

Review Article

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## Childhood Obesity: An Overview

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### ABSTRACT

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Obesity is considered as one of the most serious health challenges of the 21st century. Obesity in children is an equally significant public health concern. Childhood obesity is increasing at alarming rate every year all over the world. Obesity is defined as condition of excessive fat accumulation in adipose tissue, to an extent that health may be impaired. Childhood obesity has been linked to both environmental and genetic factors. Various factors contributing towards childhood obesity includes consumption of energy dense fast foods, decreased fruits and vegetable intake, shifting to sedentary lifestyle with no physical activity and excessive use of electronic media. Obesity is creating economic and health burden by increasing the risk for health problems such as elevated blood pressure, cardiovascular disease, insulin resistance and type 2 diabetes, respiratory and psychological problems among overweight and obese children. Nutrition education, promotion of physical activity along with behaviour modifications and decrease in sedentary lifestyle among children could be the factors in the prevention of childhood obesity.

## Introduction

### Childhood obesity prevalence

#### The global picture

The prevalence of obesity has been increasing worldwide and has almost doubled over the last decade. Overweight is stated as fifth most serious risk factor by WHO report 2000 for both developing countries and developed countries (World Health Organization, 2000). James (2004) stated high prevalence of overweight and obesity was found among

people of Middle East, Central and Eastern Europe and North America whereas developing countries are facing double burden of childhood obesity and underweight. High obesity rates have been reported from acquired affluence countries like Taiwan and Saudi Arabia. AlNuaim *et al.*, (1996) stated one in every sixth children of 6 to 18 years of age as obese in Saudi Arabia. High incidence of obesity has also been reported among school children in India. The prevalence of obesity has been found to be 5.74% to 8.82% among school children.

#### Prevalence in India

The magnitude of childhood obesity has increased very rapidly in India. Estimates of prevalence were studied by Midha *et al.*, (2012) using random effects meta-analysis and prevalence of overweight and obesity was estimated to be 12.64% and 3.39%.

Ranjani, *et al.*, (2016) reviewed studies conducted in 16 states of India. Data about prevalence of overweight and obesity from 52 studies showed that prevalence of obesity in both children and adolescent was higher in North India as compared to South India. He also found 3% increase in prevalence of childhood and adolescence obesity from 2005 to 2010.

Prevalence of childhood obesity among school age children in various parts of India is shown in tabular form in Table 1.

### **Prevalence in Uttarakhand**

Kumar and Sharma (2013) stated overall prevalence of overweight and obesity to be 14% and 18% in Uttarakhand. Baghel *et al.*, (2015) conducted study on 50 school children of Pantnagar and stated overall prevalence of overweight and obesity to be 16% and 3.80% in HIG (high income group) and 4% overweight in MIG (middle income group).

### **Childhood obesity and socioeconomic status**

Marwaha *et al.*, (2006) stated higher prevalence of overweight and obesity among upper socioeconomic school children of 5 – 18 years in Delhi. Prevalence of both overweight and obesity was higher in girls than boys in USES (upper socioeconomic status) whereas boys were having higher prevalence of overweight and obesity in LSES (lower socioeconomic status).

Kaur *et al.*, (2008) conducted a study on

16,595 school children of age 5 – 18 years belonging to low, middle and high socioeconomic status and found that prevalence of both overweight and obesity increases as the socioeconomic status increases. 9.3% and 13.1% obesity and overweight was found in high income group whereas 2.5% obesity and 4.9% overweight in middle income group followed by 1.2% and 2.4% obesity and overweight in low income group.

### **Measures of obesity**

#### **Body mass index**

WHO defines obesity as abnormal or excessive fat accumulation ([www.who.int/topics/obesity/en/](http://www.who.int/topics/obesity/en/)) to an extent that health of a person is impaired. Overweight and obesity increases the risk for a number of chronic diseases, including cardiovascular diseases, diabetes, cancer etc. BMI (Body Mass Index) is the most commonly used method for assessing overweight and obesity in adults as it correlates well with level of body fat. Body Mass Index (BMI) is defined as an individual's weight in kilograms divided by the square of their height in metres ([www.noo.org.uk/](http://www.noo.org.uk/), 2009).

The World Health Organization (WHO) classifies person with BMI greater than or equal to 25 kg/m<sup>2</sup> as overweight and BMI greater than or equal to 30 kg/m<sup>2</sup> as obese. BMI provides the most useful population-level measure of overweight and obesity as it is the same for both sexes and for all ages of adults ([www.who.int/mediacentre](http://www.who.int/mediacentre)) and can be taken easily and speedily in a non-invasive manner. This has led to the widespread use of BMI in a range of settings. Despite its considerable advantages, BMI has limitations too. The relationship between BMI and body fat is age-dependent, the proportion of fat to lean mass

becomes greater as the age increases. Pallan (2010) stated that BMI overestimate the body fat in very muscular individuals, so, not able to distinguish between fat mass and muscle mass in an individual.

### **BMI in children**

#### **BMI z – score**

Must and Anderson (2006) stated that BMI z – score or Body mass index z-scores or BMI SD score is equivalent to BMI – for – age percentile. It can be used for determining health status of children if age, sex and BMI for children are known. BMI z- score is not used for clinical practise. Child's BMI-for-age percentile can be determined clinically by using BMI-for-age growth charts for tracking health status of children.

#### **BMI – for – age percentile**

Using height and weight, BMI for children is calculated. Then, BMI is expressed as percentile by using either graph or chart. BMI percentile shows child BMI relative to children of USA who participated in survey conducted at national level from 1963-65 to 1988-94. CDC growth charts (2000) states BMI – for – age percentile for normal child between 5<sup>th</sup> to 85<sup>th</sup> percentile whereas below 5<sup>th</sup> percentile is considered as underweight and above 85<sup>th</sup> percentile upto less than the 95<sup>th</sup> percentile are considered in overweight category. Children with 95<sup>th</sup> percentile or above are considered in obese category.

### **Other measures of obesity**

#### **Skinfold thickness**

It provides information about subcutaneous fat deposits. Dwyer and Blizzard (1996) stated five sites namely triceps, biceps, subscapular, suprailiac and midaxillary for measuring skinfold thickness. Tricep skinfold is

measured at midpoint on the back of upper left arm. Bicep skinfold is measured on the front of upper left arm. Subscapular skinfold is measured just below and laterally to angle of left shoulder blade. Suprailiac skinfold is measured in midaxillary line superior to iliac crest. Midaxillary skinfold is picked up horizontally on midaxillary line, at the level of xiphoid process. Three types of precision callipers are used for measuring skinfold thickness namely: Harpenden, Lange and Holtain. 30% body mass as fat in case of girls and 20-25% body fat in case of boys are cut off value stated for obesity.

#### **Waist circumference**

Waist circumference is measure of central obesity. Higgins *et al.*, (2001) conducted study on 4 to 11 years pre- pubertal children and concluded that obese children having waist circumference > 71 cm and body fat > 33% possess increased risk for cardiovascular diseases. Adult male with waist circumference >102 cm (>40 inches) and for adult women >88 cm (>35 inches) shows risk for diabetes, hypertension, heart disease etc.

#### **Waist hip ratio**

Waist hip ratio is waist circumference divided by hip circumference. Waist circumference is measured in lowest rib margin and iliac crest in midaxillary line. Hip circumference is measured at maximum circumference over the buttocks.

#### **Hydrostatic weighing**

In hydrostatic weighing, fat content of a person is determined by displacement of water by a person. This method is costly and non-portable but is highly accurate if it is done correctly and so considered as gold standard for measuring body fat content.

#### **Bioelectrical impedance (BEI)**

In this method, electric current is passed through person's body and the impedance of the electric current is measured by impedance machine. A person with higher fat content has higher insulation. This method is less expensive than hydrostatic weighing but not very reliable for adolescents according to Stang and Story (2005) as percentage of body water is higher in pubertal and pre-pubertal adolescents and so this method is used mainly for adults.

### **Dual energy X-ray absorptiometry (DEXA)**

Dual energy X-ray absorptiometry (DEXA) measures whole body fat as well as bone mineral density. This method produce small amount of radiation by use of x –ray for measuring body fat but is very expensive. According to Bhave *et al.*, (2004) body fat cut off values in adult male is >25% and >35% in females.

### **Air displacement plethysmography(BOD-POD)**

This is a new technique that is sophisticated, accurate, non-invasive and comfortable but is very expensive.

### **Health consequences of childhood obesity**

#### **Obesity and Cardiovascular disease**

Ho (2009) found that obese children have an increased risk for developing cardiovascular complications such as hypertention (HTN), atherosclerosis (thickening of arterial wall) as well as changes in structure and functioning of left ventricular.

Leptin is a hormone produced by adipocytes of adipose tissue stated by Martins *et al.*, (2015). Leptin decreases food intake and maintain weight balance in body. Obese

person tends to develop leptin resistance and ultimately have elevated leptin levels. This causes stimulation of hypothalamus to increase blood pressure through activation of the sympathetic nervous system according to Carlyle *et al.*, (2002). Ibarra (2009) stated that obesity induced HTN causes an increase in peripheral vascular resistance via endothelial dysfunction and the hemodynamic changes occurring during obesity increases the cardiac output. In order to accommodate the demand for increased blood volume, left ventricular chamber dilates more and more and develops left ventricular hypertrophy (LVH).

Freedman *et al.*, (1999) stated that risk for cardiovascular diseases increases as the quetelet index increases. There is a change in level of diastolic blood pressure, systolic blood pressure, LDL, triglycerides and fasting insulin level. Overweight children (with Quetelet index >85<sup>th</sup> percentile) are 2.4 times more likely to have an elevated level of total cholesterol as compared to children with Quetelet index <85<sup>th</sup> percentile. So, overweight and obese child are at more risk of developing cardiovascular disease.

#### **Obesity and type II diabetes**

During the growth period, there is an increase in number of fat cell. When energy intake exceed energy expenditure, size of fat cell increases. When fat cell reaches their maximum capacity to store fat, it again starts to increase in number ([www.jyi.org/issue](http://www.jyi.org/issue)). According to Qatanani and Lazar (2007), expansion in fat mass causes release of fatty acid and elevation in plasma fatty acid concentration. Competition occurs between increased plasma fatty acid concentration and glucose for oxidative metabolism in insulin-responsive cells and Day and Bailey (2011) stated that it reduces the use of glucose as cellular energy source.

In obesity, triglycerides get deposited in

subcutaneous adipose tissue. But as the size increases, insulin resistance occur and prevents further subcutaneous lipid accumulation. According to Yaturu (2011), triglycerides then get deposited as ectopic fat, particularly in the liver and skeletal muscle and causes insulin resistance.

Insulin is a hormone secreted by beta cells of islet of Langerhans of Pancreas. Insulin converts glucose into glycogen in liver and help muscles, fat and liver cells to absorb glucose from bloodstream and thus helps to maintain the normal level of blood glucose level ([www.niddk.nih.gov](http://www.niddk.nih.gov)). Insulin resistance causes an increase in blood glucose level. Pancreas starts to produce greater and greater amount of insulin in order to maintain normal level of glucose in blood. But elevated blood glucose level is not due to inadequate insulin production by pancreas but due to subcutaneous and ectopic fat deposition. So, pancreas eventually fails to work from exhaustion ([www.opposingviews.com](http://www.opposingviews.com)).

So, obesity among children and adolescents associated with insulin resistance and insulin deficiency leads to the development of type II diabetes (T2DM) according to Hannon *et al.*, (2005).

### **Obesity and Respiratory diseases**

Obesity not only causes cardiovascular disease and type II diabetes but also responsible for causing several respiratory diseases. Obesity increases load on the chest wall and abdomen and decreases the lung volume. Obesity can lead to development of asthma or may increase the severity. Obstructive sleep apnea (OSA), obesity-hypoventilation syndrome (OHS), pulmonary hypertension, and pneumonia can also be seen in obese children and adults according to Murugan and Sharma (2008); Réthoret-Lacatis and Janssens (2008); Fiorino and Brooks (2009).

### **Other physical consequences**

Excess of body weight has adverse effect on growth and health of bones, joints, and muscles. Growth plates regulate the length and shape of bones. Excess of body weight creates stress on growth plate that may lead to arthritis, acute fractures and other serious orthopedic complications such as Slipped Capital Femoral Epiphysis, Blount's Disease, Flat Feet, Impaired Mobility etc. in overweight and obese children and adults according to Wills (2004) and (<http://orthoinfo.aaos.org/topic.cfm?topic=A00679>). Sometimes neurological and dermatological problems are also seen in obese person.

### **Psychosocial consequences**

Childhood obesity not only increases risk for physical health related problems but also has psychological consequences such as depression and anxiety, self esteem, body dissatisfaction, stigma and discrimination.

### **Depression and Anxiety**

Russell-Mayhew (2012) stated depression as both cause and consequence of childhood obesity. Childhood overweight and obesity mainly at age of 5 years increases the risk for adult depression according to Sánchez-Villegas *et al.*, (2010). Yagnik *et al.*, (2014) found that depression is more common in obese girls as increase in body weight gives them feeling of dissatisfaction about their body image. Rofey *et al.*, (2009) found both childhood depression and anxiety to be associated with weight gain.

### **Self esteem**

Self esteem is defined as confidence in one's own worth or abilities. Strauss (2000) found that while comparing with normal children, overweight/ obese children were found to have

low level of self esteem because of increased rate of sadness, loneliness and nervousness in these children.

### **Body dissatisfaction**

Awareness about body size and body dissatisfaction is found to be positively correlated with weight status and is more prominent in older children and adults. Thinner ideal body size is more preferred by overweight/ obese children than normal weight children according to Pallan *et al.*, (2011) and Hatami *et al.*, (2015).

### **Stigma and discrimination**

Obese children are frequently criticized and teased by their peers and so sometimes remains socially isolated in the school. Studies shows that 1/3 of overweight girls and 1/4 of overweight boys are being teased by their peers at school. Sometimes teachers also show negative attitude towards obese child (<http://obesityaction.org/>).

### **Aetiology of childhood obesity**

There are several factors that have potential effects on childhood obesity. The cause for childhood obesity includes:

### **Changes in lifestyle**

### **Unhealthy eating pattern and wrong choices of food**

Obesity occurs when energy intake is more than energy expenditure. Maintenance of proper body weight requires maintaining the balance between energy intake and energy expenditure. Roblin (2007) found that prevalence of overweight and obesity have doubled and tripled in the past three decades because of poor eating habits and changes in lifestyle. James and Kerr (2005) found that

increased consumption of fast food, sugar-sweetened soft drinks, processed food have been an important environmental factors contributing to childhood obesity. Poor quality diet such as high intake of fast food, soft drink and decreased consumption of fruits and vegetables, milk and milk products and whole grains are consumed by majority of children. These diets are able to adequately meet their nutrient requirements but is low in calcium and fibre and high in dietary fat and sodium according to Veugelers *et al.*, (2005). Low intake of calcium and fibre and high in dietary fat and sodium increases the risk for chronic diseases like obesity, cardiovascular disease, diabetes etc. Low frequency in the habit of eating breakfast and low consumption of milk were found to be significantly associated with obesity.

### **Fast food consumption and childhood obesity**

Kaushik *et al.*, (2011) stated fast food as foods that are served ready to eat. Frequency of fast food consumption is increasing frequently among younger generation because of good taste, ready to eat form, easy availability and low cost. French (2003) stated that reducing the price of the product serve as effective strategy to increase the purchase of particular products. Likewise, low cost of fast food increases their frequency of consumption.

### **Reason for increased fast food consumption**

Fast food chains are gaining popularity in nuclear families. Nowadays both parents are engaged in job. Because of busy schedule and limited time, mothers find difficulty in preparing regular meal for their families. They prefer skipping meals in home ([www.human.cornell.edu/](http://www.human.cornell.edu/)) and thus increases the frequency of eating out of fast food in children.

Nutritious and healthy food is now replaced

by junk food and fast food. Fast food and restaurants serving fast foods such as McDonald, Pizza Hut, KFC etc. are gaining popularity in children and adolescents through neighbours, school and TV advertisements. Also, junk food is available in and around school campus through variety of outlets. Cafeterias located near the school offers variety of junk food.

A lot of junk food advertisements are also shown in TV during children's serial break in attractive manner. Vaida (2013) stated a fact that highly nutritious and good quality food may be rejected if not properly presented while food is highly accepted if presented in attractive manner to the customers.

Also, advertisement is one of the effective tools of marketing to emotionally motivate the consumers to buy the products. Thus, TV advertisements showing junk food in attractive manner catches the children attention and encourages the child to try the taste of these foods at least once.

Prentice and Jebb (2003) found that the energy density of food is a key determinant of energy intake. Energy density of food (kilojoules per gram) is inversely proportional to energy cost (dollars per megajoule) of the food. Refined grains, added sugars and fats are good tasting, energy dense and available at low cost whereas fresh fruits and vegetables are nutrient dense and cost more. Drewnowski and Darmon (2005) stated that energy dense food and diets have low satiety value. This result in passive overeating, accidental consumption of excess energy and finally leads to weight gain.

### **Harmful substances in Junk food**

Junk food may contain any of the following harmful substances such as

#### **Trans Fat**

According to Dave and Jain (2016), trans fat is a common type of unsaturated fat with at least one double bond in the trans configuration. It adds crisp and texture to food and increases the shelf life of the product. A high intake of trans fatty acids (TFAs) intake increases low density lipoprotein (LDL-C) and decreases high density lipoprotein (HDL-C) and thus associated with the increased risk for non-communicable diseases such as coronary heart disease and the metabolic syndrome. Commercially available fast food contains saturated fatty acid and trans fatty acid in higher amount as compared to the amounts recommended by dietary guidelines. Asgary *et al.*, (2009) and Nazari *et al.*, (2012) stated that trans fatty acids like elaidic acid (C18:1 9t) and saturated fatty acids like stearic acid (C18:0) and palmitic (C16:0) acid are most common in junk food.

#### **Nitrite salts**

Nitrite Salts are added to foods such as in processed meat, bacon, corned beef, smoked fish, ham and sausages. It imparts unique flavour or colour to food, increases the shelf life and stability of the products. But these preservatives are carcinogenic and so possess many harmful effects on health.

#### **Saccharin and aspartame**

Saccharin is sodium ortho benzene or the calcium salts. It is 300 times sweeter than sucrose and is stable in wide variety of products under extreme processing conditions. Saccharin is non-nutritive sweetener, now being used to sweeten arecanut (supari and pan masala).

Aspartame is white, odourless, crystalline powder made by combining two amino acid-aspartic acid and phenylalanine. It has sugar-like taste and 180 to 200 times sweeter than that of sucrose. It is used in soft drinks, instant

coffee and tea and also in chewing gums as it enhances fruity flavour.

Saccharin and Aspartame are non-nutritive sweeteners, now being used in variety of food products but their consumption may be responsible for causing different types of cancer.

### **Buttered-flavoured chemical**

Buttered-flavoured chemical called diacetyl is used in baked goods and candies, microwave popcorn and in variety of snack foods to impart an appetizing smell and buttery taste in them. But these chemicals have adverse effect on health as it increases the risk for Alzheimer's disease.

### **Monosodium glutamate (MSG)**

Glutamate is a natural amino acid found in natural protein containing foods such as milk, mushrooms, fish, (www.globalhealingcenter.com/natural-health) meat and some vegetables. MSG is the sodium salt of glutamate. Monosodium glutamate (MSG) is used as flavour enhancer in the foods such as in masala/ spices that are used in noodles. It enhances or modifies the original flavour or aroma of the food without contributing its own flavour.

Once glutamate is ingested by us, our body is not able to distinguish between natural glutamates and glutamate of MSG. Human body metabolizes glutamate of MSG (e.g. added to a tomato sauce) in the same manner as it metabolizes glutamate found naturally in many foods (www.foodinsight.org/Content/76/pdf). MSG overexcites the cells of brain and causes damage to brain and various related diseases such as Parkinson's disease, Alzheimer's disease and learning disabilities.

### **Sodium Benzoate, Potassium Benzoate and Butylated Hydroxyanisole (BHA)**

These are added in potato chips, cakes, fruit juices, bread, pie fillings etc. to prevent spoilage caused by moulds, bacteria and yeast. It maintains appearance, palatability and wholesomeness of the products but has harmful effects on health too.

### **High Fructose Corn Syrup (HFCS)**

High Fructose Corn Syrup (HFCS) leads to obesity as it increases triglycerides level and aggravates fat storing hormones.

### **Colouring agents**

Food colouring agents gives colour and appealing look to the food and also preserves the food. It is added to food products such as Ice-cream, cakes, fruit drinks and beverages, soft drinks, etc. But these are by-products of coal tar and thus increases the risk for certain types of cancer.

### **Soft drink and childhood obesity**

Excess of soft drink consumption increases the risk for various diseases such as diabetes, heart disease, has adverse effect on bones and causes many other problems. According to one study by Mattes (1996) and DiMeglio and Mattes (2000), it was seen that person consuming soft drink had higher energy intake than those who were not consuming soft drink. This is so because when person consumes sugar – sweetened soft drink, individual's carbohydrate consumption in liquid form increases whereas person do not reduce their solid food intake. As a result, this in total leads to greater energy consumption and finally weight gain. Soft drink have high glycaemic index and hence causes rapid rise in blood glucose level after consumption. Vartanian *et al.*, (2007) found that increase



consumption of soft drink decreases the intake of milk, calcium and various other micronutrients and also increases the risk for various chronic diseases. Soft drink containing soda has high level of phosphate. So, by consuming excess of soft drink, phosphate consumption become more as compared to calcium intake and thus has adverse effect on bones.

### **Fruit intake and obesity**

Rolls *et al.*, (2005) stated that low-energy-dense diet provides low energy intake and maintains body weight. Energy density of diet can be reduced by increasing consumption of fruits and vegetables, soups, cooked grains etc. in the diet. Intake of low-energy-dense diet has benefit that it lowers the energy intake without decreasing the food volume, so, person consuming this diet don't feel hungry and able to reduce weight. Ledikwe *et al.*, (2006) stated that person consuming low energy density diet had low intake of fat and higher intake of water and several other micronutrients such as calcium, folate, vitamin A, C, iron, potassium etc. According to Bes-Rastrollo *et al.*, (2006), dietary energy density of food was found to be positively correlated with all types of fat such as trans fat, saturated fat and inversely correlated with fruits and vegetables.

Tetens and Alinia (2009) suggested that consumption of fruits has beneficial role in prevention of obesity. Healthy People 2010 (Department of Health and Human Services, 2000) stated that high intake of fruits and vegetables are associated with low incidence of non – communicable disease (NCDs) such as diabetes, obesity, cardiovascular disease etc. Joint WHO/FAO Expert (2002) recommends 400 grams or aprox. 5 serving of fruits and vegetables/ person/ day. Healthy People (2010) recommend at least two servings of fruit and three servings of vegetables per day for general population.

### **Sedentary lifestyle**

The factors like parental responsibility, over-consumption and media promotion of unhealthy foods, misuse/overuse of modern technology, children's lack of knowledge and motivation and sedentary lifestyle with no physical activity (Potestio *et al.*, 2008) and watching television for more than 2 h/day (Nawab *et al.*, 2014) is considered as most common cause of the childhood obesity. Electronic media like TV, Computer etc. have very significant effect on eating habits. The time spent in front of these electronic media and the content shown by them can be a reason for development of childhood obesity.

### **Television and childhood obesity**

Vik *et al.*, (2013) stated that chances of overweight and obesity increases in children consuming breakfast and dinner in front of television. Rey-López *et al.*, (2011) and Scragg *et al.*, (2006) stated watching television more than 2 hours per day increases the consumption of energy - dense snacks and beverages. Ramos *et al.*, (2013) found children spending more than 120 minutes per day in television watching consume more fatty food and decreases their fruits and vegetable intake. This decreases their intake of complex carbohydrates, fibre, vitamins such as A, C and minerals such as calcium, iron, phosphorus, magnesium and potassium and their intake for saturated fat and cholesterol increases. Secondly, watching television while eating food acts as distraction leading to overconsumption according to Temple *et al.*, (2007). More calories are consumed by children taking food in front of television and so associated with overweight and obesity.

Jenvey (2007) and Arcan (2013) found that Children of age 2 to 12 years watching television for more than two hours have

minimum of 38 minutes of advertising each day. A major determinant of food preferences is taste. Eating habits and preferences for particular food develops during childhood and remains almost constant throughout adulthood. Exposure to TV advertisement in early years of life influences the eating habits and food preferences in children. Advertisements repeatedly showing particular food and their positive benefits influence the cognitively immature young children to eat unhealthy food with poor nutritional quality.

According to Rosiek *et al.*, (2015), snacking and eating meal in front of television contributes to physical inactivity. TV viewing is normally a sedentary behaviour and sedentary lifestyle is one of the reasons for childhood obesity.

### **Other electronic media and childhood obesity**

Like TV, electronic video game and computer use for moderate time is also responsible for obesity. Vandewater *et al.*, (2004) stated that children spending moderate amount of time on computer or playing video game were having higher weight status, while those using a little of video game or computer were having lower weight status. Santaliestra-Pasías *et al.*, (2014) found that children both boys and girls viewing television for >4 h/day and using internet for recreational purpose had higher adherence to snacks and were less health conscious.

### **Inadequate play area**

Centre for the Study of Social policy (2011) stated that reduced access to safe place for outdoor games in children causes decrease in physical activity among children. Majority of children don't get sufficient place for play or physical activity. Elimination or reduction of sufficient play area and physical education in school contributes towards childhood obesity.

Availability of safe, clean and less traffic bicycle lanes, parks, sidewalk area is linked to higher physical activity in children. However, Bhavé *et al.*, (2004) stated that busy and full of traffic lanes and availability of motorized vehicles among majority of parents prevents children from walking on these roads or going to school by cycling. Parents consider use of motorized vehicles as safe and quicker means for leaving their children to school. Also, majority of population are having limited access to well maintained or safe parks, lack of time for physical activity and lack of recreational facilities pushes the child towards sedentary lifestyle and increases incidence of childhood obesity.

### **Obesogenic schools and Tution classes**

One of the very important factors contributing towards childhood obesity in India is excess of academic burden on children right from their childhood. Children are forced to study more, go for additional studies and to use their play time also, initially for getting admission in good schools and then for good performance in class and so on.

Murray and Ramstetter (2013) stated that vigorous play by children at the time of recess improves motor skills, provides joy and maintains active and healthy lifestyle in children. But, few schools don't have any playground or don't provide adequate recess time or play time to children. Busy time table for children right from nursery class and lack of playing area or play time in some schools decreases the level of physical activity in child and forces the child towards overweight and obesity.

### **Genetic factors**

One of the important factors contributing towards childhood obesity is genetic factors. Reilly *et al.*, (2005) found that parental obesity as strongest risk factor for childhood obesity.

**Table.1** Prevalence of childhood obesity in India

|                                  | Age group             | Place                                     | Overweight   | Obesity  |
|----------------------------------|-----------------------|---|--|--|
| <b>Chhatwal et al., 2004</b>     | 9-15 years            | India                                     | 14.2%  | 11.1%  |
| <b>Marwaha et al., 2006</b>      | 5 – 18 years          | Delhi                                     | USES<br>Boys -16.75%<br>Girls – 19.01%   | USES<br>Boys -5.59%<br>Girls – 5.73%               |
|                                  |                       |   | LSES<br>Boys -2.66%<br>Girls – 2.14%   | LSES<br>Boys -0.42%<br>Girls – 0.28%               |
| <b>Sharma, et al., 2007</b>      | 4 – 17 years          | Delhi                                     | 22%  | 6%   |
| <b>Mahajan et.al., 2011</b>      | 6 – 12 years          | Puducherry                                | 4.41%  | 2.12%  |
| <b>Nayak and VinodBhat, 2011</b> | 10 – 16 years         | Udupi district of Karnataka, South India. | 7%   | 5%   |
|                                  |                       |   | Note: Higher BMI found among children in the age of 10 – 12 years and among girls than the boys. |  |
| <b>Siddiqui and Bose, 2012</b>   | 7 – 14 years          | Madhya Pradesh                            |  | Overall–14.97%<br>Boys – 6.81%<br>Girls – 8.16%    |
| <b>Longkumer, 2013.</b>          | 8 – 15 years          | Nagaland, North – East India              | Overall – 2.28%<br>Boys – 2.08%<br>Girls – 2.48%   |  |
| <b>Vaida, 2013</b>               | 6 – 12 years          | Anantnag district of Jammu and Kashmir    | Govt. School – 4%  | Govt. School – 0%                                  |
|                                  |                       |   | Private school – 14%   | Private school – 6%                                |
| <b>Shah et al., 2013</b>         | 10 – 12 years         | Mehsana district of Gujarat               | Overall – 33.88%<br>Boys – 34.82%<br>Girls – 32.95%  | Overall – 10.67%<br>Boys – 13.39%<br>Girls – 7.95% |
| <b>Bansal et al., 2013</b>       | School – age children | Jaipur                                    | Overall – 14.83%<br>Boys – 13.92%<br>Girls – 16.23%  | Overall – 5.69%<br>Boys – 5.11%<br>Girls – 6.58%   |
| <b>Sargunam et al., 2014</b>     | 5 – 10 years          | Tirunelveli District of Tamil Nadu        | Boys – 9.9%<br>Girls – 12%   | Girls – 6.3%                                       |
| <b>Jacob, 2014</b>               | 6 – 15 years          | Ernakulam district of Kerala              |  | Overall – 3.10%<br>Boys – 3.35%<br>Girls – 2.85%   |
| <b>Ashok et al., 2014</b>        | 6 – 12 years          | Mysore, Karnataka                         | 8.4%   | 4.10%  |
| <b>Mishra et al., 2015</b>       | 10 – 12 years         | Sambalpur, Odisha                         | Overall – 9.6%   |  |
|                                  |                       |   | Males – 9%   | Females– 10.7%                                     |
| <b>Dubal, 2015.</b>              | 6 – 12 years          | Gujarat                                   | 19.4%  | 13.5%  |
| <b>Prashanth and Remya, 2016</b> | 6 – 12 years          | Kolenchery, Kerala                        |  | Overall – 6.70%<br>Boys – 4.10%<br>Girls – 6.80%   |
| <b>Gupta and Rathore, 2016</b>   | 6 – 14 years          | Lucknow                                   | 6.19%  | 5.10%  |

**Table.2** Definitions related to fast foods

| Type of food         | Definition   | Examples  |
|----------------------|--|---|
| <b>Fast food</b>     | Foods sold in a restaurant or store which are rapidly prepared and quickly served in a packaged form for take away.                        | Burgers, pizzas, fries, hamburgers, patties, nuggets.<br>Indian foods like pakora, samosa, namkeen etc. |
| <b>Junk food</b>     | Energy dense foods with high sugar/ fat/ salt content and low nutrient value in terms of etc. protein, fiber, vitamin and mineral content. | Chips, chocolate, icecream, soft drinks, burgers, pizzas etc.   |
| <b>Instant foods</b> | Foods that undergo special processing that are ready to be served once dissolved or dispersed in a liquid with low cooking time            | Noodles, corn flakes, soup powder.  |
| <b>Street foods</b>  | Ready to eat foods and beverages prepared and sold by hawkers or vendors in streets or other public places.                                | Chaat, gol guppa, samosa, tikki, noodles, chowmein, burger etc.   |

Magnusson and Rasmussen (2002) stated that if both parents are obese then probability that child will be obese is highly elevated. Lyon *et al.*, (2005) and Stein *et al.*, (2011) stated that risk for obesity ranges from 30% to 70% if parents are obese or even if close relatives are obese. Obesity genes act as recessive genes. Obesity are called complex genetic traits because each gene responsible for causing obesity have only small contribution to increase in body weight but these genes together are responsible for increased BMI if individual carrying obesity genes respond to faulty dietary habits and sedentary lifestyle.

All humans have almost the same genetic material. There is very slight difference in genome from person to person. Since, most genetic variation in human is common, actual genes responsible for causing obesity is still not very clear. Two approaches namely

linkage analysis and association studies have been used to find variants causing obesity. Several studies found that mutation in leptin gene causes severe obesity syndromes. Genes such as leptin, proopiomelanocortin, melanocortin 4 receptor (MC4R), and Bardet-Biedel syndrome loci have been found to be altered in obesity syndrome. So, obesity is very common disease occurring due to multiple factors with genetic factors playing a very strong role.

Genetically three types of obesity i.e. monogenic, syndromic and polygenic obesity were defined by Puiu *et al.*, (2013). Monogenic obesity is defined as obesity occurring due to single gene mutation e.g. congenital leptin deficiency. Leptin is a hormone derived from adipocytes and is secreted in proportion to body fat content. However, in case of leptin deficiency,

hyperphagia occurs and energy intake increases. Thus, in case of food abundance, mutation in single gene is responsible for obesity. Syndromic obesity includes disorders related to Mendelian inheritance and person is clinically obese in this. Third one is polygenic obesity, most common type and is responsible for causing obesity in majority of children. In this, individual genes are susceptible to an environment and when energy intake is more than expenditure, it leads to obesity.

### **Childhood obesity prevention**

The alarming global rise in childhood obesity has been accompanied by numerous prevention strategies. These are aimed at multiple levels and range from macro-level policy or environmental change to targeted interventions focusing on individual behaviour change as any single intervention separately will not be able to prevent childhood obesity. Formulation of policies that in total support development of healthy communities, improved accessibility of healthy food to all children and healthy school initiatives can have significant impact on prevention of childhood obesity. According to Castaño *et al.*, 2004, it is found that nutrition education, promotion of physical activity along with behaviour modifications and decrease in sedentary lifestyle of the child could be the factors in the prevention of childhood obesity.

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