)		t	p
	Mean	SD	Mean	SD		
11	9.48	5.26	10.83	4.59	1.08	0.282
12	9.79	4.88	9.92	4.44	0.195*	0.85
13	9.39	5.00	12.09	5.62	4.38*	0.001
14	8.96	4.97	10.44	5.21	2.30*	0.020
15	8.93	4.77	11.84	6.13	3.55*	0.001
16	10.58	7.48	9.07	3.89	0.63*	0.540

*Modified 't' test

The variability (SD) was on higher side in affluent schoolboys in ages 13,14 and 15 and in other ages it was more in non-affluent boys.. The mean triceps skin fold thickness differed between the two groups in ages 13,14 and 15 ($p = 0.02$)

6.3.Comparision of nutritional status by mean +/-2 SD of collected anthropometric data

Mean +/-2 SD and percentiles were used to assess thinness and overweight. The data of the present study has been compared with the mean +/- 2SD and percentiles values of 2000 CDC Growth Chart / NHANES data, 1988-1994 (as appropriate).

6.3.1.Weight: Table: 14 shows that 3 to 4 % of boys in affluent schools in age 13 and 15 were above the mean +2 SD of weight based on 2000 CDC growth chart where as it was very minimal in non-affluent schools. When compared with mean - 2SD of 2000 CDC growth chart a higher proportion of non-affluent boys were below this level at all ages.

Table: 14. Distribution of schoolboys in Bhubaneswar by age based on mean +/- 2SD weight (kg) 2000 CDC Growth Chart

Age (years)	< Mean -2SD n (%)		> Mean +2SD n (%)	
	Non affluent schools	Affluent schools	Non affluent schools	Affluent schools
11	0	0	0	1(1.8)
12	4(2.4)	1(1.5)	0	4(1.5)
13	6(3.4)	1(0.8)	1(0.6)	5(3.8)
14	13 (9.5)	5(4.3)	0	0
15	14(21.5)	2(1.7)	0	3(2.6)
16	2(16.7)	1(7.7)	0	0

The proportion increased sharply as age advanced up to age 15 and then started falling. The percentage of underweight was 13 times higher in non-affluent group than the affluent group at age 15. At all ages very small proportion of affluent boys were below mean -2 SD level.

6.3.2.Height:

The Table:15 shows that only a very few boys in both sections (1.7% in affluent schools at age 15 and 1.1% in non-affluent schools at age 13 are beyond the mean + 2SD of height of 2000 CDC growth chart . Very high proportion boys in non-affluent schools were below the mean - 2SD of 2000 CDC growth chart indicating significant prevalence of chronic under nutrition.

Table 15. Distribution of schoolboys in Bhubaneswar by age based on Mean +/- 2 SD Height of 2000 CDC Growth Chart

Age (years)	< Mean-2SD n (%)		> Mean + 2SD n (%)	
	Non affluent schools	Affluent schools	Non affluent schools	Affluent schools
11	4(20.0)	0	0	1(1.8)
12	24(14.5)	1(1.5)	0	0
13	22(12.3)	7(5.3)	2(1.1)	0
14	21(15.3)	11(9.4)	0	0
15	18(27.7)	7(6.0)	0	2(1.7)
16	2(16.7)	0	0	0

Percentage of thinness was maximum at age 15 followed by age 11. But as the sample was very small in age 11 in non-affluent section it is difficult to draw conclusion. In non-affluent group the stunting was mostly concentrated in ages 13 to 15.

6.3.3.Hip circumference

Table: 16 shows that there was a striking difference at age 13 between the two groups. Affluent boys were four times above the mean +2 SD of NHANES reference than non-affluent boys. At all ages the hip circumference were at a higher level in affluent boys than non-affluent boys. In affluent group after a fall from 11 to 12 there was a sharp rise from 12 to 13 then after a fall at 14.

Mean +/- 2 SD , Hip circumference (cm) of NHANES data (1988-1994)

Age (years)	Mean<(-2SD) n (%)		Mean >(+2SD) n (%)	
	Non affluent Schools	Affluent schools	Non affluent schools	Affluent schools
11	17(85.0)	32(58.2)	2(10.0)	10(18.2)
12	150(90.4)	51(78.5)	8(4.8)	5(7.7)
13	151(84.4)	87(66.4)	10(5.6)	28(21.4)
14	125(91.2)	83(70.9)	5(3.6)	10(8.5)
15	58(89.2)	84(71.8)	5(7.7)	19(16.2)
16	10(83.3)	9(69.2)	2(16.7)	2(15.4)

In both groups high proportions of boys were below the mean-2 SD NHANES value and in non-affluent group this was clearly higher.

6.3.4. Waist circumference (+/-2 SD)

When the waist circumferences of Bhubaneswar boys were compared with the mean + 2SD of NHANES (1988-1994) reference it was found that none from both groups was above it. There were only 1.5 % affluent boys and 0.6 % in non-affluent boys below mean -2 SD level. But peculiarly the percentage was twice in affluent section than non- affluent (Table not shown).

6.3.5.Mid-upper arm circumference (MUAC)

In the Table: 17 it is shown that the proportion of boys above the mean +2 SD of the mid-upper arm circumferences (NHANES reference) were at a very high level in affluent schoolboys than non-affluent boys in all ages except age 16.

Table.17. Distribution of schoolboys in Bhubaneswar by age based on Mean +/- 2 SD MUAC (cm) of NHANES data (1988-1994)

Age (years)	< Mean -2SD n (%)		> Mean +2SD n (%)	
	Non affluent schools	Affluent schools	Non affluent schools	Affluent schools
11	18(90.0)	43(78.2)	0	3(5.5)
12	150(90.4)	55(86.2)	4(2.4)	7(10.8)
13	166(92.7)	87(66.4)	9(5.0)	26(19.8)
14	127(92.7)	95(81.2)	4(2.9)	5(4.3)
15	61(93.8)	85(72.6)	3(9.6)	19(15.4)
16	10(83.8)	10(76.9)	1(8.3)	1(7.7)

The maximum difference was at age 13 (4 times more to non affluent boys) followed by age 15. When compared with mean -2SD both the groups were having high proportion though the percentages were more in non- affluent group in all ages. In non-affluent group the percentages remain almost constant in ages 11 to 15 within the range 90 - 94 %. In affluent section the percentage fluctuated between 73-86.

6.3.6.Triceps Skin Fold Thickness

In all ages high proportion of boys in affluent group were above the mean +2 SD of triceps skin fold thickness (based on NHANES reference) than non-affluent group (Table 18). In affluent group the increases were steady as age advanced with a small decrease at 14. It reached maximum at 15. In non-affluent group the proportions were more at 12 and 16 year (17%).

Table:18. Distribution of schoolboys in Bhubaneswar by age based on

Mean +/- 2 SD Triceps skin fold thickness (cm) of NHANES data (1988-1994)

Age (years)	Mean - 2SD n (%)		Mean + 2SD n (%)	
	Non affluent schools	Affluent schools	Non affluent schools	Affluent schools
11	17(85.0)	36(65.5)	1(5.0)	9(16.4)
12	128(77.1)	50(76.9)	28(16.9)	13(20.0)
13	132(73.7)	63(48.1)	20(11.2)	35(27.5)
14	96(70.1)	69(59.0)	16(11.7)	29(24.8)
15	51(78.5)	61(52.1)	6(9.2)	35(29.9)
16	9(75.0)	9(69.2)	2(16.7)	4(30.8)

Except at age 12 in affluent group the proportions were 2 to 3 times more than non-affluent schoolboys. When compared with mean -2SD the percentages were very high among non-affluent group in all ages (70 to 85%). Even in affluent group the percentage appeared high in all ages (50 to 70%).

6.4. Comparison of nutritional status, using percentiles of collected data

Comparison was made with percentiles of weight, height and triceps skin fold thickness.

6.4.1.Weight

In the Table:19 it is observed that when the weight was compared with ≥85 percentile of 2000 CDC Growth Chart, the proportion was strikingly high in affluent section in ages 11-15 except at age 12.In non-affluent section the proportion was very small in all ages. In ages 13 to 15 the percentages (15 to 16%) were five times more in affluent group than that of non-affluent group.

Table: 19.Distribution of schoolboys in Bhubaneswar by age based on < 3rd and ≥85th percentile weight (kg) of 2000 CDC Growth chart

Age (years)	<3rd percentile n (%)		≥ 85th percentile n (%)	
	Non affluent schools	Affluent schools	Non affluent schools	Affluent schools
11	2(10.0)	5(9.0)	0	7(12.7)
12	62(37.3)	6(9.2)	4(2.4)	3(4.6)
13	35(19.6)	7(5.34)	5(2.8)	21(16.0)
14	28(20.4)	15(12.8)	3(2.2)	10(8.5)
15	22(33.8)	7(6.0)	3(4.6)	17(14.5)
16	6(50.0)	3(23.1)	0	0

When compared with less than 3rd percentile of 2000 CDC Growth Chart the proportions were strikingly high in non-affluent schoolboys. At age 15 it was almost five times and at age 13 four times more than affluent section.

6.4.2.Height

Table: 20 shows that in non-affluent schoolboys proportion of stunting (< 3rd percentile) was very high at age 15 (around 28 %) which was only 5 % in case of affluent boys. At age 12 also the proportion was very high in non-affluent schoolboys than affluent (non-affluent 15 % vs < 2 % affluent). But at age 14 the proportion in stunting was proportionately very high than other ages in affluent section though it was slightly less than the non-affluent section. Though the picture at age 11 and 16 show very high proportion of stunting due to small numbers conclusion cannot be drawn.

Table:20. Distribution of school boys by age based on < 3rd percentile and ≥ 85 percentile, height (cm) of 2000 CDC Growth Chart, Bhubaneswar 2003

Age (years)	<3rd percentile (stunting) n (%)		≥85th percentile n (%)	
	Non-affluent schools	Affluent schools	Non affluent schools	Affluent schools
11	11(55.0)	0	2(10.0)	7(12.7)
12	25(15.1)	1(1.5)	17(10.2)	14(21..5)
13	18(10.0)	4(6.2)	24(13.4)	12(9.2)
14	21(15.3)	14(12.0)	1(0.7)	8(6.8)
15	18(27.7)	6(5.1)	1(1. 5)	3(2.6)
16	2(16.7)	1(7.7)	0	0

At ≥85th percentile in affluent section the proportions of boys were more at age 12,14 and 15 than non-affluent section. At age 12 the proportion was very high with very large difference between affluent and non- affluent schoolboys (22% vs 10 %). The fall in affluent section was gradual as age advanced but tit was very sharp after age 13 in non-affluent section. Though the proportions were closer at age 11 due to small number in non-affluent section no conclusion can be drawn. There were no individuals above 85th percentile at age 16, however, sample size was too small to make a comment on this. Similarly the 'proportion at age 16 in both groups cannot be commented due to small sample size in both groups.

6.4.2.Triceps skin fold thickness

Table: 21 shows that in both the groups the numbers were very small both at < 3rd percentile and ≥ 90th percentile. However, proportion of thinness was more among the non-affluent schoolboys.

Table: 21.Distribution of schoolboys in Bhubaneswar by age based on < 5th percentile and ≥90th percentile triceps skin fold thickness of 2000 CDC Growth Chart

Age (Years)	<5th percentile n (%)		≥ 90th percentile n (%)	
	Non affluent schools	Affluent schools	Non affluent schools	Affluent schools
11	2(10.0)	2(3.6)	1(5.0)	1(1.8)
12	6(3.6)	2(3.1)	1(1.2)	0
13	5(2.8)	2(1.5)	6(3.4)	6(4.5)
14	6(4.4)	1(0.9)	3(2.2)	2(1.7)
15	0	2(1.7)	2(3.1)	6(5.1)
16	0	0	2(16.7)	0

6.5.Comparision of thinness, overweight and obesity by BMI

BMI is recommended as the basis for anthropometric indicators of thinness and overweight during adolescence. BMI for age is recommended as the best indicator for use in adolescence: it incorporates the required information on age, it has been validated as an indicator for total body fat at the upper percentiles and provides continuity with recommended adult indicators. Moreover reference data of high quality are available. Although BMI has not been fully validated as an indicator of thinness or under nutrition in adolescents, it provides a single index of body mass applicable at both extremes [21]. In the year 2000,Cole and his colleagues have also recommended BMI international cut-off values by age and sex for children and adolescents based on six large nationally representative data [25].

6.5.1.Mean BMI (SD):

The means of BMI in all age groups were higher among affluent sections than the non-affluent section (Table: 22) In both groups BMI was maximum at age 15. Except for age 14 in affluent boys the mean BMI showed a steady increase in both the groups.

Table:22.Mean BMI (SD) of adolescent schoolboys by age,Bhubaneswar,Orissa 2003

Age Years	Non-affluent schools (n=579)		Affluent schools (n=498)	
	Mean	SD	Mean	SD
11	15.93	1.97	16.96	2.85
12	15.70	2.17	17.30	2.60
13	16.67	2.41	19.22	3.61
14	17.46	2.60	18.72	3.14
15	18.10	3.60	20.25	3.84
16	17.72	2.95	19.31	3.25

6.5.2.BMI, International cut -off points *

The following table (Table: 23) shows that in affluent schoolboys overweight starts at an early age of 11 year, reaches approximately 14 % at the age of 13 year and then remains constant till the age of 16 years. The likelihood of getting overweight and obesity combined is significantly very high in affluent group (OR 11.8, p=0.0014) at 13 year. In case of non-affluent boys, overweight is very low up to the age of 14 years and then there is sudden increase, which is maximum at the age of 16 year. It shows that in non-affluent section though obesity is negligible, overweight shows an increase as age advances. However, the number is too small at age 16 to draw firm conclusion. In affluent boys obesity shows a slight tendency to steadily increasing till 15-year age. The study suggests that the problem of overweight/ obesity is more among affluent schoolboys in all age groups and in non-affluent group the problem of overweight increases at later ages.

*BMI - international cut-off points for overweight and obesity developed by Cole et al
Ref: Cole TJ. Bellizzi MC, Fleggal KM, Dietz, WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. BMJ 2000; 320:1240

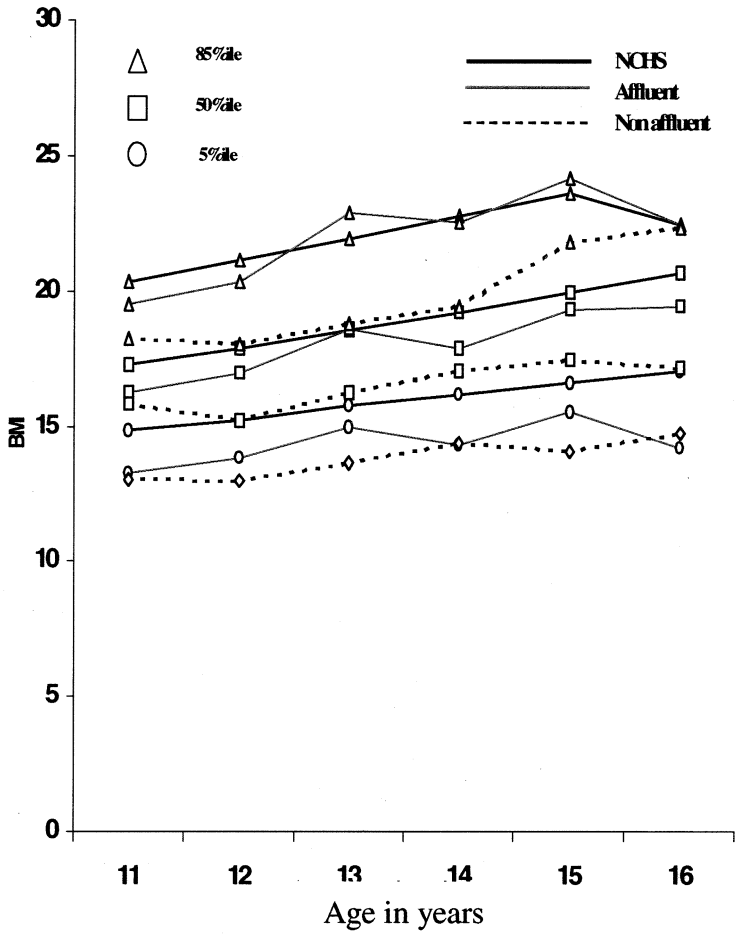
Table.23. Prevalence of overweight and obesity among school boys by age based on BMI at international cut-off points (Cole et al)*, Bhubaneswar, Orissa 2003

Age Years		Not over weight	Over weight	Obese	Over weight + Obese (O+O)	Odds Ratio (95% CI) For **O+O**
		%	n (%)	n (%)	n (%)	
11	Non Affluent (n=20)	100	0	0	0	unidentified
	Affluent (n=55)	**94.5**	**3(5.5)**	**0**	**3(5.5)**	
12	Non Affluent (n=166)	98.8	2(1.2)	2(1.2)	2(1.2)	6.9 P =0.0198 (0.74, 11.85)
	Affluent (n=65)	**92.3**	**3(4.6)**	**2(3.1)**	**5(7.7)**	
13	Non Affluent (n=179)	99.3	2(1.1)	1(0.6)	3(1.7)	11.8 P= 0.0014 (3.41, 62.79)
	Affluent (n= 131)	**83.2**	**18(13.7)**	**4(3.1)**	**22(16.8)**	
14	Non Affluent (n=117)	95.6	6(4.4)	0	6(4.4)	5.06 P = 0.0026 (1.01, 10.34)
	Affluent (n=254)	**81.2**	**18(15.4)**	**4(3.4)**	**22(18.8)**	
15	Non Affluent (n=65)	92.2	5 (7.7)	0	5(7.7)	2.94 P= 0.0325 (0.06, 14.84)
	Affluent (n= 117)	**81.4**	**17(14.5)**	**6(5.1)**	**23(19.6)**	
16	Non Affluent (n=12)	83.3	2(16.7)	0	2(16.7)	0.91 P =0.9318 (0.06, 14.84)
	Affluent (n=13)	**84.6**	**2(15.4)**	**0**	**2(15.4)**	

6.5.3.Comparison by BMI percentile of the present study

Thinness (<BMI 5th percentile) exists in very high proportion among non-affluent schoolboys where as high proportion of overweight ≥85th percentile) is seen among affluent boys. Thinness in non -affluent section is more prevalent at 16 year of age (50%)and then at age 12 year (45 %). In case of affluent section though the number is very less in comparison to non-affluent boys, thinness is seen more at the two extremes year (20 % in affluent section and 3% in non-affluent section).

Fig:2 Centiles for overweight and thinness by age of Bhubaneswar school boys



The centile curve (fig: 2) shows that at and above 85th percentile boys of affluent schools at age 13 and 15 were above the NHES/ NHANES centile curve. At 50th percentile and < 5th percentile both affluent and non-affluent boys were below the NHES / NHANES centile curve excepting at 14 in case of affluent boys. The findings in Table: 6.5.3 shows the percentage above 85th percentile at age 13 and 15 as about 20% and 16 % respectively. In all ages at <5th, 50th and ≥85th centile curves non-affluent schoolboys were below the affluent schoolboys.

Table:24 shows that at or above 85 percentile (at risk overweight) proportion of affluent boys is very high in all ages except at age 16 where it appears equivalent (8%). But as the numbers are very small at 16 it is difficult to draw conclusion. At age 13 and 15 the proportion is very high.

Table:24. Prevalence of overweight and thinness by BMI percentile by age among schoolboys, Bhubaneswar, Orissa 2003

Age (Years)	<5th percentile (thinness) n (%)		≥85th percentile (at risk overweight) n (%)	
	Non-affluent school	Affluent school boys	Non affluent school boys	Affluent school boys
11	6(30.0)	11(20.0)	1(5.0)	6(10.9)
12	75(45.2)	9(13.8)	7(4.2)	7(10.8)
13	57(31.8)	12(9.2)	6(3.3)	26(19.8)
14	36(23.3)	21(17.9)	8(5.8)	17(14.5)
15	21(32.3)	18(15.4)	5(7.7)	19(16.2)
16	6(50.0)	3(23.1)	1(8.3)	1(7.7)

As it would be expected at less that 5th percentile (thinness) very high proportion of boys were in non-affluent section. It was also observed that over all more than one third boys in affluent section than non-affluent section were below 5th percentile.

6.3.4.Comparison by BMI, WHO adult classification

WHO report, 854 (1995) on physical status say that adolescent with BMI >= 30 by age have more risk of having obesity related diseases and mortality that occur in young adults.

Table:25 Nutritional status of adolescent schoolboys by BMI based on WHO classification for adults, Bhubaneswar, Orissa 2003

Age (Years)	Charecteristics of boys	Under weight BMI ≤18.50 %	Normal BMI ≥18.50 to <25 %	Over weight BMI ≥25 to<30 %	Obese BMI ≥30 %
11	Non Affluent (n=20)	90.0	10.0	0	0
	Affluent (n=55)	**78.2**	**20.0**	**1.8**	**0**
12	Non Affluent (n=166)	88.6	11.4	0	0
	Affluent (n=65)	**75.4**	**23.1**	**1.5**	**0**
13	Non Affluent (n=179)	82.1	16.8	1.1	0
	Affluent (n= 131)	**49.6**	**44.3**	**4.6**	**1.5**
14	Non Affluent (n=117)	76.6	20.4	2.9	0
	Affluent (n=254)	**36.7**	**39.3**	**5.1**	**0**
15	Non Affluent (n=65)	67.7	26.4	2.9	0
	Affluent (n= 117)	**36.8**	**48.7**	**5.1**	**1.7**
16	Non Affluent (n=12)	83.3	16.7	0	0
	Affluent (n=13)	**46.2**	**46.2**	**7.7**	**0**

In the present study the prevalence of obesity by BMI ≥ 30 (adult classification for obesity) were very small among the Bhubaneswar schoolboys (Table:25).

Table: 26. Summary table for Nutritional status by BMI of adolescent schoolboys, Bhubaneswar, 2003

Age years)	By BMI percentile				By BMI international Cut-off point			
	Thinness (<5percentile) (%)		At risk overweight (≥85th percentile) (%)		Overweight (%)		Overweight +obesity (%)	
	Non affluent	Affluent	Non affluent	Affluent	Non affluent	Affluent	Non affluent	Affluent
11	30	20.0	5.0	10.9	0	5.5	0	5.5
12	45.2	13.8	4.2	10.8	1.2	4.6	1.2	7.7
13	31.8	9.2	2.8	19.8	1.1	13.7	1.7	16.8
14	23.3	17.9	5.87	14.5	4.4	15.4	4.4	18.8
15	32.3	15.4	7.7	16.2	7.7	14.5	7.7	19.6
16	50.0	23.1	8.3	7.7	16.7	15.4	16.7	15.4

Both by BMI percentile and BMI international cut-off (Cole's references), prevalence of overweight and obesity were consistently higher among affluent boys in all ages (11 to 16 years). At16 year the Proportion was very high among non-affluent section and equivalent to affluent section. But as at this age the sample was very small it is difficult to draw conclusion (Table 26).

6.6. Socio-economic factors and prevalence of overweight

6.6.1: Parental education and overweight (BMI ≥ 85th percentile)

Mother's education: The following Table: 27 shows that in non-affluent group there was a clear trend of increase in prevalence of overweight among boys as the mothers education level' increased. In affluent group prevalence of overweight among boys was more at both extremes of education level. Percentage of mothers having below primary level of education was very low in affluent section.

by mothers' education, Bhubaneswar 2003

Mother's education	Non- affluent		Affluent	
Less than primary	3	(1.9)	1	(16.7)
Primary to middle	12	(4.6)	6	(9.4)
Secondary and above	13	(10.1)	69	(19.4)
	X^2 (trend), 8.652		χ^2 (trend), 2.38	
	p=0.001		P= 0.122	

* $\geq 85^{th}$ BMI percentile

Father's Education: In both groups as education level of fathers increased the trend of overweight among boys increased. The overweight prevalence is maximum when the education level of fathers was at secondary level and above (Table: 28).

Table:28. Distribution of overweight (n and %)among adolescent schoolboys by fathers' education, Bhubaneswar, 2003

Fathers' education	Non- affluent schoolboys	Affluent schoolboys
Less than primary	3(3.3)	0
Middle to secondary	5(4.7)	2(10.5)
Secondary and above	20(13.2)	74(18.4)
	p=0.006	P= 0.57
	$\chi^2_{(trend)}$, 7.42	$\chi^2_{(trend)}$, 0.57

6.2.3.Father's occupation: The Table: 29 show a very contrasting picture. In affluent section overweight prevalence was very high (29%) when fathers' occupation were in professional and managerial positions.

Table: 29.Distribution of overweight (n and %)among adolescent schoolboys by fathers occupation, Bhubaneswar 2003

Fathers' occupation	Non-affluent schoolboy	Affluent schoolboys
Professional and managerial	2(4.9)	42(29.0)
Skilled manual and non manual	12(7.2)	32(13.9)
Partly skilled and unskilled	15(13.9)	2(4.5)
	p=0.063	P=0.004
	χ^2 trend, 3.46	χ^2 trend, 8.22

But in non-affluent section the prevalence was high when fathers' occupation was in partly skilled and unskilled category. But as the numbers were very small in affluent section in partly skilled and unskilled position it is difficult to comment on this finding.

6.2.4.Caste:

Table:30 shows that In affluent section higher percentage (30%) of boys with overweight belonged to upper caste families, which was only 2 % in non-affluent section.

Table: 30.Distribution of overweight (n and %)among adolescent schoolboys by caste, Bhubaneswar 2003

Caste	Non-affluent schoolboys	Affluent schoolboys
Upper caste	1(1.8)	42(29.6)
Scheduled caste	1(1.8)	32(13.9)
Scheduled tribe and others	26(7.34)	2(4.34)
	P=0.056	P=0.002
	χ^2 trend, 3.66	χ^2 trend, 13.88

Comparatively higher proportion of boys were found in Scheduled tribe and others category of non-affluent section. But in this category the sample was too small to draw conclusion.

6.7. Knowledge and Awareness

6.7.1.Perception on overweight / obesity:

Majority of boys in both affluent and non-affluent schools had some knowledge on overweight/obesity and the related health problems. More than 80% of affluent schoolboys and 70 % of non-affluent schoolboys had their understanding on overweight/obesity as gaining excess fat and excess weight. About 15 % boys of non-affluent schoolboys perceived overweight and obesity as big and bulky body, which was only 2% in affluent section. Around 9.4% boys from affluent schools and 4.5% from non-affluent schools said that they did not have any idea on overweight / obesity.

The Table:31 reflects some of understandings of schoolboys of Bhubaneswar on overweight and obesity.

Table:31.Distribution (%) of adolescent school boys by their perception on overweight / obesity, Bhubaneswar, Orissa 2003

Perception of school boys on overweight / obesity	Non-affluent schools (n=579)	Affluent schools (n=498)
Big and bulky body	16.1	2.2
Excess fat	**34.2**	**33.9**
Excess weight	**37.1**	**49.8**
Not healthy	0.0	1.4
Over eating	1.6	1.8
Over growth	0.9	0.4
Over health	3.6	0.2
Short height	1.7	0.8
Do not know	4.8	9.4

6.7.3.Sources of information on overweight / obesity

Table:32 shows that main sources of information on overweight / obesity for the boys in groups were found to be parents and the proportions were found to be equivalent (>34 %) between the two groups. In non-affluent schools 14% boys were getting information from their teachers which was only 8% in case of affluent school boys. Electronic media like television and radio played almost similar role for both sections.

Table: 32.Distribution (%) of adolescent schoolboys by main source of information on overweight and obesity, Bhubaneswar, Orissa 2003

Main source of information	Non-affluent schools (n=579)	Affluent schools (n=498)
Parents	34.4	35.5
Teachers	13.5	8.0
Friends	10.2	8.4
Radio	9.3	7.4
Television	15.5	19.1
Magazine paper	9.3	13.5
Books	6.7	4.8
News paper	0.5	1.6
No source	0.5	1.6

About 19% of boys from affluent section and 16 % from non-affluent section said that they used to get information from television. Around 8 % boys of both section used to get information from radio. Magazine and newspaper were found to be good source of information for the affluent boys and books were for non-affluent boys.

6.7.4.Knowledge on Health implication of overweight/ obesity:

It is observed in Table 33 that more than 75% of boys from both types of schools said that there are bad effects of overweight and obesity on health of an individual. More than 80 % of boys from either group mentioned that overweight/ obesity could be prevented if

precautionary measures are taken early. About 25% of boys from non-affluent schools have expressed that they have no knowledge about the health problems that may occur due to overweight/obesity. More than 30 % of boys of both section opined that the main problem of over weight and obesity is not becoming active.

Table: 33. Distribution (%) of adolescent schoolboys by knowledge on health problems due to overweight/obesity, Bhubaneswar, Orissa 2003

Characteristics	Non-affluent schools (n=579)	Affluent schools (n=498)
Anxiety	3.5	0.4
Body pain	4.1	1.4
Diabetes	5.2	11.4
Heart disease	2.6	13.7
High Blood Pressure	5.0	4.0
Respiratory Diseases	1.7	3.0
Flat Foot	0.0	2.0
Other chronic Diseases	8.3	11.8
Not Active	38.2	30.7
Looks ugly/ Social discrimination	8.3	4.2
Do not know	23.1	17.3

About 12 % students from affluent schools and less than 5% from non affluent schools expressed diabetes and heart disease as the leading health consequences due to overweight/obesity. Very high proportion of non-affluent schoolboys (4%) expressed anxiety as a health consequence of over weight / obesity but in affluent section only 0.4% of boys mentioned anxiety as a problem. Body pain, ugly looking and social discrimination are other concerns among non-affluent schoolboys. About 2 % of boys in affluent schools expressed flat foot as one of the health problems but none in non-affluent schools said this.

6.7.5.Knowledge on preventive measures

More than 80 % boys in both section had some knowledge on the preventive measures of overweight/ obesity. The following Table:35 shows that both group of boys were aware about the preventive measures for overweight/obesity though the means they mentioned differed. Higher proportion of boys in affluent section mentioned for dieting than non-affluent section (31% vs 15%). Higher percentage in non- affluent section mentioned for exercise etc than affluent section (66% vs 53%). About 6 % of non-affluent boys mentioned for consulting doctor or taking medicine while less than 1 % in affluent group said this.

Table: 35. Distribution (%) of adolescent schoolboys by knowledge on prevention overweight/obesity, Bhubaneswar, Orissa 2003

Characteristics	Non-affluent schools (n=579)	Affluent schools (n=498)
Dieting	14.6	31.2
Avoiding oily food	1.3	3.6
Exercise/running/swimming/ Cycling/playing outdoor game	65.6	53.4
Morning walk	12.4	10.0
Yogasan	0.5	1.9
Consulting Doctor/taking medicine	5.6	0.9

6.8. Food and lifestyles

6.8.1.Food preferences:

Nearly 75 % of boys from both sections used to take fast food outside home besides their regular home served food. It was observed that the frequency was more among the affluent boys. More than 72 % of boys in both sections used to consume food in between the home served food (breakfast, lunch and dinner). Around 50 % boys in both groups used take such

consumption pattern between the two groups of schoolboys.

Table:36.Distribution (%)of adolescent school boys as per their consumption* of fast-foods, Bhubaneswar 2003

Food items	Non-affluent school boys	Affluent schoolboys
Ice cream	3.2	18.2
Oil fried foods (Bada, samosa etc.)	8.2	12.2
Bread with butter/jam/omelet, cake	10.7	29.7
Chat, maggi, chowmin, pizza, burger, pettis, pastries, roles etc	22.8	41.4
Dry nut / mixtures	13.6	20.5
Chocolate	12.6	31.3
Sweets	8.6	12.7
Cold drink / lassie/ fruit juice	1.6	15.0
Milk or milk products	50.4	54.0

* Fast food items taken at least 5 days in a week

In many of the enlisted food items like ice-cream, bread with butter/ jam, chat / magi, chocolate and cold drink/ lassie etc proportions of boys were very high in affluent section than the non-affluent section. In each group equal proportion of boys used to consume milk or milk products.

6.8.1.Life Style

In both sections majority of boys were not habituated to physical work. For managing daily mobility most of the students of both schools were using bi-cycle (67% non-affluent vs 79 % affluent). Two wheelers motor bikes and other vehicles like Auto-rickshaw, car / taxi, buses etc were used mostly by affluent boys. A lower proportion of student used to manage their mobility by walking (non affluent 18% and affluent 12 %).

Table:37. Time (hours) spent by the schoolboys (%) per day outside school, Bhubaneswar, Orissa 2003

Characteristics of activities	< I hour	1 to <2 hours	>2 hours
Watching TV			
Non-affluent schoolboys	55.4	42.9	1.7
Affluent schoolboys	68.1	29.5	2.4
Computer playing			
Non-affluent schoolboys	96.9	2.9	0.2
Affluent schoolboys	95.8	4.0	0.2
Outdoor game			
Non-affluent schoolboys	65.3	30.2	4.5
Affluent schoolboys	75.7	22.9	1.4
Physical exercise			
Non-affluent schoolboys	89.9	1.3	0.9
Affluent schoolboys	90.6	8.4	1.0

Table: 37 shows that percentage of boys spent time in TV watching <1 hour was more in affluent section whereas more incase of non -affluent section when it was 1 to <2 hours. 4 % of boys of affluent schools and less than 3% in non-affluent schools spend 1 to < 2hours in computer playing. Higher proportion of non -affluent schoolboys used to spend more than one hour in outdoor game than affluent schoolboys (35% Vs 24%). About 8% of affluent schoolboys used to spend more than one hour in doing physical exercises and it was very low in non-affluent section (1%).

7.Discussion

The present study provided an opportunity to assess the anthropometric status and prevalence of obesity among apparently healthy adolescent boys of affluent and non-affluent schools of Bhubaneswar by applying international standards. This is probably the first study of its kind in the state of Orissa.

World Health Health Report 2002[60] indicates undenutrition and obesity as the extremes among the 10 top Global health risks. This study has highlighted that both chronic and acute under nutrition coexist among the non-affluent school boys and the overall prevalence of overweight/obesity is remarkably high in affluent school boys.

Prevalence of under nutrition

The study revealed that among non-affluent adolescent school boys prevalence of under weight and stunting is very high. Though the percentages are lesser still there are considerable proportion of underweight and stunted boys in affluent section

Proportion of under weight boys are found mainly in two ages i.e14-15 in both the groups. Stunting is seen in higher percentages in all ages among non-affluent section and at ages 13-15 in affluent section, which is less than 1/3rd of that in non-affluent section. When compared with the West Bengal study [48] the overall under nutrition status appears higher among the non-affluent schoolboys of Bhubaneswar. West Bengal study reported 19% of stunting at age 12 (present study 15%)and 11% at age15 (present study 28%) and in other ages West Bengal study shows much lower proportion of boys than the present study. As per National students survey (1995) prevalence of under-nutrition among Chinese school boys is found to be similar [61] (26.9%) to the findings of the present study. Recent studies [62] among rural adolescents in India reported almost double the prevalence of under nutrition in the

schoolboys (23 to 45 %) but it is less than the findings of West Bengal study (45 to 56%). The high prevalence of under nutrition among non- affluent school boys of Bhubaneswar is a matter of concern. In the present study the cause of under nutrition could not be elicited. Possible cause may be that undernourished children were apparently undernourished at their younger ages. It is reported that adolescents gain up to 30 % of their adult weight and more than 20% of their adult height during the period between 10-19 years. In undernourished children rapid growth during adolescence may increase the severity of under nutrition [16].

Prevalence of overweigh/obesity

Obesity affects almost 10 % of school children in industrialized countries and high rates are emerging in some of the developing countries. Some 30 % obese children become obese adults [3]. Food and Agriculture Organization of The United Nations states that obesity in the developing world can be seen as a result of a series of changes in diet, physical activity, health and nutrition, collectively known as the "nutrition transition". As poor countries become more prosperous, they acquire some of the benefits along with some of the problems of industrialized nations. These include obesity"[47]. In 1999 United Nations study found obesity in all developing regions, and growing rapidly, even in countries where hunger exists. In China, the number of people jumped from less than 10 percent to 15 percent in just three years. In Brazil and Colombia, the figure hovers around 40 %- a level comparable to a number of European countries. Even sub-Saharan Africa, where most of the world's hungry live, is seeing as an increase in obesity [48]. The findings of the present study suggest that the overall overweight/obesity prevalence is remarkably higher among affluent schoolboys than non-affluent: (16% vs. 4%) by Cole's international cut-offs (BMI) for overweight and obesity combined. The findings in the affluent school children are consistent with the overweight prevalence in the United States (15% in 6-19 years) as per1999-2000 National

Health and Nutritional Examination Survey ,with that of Pakistan study (18%) and Chinese study in urban school boys (14.9%)[61].

Other Indian studies among affluent schoolboys showed the prevalence of obesity in adolescents around 8% [7][10]. But as the reference standards used were different, it is difficult to compare.

The findings for non-affluent section were consistent with West Bengal middle class adolescent population i.e.4.2% "at risk over weight" as per WHO BMI criteria.

Thus the present study highlights that overweight/obesity is relatively highly prevalent among the affluent adolescent schoolboys of Bhubaneswar. This is comparable to both developed countries like United States of America and developing countries like China and Pakistan.

Bhubaneswar is the state capital and one of the typical urban areas of Orissa. There are other urban areas in the state that are alike with respect to the urban way of life in Bhubaneswar. Recently industrial townships have been coming up in different parts of the state, to exploit the abundant coal and mineral resources. Therefore along with traditional undernutrtion problem of overweight/obesity might come up in other parts of the State also.

Besides BMI, as expected mean anthropometric measurements of weight, height, hip-circumference, waist circumference, MUAC and triceps skin fold thickness are higher in boys of affluent schools compared to boys of non-affluent schools.

Prevalence of central obesity (waist- hip ratio) is found to be negligible in either section. But very high proportion of boys are above mean +2SD of hip-circumference in affluent section (at age13:21%). Surprisingly it is also noticed that in non-affluent section a considerable proportion of boys are above mean + 2SD of the reference data (at age 15: around 8%). Similarly when compared with MUAC and triceps skin fold thickness, the proportions are found to be consistently high in all age groups in affluent section but not in non-affluent section.

Growth pattern among the adolescents of United States are not necessarily the optimal patterns for other populations. It is documented in the tenth planning commission report of Government of India on "Nutrition" that there are wide variations in height, weight, body composition and BMI right from birth to through childhood and adolescence between countries and different income groups in the same country [16]. Furthermore ample evidence suggest that sexual maturation is related to being fat, and adolescents in many developing countries mature later than their American counterparts [32] [49]. It was very recently published in Nature science update as per a new report of WHO expert consultation [50],that the body mass index cut off points drawn largely based on mortality statistics from European and American populations does not fit for Asian populations. It says that "the panel weighed up mounting evidence that Asian populations have a particularly high risk of type 2 diabetes, cardiovascular diseases and mortality from other causes at relatively low BMI. That is thought to be largely due to their higher proportion of body fat, often hoarded around the waist, relative to other ethnic groups. For these populations they found that a BMI of 26-31 was high risk".

In the present study data have been compared with the reference data based on United States population. Considering above-mentioned points there is apprehension that the problem of overweight in Bhubaneswar might have been under estimated by this study. .

The data has also been compared with Cole's international cut-offs (BMI) by age and sex. But this reference is based on the populations of six nationally representative countries [25] out of which only Brazil can be compared with our situation with regard to the socio-economic status. So more or less the Cole's reference values may also tend towards developed countries.

Considering above points it is felt that even though by using Cole's international cut off values (BMI) by age and sex for children and adolescents the prevalence of

might have underestimated the prevalence of overweight/obesity in Bhubaneswar.

In this study BMI has been taken as gold standard for assessing adolescence nutrition status. Though BMI is considered as the presently available best indices there are limitations [58] and lot of debates are going on, for its use for international comparison:

(I) The very high percentile level at any given age, and the matched skewing of the age specific distribution towards higher values when compared with many other well nourished populations were of particular concern.(2) Little is known regarding specific BMI values in adolescence and their relationship with concurrent or future risk or response to interventions. Nevertheless the WHO consultation committee concluded that the elevated and skewed levels of the upper percentiles of the BMI distribution for US children and for children with similar patterns in other developed countries do not provide a desirable pattern that should be used as healthy goal for adolescents internationally. Due to unavailability of other data specifying optimum cut-off values for BMI in adolescence the committee recommended that for uniform reporting purposes BMI for age data for US children published by Must et al[59] be used on a provisional basis until better reference data for adolescent growth are available.

Possible influencing factors for the prevalence of overweight in Bhubaneswar

Multiple epidemiological studies have found various etiological factors of childhood obesity in developed countries [51-52]. These factors are divided into "heredity and "environment", but only the factors in the environment can be controlled for prevention [53].

There is remarkable variation between the two groups by their socio-demographic characteristics. Majority of boys in both the sections were from upper caste and Hindu families. But very high proportion of parents having higher level of education is in affluent section. By occupation also very high proportion of fathers in affluent section are in high position (professional and managerial) than non-affluent section.

In general the study findings regarding the relationship between overweight/obesity and socioeconomic status showed that parental education level and job status have influences to gain higher BMI among the boys of affluent section. These findings are supported by other studies: the study conducted by EI-Tawila and others reported that that in Egypt the prevalence of adolescence obesity in high socioeconomic strata was more than double to low socioeconomic group (7.0% vs 3.1%)[54].

In modern time the environmental influences have tended to overwhelm and up set the food consumption behavior and lifestyle, which in turn increased the risk of becoming overweight/obese. In the present study we found that frequency of consuming fast food was more among affluent boys. Though remarkable difference could not be noticed still the sedentary life style was observed more among affluent boys.

Knowledge and awareness

It was found that both groups of boys had basic knowledge and awareness on causation of overweight/obesity, its health implications. Majority in both groups were aware on the preventive measures. Parents were found to be good source of information of the subject in both sections. Teachers play better role in providing information in non-affluent schools. This suggests that when health education programmes for obesity be implemented in schools along with school students, parents and teachers should also be targets.

Health implications

As per the WHO expert committee report 1995[21] adolescents with BMI >=30 by age have more risk of having BMI related diseases and mortality that occur in young adults. There are very few published studies in India to compare the present study findings with the above criteria. The study conducted by Umesh Kapil and his colleagues in Delhi affluent schools was based on BMI criteria for adults [7] i.e if BMI analogue for age and sex is 25 kg / m^2,

and sex is 30 kg/m^2 and more then the child is obese. The Delhi study reported that the prevalence of obesity was 7.4 %(8% boys and 6 % girls) and overweight was 23.9%(23.1% boys and 24.7 % girls). In the present study when overweight and obesity was assessed by this classification it was found that overall prevalence of overweight among affluent boys was only 3.5 % and in non-affluent section it was very low (0.9 %) and obesity prevalence was 1.6% in affluent boys and nil in non-affluent group.This consoles that BMI related morbidity and mortality problems have not emerged to an alarming state in Bhubaneswar. However the prevalence of overweight among adolescent schoolboys of Bhubneswar as per the WHO criteria (BMI percentile) and Cole's international cut-offs of BMI for adolescents is very high and is par with overweight prevalence of adolescent populations in United States. This is to be taken seriously as it can be considered as the beginning of the threat of globosity (Global epidemic) in Bhubaneswar. Possible preventive measures must be adopted early to avoid the morbidity and mortality due to the overweight/obesity related non-communicable diseases.

Limitations of the study

- Selection of boys: schools were selected by purposive sampling procedure keeping in view the operational feasibility. The students were mostly from upper caste and a few from scheduled caste and scheduled tribe. More than 90% boys belong to Hindu families. Thus this might not be the representative sample for all adolescent schoolboys of Bhubaneswar.
- *Date of Birth:* Dates of birth of the students were collected from the school registers and could not be checked from parents or crosschecked with the birth certificates.

- *Information on socio-demographic status*: Information on socio-demographic status was collected from students only. Though might be rare, younger children of aged 11 and 12 might not be fully aware of their parental education and occupation.
- There is possibility that a boy of affluent section may be studying in non-affluent school and vice versa. but this has not been examined in the present study. Though the figure might have been small their influence on assessment of obesity is undetermined.
- *BMI as gold statndard*:In this study BMI has been taken as the gold standard for classifying overweight/ obesity among adolescent schoolboys though there are limitations with BMI classification.
- *The reference data* : The reference data used for comparison were the data for US populations, which might have underestimated the problem.

Recommendations

1.There are very few studies to assess the adolescence nutrition including overweight and obesity in Orissa. Further studies particularly with subgroups at high risk for under nutrition and over nutrition (over weight/obesity) are suggested.

2.Both under nutrition and over nutrition among schoolboys should get public health attention.

3.Adolescence overweight/obesity bears major risk for non-communicable diseases and organ complications in young adults. Treatment in adults is largely unsuccessful. Easiest way to control obesity is thought to be prevention. And prevention of obesity in childhood is regarded as important and the best way to prevent adult obesity up to now [55]. WHO in its 1998 report also mentioned that improved prevention and therapy for childhood obesity are the most cost effective approaches to reduce morbidity and mortality in adulthood [3] WHO described three potential approaches for preventive interventions to deal with this problem

(i) reduction in dietary intake, (ii) increase in the energy spent on activity and (iii) reduction in inactivity. However USA was not successful in controlling childhood obesity until now and more broad based approaches have been required [56]. Recently Gortmaker et al reported the success in a school based interdisciplinary intervention and it indicated a promising school based approach to reduce obesity among youths [53].

In Bhubaneswar prevalence of overweight is found to be more among affluent schoolboys. To prevent the ensuing public health problem following measures may be suggested.

Preventive measures

- School programmers that encourage more physical activity and exercises may be adopted especially in affluent schools.
- There should be policy decision for adopting nutrition education in schools that may address the issue of overweight and obesity.
- As it was found that parents and teachers were potential source of information they may be given adequate information, which would help in curbing the rising problem particularly in affluent schools.
- To effectively fight the epidemic of overweight/obesity, population based social and environmental approaches may be considered.

Managing the risk

As per WHO expert committee (1995)[21] report on "Obesity evaluation and treatment", children with a body mass index (BMI) greater than or equal to the 85th percentile with complications of obesity or with a BMI greater than or equal to the 95th percentile with or without complications, should undergo evaluation and possible treatment. Considering the above fact and as anthropometric measurements

are easier to conduct & cost effective, yearly screening programmes may be conducted as part of school health programme to detect overweight / obesity using BMI, particularly in affluent schools.

Conclusion

The present study in Bhubaneswar showed that both ends of malnutrition i.e. under nutrition and overweight/obesity are coexisting among the adolescent schoolboys. Overweight/obesity appeared to be posing more problems in affluent section and under nutrition in non-affluent section. This is similar to the findings of developing societies that are undergoing nutrition transition. Gaining overweight appeared to be influenced by the parental education and father's occupation. Food habits and the urban way of lifestyles, less physical work appeared to favour gaining weight among affluent boys.

On the other side overweight/obesity related chronic diseases are becoming a serious health problems in both developed and developing countries worldwide. The burden of such diseases will certainly be a heavy load on Orissa where under nutrition needs high priority public health attention.

Controlling childhood overweight/obesity is the most cost effective way because: it reduces the risk population that consists of overweight/ obese children who have a high risk of adult obesity in the future and the other is forming a healthy lifestyle including healthy dietary habits during childhood.

It is obvious that resources are few to manage such a dual nutritional burden and again no successful measures have been reported for controlling overweight/obesity from developed countries. Therefore the new problem of malnutrition along with the old should be addressed urgently at policy, society and school level

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9. ANNEXURES

Annexure I

Table:1. Distribution (%)of boys below "means - 2 SD"of anthropometric measurements by age, Bhubaneswar, 2003

Age year	Weight		Height		Hip circum-ference		MUAC*		TSFT**	
	Non-affluent	Affluent	Non-affluent	Affluent	Non-affluent	Affluent	Non-affluent	Affluent	Non-affluent	Affluent
11	0	0	20.0	0	85.0	58.2	90.0	78.2	85.0	65.5
12	2.4	1.5	14.5	1.5	90.4	78.5	90.4	86.2	77.1	76.9
13	3.4	0.8	12.3	5.3	84.4	66.4	92.7	66.4	73.7	48.1
14	9.5	4.3	15.3	9.4	91.2	70.9	92.7	81.2	70.1	59.0
15	21.5	1.7	27.7	6.0	89.2	71.8	93.8	72.6	78.5	52.1
16	16.7	7.7	16.7	0	83.3	69.2	83.8	76.9	75.0	69.2

Table:2 Distribution (%)of boys below 5th percentiles of TSFT and BMI(NHES/NHANES reference) by age, Bhubaneswar, 2003

Age (year)	TSFT Non-affluent	Affluent schools	BMI Non-affluent	Affluent schools
11	10.0	3.6	30.0	20.0
12	3.6	3.1	45.2	13.8
13	2.8	1.5	31.8	9.2
14	4.4	0.9	23.3	17.9
15	0	1.7	32.3	15.4
16	0	0	50.0	23.1

Annexure II

International cut-off points for BMI for overweight and obesity by sex between 2 and 18 years ,defined to pass through BMI of 25 and 30 kg/m^2 at age 18, obtained by advancing data from Brazil, Great Britain, Hong Kong, Netherlands, Singapore, and United States

Age in Years	Body mass index 25 kg / m^2 at 18 yrs		Body mass index 30 kg / m^2 at 18 yrs	
	Male	Female	Male	Female
2	18.41	18.02	20.09	19.81
2.5	18.13	17.60	19.80	19.55
3	17.89	17.56	19.57	19.36
3.5	17.69	17.40	19.39	19.23
4	17.55	17.28	19.29	19.15
4.5	17.47	17.19	19.26	19.12
5	17.42	17.15	19.30	19.17
5.5	17.45	17.20	19.47	19.34
6	17.55	17.34	19.78	19.65
6.5	17.71	17.53	20.23	20.08
7	17.92	17.75	20.63	20.51
7.5	18.16	18.03	21.09	21.01
8	18.44	18.35	21.60	21.57
8.5	18.76	18.69	22.17	22.18
9	19.10	19.07	22.77	22.81
9.5	19.46	19.45	23.39	23.46
10	19.84	19.86	24.00	24.11
10.5	20.20	20.29	24.57	24.7
11	20.55	20.74	25.10	25.42
11.5	20.89	21.20	25.58	26.05
12	21.22	21.68	26.02	26.67
12.5	21.56	22.14	26.43	27.24
13	21.91	22.58	26.84	27.76
13.5	22.27	22.98	27.25	28.20
14	22.62	23.34	27.63	28.57
14.5	22.96	23.66	27.98	28.87
15	23.29	23.94	28.30	29.11
15.5	23.60	24.17	28.60	29.29
16	23.90	24.37	28.88	29.43
16.5	24.19	24.54	29.14	29.56
17	24.46	24.70	29.41	29.69
17.5	24.73	24.85	29.70	29.84
18	25	25	30	30