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FACTORS CONTRIBUTING TO CHILDHOOD OBESITY AND ITS IMPACT: A CRITICAL CONCERN FOR CHILD HEALTH IN THE UNITED STATES

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ABSTRACT

Childhood obesity is growing like an epidemic in America. It has more than tripled in the past 30 years. The percentage of children ages 4 -12 years who were obese increased from 7% in 1980 to nearly 20% in 2020.[29] Overweight is defined as having excess body weight for a particular height from fat, muscle, bone, water or a combination of these factors, while obesity is having excess body fat.[4,28] Obesity is risk factor for cardiovascular diseases like high cholesterol and high blood pressure, Pre diabetic factor for type 2 diabetes, bone and joint disabilities and sleep apnea. Along with physical disabilities, it also incurs Psychological, emotional, mental and behavioral instabilities leading to poor self-esteem, mental issues and poor health habits. Factors causing obesity is imbalance between energy consumption and energy expenditure and there are many contributing sub factors to it. Many government, public and private sectors are running successful programs to control obesity at school level on daily basis like "**Gimmie 5**", "**Let's Move!"** is a national campaign that was introduced by Michelle Obama in **2010**, and The National Physical Activity Plan **(NPAP)** is the product of a private-public sector collaboration that creates policies, programs, and initiatives aimed toward activity for the American population.

INTRODUCTION

This is the fact that one third of the American children are carrying too much weight. There are lot of reasons and contributing factors to this problem. All healthcare professional and providers agree on two basic factors and that is the children are not eating right kind of food and they are getting less and no exercise on daily basis. Childhood obesity does not leave its burden when they enter teenage rather, they carry them to adulthood creating a generation with chronic diseases high cholesterol, diabetes and heart disease. Calculating body mass index or BMI is the most common method of initially assessing whether or not an individual is considered overweight or obese. Body mass index is determined by measuring an individual's weight in relation to their height. In particular for children and adolescents ages 2-19 years, age and sex are factored into determining weight status due to the fact that body development varies dramatically between boys and girls during these years. Obesity is defined as a BMI at or above the 95th percentile for children of the same age and sex.[28,29]

Prevalence of Childhood Obesity

From the year 1980 until now, the occurrence of obesity in children has more than tripled (25, Table 3). In 2018, approximately 19.3% of children in the United States that were aged 2 to 19 were suffering from obesity. There were huge disparities noted within diverse racial and ethnic lines.[30] For instance, in the same year, age groups among non-Hispanic Asians had the lowest rate of obesity at 8.7%. Conversely, non-Hispanic blacks had the highest rate of obesity among the kids which is 22%; followed by Hispanics at 25.8%. Gender-wise, obesity rates were comparable between boys and girls overall, at 20.9% and 18.5%, respectively. They were in turn followed by non-Hispanic whites whose rate of obesity was at 14%. These estimates were obtained by interpreting the data from the 2015 to 2016 National Health and Nutrition Examination Survey (NHNES) which is acknowledged as the gold standard for national estimates and trend analysis in body mass index (BMI).[29]

FACTORS CAUSING OBESITY

Successful Energy consumption

Role of food is very crucial in development of obesity in children. Milled, refined grains and the foods made with them like white bread, white pasta, rice and processed breakfast cereals; they all are rich in rapidly digested carbohydrate. So are potatoes and sugary drinks. They have a high glycemic index and glycemic load. Such foods cause fast and furious increases in blood sugar level and insulin that, in the short term, can cause hunger

to spike and can lead to overeating.[3] Sedentary life style with increased consumption of French fries, extra 3.4, 1.3, 1.0, and 0.6 pounds every four years, respectively.[6] Fast food with large portion sizes and high energy density food contributes towards high calorie consumption. There is less option for healthy choices and more for unhealthy snacks in vending machine at school and recreational centers and parks.

Failure of Energy expenditure

Other factors exacerbate health and contribute to childhood obesity. There is lack of daily physical activity in schools and at home. Many schools do not offer physical education classes on daily basis. Some students have very little physical activity outside of their physical education courses during their school day and most kids are not supervised at home so after school they get busy in playing video game or TV, computers or playing hand games. Parents' busy schedules, ease of access to junk food through vending machine at school and less expensive options steer many towards fast food. Those living in urban areas or isolated areas may also have difficulty obtaining healthy nutrition options that leads to an increased intake of more affordable unhealthy options. Cultural food is big hindrance in the way to healthy eating habits. Lack of parental and caregiver nutritional educational, people from rural areas and under develop countries prefer to consume processed food as compare to freshly cook. Daily servings of fruits and vegetables are negligible.

Socioeconomic status

Socioeconomic status **(SES)** has great influence on the rate of childhood obesity. Both the upper and lower socioeconomic group suffer. The environment of urban areas is not one of easy access to healthy food options or safe places for children to be active. Because of affluence of money most people of this group dine out, consume red meat and Complex Carbohydrates. Lack of fresh fruits and veggies and exercise is status symbol. They prefer to ride than walk whereas children from lower SES normally have less access to healthy food options but safer places to be active. This group is usually in minority which itself is a risk of obesity. As it stated "Physical activity levels are inversely related to a low SES and this might be due in part to an inequality in community tax base and fiscal health, amenity levels in neighborhood environments, and access to these key public facilities and services such as recreation facilities".[12]

Genetic Predisposition

Childhood obesity is a polygenic disease. Polygenic means that it is connected to multiple genes along with environmental factors that interact with the genes. Studies and research on polygenetic in obesity can help provide the explanation as to why fifteen percent of children who suffer from obesity have a genetic reason to suffer from such conditions. A study of 12,500 families where participants' diets and exercises were strictly regulated. It was found that a predetermined genetic characteristic was the main reason some people became more obese than others despite being given similar amounts of food and the same exercise regime. The genetic results of this study were found in roughly two-thirds of the populations but a third of people's bodies are able to easily maintain their calories balanced with their activity.[14]

Numerous scientific studies have identified specific genes located on chromosomes 15, 2, and 7 that are strongly associated with obesity. The interaction between these genes and environmental factors adds a layer of complexity to our understanding of how genetics contribute to obesity. Researchers have made significant advancements in this area and have pinpointed four regions in the human genome that contain genes closely linked to obesity. These genes have a profound influence on metabolism and the functioning of the nervous system, providing valuable insights into the impact of chromosomes 15, 7, and 3 on obesity.[15]

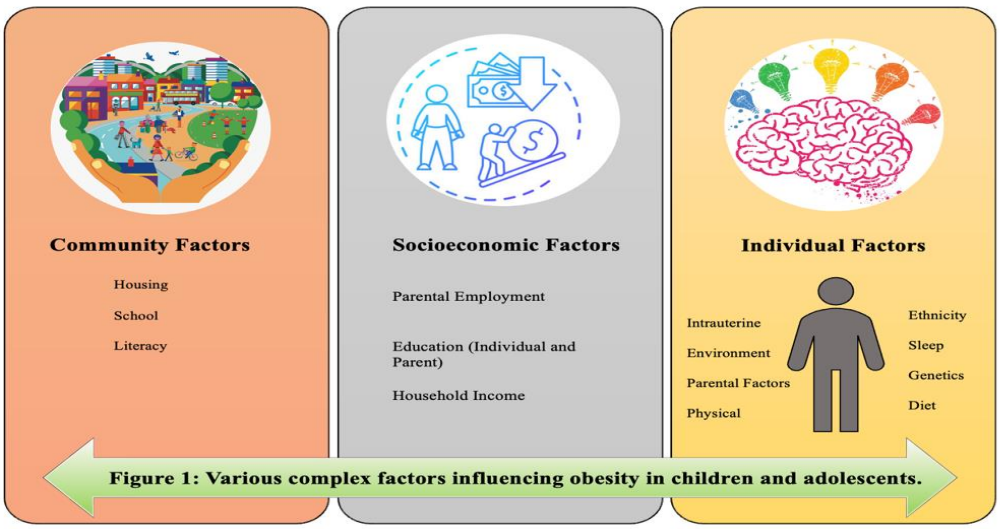
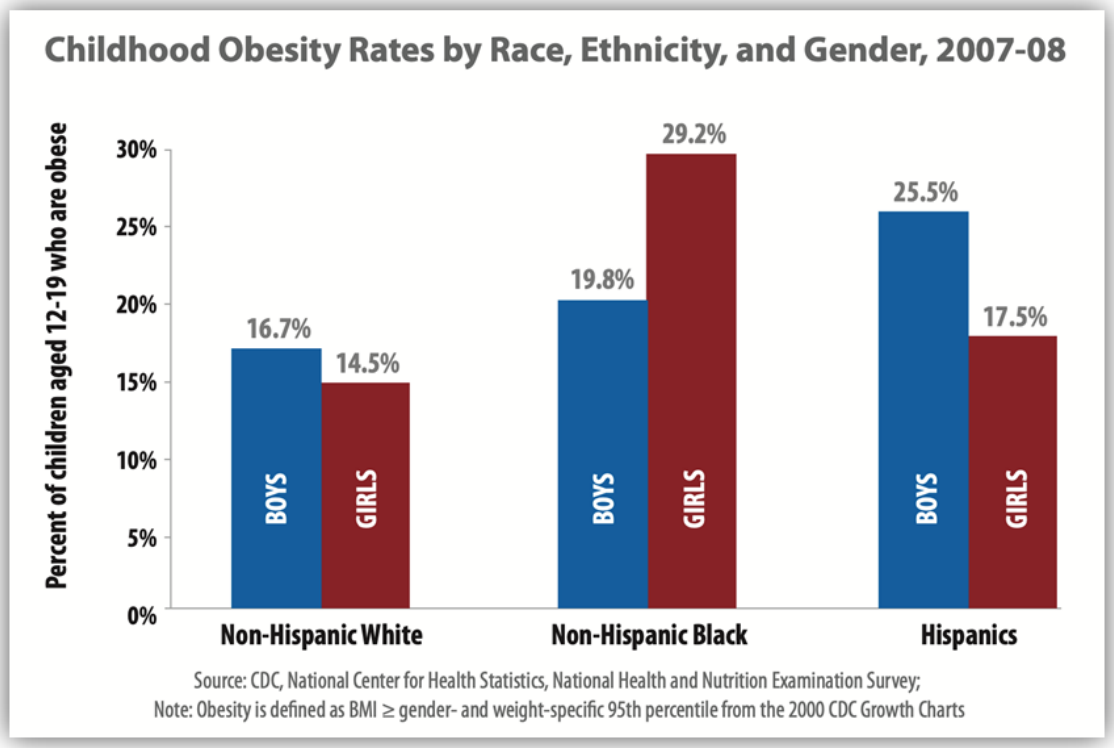


Figure 1: Various complex factors influencing obesity in children and adolescents.

Racial and ethnic disparities

Childhood obesity exhibits notable variations across different racial and ethnic groups. Non-Hispanic black girls and Hispanic boys tend to have the highest rates of obesity, while American Indian/Native Alaskan children also experience significant prevalence. In a study involving four-year-old, obesity was found to be more than twice as common among American Indian/Native Alaskan children (31%) compared to their white (16%) or Asian (13%) counterparts, marking the highest rate among all racial and ethnic groups examined **([30], Table 1).**



Unhealthy dietary habits

Unhealthy dietary habits emerge as a critical reason behind childhood obesity. As is noted by Oude Luttikhuis et al., "poor nutrition can significantly impact the chances of becoming obese".[16] Both behavioral factors, such as an unhealthy dietary pattern, and individual factors, including preferences, contribute to obesity. Whether a child eats too much high-calorie food, such as soft drinks and fast food, or too few vegetables, fruits and whole grains can have a big effect on that child's weight.

Harsh findings recommend that reducing intake of calorie-dense and nutrient-deficient foods is key. In addition, it is recognized that high-fat and high-sugar foods can engender addiction-like reward futures, hence posing a probability of too much consumption. Furthermore, there is the belief that children need high-calorie and concentrated sweets for energy, and so it is normal to indulge.

High consuming such calorie-laden food and beverages only leads to weight gain, which then affects self-esteem and lays down the foundation for obesity. It is also proven that the early onset of smoking and alcohol abuse is more possible in obese youth. It astoundingly has an effect on public healthcare prices related to obesity; in accordance with Schneider, "all forms of therapy for childhood obesity would lower healthcare costs in the long term".[17] His research presents that within 5 years, up-front prices to cowl weight management interventions akin to dietitians, pediatricians, and behavioral counselors can be counteracted by the money saved from reduced medical needs.

Biological Factors

The intricate system of neural and hormonal regulation, known as the Gut-Brain axis, has a noteworthy impact on hunger and satiety **(21, Figure 2).** Various factors such as sensory stimulation (smell, sight, and taste), signals from the gastrointestinal system (peptides, neural signals), and hormones circulating in the body also play a role in influencing food intake.[18] The hypothalamus, a critical brain region involved in the regulation of appetite, is modulated by key hormones such as ghrelin, originating from the stomach, and leptin, primarily secreted by adipose tissue, which respectively stimulate hunger and suppress appetite.[20]

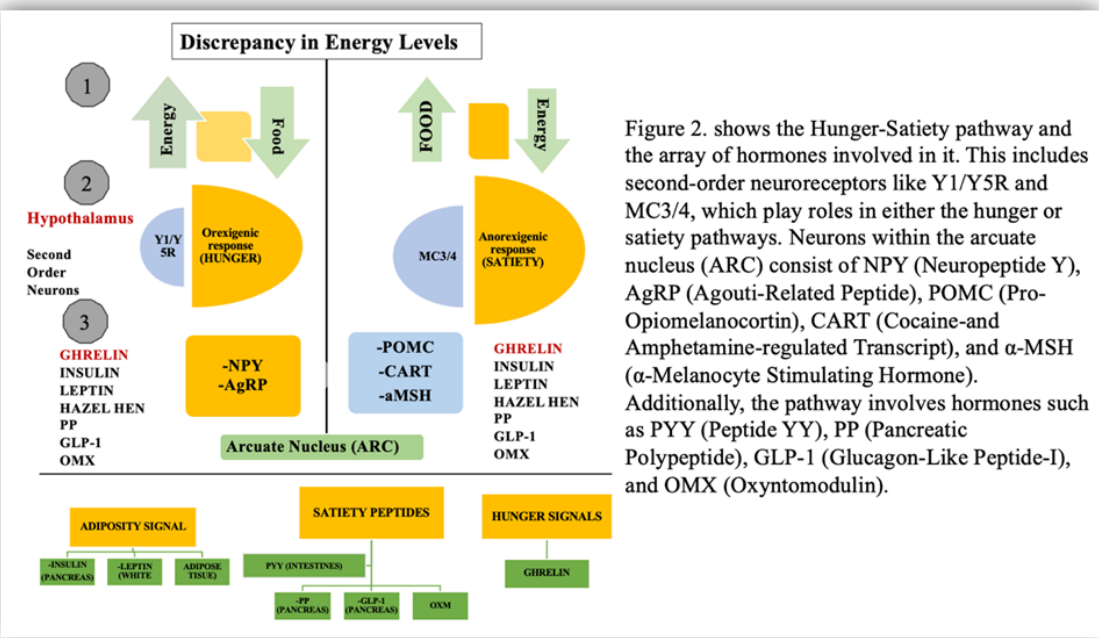


Figure 2. shows the Hunger-Satiety pathway and the array of hormones involved in it. This includes second-order neuroreceptors like Y1/Y5R and MC3/4, which play roles in either the hunger or satiety pathways. Neurons within the arcuate nucleus (ARC) consist of NPY (Neuropeptide Y), AgRP (Agouti-Related Peptide), POMC (Pro-Opiomelanocortin), CART (Cocaine-and Amphetamine-regulated Transcript), and α-MSH (α-Melanocyte Stimulating Hormone). Additionally, the pathway involves hormones such as PYY (Peptide YY), PP (Pancreatic Polypeptide), GLP-1 (Glucagon-Like Peptide-I), and OMX (Oxyntomodulin).

Additional appetite-regulating hormones released from the pancreas and gut interact with the hypothalamus, thereby influencing hunger and satiety through diverse signaling pathways. Emotional disturbances and disruptions in sleep patterns can lead to heightened appetite, often mediated by ghrelin, thereby contributing to emotional eating.[19] Recent research underscores the significance of alterations in the gut microbiome in relation to weight gain, with factors including birth circumstances, dietary habits, and antibiotic usage impacting the composition of gut microbiota. Dysbiosis, particularly affecting short-chain fatty acids (SCFAs), has been implicated in the pathophysiology of obesity; however, conflicting data necessitates further investigation through randomized control trials.[31]

Moreover, the bidirectional interaction between the gut microbiota and the liver, influenced by factors such as diet and genetics, is essential for maintaining normal homeostasis.[18] Disruption of the gut-liver axis due to increased intestinal permeability may lead to various liver diseases, including hepatic steatosis, non-alcoholic steatohepatitis (NASH), cirrhosis, and hepatocellular carcinoma. Additionally, medical conditions such as type 2 diabetes, metabolic syndrome, and psychological disorders like anxiety and depression have been associated with alterations in the gut microbiome.

Physiological Factors in Pediatric Obesity: Clinical Insights

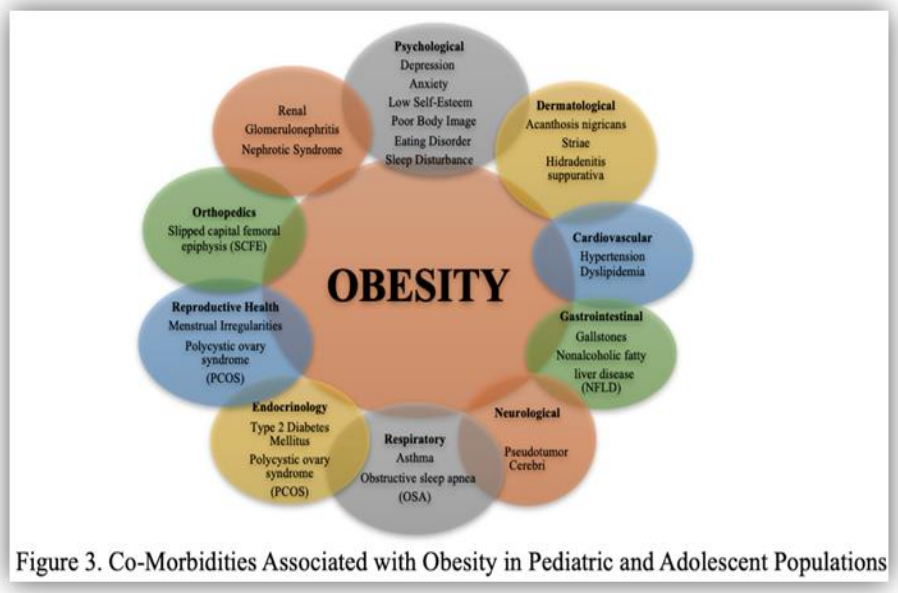


Figure 3. Co-Morbidities Associated with Obesity in Pediatric and Adolescent Populations

It is widely acknowledged that experiencing increased body mass index (BMI) at an early age, specifically before reaching 5 years old, poses a significant risk for developing obesity, along with its associated health complications and metabolic syndrome. Normally, children experience a decline in BMI to a minimum before it begins to rise again as they transition into adulthood, a phenomenon referred to as adiposity rebound (AR). Typically occurring between the ages of 5 and 7, AR occurring earlier than 5 years old is classified as early AR. Early AR serves as an indicator of heightened susceptibility to obesity-related health issues, encompassing cardiovascular risks such as hypertension, dyslipidemia, prediabetes, and type 2 diabetes, as well as hormonal imbalances, orthopedic complications, sleep apnea, asthma, and fatty liver disease[22] **(Figure 3).**

Developmental Influences on Early Eating Habits: From Infancy to Adolescence

Eating habits undergo significant changes during the early years of life. Infants and young children learn about food through direct experience and by observing others. Initially, feeding establishes a sense of security and trust between the child and parent, but as children grow, they gain more control over their eating behaviors due to rapid physical and cognitive development. Economic constraints and time limitations often lead parents to rely on processed and inexpensive foods, which are energy-dense. Moreover, cultural practices such as offering large portions and encouraging children to finish their meals are common. Some parents overly focus on their child's diet, which can backfire by promoting unhealthy eating habits or excessive weight gain.[23]

During middle childhood, children experience greater autonomy and encounter a wider array of food choices, particularly within school or daycare environments, which may contribute to a rise in sedentary behaviors. Adolescence represents a pivotal developmental stage characterized by heightened peer influence, the availability of convenient yet unhealthy food options, and an increase in sedentary pastimes such as screen time, all of which can contribute to the development of unhealthy eating habits and decreased levels of physical activity. Moreover, concerns regarding body image and weight management become increasingly prominent during this phase of development.[24]

METHODS

Children are a difficult segment of population to control in regards to obesity prevention. Since they are in age groups where the only focus is food irrespective of the calorie count. Secondly, since this group is not concern of their appearance so they are unaware of the consequences of being overweight, thirdly their parents dictate so much of what they want and do. Because of this, much of childhood obesity prevention consists of steps the parents can take to make sure that their children are not going to be obese. At its core, "obesity occurs when a person consumes more calories than he or she burns. For many people this boils down to eating too much and exercising too little".[11] It is imperative to make sure that an adequate amount of physical activity is included in a child's everyday life, with at least 60 minutes of physical activity recommended per day as well as 30 minutes of vigorous activity three times per week.[4] Multi-disciplinary interventions result in significant positive effects on not only body weight and BMI but also body fat and body lipid. These interventions include Dietary intervention, Nutritional education, change in physical activity both Habitual activity physical and Fitness, Behavioral modification, Parental involvement, Intensive family therapies, Environmental Support There are many successful programs run by Federal, state and local governments as well by nonprofit organizations.

Gimmie 5 Program

"**Gimmie 5**" is a school program that specifically encourages students to eat five servings of fruits and vegetables a day. "**Gimmie 5**" is a multi-component, school-based dietary intervention for the target population of fourth and fifth graders. The intervention includes twelve 45 to 55 minutes classroom sessions targeting vegetable consumption for fourth grader and twelve 45-to-55-minute classroom sessions targeting fruit and juice consumption for fifth graders.[1]

"Let's Move!" Program

It is a national campaign that was introduced by Michelle Obama in 2010. This campaign aims to improve the nutritional quality of school lunches, increase physical activity among children, and educate students and their family to make healthier choices in their lifestyle to help prevent and decrease the rate of childhood obesity. Mrs. Obama feels that the physical and emotional health toll of an entire generation and the economic health of the nation's health care system are at stake.[2]

"National Physical Activity Plan "[NPAP]

It is the product of a private-public sector collaboration that creates policies, programs, and initiatives aimed toward activity for the American population. The campaign funds initially came from the CDC. However, contributions continue to come from organizations that have joined as Organizational Partners or Collaborative Partners.[9] Hundreds of organizations are working together to change our communities in way that will enable every American to be sufficiently physically active.[9]

Mississippi's schools introduced Mississippi's Fresh Fruit and Vegetables Pilot Program. According to the National Center for Chronic Disease Prevention and Health Promotion **([NCCDPHP], 7)**, The Rhode Island Department of Education (RIDE) initiated healthier nutritional environments in all 36 of its school districts.[28] Through collaboration with RIDE, the Rhode Island Department of Health (RIDOH) and the Rhode Island Healthy Schools Coalition, a successful

partnership provided nutritious choices for schoolchildren.

RESULTS

The prevention and control of Childhood obesity is result of combine effort of government at all levels as well the involvement of individual, group and community. The implemented programs showed different rate of success. Even though "Let's move" program is in early stage but it is able to cut 1.5 trillion calories from major food manufactures products, major chain stores have improved their produces sections, and chain restaurants have introduced healthier options in their children's menus.[27] There is also an increase in community gardens and parks to help improve access to healthy food options and increase physical activity.[27] On average, following implementation of the "Gimmie 5" program, showed students consumed 0.2 more servings of fruit, juice, and vegetables per day. These students also increased the frequency with which they specifically asked for fruits, juices, and vegetables and increased their fruit, juice, and vegetable eating self-efficacy. However, their eating preferences and expectations relating to the enjoyment of fruit, juice, and vegetable eating did not change significantly.[1]

NPAP program supports physically active lifestyles, with the sole purpose of improving health, prevent diseases and disabilities and enhance quality of life. The NPAP is comprised of eight organized social sectors, Business and Industry, Education, Mass Media, Parks, Recreation, Fitness and Sports, Public Health, Transportation, Land Use and Community Design, Volunteer and Non-Profit.[9] The NPAP is geared for the entire population, but has specific programs and goals for children through the schools, mass media and at home. They support the First Lady Obama's "**Let's Move!"** campaign.

DISCUSSION

The childhood obesity has become public health issue at national level. The joint effort at all level seems to be insufficient as current findings are showing that these interventions are not doing much to help prevent childhood obesity in adolescents. "School-based interventions have had little success; only about half of these interventions produce any significant change in eating behavior, physical activity or weight status, and the largest, most rigorous studies tend to be the least successful".[16] This is unfortunate since a majority of the prevention efforts lie in these approaches. "With the interventions that have shown any significant effects, the effect sizes are small in relation to the increasing obesity levels making it unlikely that these interventions could meaningfully impact recent obesity trends".[16] Our aim is to address the pervasive issue of childhood obesity within a single generation, with the ultimate goal of reverting prevalence rates to those observed prior to the onset of this epidemic. This entails achieving a childhood obesity rate of merely 5% by the year 2030. To realize this objective, it is imperative to swiftly "bend the curve" by implementing interventions that result in a 2.5% reduction in the current rates of overweight and obese children by 2015, followed by a subsequent 5% reduction by 2020. Our progress will be meticulously tracked using the CDC's biennially aggregated National Health and Nutrition Examination Survey (NHANES) **([30], Table 2).**

There are many factors which contribute to this ineffectiveness. It requires aggressive interventions from everyone at all levels. Along with dietary restriction and physical activities the family and children require nutritional education, Intensive family therapy, Parental involvement, Behavioral modification and Environmental Support. All these efforts require involvement of primary care physician, health care providers, community workers and the motivation of individual.

- Children should be offered fresh fruits and vegetables in lunches at home and at school.
- Parents should cut down outside dining.
- Healthy habits start from home so parents should be a role model for their kids. Physical activities involving whole family like biking, swimming, basketball in summer and Zumba, yoga, tread mill in winter would help in controlling weight of whole family.
- Homemaker should get in to habit of reading food labels and calorie count.
- Complex carbohydrate should be avoided and more plant protein and poultry should be included daily menu.
- Habit of eating health breakfast with 4-5 servings of fruit and veggies along with main course meals will help in reducing weight.
- People from different ethnic group should be taught to modify their food recipes according to the health benefits.
- In school lunch supervisor should be vigilant on the quality and quantity of kid's meals.
- Vending machines in school should replace junk food with healthy snacks like 2% milk, low fat or sugar free cookies, baked chips, low sugar drinks and water.
- Early morning one-hour physical activity should mandatory for all kids in school.
- Valentine day and Halloween should be celebrated with more healthy snacks instead of candies and chocolate.

If we all work in collaboration and in coordination, there is no doubt that we will not be able to achieve the goal in controlling childhood obesity. Still, we need more efforts and support from government at all levels along with individuals, organizations and communities.

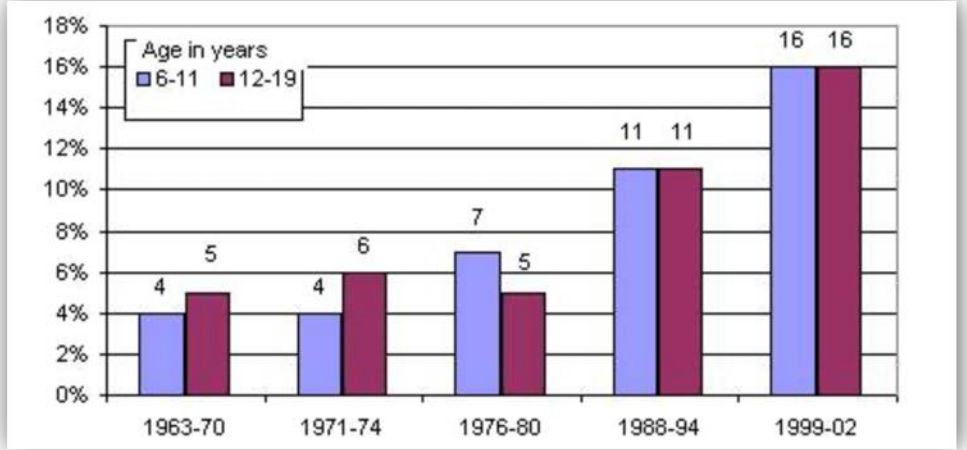


Table 3: CHILDHOOD OBESITY: FROM 1963- 2002.

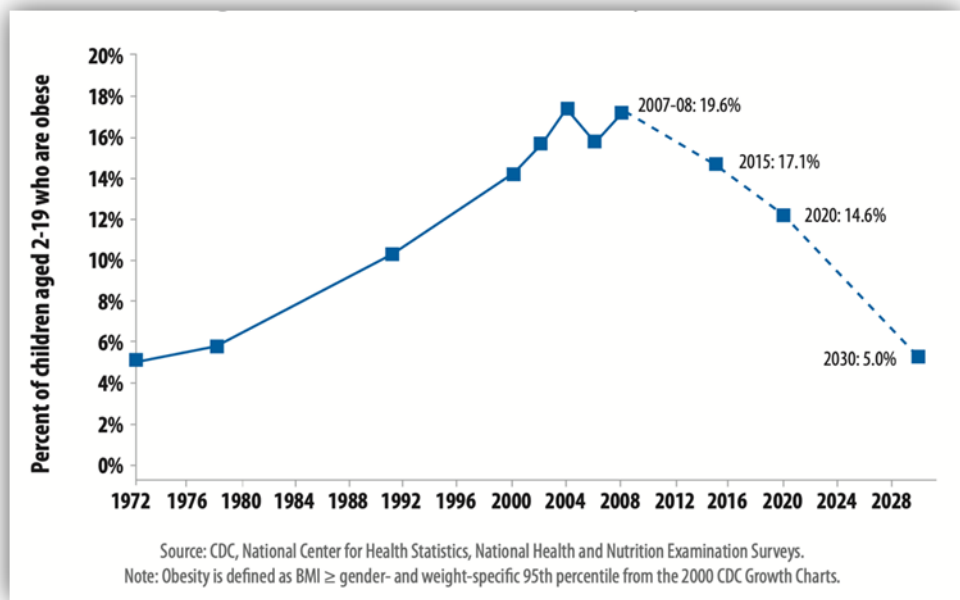


Table 2: Bending the curve: Childhood Obesity, 1972-2030.

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