Childhood Obesity, Health & Nutrition and its Effects on Learning

By Dr. Chrystyne Olivieri, DNP, FNP-BC, CDCES

Abstract

The purpose of this article is to examine the compelling evidence of childhood obesity across the world and within the United States and the major contributors to this health crisis. Factors contributing to the obesity health crisis and potential interventions are given a preliminary analysis within related research literature.

Overview of the Issue

According to the Center for Disease Control's most recent data, the prevalence of obesity is now 18.5% among youth (compared to 39.8% in adults). This statistic is slightly higher (20.6%) if one considers adolescents aged 12-19. Based on ethnicity, rates are highest for Hispanic (25.8%) and Non-Hispanic Black (22%) whereas Non-Hispanic Asians have the lowest rate (11%). Non-Hispanic white rates fall in between at 14.1% (Hales, Carroll, Fryar, & Ogden, 2017). These data are based on the National Health and Nutrition Examination Survey (NHANES), a survey research program conducted by the National Center for Health Statistics to longitudinally assess the health and nutritional status of adults and children in the United States.

According to the World Obesity Foundation: Atlas of Childhood Obesity, October 2019, the current number of children ages 5-19 years old living with obesity is 158 million individuals. This number is predicted to rise to 254 million by 2030 (retrieved from www.worldobesity.org 10/15/19).

Tim Lobstein, the director of Policy at the World Obesity Federation, was a contributing editor for this WHO document. He has been a tireless advocate in combating childhood obesity, focusing efforts on the marketing of food and beverages to children, nutritional policies and programs and on health inequalities and income disparities. Obesity, previously believed to be a factor of over-nutrition, currently is strongly associated with poor diet. New research is now linking obesity with under-nutrition. Known as the double burden of malnutrition, obesity, and under-nutrition are often seen in the same person (Dietz, 2017). This problem among U.S. children has become a health crisis within the last three decades (Tim Lobstein et al., 2015). According to Lobstein et al in the 2015 study, it is the energy-rich but nutritionally poor diet that leads to rapid weight gain. He suggests a need for improvements to governmental nutrition policies, commercial food promotion and marketing to children. Despite documented childhood weight gain, significant nutritional deficiencies co-exist, often leading to stunting (short stature).

Most Americans consume the Standard American Diet (SAD) which is very high in ultra- and highly processed foods. These food choices are very unbalanced, nutritionally speaking and can sometimes contribute to 60% of daily calories and 90% of added sugars (Eurídice Martínez Steele et al., 2016). Most ultra-processed foods are high in sugar, refined carbohydrates (like sugar and grain-based foods) and chemically altered industrial seed oils (canola, soybean and other seed oils). This phenomenon seems to be increasing worldwide. According the findings from Euridice et al., ultra-processed foods are cheap and of lower quality ingredients. However, factors like a pleasant mouth feel, enjoyable taste, palatability and sensory enjoyment make them highly desirable.

In contrast, these food choices have little-to-no nutritional value and are very high in calories. Food manufacturers work very hard to showcase the positive (taste) to disguise the negative aspects (excessive sugar leading to weight gain, poor nutritional value) of their products (Euridice Martínez Steele, Popkin, Swinburn, & Monteiro, 2017). It appears that it is the hyper-palatability, long shelf-life and portability which makes these foods so attractive to busy families and children.

Despite the fact that processed foods are easy and fast to prepare and to consume, it is this very convenience that is hurting our children. Problems cascade from these conveniences. Consumption of these convenience foods are believed to alter the brain's perception of appetite, reward and cognitive control and appears to lead to additional cravings associated with convenience foods. Obesity is often the result. Manipulation by food manufacturers goes mostly undetected by most Americans (Blechert, Klackl, Miedl, & Wilhelm, 2016). Foods like sodas and other sweetened beverages (includes fruit juice), sweet or savory snacks, reconstituted meat products, prepared frozen meals, sweetened yogurts, boxed and bagged

foods like chips, pretzels, cookies, crackers and cereals all fall into this category. Mostly all of these food choices are made with artificial ingredients (sweeteners, flavors and colors) as well as with highly oxidizable fats like seed oils and trans-fats. They are also poor sources of healthy fats, protein and fiber as well as of important micronutrients like potassium, iron, calcium and magnesium.

Efforts to try to achieve improved food fortification through enrichment have failed miserably. Lobstein et al participated in a study in conjunction with the World Obesity Federation, (2019) asserting that reducing the obesity rates (and associated under-nutrition) targets for 2025 are likely to fail. He warns those in the medical field to expect an increase in significant obesity linked health problems, especially in children (T. Lobstein & Jackson-Leach, 2016).

Health Effects associated with Obesity

Health problems traditionally only seen in the adult population like hypertension are increasingly found in children (Samuels, Bell, Samuel, & Swinford, 2015). They are often associated with obesity. Type 2 Diabetes (T2DM), a dangerous metabolic disease previously only diagnosed in adulthood, is now often found common in children and adolescents. The development of T2DM in youth is particularly dangerous for the cognitive abilities of our young people, but also for their overall health.

A study by M. Constantino, et al. on the relationship of T2DM diagnosed in youth comparing complication risk and mortality, found that the progression of complications (kidney disease and neuropathy) occurred faster and more aggressively than in adults (Al-Saeed et al., 2016). Constantino first identified this problem in a prior study about the dangers of T2DM in youth compared to type 1 diabetes and found T2DM to be the far more aggressive type of diabetes (Constantino et al., 2013).

"Treatment Options for T2DM in Adolescents and Youth" (the TODAY study), a large-scale study from 2007, examined the benefits of intensive and sustained lifestyle interventions to children from mainly racial/ethnic minorities with T2DM. It found that despite good glycemic control (blood sugar control), the metabolic abnormalities of abdominal adiposity, hyperlipidemia, hypertension and early kidney disease were not ameliorated (Zeitler, P., Epstein, L., Grey, M., Hirst, K., Kaufman, F., Tamborlane, W., & Wilfley, D. (2007). A 2013 follow up study on TODAY found that hypertension and early kidney disease progresses despite adequate glycemic control (Lynch, J., Elghormli, L., Fisher, L., Gidding, S. S., Laffel, L., Libman, I., Pyle, L., Tamborlane, W. V., Tollefsen, S., Weinstock, R. S., & Zeitler, P. (2013). Glycemic control is achievable by using pharmaceuticals however their use is limited in the pediatric population compared to their use in adults. This study suggests that lifestyle interventions (improving diet and increasing daily activities) to gain glycemic control will help preserve the health and cognitive function of our young people. Merely achieving glycemic control with pharmaceuticals only addresses the symptom of the problem. The cause of the problem, rooted in poor food choices, too little physical activity and subsequent obesity must be addressed to adequately improve health outcomes.

In addition, poor childhood nutrition is associated with increased risk of health problems when entering adulthood (Banfield, Liu, Davis, Chang, & Frazier-Wood, 2016). Poor dietary patterns that start in infancy, can also be associated with poor learning and cognitive abilities later in life. Poor school performance and low academic achievement have been linked to overconsumption of high energy foods and excess body mass (obesity) (Pearce, Scalzi, Lynch, & Smithers, 2016). This Australian study found that children who are obese in their first year of school may be exhibiting a lower level of cognition compared to their healthy weight peers. This phenomenon is believed to be evolutionary.

A 2019 paper in Trends in Cognitive Sciences authored by Mark Mattson discussed how it is not consistent with our DNA to overconsume on dietary energy (mainly sugar and carbohydrates) with little energy output (daily activity). However, that pattern appears to be very consistent with modern human lifestyles. Over several million years, humans have evolved specific eating patterns with frequent periods of food scarcity, that is not consistent with the current paradigm of eating "three meals a day."

An overconsumption of calories when eating the SAD is inconsistent with a frequent human evolutionary metabolic state known as "ketosis". Ketosis is a metabolic switch in energy utilization from sugar to fat, which cannot happen when consuming a diet high in sugar and carbohydrates and eating three or more times a day. Mattson concludes that chronic excessive energy intake is associated with impaired cognition. Specifically children's excessive abdominal adiposity in children associated with insulin resistance is the driving force in impaired cognitive function, poorer academic and occupational achievement compared to normal weight classmates (Mattson, 2019). This state of excessive abdominal adiposity in children leads to type 2 diabetes (T2DM) in youth; a more dangerous metabolic state for children than for adults since childhood, a progressive and dynamic stage of human development, is highly sensitive to nutritional needs. This condition profoundly affects cognitive development as well as physical growth.

Brain Development and Cognition in Youth

Evidence suggests that improving brain development in our children should be of utmost priority. In a study in 2016 "The Role of Nutrition in Brain Development", Cusick and Georgieff identified that children's diets often mirror their parents (Cusick & Georgieff, 2016). Poor parental food habits are passed on to their children. The long-term consequences of poor nutrition (from gestation through toddlerhood) and subsequent poor cognitive performance will cost society profoundly. They identify poor quality protein, low intake of healthy fats and poor intake of important micronutrients (iron, zinc and iodine) in the SAD to be contributing factors (**see Table 1**).

Table 1 Common Nutritional Deficiencies associated with SAD**

Micronutrient	Essential For:	Dietary Sources	Special Notes:
IRON	Necessary for oxygen transport in Hemoglobin – red blood cells Prevents Anemia	Heme-Iron: *Well-absorbed by humans* Animal Products: Red Meats, Organ Meats, Seafood and Shellfish Non-Heme-Iron: *Not well-absorbed by humans* Spinach, Kale, Collard Greens Legumes (beans, lentils)	Iron supplementation is essential in Vegans and Vegetarians. Many common iron supplements associated with constipation and dark stools Vitamin C enhances iron absorption
IODINE	Critical for fetal and brain development Essential for proper reasoning and overall cognitive function in youth	Wild-caught seafood Seaweed Eggs	Iodine supplementation is essential in Vegans and Vegetarians. Also recommended for general population if not obtained from dietary sources to support healthy thyroid function
Vitamin A	Essential for eyesight and immune function Supports cellular growth and cell differentiation	Associated with foods high in Beta-Carotene: Carrots Sweet Potatoes & Yams Winter Squash Spinach, Kale, Collard Greens	Prior attempts to fortify foods have not adequately reduced vitamin A deficiency problems world-wide - mainly due to poor absorption issues
ZINC	Immunity and resistance to infection Proper neurological growth, protein synthesis and cell division	Animal products: Meats and Eggs Shellfish Legumes Nuts & Seeds	Main ingredient in many cold lozenges. To be taken at first onset of common cold symptoms
FOLATE (Vitamin B9)	Essential for fetal neurological development (brain, spinal cord, nerves) Adequate levels known to reduce fetal neural tube defects Necessary for adequate red blood cell production	Liver and Organ Meats Legumes Asparagus Spinach Artichokes	Folate supplements VASTLY differ from Folic Acids supplements. Folate is best obtained from a healthy diet, but folate supplements may be absorbed adequately Folic Acid is synthetic and many consider toxic – not recommended

** Obtaining these necessary micronutrients from "enriched" grain products (like breads, crackers, pasta, noodles and other sources like legumes) are not absorbed well in the human gastrointestinal tract due to high levels of naturally occurring phytates. Therefore, the bioavailability of these essential micronutrients from these sources will be lower than from other sources like animal products and vegetables.

Chronic undernutrition including iron and iodine deficiencies have been found to further contribute to poor child brain and neurological development (Grantham-McGregor, Fernald, Kagawa, & Walker, 2014). This study found that children benefited from nutritional interventions including supplementation for both their development and nutritional status.

This problem is noted to begin in infancy as nutrition is important for cognitive development starting from the beginning of life. Brain development is enhanced from early childhood, having long-term effects on cognitive performance through adolescence (Nyaradi, Oddy, Hickling, Li, & Foster, 2015). Poor quality foods, processed foods, fast foods, high carbohydrate and sugary foods are not associated with a healthy brain. Healthy fats have been extensively studied to be associated with overall health and brain and neurological development (Gershuni, 2018). However, the rapidly developing brain during adolescence is particularly vulnerable to poor nutrition and it is this time of life that requires the most nutritious foods for adequate brain development (Reichelt & Rank, 2017).

Unhealthful dietary patterns were found to be associated with poorer academic achievement in an independent study done in 2019 (Bleiweiss-Sande et al., 2019). The researchers used a diverse sample of over 860 children obtained from 3rd and 4th grade in an urban school in the Boston area. When unhealthful foods like sweet snacks, salty snacks sweetened beverages and even fruit were highly consumed, math and English standardized test scores were lower compared to controls. They were surprised to find fruit to be associated similar to other sweet foods. This was not expected since fruit is generally considered to be a healthy food, although it may be overconsumed by children. Based on these findings, it may be assumed that dietary changes may positively influence child academic achievement and development.

In a systemic review from 2013, both math and language learning were found enhanced by both physical activity and improved nutrition among school age children. The implementations of school health promotion interventions was encouraged (Pucher, Boot, & De Vries, 2013). A study done on Korean children found that diet impacts cognition and learning in profound ways. Kim & Kang found a link between overconsumption of carbohydrates, specifically noodles, white rice and ramyeon (Korean instant noodle) and impairment of verbal memory, test scores and reasoning. It also found increases in inattention and impulsivity. Their study also found that the consumption of fast food and Coca-Cola was related to poor cognitive function, especially working memory, test scores and reasoning (Kim & Kang, 2017).

It is not just school work that suffers for obese and malnourished children, but also behavior issues. There is evidence that obese children have more behavior problems than non-obese children (Carey, Singh, Brown III, & Wilkinson, 2015). These researchers cited internalizing problems (low self-esteem, sadness, acting withdrawn) and externalizing problems (arguing, fighting, disobedience) along with school disciplinary problems (detentions and suspensions) more prevalent among obese children.

In light of the SAD in the U.S., Florence et al found a strong association between childhood overweight, underlying poor dietary habits and poor school performance (Florence, Asbridge, & Veugelers, 2008). Their findings suggest enhanced learning as an additional benefit of a healthy childhood diet. They also identified overweight children to have lower levels of academic achievement. Their findings affirmed that it was not specifically the weight of the child, but the poor nutrition associated with being overweight that was the problem. Overall, the daily intake of healthy foods will have the most impact on improving cognitive function in youth. Their suggestions call for improvement of school nutrition programs that also have potential to improve student's academic performance. Since this study was conducted in 2008, many schools have already started to implement nutritional improvement programs.

How Can Schools and the Government Help?

In a study conducted in Oregon in 2015, teachers were asked how to incorporate nutritional knowledge into current curriculum. Most teachers reported that current approaches to nutritional education during childhood and adolescence have been largely ineffective in changing current students' food choices. They cited barriers to change to be: competing academic expectations, lack of suitable curricula and food environment at school and home that does not support what is taught in class (Perera, Frei, Frei, Wong, & Bobe, 2015).

Despite these difficulties, schools in the U.S. are the ideal setting to implement interventions to promote nutrition and physical activity. One such school district in Chicago decided to implement their own experiential learning program to incorporate hands-on cooking for students to improve nutrition knowledge (Jarpe-Ratner, Folkens, Sharma, Daro, & Edens, 2016). This 10-week after-school cooking and nutrition course was taught at each of the 17 schools using professional chefs. Chefs completed a standardized training and were issued a curriculum upon training completion. The curricula were reviewed by a registered dietician and related to the premise that a home food environment high in accessibility of vegetables and other healthy foods predicts diet quality in children.

Parents have a strong influence on the food choices made by their children and were included in the treatment by encouraging them to attend a special presentation. This study, sensitive to cultural food variations, found that it is possible to increase healthy behaviors within a family based on an experiential cooking and nutrition education program. According to their findings, although behavior change is not easy, children's exposure to new foods, different ways to prepare them and the positive

Table 2 Natural Diet Guide to Avoid Obesity and Disease:

	Carbohydrates	Fats	Protein
GO **Green** **Enjoy Daily!**	Non-starchy Vegetables: Like artichokes, asparagus, beets, Brussels sprouts, broccoli, carrots, cauliflower, celery, cucumber, eggplant, green beans, leafy greens*, jicama, leeks, mushrooms, okra, onions, peppers, radishes, snap peas, sprouts, summer squash, spaghetti squash, tomato, turnips, zucchini Eat fruit in-season: Like blueberries, blackberries, strawberries, raspberries are best. Other low sugar fruits include pears, apples, peaches, lemons, limes, oranges, grapefruit, avocado, green bananas Fermented vegetables; sauerkraut, Kimchi	SFA*: Coconut oil, palm kernel oils, grass-fed butter, ghee, fatty fish*, eggs, dark chocolate MUFA*s: Olives, olive oil, avocado, avocado oil PUFA*: Flax, leafy greens*, fatty fish*, chia seeds Some full-fat dairy (plain yogurt, cheese)	Animal Sources: Grass-fed* and organically raised meats, wild-game meats*, pasture-raised poultry, wild-caught fish, seafood, pasture-raised eggs, liver, organ meats, unprocessed bacon Vegetable Sources: Nuts*, seeds
CAUTION **Yellow** **Eat on Rare Occasions**	Starchy Vegetables: Like beans and lentils (legumes) corn, peas, white potatoes, parsnips, plantains, sweet potatoes, taro, winter squash*, yams, yucca Quinoa, Buckwheat, Wild Rice Avoid fruit out of Season: most too high in sugar content for all year consumption Rarely eat melons and tropical fruit (ripe bananas, pineapple, papaya) - high in sugar	Flaxseed and hempseed oils	Factory raised, grain-fed beef, lamb, pork, poultry Most farm-raised fish Factory raised eggs Legumes, beans lentils, peanuts Fermented soy
STOP **Red** **Rarely, if ever, eat these dangerous, nutritionally poor & highly inflammatory foods**	Processed, Prepackaged & Fast-Foods: Anything from a bag, box, bottle, package and most cans. Includes Pizza and most take-out & convenience foods Grains & Grain Products; Like wheat, rice, corn, oats, rye, millet, bulgur, amaranth, barley, farro, triticale, teff, spelt This includes bread, cereal, pasta, noodles, crackers, cookies, muffins, cake, wraps, tortillas Sweets: Like soda, fruit juice, candy, sweetened yogurts, ice cream, cake, cookies	Chemically-Altered Oils: Canola, soybean, sunflower, safflower, corn, cottonseed, grapeseed, peanut oils Partially-hydrogenated trans-fats Margarines Low-fat & non-fat dairy (yogurt, cheese)	Highly processed meats (hot dogs, bacon, ham, corned beef, pastrami, salami) made with chemicals, dried-meats, deli meats, chicken nuggets Unfermented soy

*Fatty Fish – Include mackerel, salmon, anchovies, sardines, tuna, herring, squid, shellfish; Grass-fed meats – Beef, Lamb, Pork, Bison; Leafy greens – Include beet greens, cabbage, collards, dandelion, endive, kale, lettuce, parsley, spinach, Swiss chard, turnip greens, micro-greens, watercress; MUFA – Monounsaturated Fatty Acids; PUFA – Polyunsaturated Fatty Acids; Tree nuts – macadamia, walnuts, coconut, pecans, almonds, pistachios, hazelnuts, brazil nuts; SFA – Saturated Fatty Acids; Wild-game meats – Include venison, rabbit, pheasant, wild duck, bison, elk, caribou, wild boar; Winter squash – Acorn, Butternut, Pumpkin

social aspects associated with these activities can have a profound effect in changing the current situation of obese children and their families. (**see Table 2**).

Since 1980, the U.S. government became involved in setting public nutrition recommendations. Dietary guidelines for Americans have been published and updated every five years since 1980 in an attempt to guide healthy food choices. Unfortunately, this government policy lead by the United States Department of Agriculture (USDA) has not ameliorated the obesity epidemic. The U.S. government has also tried to implement policies to address the obesity problem among children by focusing on food at school. The USDA also sponsored the National School Lunch Program which provides nutritionally balanced, free or low-cost meals to millions of children. However, this is only one part of the solution.

The Centers for Disease Control and Prevention provides recommendations for Coordinated School Health approach, coordinating health and physical education as well as nutrition services into the school environment (Carey et al., 2015). These services are available in schools. However these interventions need to be supported both within the community and in the home. Socio-economic inequities, parental education about the importance of nutrition and physical activity may be lacking and could be addressed in a school setting as a community public service. Until nutrition education produces healthier children, parental involvement may be of specific benefit for implementation in a school setting. A structured approach is crucial to not only improving outcomes in these children, but in preventing long-term costs associated with poor student outcomes and future health problems associated with a lifetime of obesity and malnutrition.

This article outlines compelling evidence for a pervasive problem. Over the last two decades, childhood obesity remains on an upward trajectory for all age groups with obese children often becoming obese adults. The forseable future does not seem to currently be turning the tide. The continued increase in childhood obesity is likely to overwhelm the current medical systems in many countries throughout the world. There is much more to be done to mitigate obesity, the subsequent health problems, and the cognitive issues that seem to coincide in occur with too many children. In light of the presented evidence in this article, the cognitive, social and behavioral problems associated with obese children is a problem that will not likely be solved in the short term without schools becoming more involved with nutrition.

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Dr. Chrystyne Olivieri, DNP, FNP-BC, CDCES is Assistant Professor at Long Island University in the Graduate Nursing Department. She also has a private medical practice i focusing on those with all forms of Diabetes, Obesity, Thyroid disease.