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# Food Industry Practices and the Associations to Public Health: A Complex Matrix of Ethical and Social Problems

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## Abstract

The origin of the United States obesity epidemic and associated chronic diseases cannot be attributed to a single source. Factors involved are multifaceted and require an interdisciplinary approach to best analyze the intersecting points fuelling the problem. The majority of the obesity discussion will be limited to the interplay of industrial food practices and the nutritional composition of processed food. This paper discusses the management of the industrialized food system, philosophy of policy creation, the overlap of human psychology, and how these components impact current public health problems.

## 1. Management

Two-thirds of Americans are overweight or obese. According to the National Institute of Health 74% of US men and 64% of women are overweight or obese.[1] The chronic diseases associated with obesity are now becoming more prevalent. As other cultures begin to become addicted to the high fat palatable foods of the Western diet, and face the same health problems as the US, the association between highly processed foods and adverse health effects are clear. Obesity rates in developing countries are climbing.

The obesity epidemic is a problem of processed industrialized foods that are highly palatable and packed with fat, sugar, and salt. As food companies enter the market they strategize with competing factors: the need for cost reduction verses the pressure for responsiveness to adapt to customer taste.[2] Companies strive to globalize products, by increasing the processing of food in order for it to withstand longer transportation time and simultaneously be able to produce on an economy of scale that will drive down cost. When production is ramped up to an economy of scale each unit is cheaper to produce, and thus results in more profit margin per sale. Cost reduction is balanced with the demand for customization and the customer taste preferences, which are for fatty, sugary, and salty foods. Consequently when customer demand is first priority, health suffers.

Food companies must learn their customer's hedonic set points before others in their market sector or risk being pushed out by a competitor. Companies that learn to harmonize these polarities fastest will most likely benefit from the first mover's advantage and dominate in their market sector. This phenomenon has created a food industry in which practices are guided by potential profits, operating within a cost containment strategy contradictory to human health. These practices have only exacerbated the effects of an already existing issue of income inequality within US society. Nutritionally-poor food is predominantly inexpensive, this results in easy access to the lower income groups, and this poor nutrition results in health disparities. Personal food decisions have now become an issue of access as well as choice. As U.S. demographics shifted during the 20$^{th}$ century to suburban versus urban living, the industry followed wealthier predominantly white buyers out of cities, leaving many at the lower end of the economic spectrum in urban areas with little or no access to healthy foods and causing a public health epidemic.[3,4]

In their fight for a place in the expanding global market and local niches, companies are not always worried about a double or triple bottom line. Companies are striving for a sustained competitive advantage where they are

consistently turning out higher profits than any competitor in the industry. This leads companies to look for a way to stabilize their perishable food items and increase shelf life. Increased shelf life equals increased profits. Cheap and healthy don't have a symbiotic relationship, especially when it comes to processed foods.

Food companies have come up with a business savvy answer to the problem of cost reduction and customer preferences, and that is to sacrifice the health of the product for its longevity on the shelf. One way shelf life can be increased is to use hydrogenated oils. They are cheap, and they extend shelf life as well as retain a highly palatable taste. In the process a byproduct that is detrimental to human health is created, trans fats. Consumption of trans fat contributes to obesity and chronic disease such as heart disease and diabetes.[5]

Corporate social responsibility is a topic that is still being studied but its theoretical analysis has been well analyzed. Industrial food companies are pressed by placement of blame to consider more than just their net profit bottom line because of the obesity crisis. The link between diet and health is clear, but is it the companies' responsibility to consider something more than its bottom line?

Donaldson and Davis' Stewardship theory asserts "There is a moral imperative for managers to 'do the right thing', without regard to how such decisions affect firm performance."[6] Are food companies responding to the need to improve consumer health because of the increasing obesity epidemic or are their actions following marketing trends? As customers become more aware of the nation's health problems an increased number seek out healthier options. This has lead to a change in how companies package and promote their product. Food packaging now has healthier facade that advertises buzzwords consumers associate with health. There has even been new terminology to describe this deceptive practice. "Greenwashing" has been associated with deceptively making a product more environmentally friendly, while "healthwashing" is associated with deceptively overstating the positive health affects associated with consumption. It is not a socially responsible response to the public health problem. Until there is a shift in motivations the food company that moves toward "healthier options" cannot be considered a socially responsible one. The question still remains whether social responsibility is a corporation's responsibility at all. Milton Friedman a respected American economist that taught at the University of Chicago for over three decades said, "The social responsibility of a business is to increase its profits."[7] And Robert Kreitner, PhD, international management professor at Arizona State University and author says, "A business has a social obligation that goes above and beyond making a profit"[8]

Archie Carroll, an ethics scholar who teaches corporate and social responsibility at Terry College of Business and University of Georgia, created the global responsibility pyramid (adapted below). The pyramid indicates the four areas of business that need to be functional for a corporation to be considered socially responsible. Social responsibility, or lack there of, is a philosophical point of discussion when addressing responsibility as it pertains to the public's battle with obesity. The food industry continues to use and produce products that are damaging to human health to extend shelf life and thus increase profits. For example, food marketers are aware of how the sensory system can be triggered to excite the brain's reward system, and this knowledge is used in advertisement to cue human biological drives that motivate people to consciously and subconsciously eat more. Blame is hard to place though, considering the responsibility of purchasing and consumption lies with the consumer. Persuasive arguments on both sides of the debate continue; ethical business practices of companies within the food industry verses the responsibility of the consumer to decide what they are willing putting into their bodies and how much.


Figure 1. Carroll's global responsibility pyramid. [9] Adapted from Carroll, 2009

A strong argument for the responsibility of consumption being placed on the consumer is the success of Wal-Mart. Wal-Mart's inventory management techniques have created huge shifts in the supply chain system. Wal-Mart's technique and technology have changed the inventory system from a "push system," where inventory replenishment was based on the anticipation of increase or continued customer demand, to a "pull." The "pull system" approach relies on customer preferences and demand to move product along within the logistical supply chain. The "pull" system has been more efficient and has created a vast amount of reactive flexibility that the "push" system lacked.[10]

In 1969, Wal-Mart had eighteen locations, and grew rapidly through the 1980's. By 1984, Wal-Mart had 640 domestic stores. It had mastered local customer preferences in small towns; it had found success and its niche in the market by adapting to customer demand. In 1992 Wal-Mart started its international ventures, growing to a size that allowed it to take advantage of the cost reductions associated with working on an economy of scale. Based on its revenues, in 2002, Wal-Mart emerged on the global market as the largest company in the world.[11] In the fast paced change of the continually globalizing market, Wal-Mart had successfully dominated a domestic market and then a global one. This was in thanks partly due to flexibility and efficiency of the "pull" inventory system that stocked customer demands. Wal-Mart had harmonized customer preferences with large scale cost reduction, and it was turning them large profits. It is a successful model that others have tried to copy.

What is a business success story telling us about health? The "pull" inventory system that relies on customer preferences and demand to move product along within the logistical supply chain is successful and giving people what they want makes money. If low cost food products that are high in fat, sugar, and salt are what people want and giving people what they want has been a recipe for success in business then business must first address their most important concern regarding survival, their bottom line profit. With whom should we place blame, business for providing low cost food that can be detrimental to public health, or the consumer that continues to demand it?

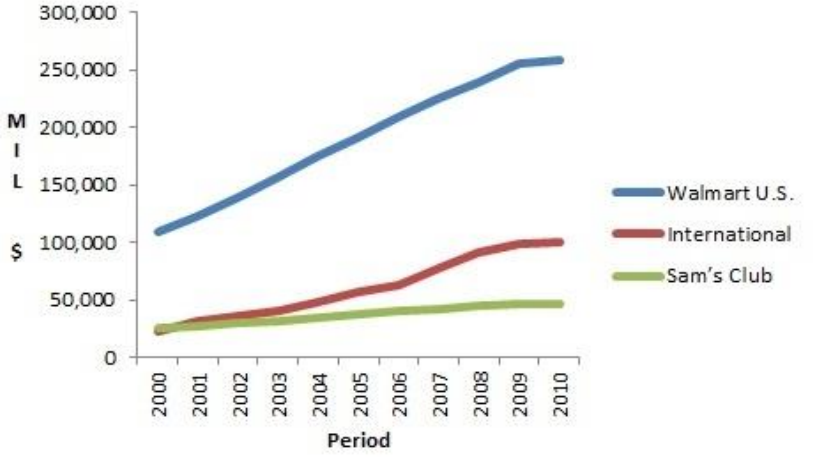


Figure 2. Trend of Wal-Mart's revenues over the last ten years. [12]

The obesity crisis has given customers a heightened interest in health; Wal-Mart also noticed the market trend toward healthier options. Perceived health has become an important marketing tool and with little or no education the consumers are vulnerable to well-advertised products that offer very little in the way of health. Wal-Mart has kept up with the emerging health trend and publically announced an initiative to work with food processors to lower the amount of sugar, fat, and salt in the products they carry. This initiative proposes to have healthier processed options on the shelves by 2015.[13] Wal-Mart realized the link between highly processed food filled with sugar, fat, and salt and the public health epidemics as well as the link between perceived health and profits. While the initiative seems to be positive shift toward health consciousness, it has been criticized for having low health standards. This has left critics to wonder if Wal-Mart's initiative is a marketing ploy or an honest attempt at improving public health.

Food industry research and marketing has also increased the standard portion size. Customers also like to feel like that they are getting a good deal for their money. Increasing plate and portion sizes gives the customer this sensation with only marginal added cost for the restaurant, increasing profits for everyone along the food manufacturing supply chain. More food being purchased by the consumer equals more profits for every capitalist within the supply chain.

Mike McCloud, a former executive for Coca-Cola, worked on a project at Coca-Cola's headquarters in Atlanta. The focus of this study was to drive up soda sales by shifting the standard small cup size of eight ounces up to a twelve ounce cup. Working with other large food industry companies such as McDonald's and Burger King, McCloud and team were able bring these industry giants on board with their increased portion idea, citing that everyone was to stand to make more money since soda has about a ninety percent profit margin. It wasn't hard to make their case to McDonald's. McCloud said, "We had to convince everyone that 90 percent of a $1 is good, but wouldn't it be great if we could get you 90 percent of $1.50 by adding another 3 cents' worth of product?" With this rationale, McCloud and team were able to shift the standard industry small from an eight ounce cup to a twelve and double the standard industry large from sixteen ounces to a thirty-six ounce cup. [14]

This one example of Coca-Cola using smart economics to change industry standards to generate a heftier bottom-line is not unique as portion sizes continue to grow nationwide. Cost is driving consumption. McCloud has said, "In lieu of real food, the industry is baking with "a chemical mix of preservatives and oil." "In his view, it's the low cost of readily available fats and sugars that drives their use. "If McDonald's could sell anything and make money at the same rate that they're doing now, they couldn't care less whether it was fat or sugar-laden. It just happens to be that fats and sugars and flours are some of the least expensive food items we have in the world."[15]

It is these types of industry practices that are often met with the ethics questions. Is it ethical to use psychological research that has endless funding from industry giants to essentially trick the consumer into eating more for a few extra cents of profit, knowing full well there is an obesity epidemic in the United States that is being fueled by these types of industry practices; or, is it smart business to sell to people who will buy it?

## 2. Policy

When analyzing the factors that contribute to creating Public Health issues narrowing the view to only governmental policy would be remiss. Understanding goals of corporate policy is just as important as governmental. Due to strong corporate lobbying governmental and corporate policy can be one in the same. This type of pressure from food industry players has lead to policy creation that has put profits over people, and the public's health has suffered.

One example of governmental policy succumbing to the pressure of industry lobbyists is the controversy that surrounds the revision of the food pyramid. Every five years the U.S. Department of Agriculture revises the dietary guidelines recommended to the public. In 1991, "The USDA blocked publication of the 1991 *Eat Right Pyramid* under pressure from meat and dairy groups objecting to the position of their products in its hierarchy."[16] The USDA responded to the meat and dairy industries complaints that claimed the *Eat Right Pyramid* stigmatized their product via placement. After a year of review and an additional million dollars of taxpayer money the *Eat Right Pyramid* was revised and *The Food Guide Pyramid* was released to the public. The USDA is mandated to protect agriculture as well educate the general populous about diet and health.[17] Here lies a conflict of interest that creates conflict in policy creation. This conflict of interest is an ongoing problem. In 2010 the USDA was met yet again with strong lobbying by National Pork Producers, Egg producers, The Sugar Association, and The Salt Institution.[18] The lobbying parties were in opposition to the latest food pyramid revision and all sought to undermine dietary advice.

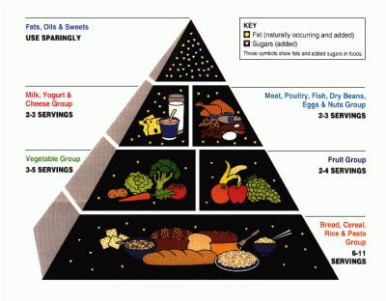

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Figure 3. USAD guidelines 1991.

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Figure 4. USDA guidelines 2010.

The creation of policy intended to regulate factors that are contributing to obesity is grey area, that won't necessarily benefit from traditional political philosophy. John Rawls, a moral and political philosopher, wrote *The Theory of Justice*, which has been used as "the text" for American political philosophy. Rawlsian philosophy of ethics teaches that we should consider what is just when creating policy. How one comes to determine what is just or moral for anyone and everyone is to consider an issue from behind the veil of ignorance. The policy maker is to forget his or her status within the socioeconomic strata, society, and then consider what he or she would want the outcome to be if they didn't know if they stood to benefit from their decision. It is a technique intended to make "disinterested" policy makers, and thus to create legislation that is just.[21] Although Rawl's philosophies are employed in many areas of our governmental system, when deliberating on policy regarding our food system to curtail obesity and chronic disease there arises an issue of equity vs. equality. Rawl's philosophies are tailored to produce equality but when discussing food access and health disparities a strategy of equity needs to be employed for effective change, as we see later from the results of Brazil's equitable Zero Hunger program.

Food justice is a movement that addresses inequity in food access especially fresh nutrient-rich foods. It is also closely linked with economics and business strategy. Business strategy has produced profitable economic outcomes that have deeply affected food access. Industrialized highly processed foods happen to be the worst for human health as wells as the cheapest leaving them more accessible within the budgets of those in low socioeconomic brackets.[22] Many of the business savvy decisions that lead to large profits in the grocery chain industry have had unforeseen consequences for residents of low-income inner cities. Profitable business decisions have had the unintended consequence of creating vast inequities in access to food.[23]

In the 1960's and 1970's a shift in food retailer policy to target white middle class suburban families has externalities that creates food access issues for inner city demographics. With the increase in population the food industry has industrialized to meet demands. As populations and demographics change so do food retailer's focus.

Food retailers shift their policies to focus on this increasing demographic which happens to be white middle class. Large-scale grocery stores started to migrate to the suburbs during the 1960s and 1970s following the dollars of middle class white families. "Over the last fifty years major grocery chains have sought suburban locations to accommodate larger stores, more parking spaces, and higher profits." [24] The low- income minorities that remained in the city were left with conditions referred to as food deserts. This issue remains relevant. With limited access to food, especially fresh plant-based whole foods, nutritional deficiencies are on the rise along with chronic health issues. "Food, and poor nutrition in particular, is a risk factor in four of the six leading causes of death in the United States-heart disease, stroke, diabetes, and cancer."[25] "The market-driven relocation of groceries to the suburbs left behind the conditions for a public health disaster."[26]

If one is making a decision blind to his or her socioeconomic status one's deliberation might be invaluable when considering the distribution of ill health is skewed. Rudolf Virchow, a German physician and father of modern pathology, believed that politics and medicine needed to be studied together as a social science. What he pointed out is that the disease of a population can be traced to that society's defects. The health of a population is indicative of the health of society and its governance. The distribution of health disparities in the United States indicates our societal ills as a country.[27]

When it comes to health in the United States the individuals with the highest rates of obesity and chronic diseases are at the bottom of the economic ladder, therefore, ill health is disproportionally skewed toward the lowest income. Education and income are the most telling indicators of adult health.[28] So those that are most likely to be the non-producers of society are the ones that need the most support from it. The United States government doesn't have the extra capital in a down economy to put up the amount of funding that has shown impactful results in other countries. Reallocating the needed funds from another sector, such as the defense budget, seems unlikely due to an ideology that has yet to make public health and nutrition a priority.

This causes the issue of policy creation and regulation to demand equity instead of equality. To have a real impact on the proliferation of obesity the program funding, policy, and regulation would have to be need-based. Need-based is not an idea that has been well received in American politics. A need-based system brings Karl Marx and socialism to mind for many people. It was Karl Marx who said, "From each according to his abilities', to each according to his needs." How do we create American policy that will positively impact health without singling-out specific demographics? From the condition of the American population and the height of which the obesity crisis has reached some people have a clear need for paternalism. How do we balance the need for paternalisms without infringing on people's freedom to make decisions about what they choose to eat?

The Brazilian government that functions in the same environment of vast income inequalities as the United States has decided to address their food justice issues with a program called "The Zero Hunger Strategy." The program has produced impressive measurable success addressing food justice issues. Policy changes were made that mandated continuous access to nutritionally healthy foods a human right, creating Law No. 11346 in September 2006. Law No 11346 states "This law grants the status of public policy to food and nutrition security, thus requiring the State to enforce the universal right to regular and permanent access to good quality food in sufficient quantities, based on healthy food practices which respect cultural diversity and which are environmentally, culturally, socially and economically sustainable." These policy changes have improved childhood mortality rates, chronic malnutrition, and food insecurity. These improvements place Brazil in the high performing category on the United Nations Human Development scale.[29]

How has Brazil managed to generate this amount of success? Brazil differs from the United States in that it currently has one of the world's largest economies due in part to oil reserves and agricultural exports. This has allowed them to spend a massive $35 billion on their "Zero Hunger Strategy" program to achieve these results. They also have leftist leaders Luiz Inacio (Lula) and President Dilma Rousseff (Lula's successor) that favor redistribution of wealth to decrease the countries income inequalities. Both leftist leaders have supported aggressive economic expansion and big business and have taken a portion of the proceeds and redistributed it to the poor where food injustices are disproportionately skewed. For change similar to what Brazil has achieved to happen in the US, the United States policy makers need massive resources at their disposal as well as to adopt a shift in ideology that would view food as a human right. [30]

## 3. Psychology

What drives the desire associated with food? The secrets to attraction and impulse to eat can be found deep in the electro-chemical circuitry of the brain. Neurons are the electro-chemical messengers of the brain. When we eat

chemicals are released that travel through this network exciting it. The more exposure a neuron has to a particular stimulus, the more it develops a preference for that stimulus, firing more, becoming more excited the next time it encounters this particular stimulus. This creates a stronger association with the stimulus; this is referred to as Hebbian plasticity. The message to eat this stimulus again is now amplified and the motivation to pursue this stimulating food is more intense.

A study conducted at Carleton University investigated rats' incremental willingness to work for food. They found that the rats were willing to work harder to receive a reward of sucrose water at each increased increment of sucrose level, until the level of sweetness went past the point of palatability for animals. The pursuit of reward becomes stronger the more palatable the food. Increase the palatability of sugar by adding fat and animals are willing to work even harder. [31]

This experiment reflects what we know about neural behavior. Once the rats' reward system had been excited and encoded with the sucrose water, their motivation to receive the reward again was amplified and they were willing to work harder to get it. This is the same association made in the human brain. Edmund Rolls, a professor of experimental psychology at Oxford University has researched the effects of neural sensory stimuli with functional magnetic resonance imaging (fMRI). Foods that are highly palatable are most excitatory to the neural network creating the strongest drive to seek them out.[32] Highly palatable foods laced with sugar, fat, and salt are most excitatory to the brain and this is why we always want to eat what is the worst for us. Marcia Pelchat of Monell Chemical Senses Center explains that by eating the foods that you find most enticing today the urge to eat them tomorrow will just be even stronger. [33]

Not only are highly palatable foods excitatory to the brain they are pleasurable as well. Highly palatable foods produce opioids or endorphins, the so-called "happy chemicals" which have a similar effect within the brain as drugs. These chemicals are part of the opioid circuitry. When the brain's neurons that respond to taste are stimulated in the lower brain the opioid circuitry is stimulated and endorphins are released. The lower brain is where neuroscientists think neural pathways of habits are being imprinted creating a bottom-up stimulus response conditioning. The sensory information is then relayed from the lower brain to the midbrain and on to the nucleus accumbens area of the brain that is central to reward. This cascading reaction within the body is perceived as pleasure to the consumer. This reaction can also be interpreted by the consumer as pain relief and stress reducing making it understandable why people seem to be not only physically addicted to food but psychologically as well.[34]

Dr. Kessler and his colleague Dana Small of John B. Pierce Laboratory and Yale have been investigating what drives some to eat more than others. They have been working on the biological mechanisms that are driving people's relationship with food. They have studied particular behavioral and biological differences in those that are driven to over-eat and those that seem unaffected by the lure of foods. They have identified a condition that has been accurately named "conditioned hypereating." Dr. Kessler and Small found those who score high on the conditioned hypereating questionnaire about thought patterns and will power as it relates to food also had visible differences within the reward centers of their brains.

When looking into the reward centers of these high-scoring participants it was evident that they were experiencing hyperactivity in the amygdala, an area of the brain that allows for anticipation of reward. These participants responded to the cues of food smell with increased amygdala activity as expected in low-scorers. What was interesting is, in the conditioned hypereaters group the enticement of the smell did not reduce over time like in the low-scores; but became more pleasant as time went on. The amygdalas of conditioned hypereaters group continued to show high levels of activity past the point of anticipation of reward and into the consumption phase. This discovery is evidence that the population of people showing the symptoms of conditioned hypereating is even more vulnerable to reinforcing effects of the body's reward system. Eating highly palatable foods for these conditioned hypereaters is only going to continue to enhance the circular-cycle to eat more rewarding foods.

As science learns more about what drives eating and our reward system, a drug that was pulled from market in 1997 has taught science something about suppressing the drive to eat and our reward system. Proven to be dangerous because of its effects on the heart, the popular diet drug Phen-fen was effective at treating obesity. Phen-fen worked on two chemical neurotransmitters dopamine, which is associated with reward-driven learning, and serotonin, which reduces the activity of reward pathways. Patients actually reported completely different thought patterns while on the drug. They were freed persistent compulsive thoughts surrounding food. Many of the doctors poled said Phen-fen was the most effective drug therapy they ever had for treating obesity. Lessening the effectiveness of the reward system can reduce drive and encoding, making a behavior like unconscious eating less likely to become a bottom-up stimuli response habit.[35]

Wal-Mart is a solid example of how demand for the type of foods customers become addicted to and habitually eat drives the availability of products on the market. Work behind the scenes influences the market as well; food marketers work on how to get customers to buy and consume larger quantities by increasing industry standard sizes.

The food industry is continuously funding psychological research to guide their product marketing and make products irresistible to the consumer cueing them to eat more. One example of this type of research into the psychology of food was study done by the food manufacturer, McCormick, who dubbed their study Crave It!. The goal of their research was to decode what creates craveability for consumers. The study was able to categorize their respondents into four groups: the classics, the variety seekers, the imaginers, and even the nutrition-focused group. With this information food manufactures and restaurants now have a narrowed and targeted insight into how to present food to each of the four groups to induce craveability. "Take the basic hamburger as an example. Serve it on a bun with a little ketchup, and it suits the classics. Add onions, bacon, and three layers of cheese, and variety seekers are happy. Market it with images of a summer barbecue, and imaginers can't get enough. Eliminate the bun and label it a low-carbohydrate burger, and you'll satisfy those thinking about nutrition." "It takes full advantage of a substantial body of research showing how sensory cues- variety on our plates, food packaging, lighting, noise level, and other aspects of restaurant ambience, along with social setting- can stimulate intake" [36]

The knowledge of how the body's chemical systems respond to the sights, sounds, and smells of food is not only privileged to the scientific community. This is information that food industry research and marketing use to trigger human cues to crave. Cues are everywhere, visually as billboards on the side of the road, the smells that fill the mall as customers pass a Cinnabon, and even the sound of clanking ice cubes and fizzling carbonation of a soda before a movie. Advertisers have learned that engaging the senses cue people to consume. Being aware of the triggers that cause cravings can help us to become more aware of our own drives and realize when we are hungry verses when we have been drawn in by an effective advertisement.

## 4. Health and Wellness

Obesity is not simply just a problem of chronic overconsumption. The consideration for the type of food being ingested as well has how the body metabolizes it must also be taken into account. Physiology, lifestyle, stress, psychological factors, sleep patterns all intertwine to make health very individualized topic. Food has become more industrialized and the composition has changed to become more calorie dense and nutrient insufficient. This means that a person could over-consume, be gaining weight, and still be malnourished. Theses calorie rich foods filled with high fat, sugar, and salt are more readily available than ever before. Soda and vending machines are everywhere, even schools. Everywhere the American public turns processed food is there, easy, convenient, and tempting. Advertisers have made sure that if a consumer is not out of the house where food and advertisement is present they are being reminded of it at home as well. Children watch an average of 5,500 food commercials per year and when asked to distinguish between what was healthy and what was not, children were more likely to (incorrectly) choose the product that was more highly advertised rather than the healthier one. [37]

Sedentary lifestyle is also contributing to obesity. The more physical activity a person gets the more calories they burn. Television, computers, and video games are contributing to this sedentary lifestyle. Children considered heavy TV watchers viewing 4 or more hours of TV have significantly more body weight than light TV watchers. They are more likely to smoke and questions about their social skills to deal with peer pressures have been raised by researchers. Heavy media users are also estimated to sleep an average of two hours less a night. This sleep depravation affects the proper function of the stomach stretch receptor hormone leptin that signals the consumer's brain they are full and to stop eating. As a result the tendency to overeat as well as the reduced time spent in slow wave sleep puts these children at a higher risk of developing type 2 diabetes.[38] "Since 1988 the incidence of childhood obesity in the United States has doubled among children ages 6 to 11 and tripled among 12 to 19-year-olds. These youth are at risk for heart disease, diabetes, sleep apnea, joint problems, and high blood pressure."[39]

Obesity itself is not a chronic disease but a risk factor for many. The trend in increased obesity correlates with the increase of diabetes, implying causation. According to the CDC diabetes kills nearly 70,000 every year, a relatively meager number when compared to the deaths per year from heart disease or cancer. However, diabetes can be reversed and controlled by diet and lifestyle changes, yet prescription drugs are the plan that most treatments take.

Type 2, diabetes mellitus is a disease of the endocrine system. When high blood sugar is detected the pancreas triggers the release of insulin. In response to the release of insulin cells with appropriate receptor sites will transport the glucose into the cell. This then lowers the amount of glucose circulating in the blood and signals insulin to shutdown its release returning the body to homeostasis. This is refereed to a negative feedback loop. Poor dietary choices can affect the endocrine system and can cause insulin resistance. When this happens the body is making enough insulin but the cells have become resistant to insulin's signal to allow sugar in. This results in the level of sugar circulating in the blood to remain high. A person with a blood glucose level greater than 126mg/dL is considered to be a diabetic; the normal range should fall between 70 and 100mg/dL.

Poor dietary choices that result in high consumption of fat, sugar, and salt along with sedentary lifestyle are major contributors to the development of diabetes. When a person ingests a diet that is high in refined sugars, items that have a high glycemic index, their blood sugar is spiked quickly, rather than a healthier steady increase and decline. The body's response is to release a flood of insulin until circulating blood sugar levels drop. Over time these target cells with appropriate receptor site for insulin become accustomed to excessive demand and high levels of insulin requiring more and more to get the cells to uptake sugar. This is insulin insensitivity.

Dietary fat also contributes to insulin resistance. A study done by the Garvan Institute of Medical Research was on the dietary fat composition of rats. Researches tested the effects of three different types of fats, including polyunsaturated fats, monounsaturated fats, as well as saturated fats. Fat molecules have a long chain or tail that carry hydrogen. Polyunsaturated fats carry more than one kink in the tail and each slot available for hydrogen is not filled. The configuration of multiple kinks in the tail of polyunsaturated fats makes it difficult for the chains to consecutively fit on top of each other and create a solid structure. Monounsaturated fats have only one kink in their tail this makes stacking them on top of each other to create a solid wall easier than polyunsaturated fats. Saturated fats have hydrogen in each slot available along its chain, making the chain completely saturated with hydrogen. The tail of a saturated fat is straight lacking any kinks and is easiest to build a solid stable structure with. The shape of polyunsaturated and monounsaturated fat makes it difficult for these fats to create a solid plaque inside the vessels of the body. Saturated fat has a long straight solid chain that allows the next fat molecule to easily build on top of it and form plaque within blood vessels. Saturated fats are the prefect shapes for plaque building that can result in atherosclerosis and this is why they are the worst for human health.

The results of the study done by the Garvan Institute of Medical Research reflected the hierarchy of fat as it relates to human health through insulin resistance. A diet high in fat contributes to insulin resistance. The study showed that the group of rats that were fed a diet of saturated fats was significantly more insulin resistant than the rats fed a diet of polyunsaturated or monounsaturated fats. Not only can dietary fat affect insulin sensitivity, the amount of body fat present can as well. The amount of adipose tissue or body fat that a person carries can affect insulin sensitivity levels as well. Excess body fat as well as sleep deprivation can release the stress hormone cortisol, which also negatively impacts insulin sensitivity. [40,41]

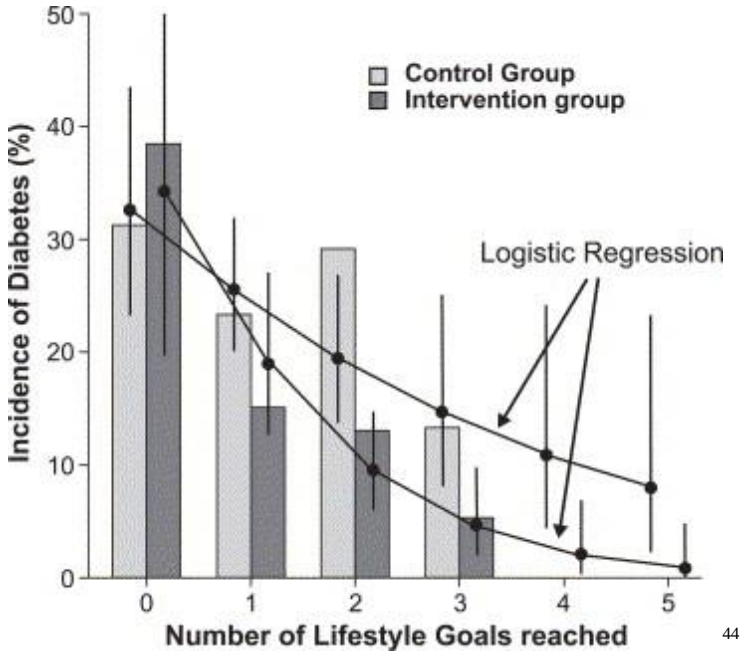
Insulin resistance can affect how the consumer's body metabolizes the food taken in. The deficiency in insulin to the cells affect how fats, sugars, and protein are metabolized resulting in higher levels of all three to be circulating in the blood. These extra particles in blood cause the solution to become hypertonic and as a result blood is more viscous. This increased viscosity has a damaging affect on the small capillaries causing them to become stiff and hard in a process called microangiopathy, which decreases blood flow to tissues. The thickened blood has a hard time flowing through the smallest vessels of the body, capillaries, damaging them with small blockages or hemorrhages. This is especially damaging to the eyes, kidneys, and peripheral vascular system because of the large amount of capillaries in these areas. Long-term capillary damage can lead to blindness, retinopathy, kidney disease, nephropathy, and nerve damage, neuropathy.

A diet high in salt in excess of a gram a day can contribute to hypertension. While hypertension has many contributing factors, increased salt intake has been linked as one. Hypertension is increased pressure inside the blood vessels of the body. This creates strain on the vessel walls, weakening them. In combination the dietary effects of salt, fat, and sugar increase pressure on the vessel walls. Fat builds up plaque inside arteries narrowing the lumen further increasing pressure. The effects of a high sugar diet increased blood viscosity resulting from insulin resistance. These affects in combination wreak havoc on the cardiovascular system. The compounding effects of poor diet are why cardiovascular disease and diabetes are usually comorbidities meaning one is usually found in the presence of the other. [42]

Converting to a diet that is low in fat, sugar, and salt can have dramatic reversing effect on diabetes as well as improve indicators such as blood pressure and cholesterol of comorbidities like hearth disease. Not all cells in the body require the hormone signal from insulin to transport sugar into cells. Cells of the digestive track, of the brain, and most importantly skeletal muscles cells can uptake sugar from the blood stream with out the need for insulin. This becomes an important fact in lifestyle changes needed to regulate diabetes. This allows a person to be able to exercise and the circulating blood sugars be taken-up and burned off to reduce blood sugar levels by the musculoskeletal system.

Diet and lifestyle modification that best improve insulin sensitivity recommended by Martin O. Weickert of the Warwickshire Institute for the Study of Diabetes, Endocrinology and Metabolism are: an energy-reduced diet to address to prevent future fat storage, physical activity that will lower circulating blood sugar levels and increase the body's sensitivity to insulin, and weight loss because decreased amounts of adipose tissue almost always increases the body's sensitivity to insulin. In a study of Nutritional fats and the risk of type 2 diabetes and cancer by the Division of Endocrinology, Diabetology and Clinical Nutrition, Department of Internal Medicine, Switzerland

patients were assigned lifestyle change goals and the incidence of diabetes over five years was tracked. The patients that met more of the diet and lifestyle goals over the five-year period had less incidence of diabetes. Patients were asked to reduce body weight by five percent or greater, fat intake be thirty percent or less of total caloric intake, saturated fat be less than ten percent of total intake, fiber consumption increase to fifteen grams or more, and to exercise four or more hours a week. [43] Corresponding results for the met number of lifestyle goals can be seen in the chart below.



[44]

Figure 5. Lifestyle goals and incidence of diabetes.

## 5. Conclusion

The severity of the United States obesity and chronic disease epidemic cannot be traced to a single source, but the condition of American public health is indicative of under-lying social problems. To quote Rudolf Virchow "the disease of a populous is traceable to defects in society."[45] The food industry seeks to turn profits with cheap ingredients and low-income households try to stretch budgets by turning to calorically dense foods that compromise nutrition simultaneously leading to overconsumption;[46] this is the intersection of an under-lying social problem of inequity amongst the population. The discussion about what or who is at fault, food industry, remiss policy makers, or personal responsibility of consumers is ongoing. The obesity epidemic has caused health disparities that have highlighted an under-lying issue of income and education inequality. Although the factors that contribute to the public health epidemic continue to expand, a singular solution on an individual level is becoming clearer. For those who are privileged enough to afford changes, a lifestyle change including exercise and appropriate sleep as well as an energy-reduced diet containing whole foods high fiber, low in fat, sugar, and salt can drastically reduce the incidence of obesity and diabetes while reducing the risk and complication of comorbidities such as heart disease, cancer, and stroke.

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