PALEOLITHIC PROTECTION IN A WESTERN WORLD: A LOOK INTO PREAGRICULTURAL NUTRITION AS A REMEDY FOR THE DISEASES OF CIVILIZATION

by
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I dedicate this thesis to the children and adults who suffer from noncommunicable diseases such as diabetes mellitus, heart disease, and cancer, in hope that one day their pain will be alleviated. And to my parents, I hope this achievement stands for the sacrifices you have made for me so that I may have great and numerous opportunities in my education and life.

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ABSTRACT

EMILIE ROSE CARON: Paleolithic Protection in a Western World: A Look Into Preagricultural Nutrition as a Remedy for the Diseases of Civilization
(Under the Direction of Dr. Susan Pedigo)

The aim of this investigation is to discover the associations of the Western diet to noncommunicable diseases and to determine if a reversion to a Paleolithic diet will provide treatment and prevention of these diseases. Noncommunicable diseases, otherwise known as "Diseases of Civilization", are lifestyle influenced diseases and encompass obesity, diabetes mellitus, cardiovascular disease, and associated cancers. Incidences of these diseases have skyrocketed in the past century and show no signs of decline. Since 1900, the death rates due to heart disease and cancer have risen to account for 47% of total deaths in the United States in 2010. (Tippett, 2014) This investigation provides a look into the influence of processed foods, fast foods, and the biochemical processes of the human body to discover the effects of diet on disease. Based on the results of this investigation, the Paleolithic diet serves as an ideal diet to follow in order to prevent contraction of noncommunicable diseases. However, execution of this diet is very difficult. Therefore, small steps towards the dietary habits of Paleolithic people such as purchasing seasonal, locally grown food, avoiding processed foods and fast foods, and spending more time cooking and learning about healthy foods could begin to change the effects of this epidemic.

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LIST OF ABBREVIATIONS

BMI	Body Mass Index
BP	Blood pressure
CDC	Centers for Disease Control and Prevention
CHD	Coronary Heart Disease
GH	Growth Hormone
GI	Glycemic Index
GL	Glycemic Load
IGFBP	Insulin-like Growth Factor Binding Proteins
IGF-1	Insulin-like Growth Factor-1
IGF-3	Insulin-like Growth Factor-3
HDL	High Density Lipoprotein
LDL	Low Density Lipoprotein
MetS	Metabolic Syndrome
MUFA	Monounsaturated Fatty Acid
NCD	Noncommunicable Diseases
PHVO	Poly-Hydrogenated Vegetable Oil
PUFA	Polyunsaturated Fatty Acid
SFA	Saturated Fatty Acid
TFA	*trans*-Fatty Acid
WHO	World Health Organization

INTRODUCTION

In the past century, the pervasiveness of processed and prepared foods has revolutionized the modern human diet. The daily food choices of the average modern person vary widely from that of the Paleolithic era. Humans are no longer hunting and foraging for their own food, but they are also not consuming the beneficial foods that are available from this form of self-preservation. Take a hypothetical and typical diet of a 12-year-old American boy: for breakfast, a bowl of Honey Nut Cheerios with skim milk and a tall glass of orange juice; for lunch, a peanut butter and jelly sandwich with potato chips, a gummy fruit snack, candy bar, and soda; for dinner: macaroni and cheese and a bowl of chocolate ice cream for dessert. Observably, the diet does not consist of a variety of vegetables, healthy fat, antioxidants, or lean protein—food groups that contain highly nutritious macromolecules essential for the proper functioning of the human body.

Today, food has become increasingly more about convenience, and the most convenient and easy to prepare foods often contain high amounts of sugar and carbohydrates (O'Keefe & Cordain, 2004). Synthetic carbohydrates, salt, and sugars are inexpensive to produce, and therefore flood super markets and particularly, low income homes. Once consumed, the sugary, processed food breaks down into glucose and is absorbed within the small intestine into the blood stream to be transported for use throughout the body. The circulating blood glucose initiates the release of insulin, which signals the body to take up the glucose and store it as glycogen and triacylglycerol. Both can be used later to maintain healthy circulation of nutrients between feedings. Insulin and glucagon are the two key hormones that maintain the blood sugar and lipid levels in the body. When circulating blood glucose is low, glucagon is signaled and the liver store of glycogen is converted into glucose and released into the blood stream. Insulin and glucagon help to maintain a blood glucose concentration of about 90 mg per 100 mL of blood (American, 2015). The problem with the modern diet, however, is the constant uptake of glucose. When the human body is receiving copious amounts of glucose for a long period of time, the sensitivity to insulin decreases (known as insulin resistance)—causing dysregulation of lipid and glucose homeostasis in the body. The liver fails to convert those glucose molecules to glycogen efficiently. In addition, the level of circulating glucose and lipids increase, leading to serious vascular problems and weight gain compounding an already compromised condition (Freudenrich, 2001). This is known as type II diabetes, an epidemic in modern day America. According to the National Diabetes Statistics Report, in 2012, 29.1 million Americans (9.3% of the population) had diabetes. Even more concerning, is that 86 million Americans 20 years and older had prediabetes. Diabetes is also the 7th leading cause of death in the United States. Diabetes has a strong correlation with cardiovascular disease: adults with diabetes are two to four times more likely to have heart disease or a stroke than adults without diabetes. According to the American Diabetes Association (2014), diabetes is considered to be one of the seven major risk factors for cardiovascular disease.

Cardiovascular disease accounts for 17.3 million deaths worldwide per year, and it is expected to grow to at least 23.6 million by 2030 (National, 2015). The most common disease of the heart is Coronary Heart Diseases (CHD), and is caused by atherosclerosis in the arteries of the heart. Atherosclerosis is the accumulation and buildup of plaque within the arterial walls, and can occur in arteries throughout the body as well. Buildup of plaque causes restricted blood flow putting the patient at a high risk for a stroke or myocardial infarction (heart attack). The "lipid hypothesis" is the belief that low-density lipoprotein (LDL) cholesterol is a major risk factor for heart disease, and is commonly used as an argument against the Paleolithic diet, which will be discussed in the next chapter. However, the type of fat is more important than the total amount of fat consumed as will be discussed in Chapter III.

Cancer is another disease influenced by diet. Studies show that diets account for about 30% deviation in risk of cancer in Western countries (Lindeburg et al., 2012). Obese patients are at greater risk—especially for breast, colon, and other epithelial related cancers. By following a healthy diet similar to that of the Paleolithic period, some cancers can be avoided (National, 2015). The nutrient-poor and carbohydrate loaded food of the modern American diet is making millions of people sick. The human diet has a large influence on disease, and maintaining a healthy diet and lifestyle is key to prevention of these deadly diseases.

The Paleolithic era spans from 2.6 million years ago to 10,000 years ago, and it is during this era that humans evolved. The end of the Paleolithic period was signified by the beginning of agriculture, which revolutionized the way food was obtained. Over 2.6 million years ago, there were no supermarkets, no chemically-laden foods, and no fast food chains. There were just whole and natural foods that existed and grew within the ecosystem. Paleolithic humans hunted and foraged for their food as it was needed and available. Wildly sourced food products provide great sources of lean protein, healthy fats, vitamins, minerals, and antioxidants. In comparative studies to the present-day hunter-gatherers, incidences of diabetes and cardiovascular disease were almost nonexistent, and these people are shown to be overall healthy and physically fit (Lindeburg et al., 2012). During the Paleolithic era, the interactions of metabolic hormones worked efficiently with the availability of protein, fats, and vitamins to maintain blood glucose levels, and to store fats in adipose to provide an energy reservoir for times when food sources were scarce. Many researchers claim that humans have not evolved as quickly as the human diet has evolved, therefore the reason these modern American diets are contributing to disease and death. During the Paleolithic period, it is believed that the human genome functioned perfectly to digest and absorb the macromolecules provided in the available foods. Over the past 10,000 years and leading up to the 21st century, a very short time in terms of the history and prehistory of modern humans, the human genome has remained predominantly fixed. The unsuitable changes in human diet have been accelerating particularly within the last century. Appropriately stated, "socially, we are people of the 21st century, but genetically, we remain citizens of the Paleolithic era" (O'Keefe & Cordain, 2004).

Over time, humans have become more susceptible to obesity, diabetes, heart disease, and cancer—collectively referred to as the diseases of civilization or noncommunicable diseases (NCD). The human race has made large advancements in technology and science, but the incidence of these diseases has increased and continues to rise. This document will explore the benefits of the Paleolithic diet, hazards of the modern Western diet, and the influence of our modern diet on the prevalence and causes of diseases of civilization.

I. THE PALEOLITHIC DIET

The Paleolithic Era, 2.6 million to 10,000 years ago, was paramount to the development of human history: it was the earliest period of human development. Also known as the Old Stone Age, this time period brought about critical evolutionary advancements of the hominids when Homo sapiens arose from their predecessor, Homo erectus. Studies estimate that the expansion of modern humans occurred approximately 56,000 years ago from a small population of 1,000 in East Africa (Liu et al., 2006).

Once Homo sapiens became widespread, the diet and foods consumed varied depending on latitudinal and longitudinal locations. Humans living near oceans or bodies of water would consume shellfish and other assorted seafood. Those located on land and amongst rougher terrain would consume wild game and lean meats, which were much different in taste and nutritive value than the modern day meat found in grocery stores. Nuts and uncultivated fruits and vegetables were found in different locations, and existed only in season because the agricultural revolution did not occur until the end of the Paleolithic era, about 10,000 years ago. It is also important to note that during this era there was no concept of “meal time.” When hungry, hunter-gatherers would source their food and eat it immediately. This concept is known as intermittent fasting, or sporadic eating, and is highly relevant to the hypothesis of the thrifty genotype discussed later.

Similar to the modern Western diet, the diets of hunter-gatherers consisted of essential macronutrient distributions. They consumed a diet high in protein including shellfish, fish, wild game, birds, eggs, and other regionally specific animal proteins. Paleolithic humans ate many polyunsaturated fats and saturated fats found in nuts and animal fats. Depending on location and season, they would be able to collect vegetables and fruits growing in the wild.

The human genome is incredibly important when it comes to the human diet. Every person has a distinctive and unique genetic makeup that requires essential nutrients and determines the health and well being of that person. The human genome has remained predominantly fixed since the inception of human culture and food source specialization. Proponents of the Paleolithic diet believe that because of this, humans have not fully evolved to eat and properly digest the foods of the Western diet. Genomic studies have revealed crucial information about the human genome. Humans and chimpanzees genetically differ by only 1.6% (Sibley & Ahlquist, 1984). In addition, modern Europeans are more similar to their Cro-Magnon ancestors, the earliest modern humans or Homo sapiens sapiens, than they are to 20^{th} century Africans or Asians (Turner, 1983). As such, we are tied to our ancient regional roots.

In 1962, James V. Neel proposed the "thrifty" genotype hypothesis as an explanation to why humans are susceptible to diabetes and associated noncommunicable diseases. Note, that it is currently well known that diabetes possesses a strong genetic factor. This "thrifty" gene may have been selected for or considered historically advantageous in Paleolithic times, but detrimental to health in the modern world. For example, during the Paleolithic period, hunter-gatherers with this gene would store fat quickly during times of abundance and surplus so that during times of famine, the body would be able to survive (Neel, 1962). Obviously, possessing this gene during the

Paleolithic period would be profound. It was especially beneficial to childbearing women. Compare this hypothesis to the genetic basis of sickle cell anemia. The sickle cell gene is caused by a single amino acid mutation in the beta chain of the hemoglobin gene—the protein that carries oxygen through the bloodstream. Sickle cell anemia, or sickle cell disease, occurs when the mutated gene is inherited from both parents, and affected patients suffer and have shorter lifespans. Heterozygous carriers of this gene, however, possess a protective advantage against malaria. The sickle cell hemoglobin prevents the Plasmodium parasite from infecting red blood cells (Instituto, 2011). Thus the sickle cell trait kept populations in the African tropics healthy throughout their childbearing years. Today, malaria is no longer the problem it formerly was. The disease is much more constrained due to mosquito control and medication. Perhaps the "thrifty" gene works in a similar way. In modern day and especially Westernized countries, famines are rare. Therefore, people with this genotype are constantly and quickly storing fat and preparing the body for a famine that never comes.

The "modern" paleo lifestyle focuses on consuming grass-fed meats, fresh fish and seafood, fresh fruit and vegetables, eggs, nuts and seeds, and healthy oils and fats, such as olive, walnut, flaxseed, macadamia, avocado, or coconut oils. The diet avoids cereal grains, legumes, dairy, refined sugar, potatoes, processed foods, salt, alcohol, and refined vegetable oils. The benefits of the Paleolithic regimen are the nutrient dense food groups that supply macromolecules such as lean proteins, monounsaturated and polyunsaturated fats, fiber, vitamins, minerals, antioxidants, and polyphenols. These macromolecules work to boost the immune system and energy efficiency of the human body.

In testing the potential impact of the Paleolithic diet, researchers conducted a randomized controlled single-blinded pilot study on a group of people in the Netherlands with Metabolic Syndrome (MetS) to determine and compare the effects of the Paleolithic diet to a reference diet (based on the guidelines for a healthy diet from The Dutch Health Council). People that suffer from MetS have a high risk of acquiring type II diabetes and cardiovascular disease. The study concluded that consuming a Paleolithic diet conferred benefits to the patients and improved several cardiovascular risk factors. The results of the study are shown in **Table 1-1** (Boers et al., 2014).

Table 5
Differences between baseline and after intervention for both groups

Variable	**Paired Differences**								
	All (*n* 34)			**Palaeolithic (*n* 18)**			**Reference (*n* 14)**		
	Mean	**SD**	***P****	**Mean**	**SD**	***P****	**Mean**	**SD**	***P****
Anthropometric									
Abdominal circumference (cm)	−3.2	2.2	0.00	−3.1	2.0	0.00	−3.3	2.4	0.00
Systolic BP (mmHg)	−6.6	9.8	0.00	−8.5	12.0	0.01	−4.2	5.6	0.02
Diastolic BP (mmHg)	−6.0	7.5	0.00	−8.0	8.3	0.0	−3.5	5.6	0.03
Glucose tolerance and insulin sensitivity									
Glucose *fasting* (mmol/l)	−0.4	0.5	0.00	−0.4	0.5	0.01	−0.4	0.4	0.00
Insulin *fasting* (mU/l)	−2.1	4.3	0.01	−2.7	5.0	0.03	−1.4	3.2	0.14
$HOMA_{IR}$	−0.7	1.3	0.00	−0.9	1.5	0.03	−0.5	0.9	0.06
AUC *glucose* (mmol/l x min)	−6	141	0.81	−18	170	0.66	9	98	0.73
AUC *insulin* (mU/l x min)	−921	3 565	0.15	−1 918	4 361	0.08	362	1 515	0.39
TG:HDL-C (mol/mol)	−0.4	1.0	0.04	−0.8	1.2	0.01	0.2	0.3	0.08
Lipids									
TC (mmol/l)	−0.6	0.7	0.000	−07	0.7	0.00	−0.4	0.5	0.02
HDL-C (mmol/l)	−0.1	0.2	0.001	−0.0	0.1	0.38	−0.2	0.1	0.00
LDL-C (mmol/l)	−0.2	0.5	0.01	−0.3	0.5	0.02	−0.2	0.5	0.18
TG (mmol/l)	−0.5	1.0	0.01	−0.9	1.1	0.00	0.1	0.4	0.63
TC:HDL-C (mol/mol)	0.1	1.2	0.72	−0.5	0.7	0.01	0.9	1.3	0.03
Inflammation									
hsCRP (mg/l)	0.3	2.5	0.54	0.2	2.8	0.79	0.4	2.1	0.49
TNFα (pg/ml)	0.2	1.3	0.45	0.1	1.6	0.87	0.3	0.7	0.13
Intestinal permeability									
Lactulose:mannitol (mmol/mol)	0.003	0.020	0.3	−0.002	0.020	0.65	0.009	0.012	0.11
Other laboratory parameters									
Urine									
Sodium:potassium (mmol/mol)	−0.88	0.93	0.00	−1.11	0.97	0.00	−0.57	0.82	0.02
Serum									
Homocysteine (μmol/l)	0.8	1.6	0.01	1.2	1.3	0.00	0.3	1.9	0.60

Abbreviations: *TG* triglycerides, *HDL-C* HDL-cholesterol, *TC* total cholesterol, *LDL-C* LDL-cholesterol.

Mean values and standard deviations, per-protocol.

**P* values for the difference between baseline and after intervention, computed by two-tailed paired t-test, not adjusted.

Table 1-1. Paleolithic diet study results. Differences between baseline and after intervention for both groups of the study. Taken from (Boers et al., 2014)

The Paleolithic diet has numerous possible advantages. As seen in the study conducted by Boers et al. (2014), improvements in lipid profiles, unintended weight loss, lowered systolic blood pressure (BP) measurements, lowered cholesterol levels, and lowered insulin resistance are a few of the promising results. Consuming a Paleolithic diet has cardioprotective effects and preventative measures against the diseases of civilization, or non-communicable diseases (NCD). Steps toward consuming whole and natural foods and away from processed and chemically laden food could affect drastic change in the health of Westerners.

II: THE MODERN, WESTERN DIET

What has caused the transformation of the Western diet? How did humans' dietary habits change so drastically and quickly? The Western diet is highly influenced by American culture. In America, there is a fusion of many cultures and their respective ethnic foods. Fast food and the constant desire for excess in all aspects of life has led to the prevalence of obesity and noncommunicable diseases. The Western diet consists of 50% carbohydrates, 15% protein, and 35% fat—not to mention a lower overall nutritional value and few essential vitamins (Cordain et al., 2005). Within the past century, the Western diet has been shaped by the industrial revolution, creation of processed foods, and the fast food industry. It is important to understand the history and current influence of these industries to fully grasp the negative consequences of the Western Diet.

Fast Food

Before the 17^{th} century, families ate almost every meal at home. Taverns and inns were the only vender of cooked meals. Travelers used taverns as a place to meet and socialize over drinks. This only served a small market of people: mostly men and travelers. Restaurants did not become popular or a common place for families to visit until the 1900s. White Castle was technically the first "fast food" restaurant, and opened in Wichita, Kansas in 1921. Fast food became increasingly trendy with the rise of carhop service beginning in the 1940s—especially with the younger generation of the time period. It was McDonald's who revolutionized the fast food industry.

McDonald's opened in 1955, and served a limited menu and offered fast service. By focusing on only a few menu items and using the assembly line technique, the restaurant was able to provide burgers of uniform quality to eager customers quickly and efficiently. Americans were hooked. The restaurant grew from 250 locations in 1960 to over 3,000 by 1973. The fast food industry boom had begun (McDonald's, 2015). Today, there is a fast food restaurant for almost every type of food: fried chicken, southwestern, donuts, etc. The fast food restaurant has permeated the American lifestyle. Wherever a person goes, there is a fast food service restaurant: street vendors, food trucks, delivery services, sports arenas, gas stations, and convenience stores. Fast food has become an industry that employs over 3.7 million people world-wide with a total of more than 600,000 stores (McDonald's, 2015).

Although the success of fast food businesses boosts the American economy, it is harming the health of our children. Fast food restaurants like McDonald's target children with marketing and advertisements. Children are incredibly susceptible to these marketing tactics and begin to favor the products that are marketed. These habits of eating fast food and high caloric food are reinforced early in life and continue into adulthood where people continue to make the same food choices that they made in their youth. According to the World Health Organization (WHO), it is highly probable that the marketing of fast food is contributing to obesity in American children. Companies spend over 10 million dollars on marketing alone so that children will begin to recognize their brand (Hite & Hite, 1995). These companies use bright colors and cartoons to win the favor of children. Their products even appear in movies and television shows, a technique known as product placement. One of the most famous incidents of product placements is

Reese's Pieces in *E.T. The Extra Terrestrial*. Elliot strategically uses Reese's Pieces candy to lure E.T. Hershey, the company that owns Reese's Pieces paid $1 million to promote their candy with E.T. Just two weeks after the movie's premiere, the company experienced a 65% increase in sales (Zimmerman, 2013). Popular cartoon characters are on the colorful packages of unhealthy, high caloric products, and children have preference toward these products. A study found that low-income children preferred foods if they thought they were from McDonald's—even carrots, which are not a product of McDonald's. In the same study, children still preferred foods that were marketed as McDonald's over unbranded foods even though some of the foods offered were from McDonald's but the branding was removed (Robinson et al., 2007). The problem continues with limited availability of healthful food options in low income areas of the United States.

Food deserts exist in low-income neighborhoods or regions where there is limited access to healthy and affordable food. These areas also have higher exposure to fast food restaurants. Therefore, residents are more likely to eat these foods based on the availability. There is increased consumption of fast food among nonwhite and low-income populations. Since fast food has been linked to obesity, low-income people have a higher probability of becoming obese (French et al., 2000; Jeffery & French, 1998). Research indicates that food availability in grocery stores is linked to the dietary habits of nearby restaurants. For example, healthy products are in higher availability and selection in grocery stores that sell high volumes of healthier foods. Restaurants and groceries conform their selection of store products and menu items to the food purchasing habits of nearby residents. This may seem to companies that the demand for healthy food is weak, however with decreased access to transportation the demand and preference for particular foods is often dictated strictly by what is accessible. It is important to note that cost is also a large factor in the food purchasing habits of low-income people. Residents of low-income areas often seek and buy the lowest priced foods which tend to have the highest caloric value (Morland, 2002; Turrell, 1996). Solutions must be made to supply individuals living in these food deserts with access to transportation and healthier, affordable food options in order to prevent further cases of obesity, heart disease, and cancer.

Food Processing

Food Processing began in prehistoric times with techniques such as fermentation, sun drying, salt preservation, and smoking of meats. These procedures remained the only preservation methods until the onset of the Industrial Revolution. Since, modern techniques have been perfected and include extreme heating, ionization, pasteurization, irradiation, and sterilization. Currently, almost all food is processed in some way, shape, or form. Processed foods are classified into one of three groups based on the extent and purpose of the industrial processed that is conducted: unprocessed and minimally processed foods (Group 1), processed culinary or food industry ingredients (Group 2), and ultra-processed food products (Group 3) (Monteiro et al., 2010).

Group 1 encompasses unprocessed and minimally processed foods. Minimal processes are often but not always physical and applied to a single basic food item for preservation and accessibility. Minimal processes used include cleaning, removing inedible parts, grating, squeezing, flaking, bottling, drying, chilling, freezing, pasteurization, fermentation, fat reduction, vacuum, and simple wrapping. Foods such as fresh meats and milk, grains, legumes, nuts, fruits, and vegetables are commonly minimally processed in a number of ways and sold. This process even includes bottling water (Monteiro et al., 2010).

Group 2 includes substances that are extracted from a Group 1 food product and purified in order to produce culinary or food industry ingredients and products. These processes are physical and chemical, and they include milling, refining, hydrogenation, hydrolysis, and additives. These processes are often helpful in making unpalatable or inedible foods useable. The common food items of this group are starches and flours, oils and fats, salt, and sugar and sweeteners (including high fructose corn syrup) (Montiero et al., 2010).

The last group is ultra-processed food products that are ready to eat and require zero to little preparation. These food products are made by the processing of many food items from groups 1 and 2. Group 3 processing procedures include salting, baking, frying, deep frying, pickling, canning, and include additives and preservatives. The benefits of these foods are longer shelf lives, easy preparation and consumption, and incredible palatability. Group 3 products are often ready-to-eat snacks and pre-prepared ready-to-heat meal replacements. A summary of these three groups can be found in **Figure 2-1**. The most concerning and detrimental group in terms of contribution to NCD is Group 3.

Food classification based on the extent and purpose of industrial processing.

Food group	Extent and purpose of processing	Examples *
Group 1: unprocessed or minimally processed foods	No processing, or mostly physical processes used to make single whole foods more durable, accessible, convenient, palatable, or safe	Fresh, chilled, frozen, vacuum-packed fruits, vegetables, fungi, roots and tubers; grains (cereals) in general; fresh, frozen and dried beans and other pulses (legumes); dried fruits and 100% unsweetened fruit juices; unsalted nuts and seeds; fresh, dried, chilled, frozen meats, poultry and fish; fresh and pasteurized milk, fermented milk such as plain yoghurt; eggs; teas, coffee, herb infusions, tap water, bottled spring water
Group 2: processed culinary or food industry ingredients	Extraction and purification of components of single whole foods, resulting in producing ingredients used in the preparation and cooking of dishes and meals made up from Group 1 foods in homes or traditional restaurants, or else in the formulation by manufacturers of Group 3 foods	Vegetable oils, margarine, butter, milk cream lard; sugar, sweeteners in general; salt; starches, flours, and "raw" pastas and noodles (made from flour with the addition only of water); and food industry ingredients usually not sold to consumers as such, including high fructose corn syrup, lactose, milk and soy proteins, gums, and preservatives and cosmetic additives
Group 3: ultra-processed food products	Processing of a mix of Group 2 ingredients and Group 1 foodstuffs in order to create durable, accessible, convenient, and palatable ready-to-eat or to-heat food products liable to be consumed as snacks or desserts or to replace home-prepared dishes	Breads, biscuits (cookies), cakes and pastries; ice cream; jams (preserves); fruits canned in syrup; chocolates, confectionery (candies), cereal bars, breakfast cereals with added sugar; chips, crisps; sauces; savoury and sweet snack products; cheeses; sugared fruit and milk drinks and sugared and "no-cal" cola, and other soft drinks; frozen pasta and pizza dishes; pre-prepared meat, poultry, fish, vegetable and other "recipe" dishes; processed meat including chicken nuggets, hot dogs, sausages, burgers, fish sticks; canned or dehydrated soups, stews and pot noodle, salted, pickled, smoked or cured meat and fish; vegetables bottled or canned in brine, fish canned in oil; infant formulas, follow-on milks, baby food

* These listings do not include alcoholic drinks. The examples given are not meant to be complete. Many others can be added, especially to group 3, using the general principles specified in the text and as indicated in the second column.

Table 2-1. Food classification based on the extent and purpose of industrial processing. Taken from (Montiero et al. 2010)

Ultra-processed foods continue to dominate the food market. They have begun to displace the consumption of fresh or minimally processed whole foods among consumers. In one study, researchers compared the overall consumption of ultra-processed food products in Canada and Brazil. As a percentage of total calories, each country experienced an increase in the dietary share of ultra-processed products in the average household. Canada increased from 24.4% in 1938 to 54.9% in 2001. In Brazil, there was an increase from 18.7% in 1987 to 26.1% in 2003 (**Figure 2-1**) (Monteiro et al., 2013). A separate study found that about 70% of the American diet is from processed foods (Poti et al., 2015).

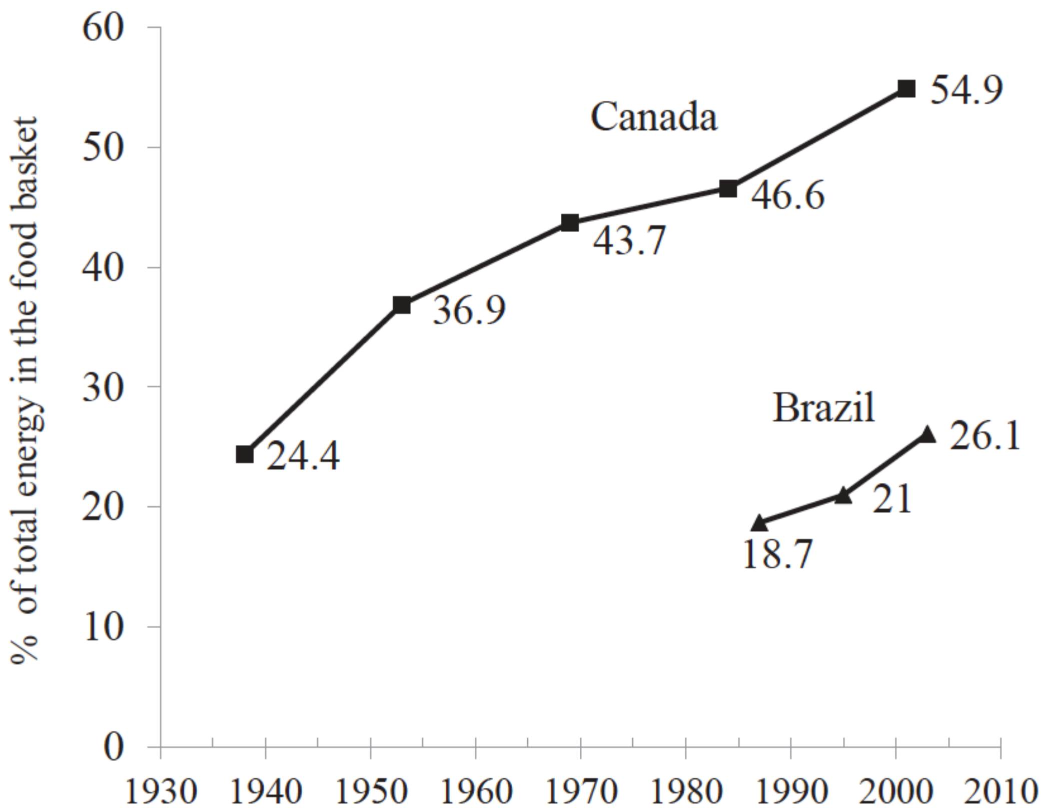

Figure 2-1. Changes over time due to ultra-processed products. Time changes in the dietary share of ultra-processed products in the average household food basket in Canada and Brazil. Taken from (Monteiro et al., 2013)

The processed food industry is incredibly profitable. Corporations such as Nestle, PepsiCo, and Kraft are shaped by international economic policies, and these policies are formulated to promote the flow of capital and trade. The trade agreements, international and global, have promoted food manufacturing and similar corporations to absolutely dominate the marketplace. Collectively known as Big Food, these corporations spend enormous amounts of money on advertising and marketing (especially to children) to promote their ultra-processed products (Montiero et al., 2012; Hawkes et al., 2010; Rayner et al., 2006). Big Food is often (and distressingly) compared to Big Tobacco. These corporations go to great lengths to avoid regulation with front groups (groups that represent one exclusive agenda while actually serving some other interest whose sponsorship is hidden), government lobbyists, lawsuits against entities focused on regulation, and empty promises of self-regulation (Montiero et al., 2013). Industrial epidemic is a term to describe the harmful health effects associated with goods such as tobacco, alcohol, and the food and drink industries (Jahiel & Babor, 2007). These corporations are causing populations to become sick and perish of noncommunicable diseases (NCD). For example, in addition to deaths attributed to tobacco and alcohol, over 18 million people die every year from complications from high blood pressure, high BMI, high fasting blood glucose, and high cholesterol—all attributable to the consumption of ultra processed food items (Lim et al., 2013).

Luckily for these corporations, consumers spend at least 20% of their income on food (Malik et al. 2010). These corporations are collectively referred to as Big Food because the ten largest food companies control over half of all food sales in the United States. These corporations use similar strategies that the tobacco companies use to control and prevent public health regulations. The strategies include using biased research findings, co-opting policy makers and health professionals, lobbying politicians and public officials to oppose regulation, and encouraging voters and consumers to oppose public health regulations. Ultra-processed food corporations are incredibly innovative and powerful in these tactics. To maintain their image, they promote actions outside of their areas of expertise. For example, ultra-processed food and drink corporations publicly promote physical activity or causes such as cancer research (Moodie et al., 2013).

Possible public health solutions to these Big Food corporations incorporates a few different strategies such as industry-operated, voluntary self-regulation, public-private partnership, and public regulation. Each has their caveat. Voluntary self-regulation often results in manipulation to buy more products. Public-private partnership is considered dishonest. For example, the partnership between the International Diabetes Federation and Nestlé is highly criticized (Ball, 2004). Public regulation is a similar strategy to that of firearm control, road traffic, drugs and tobacco, and protecting parks and open spaces. In this strategy there are many conflicts of interest between promotion and protection of public health and the Big Food corporations that benefit from unhealthy choices (Moodie et al., 2013). It seems that the citizens of the United States are so influenced by these corporations to the point that regulation seems impossible. One thing is for sure, steps must be taken soon to prevent death from noncommunicable diseases, or public health will continue to decline in this era of plenty.

A Proposed Solution

It is probable that reverting back to the primal dietary habits of the Paleolithic era could solve and possibly eliminate the incidence of the diseases of civilization. The Paleolithic lifestyle provides nutrients and energy without harmful chemicals and other products found in processed foods characteristic of the Western diet.

III. DISEASES OF CIVILIZATION

Today, humans are suffering from diseases that our ancestors, the Paleolithic people, rarely incurred. Diabetes, heart disease, and cancer are rampant across the populations of current day, and are claiming an astounding majority of deaths. This was not always the case. According to United States demographic data from 1900, the life expectancy of the average citizen was 47.3 years of age. During this year, the top leading causes of death consisted of infectious diseases such as pneumonia or flu, tuberculosis, and gastrointestinal infections. Fast-forward to 2010, the life expectancy rose to 78.7—an increase of 30 years. This increase in life expectancy may seem to stand as proof for an overall increase in the quality of life and effective disease prevention, and is even a common, yet weak, argument against the relevance of the Paleolithic diet. However, numerous scientific advancements in the prevention of infectious diseases occurred over the past century. In 2010, there was a steep decline in infectious diseases from 1900—about 46% decrease—due to overall improvements in sanitation, medical treatments, vaccinations, public health, etc. (**Figure 3-1**).

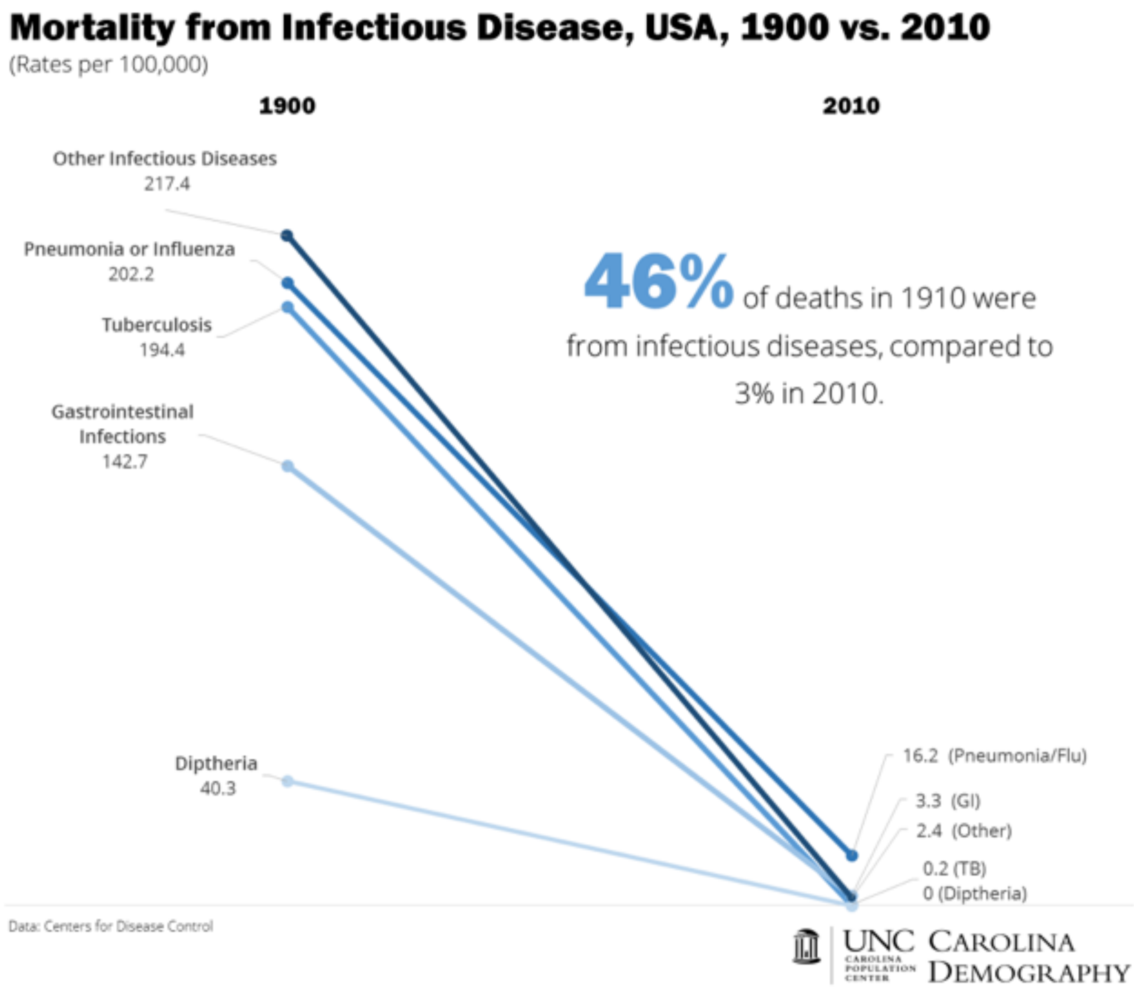

Figure 3-1. Mortality from Infectious Diseases in the United States in 1900 versus 2010. Taken from (Tippett, 2014)

Regardless of the advancements in infectious disease prevention and increase in life expectancy, the incidence of heart disease and cancer is incredibly troubling. Over the past century, the increase in these chronic diseases as the leading causes of death is the most revealing—increasing to yield 47% of total deaths in the United States in 2010 (**Figure 3-2**) (Tippett, 2014).

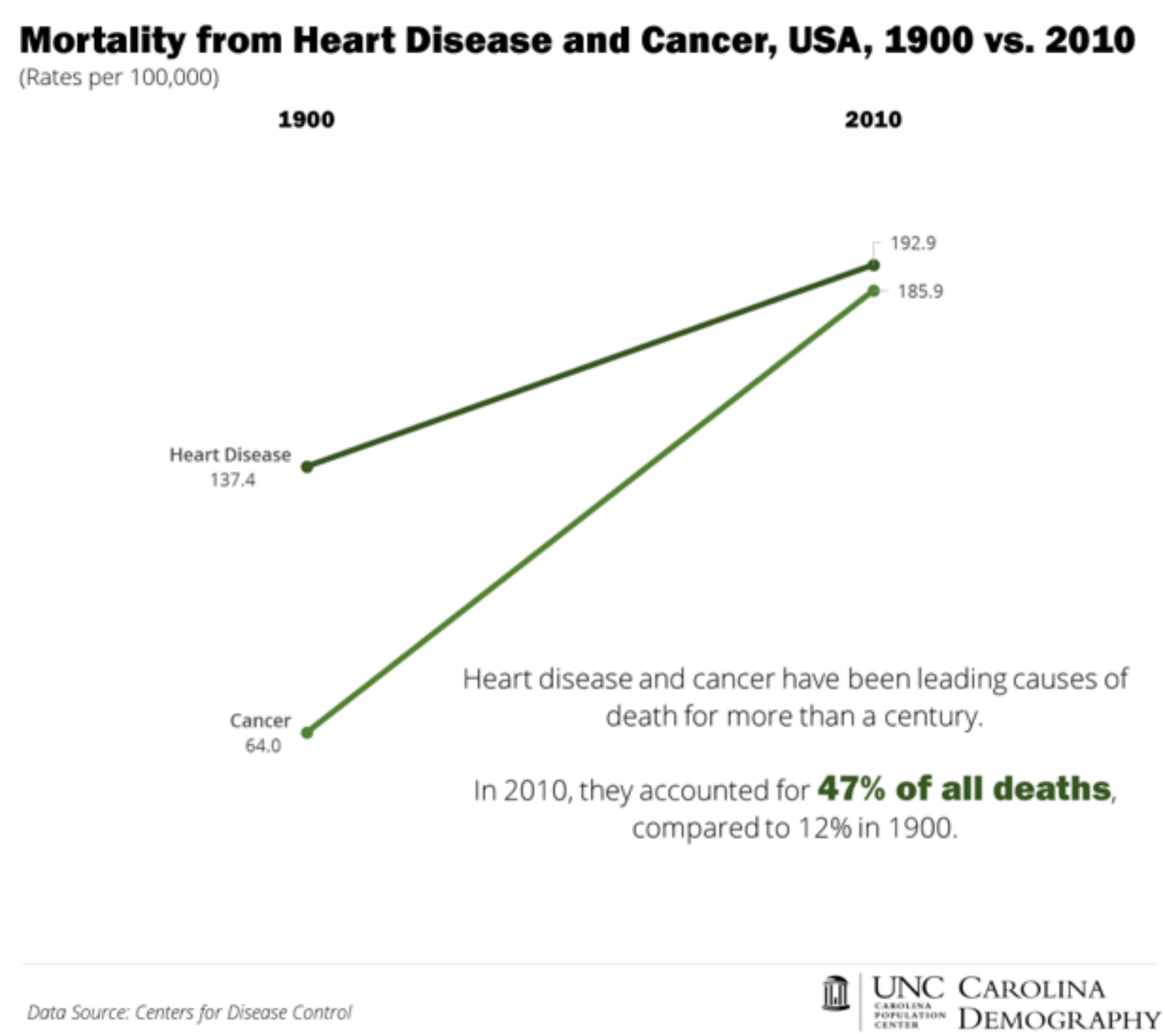

Figure 3-2. Mortality from Heart Disease and Cancer in the United States in 1900 versus 2010. Taken from (Tippett, 2014)

According to the most recent data from the National Center for Health Statistics (2015), diseases of the heart are the number one cause of death, cancer is the second most, and diabetes mellitus is the seventh. It is important to note that diabetes mellitus is often a precursor to heart disease. These leading three causes of death are commonly referred to as “Diseases of Civilization”, or lifestyle diseases. These diseases are sometimes preventable and symptoms can decrease with simple lifestyle changes—especially in diet.

The frequency of diseases of civilization appear to increase as countries become more Westernized and industrialized. For example: The United States has far more instances of such diseases than India or countries of the Middle East. Contrastingly, countries that have yet to Westernize maintain a low incidence of the diseases of civilization. Diabetes, heart disease, and cancer are all heavily influenced by diet choices. The occurrence of obesity is a significant marker of the probability a person may suffer from one of the diseases of civilization. It is important to understand the prevalence of obesity in Western societies versus its incidence in ancestral, hunter-gatherer societies.

Obesity

Approximately one-third of the adults in the United States are obese. Obesity is easily considered an epidemic in today's society. People with obesity are highly predisposed to diabetes and other life-threatening conditions—close to 90% of the people with type II diabetes are obese or overweight (Ogden et al., 2014). Obesity is measured by a person's Body Mass Index (BMI). Body mass index is the measure of body fat, and is a person's weight in kilograms divided by the square of height in meters. A person is considered underweight if their BMI is less than 18, normal if 18.5 to 24.9, overweight if 25-29.9, and obese if greater than 30. Obesity was incredibly rare in Paleolithic populations. A lower body mass index (BMI) existed in ancestral hunter-gatherer societies compared to today's Westernized societies. For example, in Kitava, 87% of men and 93% of women aged 40-69 years possess a BMI below 22 kg/m^2, a signifier of normal weight. No person in this age group in Kitava was found to be overweight or obese. There also was found to be a lower-waist (cm)/height (m) ratio in people of Kitava compared with that of Swedes (**Figure 3-3**) (Carrera-Bastos et al., 2011) (Lindeburg et al., 2012).

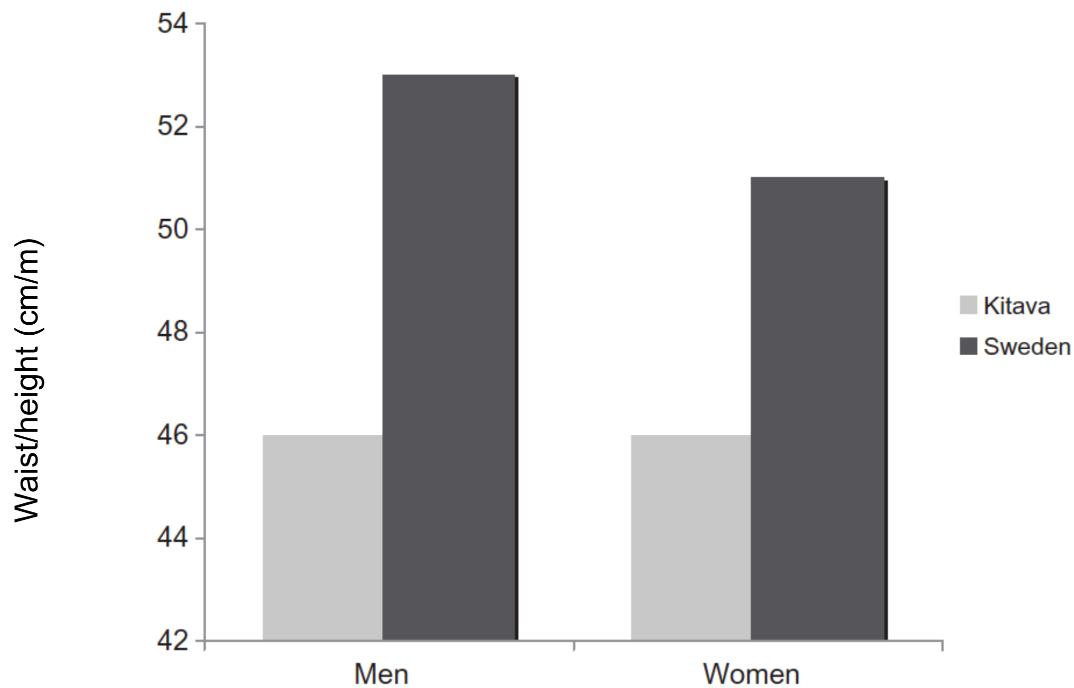

Figure 3-3. Waist circumference (cm)/height (m) in Kitava horticulturalists versus in Swedes. Taken from (Carrera-Bastos et al., 2011; Lindeburg et al., 2001)

How do the Kitava do it? The Kitava is a society of horticulturists, and was found to be one of the last populations with Paleolithic dietary habits, and is often used as a comparative society that adequately possesses a Paleolithic lifestyle. This population inhabits one of the Trobiand Islands in Papua New Guinea's archipelago. In a separate study, a lower tricipital (of the triceps) skinfold thickness (mm)—a common measurement used to signify body fat content—in multiple populations of hunter-gatherers (African pygmies, aborigines, !Kung, and Inuit) was found and compared to that in healthy Americans. Modern Americans nearly doubled the tricipital skinfold thickness of the hunter-gatherer populations (**Figure 3-4**) (Carrera-Bastos et al., 2011; Eaton et al., 1988).

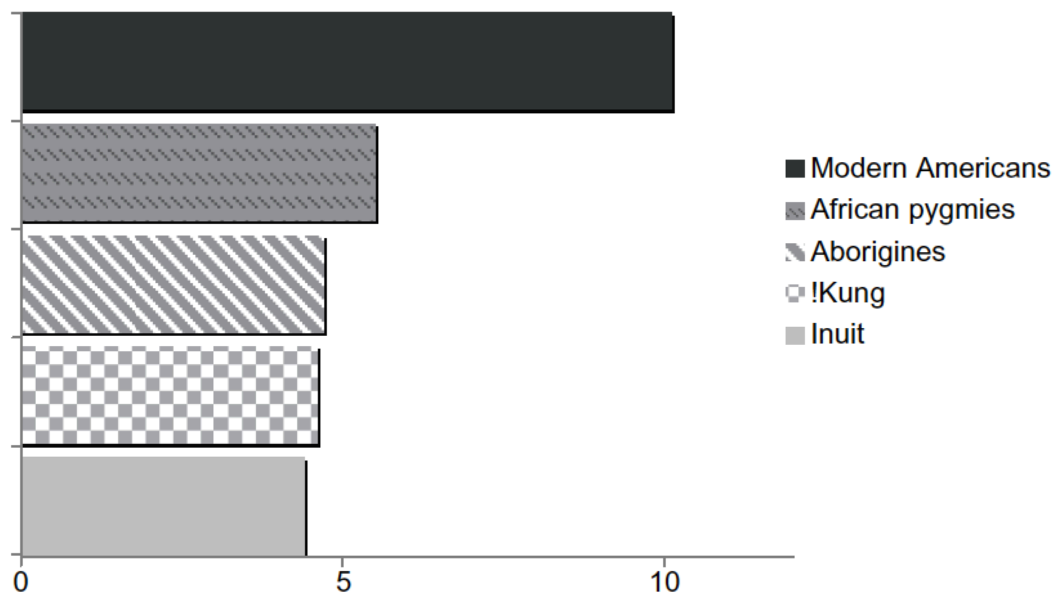

Figure 3-4. Tricipital skinfold (mm) in several different populations. Taken from (Carrera-Bastos et al., 2011; Cashman, K.D. et al., 2008)

Metabolism includes a combination of three compensatory factors: conversion of excess fuel into fat stores of adipose tissue, the burning of excess fuel through exercise, and turning fuel into heat, or thermogenesis (Nelson & Lehninger, 2008, p. 930). The body relies on the metabolism of food consumed to properly function. Sometimes, a person eats too much food causing the excess energy to be stored as fat, and the continuation of this habit leads to obesity. It is important to understand the underlying causes of obesity within a complex set of hormonal and neuronal signals.

Leptin is an adipokine, a peptide hormone that can act as an autocrine, paracrine, or endocrine hormone. It carries the information about the sufficiency of triacylglycerol, or energy reserves, stored in adipose tissue to the brain and other tissues (Nelson & Lehninger, 2008; Klok et al., 2007). Leptin signals the hypothalamus to decrease appetite. In a study with laboratory mice, two models were examined. One mouse possessed a double knockout of the gene that produces the product leptin, ob/ob. This mouse was in a constant state of starvation and could not make leptin—leading to uncontrollable feeding and effectively becoming obese. Once leptin was injected into these mice, they were able to lose weight and increase other bodily functioning activity such as movement and reproduction (Halaas, 1995). The second mouse possessed a double knockout of the gene that produces the leptin receptor protein, db/db. These mice were obese and diabetic. The leptin receptor is encoded by the DB gene and when defective, the signal function of leptin disappeared (Bahary et al., 1990). From this study, researchers were able to discover that leptin signals to the hypothalamus that fat stores are adequate thereby inducing a decrease in eating and movement. One might assume that obesity is the result of low leptin levels—easily curable by the injection of this adipokine. However, it is found that blood levels of leptin are much higher in obese patients (this is not the case of the ob/ob mice that could not make leptin). It is possible that elevated levels of leptin are the result of a (failed) effort to overcome leptin resistance (Nelson &

Lehninger, 2008, p. 933). Similar to leptin resistance, insulin resistance can occur in overweight and obese patients.

Insulin also acts on the hypothalamus and signals the body to stop eating. A cross-talk is hypothesized between insulin and leptin. Leptin was discovered to make the cells of the liver and musculature more sensitive to insulin. The insulin receptor has an innate Tyrosine kinase activity. When the leptin receptor is occupied by its ligand, it is phosphorylated by a soluble tyrosine kinase known as JAK. It is possible that leptin and insulin binding to their respective receptors may cause phosphorylation of the same substrate—consequently inhibiting eating. As will be discussed later, insulin resistance is a major contributing factor to diabetes (Lowell & Schulman, 2005).

Adiponectin is another contributing factor to obesity. This adipokine (peptide hormone) is found and produced in adipose tissue. Its main function is to increase the sensitivity to insulin in other organs. It possesses positive attributes such as guarding against atherosclerosis, and protecting against inflammatory reactions. Adiponectin plays a large role in β-oxidation, inhibits fatty acid synthesis, and activates the uptake of glucose and its catabolism. Like leptin and insulin, it acts on the hypothalamus. In a study with laboratory mice, it was found that those with ineffective adiponectin genes are insulin resistant compared to mice with normal adiponectin. Insulin insensitivity is characteristic of type II diabetes (Nelson & Lehninger, 2008, p. 934).

In the stomach, a hormone known as ghrelin is produced and functions to increase hunger prior to meal time. After a meal, there is a significant drop in ghrelin. The peptide hormone, $PYY_{3\text{-}36}$, is secreted in the lining of the intestines in response to the intake of food. This hormone spikes just following a meal. It acts on the arcuate nucleus and reduces hunger. The efficiency of these hormones is central to promoting normal eating behavior and preventing the under-or-overconsumption of food (Nelson & Lehninger, 2008, p. 937).

The system of neuroendocrine activities of leptin, insulin, adiponectin, ghrelin, and PYY_{3-36} is essential in prevention of overconsumption and obesity. These hormones are summarized in **Table 3-1**. Dysregulations in these hormones are most always consequences of overeating, resulting in a chronically obese patient. In obese and overweight patients, there is an added stress on the body to use insulin and other metabolic hormones to maintain circulating blood glucose and lipids. Obesity only increases the incidence of diabetes, and adversely impacts those affected with diabetes.

Hormone	Tissue Origin	Purpose	Signal
Leptin	Made by adipose	Regulate the balance of energy	High level signals suppression of hunger
Insulin	Produced by beta cells in the pancreas	Regulates metabolism of carbohydrates	High level signals uptake of glucose
Adiponectin	Made by adipose tissue	Modulates glucose metabolism and fatty acid oxidation	Activates uptake and catabolism of glucose
Ghrelin	Produced by ghrelinergic cells in the gastrointestinal tract	Regulates appetite	High level signals hunger
PYY_{3-36}	Secreted by lining of the intestines	Reduces hunger	Levels spike after meal and suppress hunger
Glucagon	Produced by the alpha cells of the pancreases	Raises levels of glucose in the blood stress	Released when circulating blood glucose is low, high level signals for release of glucose

Table 3-1. Summary of hormones affecting obesity. (Nelson & Lehninger, 2008)

Diabetes

Diabetes, currently the 7th leading cause of death in the United States, affects about 29.1 million Americans, or 9.3% of the population, according to data collected by the American Diabetes Association in 2012. It is incredibly concerning that 86 million Americans aged 20 and older that have been diagnosed with prediabetes. Diabetes, or diabetes mellitus, occurs when a patient cannot make insulin or becomes insensitive to insulin. Carbohydrates are broken down into glucose molecules and absorbed into the blood stream. The presence of high glucose signals the release of insulin telling the body to store excess glucose as triacylglycerol or glycogen for times when the body is in short supply of circulating blood glucose. There are two types of diabetes: type I and type II. Type I diabetes occurs when the body does not produce insulin. It is almost always diagnosed in children. These patients rely on administered insulin to maintain glucose levels. In type II diabetes, the body is not using insulin properly. Early in the disease, the pancreas makes extra insulin to incur a better response to the extremely high glucose levels (hyperglycemia) due to overconsumption of high glycemic index foods and low level insulin resistance, but after a while, the body becomes unable to make insulin at the level needed for response. The body is no longer able to efficiently make use of the energy consumed (high blood glucose), and the patient therefore suffers from an increase in fat storage (maintaining efficient insulin-induced fat storage in adipose tissue). Among middle-aged and older individuals in non-Westernized traditional populations there is excellent functioning of insulin sensitivity. In the horticulturists of Kitava in Papua New Guinea, there is lower fasting plasma insulin concentrations and higher insulin sensitivity (indicators of possible diabetes) than that of healthy Swedes (**Figures 3-5 and 3-6**) (Carrera-Bastos et al., 2011; Lindeburg et al., 2012).

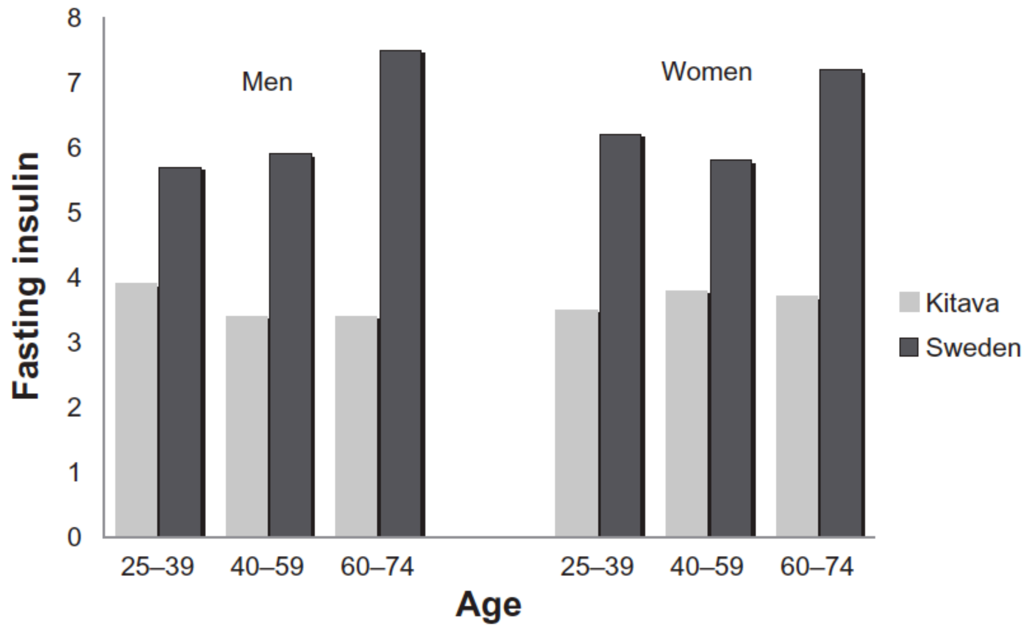

Figure 3-5. Fasting plasma insulin (IU/mL) in Kitava horticulturalists versus in healthy Swedes. Taken from (Carrera-Bastos, p. et al., 2011)

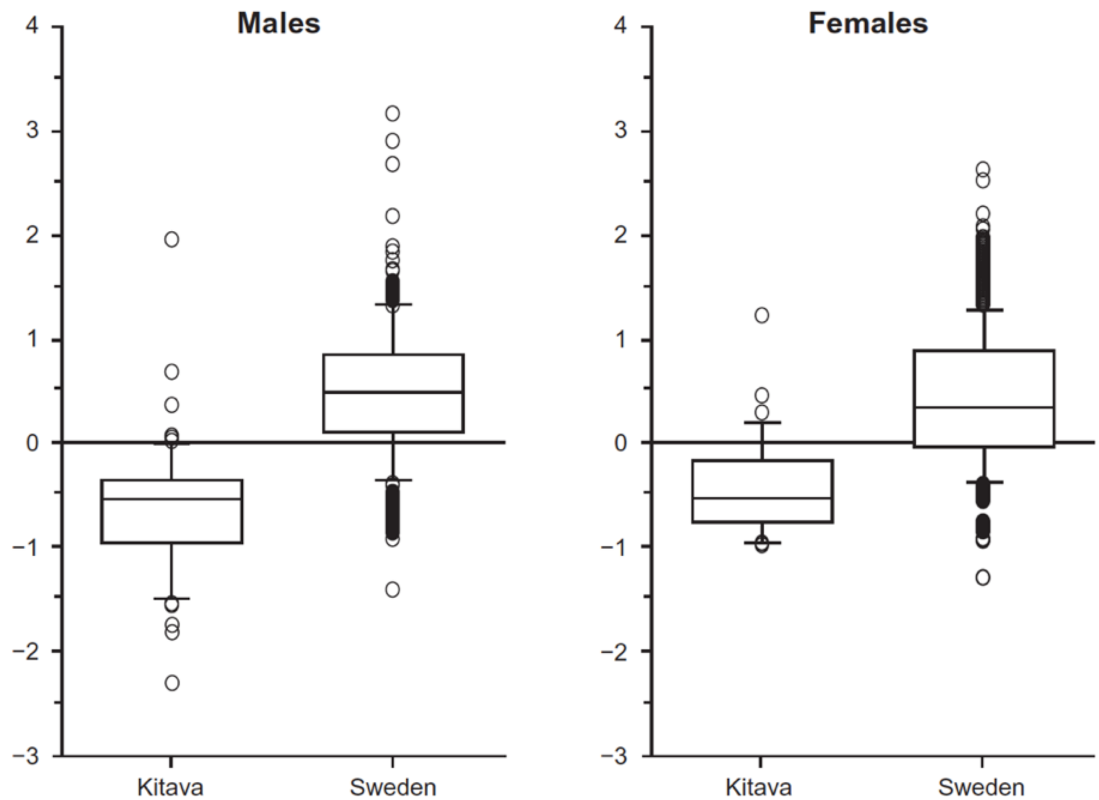

Figure 3-6. Homeostatic Model Assessment Index (used to quantify insulin resistance) in Kitava Horticulturalists versus in healthy Swedes. Scores at 0 denote average insulin sensitivity, scores above 0 denote resistance, and scores below 0 denote higher insulin sensitivity. Taken from (Carrera-Bastos et al., 2011)

It is incredibly important for diabetics to take glycemic index (GI) and glycemic load (GL) into consideration when modifying their diet. Glycemic index is based on a scale of 0 to 100 and ranks carbohydrates based on the rate of conversion to glucose within the body. Foods with high glycemic index values cause the quickest rise in blood sugar or glycemic response. For example, pure glucose has a glycemic index of 100 because it does not require any conversion within the human body. Comparatively, foods with low glycemic index, such as carrots with a score of 35 take longer to convert to glucose to be absorbed and used within the body. Glycemic load (GL) takes into account the glycemic index score and number of carbohydrates in a given food item (American, 2015). It is estimated that the glycemic load of ancestral Paleolithic peoples was notably lower than that of modern, Western diets. In overweight and type II diabetic patients, a diet of low glycemic load may present a profile with lower levels of glucose, insulin, selected lipoprotein, and inflammatory cytokines.

Proper macronutrient allocation is also integral to the prevention and relief of diabetes. Typical Western diets consist of about 15% protein, 50% carbohydrates, and 35% fat (Cordain et al., 2005). Paleolithic diets consisted of higher protein content (19-35%), fewer carbohydrates (22-40%) and similar or increased fat (28-58%) (Cordain et al., 2000). High protein diets have been found to improve insulin sensitivity in patients. Dietary protein supplies amino acids to the body which are essential nutrients and building blocks for nucleic acids, hormones, proteins, etc. Diets with reduced carbohydrate intake may also lead to decreased insulin resistance. Carbohydrates, as noted earlier, may cause insulin insensitivity if consumed in excess. Through dietary and lifestyle change, the symptoms of diabetes can be alleviated, however, risk of heart disease and stroke remains constant due to the presence of hypertension, high cholesterol, obesity, and the concomitant lack of physical activity typical in those with type II diabetics.

Diseases of the Heart

Collectively referred to as diseases of the heart, heart disease is currently the leading cause of death in the United States, accounting for over 600,000 deaths in 2014. Cardiovascular disease accounts for 17.3 million deaths worldwide per year, and it is expected to grow to at least 23.6 million by 2030 (National, 2015). Heart disease claims more lives than all forms of cancer combined. Coronary Heart Disease(CHD), also known as Coronary Artery Disease, is the most common. CHD is caused by atherosclerosis in the arteries of the heart. Atherosclerosis is the accumulation and buildup of fat deposits, or plaque within the arterial wall, and can occur in other arteries throughout the body. This stiffening of the arteries causes restricted blood flow. When blood flow is restricted, a patient is at high risk for a stroke or heart attack—occasionally resulting in serious long term health deficits or death. Platelets circulate through the blood and target damaged blood vessels. The name platelet refers to their shape. These microscopic disc shaped objects change conformation when damage is detected—this is their 'active' form. At this point, the platelets grow tentacle like arms in order to attach to a damaged site and repair. Although platelets mend damage, they become an issue in the incidence of plaque buildup, also known as thrombosis. When plaque builds up within the coronary arteries, it encompasses a high potential of rupturing through the endothelium because it is narrowing the lumen of arteries and reducing blood flow. Once the plaque ruptures, platelets receive a signal that the artery is damaged and initiate their active form to repair. However, the platelets begin to narrow the coronary artery further. At this point, blood clots start to form. Blood clots form with the help of fibrin, a soluble protein that circulates in the bloodstream. Fibrinogen is converted to fibrin in response to thrombin in the formation of blood clots. Fibrin is necessary and helpful in the human body to manage inflammation and prevent further bleeding in small traumatic areas. At high levels, however, fibrin can cause numerous issues. Fibrin provides a scaffold for platelet aggregation, resulting in a blood clot. A general practitioner can test fibrinogen levels. The elevation in the blood signals a high susceptibility to a heart attack or stroke.

Even fibrin can cause damage to the vascular endothelium, promoting atherosclerosis (Smith, 2015). Blood clots decrease, sometimes terminate, the rate of blood flow to the heart and tissues, also known as ischemia. This is a major factor in Coronary Heart Disease. Food from the Western diet has been found to be highly atherogenic, contributing to CHD.

In one study, atherosclerosis was found to be highly responsive to negative dietary changes (Western foods) compared to smoking, low physical activity, or psychological stress alone (Lindeburg, 2012). The case of fat and the incidence of heart disease is integral in understanding the benefits of Paleolithic diet versus the Western diet.

There is high concern among skeptics that a Paleolithic diet would encourage a higher consumption of dietary fat with a resulting increase in heart disease is not warranted. The "lipid hypothesis" is the long accepted assumption that low density lipoprotein (LDL) cholesterol is a major risk factor for CHD. There is a great need for dietary fatty acids for effective biochemical processes such as endothelial activation, thrombogenesis, plaque rupture, inflammation, and smooth muscle cell proliferation (Ramsden et al., 2009, p. 290). The type of fat consumed is much more important than the absolute amount of dietary fat consumed. There are many different types of fats: monounsaturated fats(MUFAs), polyunsaturated fats(PUFAs), saturated fatty acids(SFAs), and *trans*-fatty acids(TFAs). Here the influence of MUFAs, SFAs, and TFAs will be discussed.

TFAs are found in hydrogenated oils such as household margarines, shortenings, and poly-hydrogenated vegetable oils (PHVO, the medium for which commercially fried food is often fried in)—characteristic of the Western diet. The increased consumption of TFAs did not come about until the invention of the hydrogenation process in 1900, and TFAs increased in popularity with the creation of Crisco in 1911 (Ramsden et al., 2009, p. 292). Hydrogenation occurs when, in the presences of a Nickel catalyst, hydrogen adds across a C-C double bond to "saturate" the bond with hydrogen. In a side reaction a cis-fatty acid receives hydrogen resulting in a configuration in the shift of the double bond and formation of a trans-fatty acid. The purpose of this process is to yield a product with more desirable properties such as a lower melting point (converting a liquid oil into a solid fat, or lard). TFAs have recently been linked to endothelial dysfunction, inflammation, and sudden cardiac death (Mozaffarian & Willett, 2007). Studies have even shown that TFAs are more highly associated with CHD than SFAs (Ramsden et al., 2009, p. 292).

Despite popular belief, some SFAs do not confer harmful effects on the heart. There are multiple types of SFAs such as stearate, laurate, myristate, and palmitate, that differ only in the length of the fatty acid tail, to name a few (Ramsden et al., 2009, p. 293). Stearate is found most commonly in cocoa butter, and does not increase levels of low density lipoprotein (LDL) (Grundy, 1994). In addition, laurate and stearate possess the capability to reduce the total cholesterol/HDL ratio. Palmitate heightens thrombogenesis and is found in dairy products (uncharacteristic of the Paleolithic diet) and grain-fed animals (animals did not consume grain products during the Paleolithic era). Despite the effects of palmitate, some research has shown no link between CHD and SFA consumption (Ramsden et al., 2009, p. 293).

MUFAs are found in olives, olive oils, nuts, and avocados, and are considered a better substitution for TFAs. This type of fat is cardioprotective, and diets high in MUFAs have been found to have lower rates of CHD (Tunstall-Pedoe et al., 1999). MUFAs improve insulin sensitivity, decrease thrombogenesis, lower LDL oxidation, and enhance lipoprotein parameters. MUFAs were a significant source of energy in preagricultural human diets accounting for about half of the total fat and 16% to 25% of the total energy (Cordain et al., 2002b). The naturally occurring MUFAs were able to satiate and provide energy for hunter-gatherers.

In the modern world, fat has a negative connotation and is considered something that causes obesity, heart disease, and death. Fat, however, is an incredibly important macronutrient. It has a major role in many biochemical processes. The fat disconnect occurs when it comes to the types of fat consumed. Western diets possess high amounts of TFA and harmful SFAs which result in the leading cause of death, heart disease. Preagricultural humans were consuming larger amounts of fat that provided energy and satiety from MUFAs and good types of SFAs.

Cancer

According to the CDC, about 20.3 million adults have been diagnosed with cancer—8.5% of the United States population. Studies indicate that variance in diets account for about 30% deviation in risk of cancer in Western countries. The high numbers of obese patients within the Western societies are influential on the rates of cancer. In obese patients, there is an increased risk of cancer of the breast, colon, prostate, endometrium, kidney, and gallbladder—further connection of diet and cancer (National, 2015). Cancer is often a result of a genetic mutation or longevity of life—these types of cancer are unpreventable. However, some cancers can be avoided by adhering to a healthy diet and lifestyle similar to that of humankind's preagricultural ancestors. Lower cancer rates have been reported among hunter-gatherers in the Amazon, Malaysia, and the Arctic (Lindeberg, 2012). Proof and explanation lie in the data of ancestral, traditional peoples who follow Paleolithic diets. In Kitava, a comparative population of Paleolithic people mentioned earlier, people were unaware of malignant cachexia (a long term emaciation that ends in death) and the incidence of slowly developing tumors among residents is considered exceedingly rare. These islanders also have low rates of superficial malignancies, which consisted of skin or throat cancers, lymphoma, breast cancer, etc. Interestingly, it has been observed that migrant women from countries of low risk of breast cancer who move to countries with a high risk for it have an increased probability of developing the disease. Daughters of these migrant women also have an increased risk of acquiring breast cancer (Lindeberg, 2012). In addition, the Western diet is associated with many types of cancers.

As noted earlier, the Western diet possesses a high glycemic load. Glycemic load may actually have an influence on the probability of succumbing to cancer. When a diet consists of a high GL, hormonal changes may ensue. For example, elevated insulin-like growth factor-1 (IGF-1) to insulin-like growth factor binding protein-3 (IGFBP-3) ratios have been observed in diabetics with high GL diet. A high ratio of IGF-1 to IGFBP-3 have been suggested to have carcinogenic properties (Cordain et al., 2002a).

Increased IGF-1 on mammary epithelium is associated with breast cancer (Herman-Giddens, 1997). Research showed that IGF-1 receptors were present in 90% of primary breast cancer cell lines. A hormone called oestrin plays a role and sensitizes mammary cells to the proliferative effect of the IGF-1 receptors. Synthesized by the liver under growth hormone (GH) stimulation, IGF-1 is not stored locally. The hormones circulate through the bloodstream as a complex bounded to IGF-binding proteins (IGFBPs) (Apter & Sipilä, 1993). Further association of the Western diet and breast cancer is linked to the early onset of menarche and puberty.

The Western diet has been linked to an early onset of menarche and puberty, and is associated with earlier onset of hyperinsulinemia, a marker of increased risk for breast cancer. Hyperinsulinemia is the presence of excess levels of insulin in the blood relative to glucose (not to be confused with hyperglycemia, abnormally high levels of circulating blood glucose). Hyperinsulinemia has also been found as a risk marker for postmenopausal breast cancer (Frisch & McArthur, 1974). In addition, a higher risk of colon cancer has been associated with the Western diet. In fact, a three-fold increase in risk in participants of a study aged 55 years and younger (there was a slightly stronger association for men) (**Figure 3-7**) (Slattery et al., 2000).

	All subjects OR (95% CI)[1]	Age at diagnosis		
		≤55 years OR (95% CI)	56–66 years OR (95% CI)	≥67 years OR (95% CI)
Western diet				
Low	1.0	1.0	1.0	1.0
Intermediate	1.3 (1.2–1.6)	2.5 (1.4–4.4)	1.2 (0.8–1.8)	1.2 (1.0–1.6)
High	1.5 (1.2–2.0)	3.1 (1.6–6.2)	1.4 (0.8–2.3)	1.4 (0.9–2.1)

[1] Adjusted for age, sex, calories, BMI, long-term vigorous physical activity, and usual number of cigarettes smoked per day.

Figure 3-7. Western diet and colon cancer associations. Taken from (Slattery et al., 2000)

There seems to be a correlation of cancers of the epithelium and the Western diet. Modifications to the diet could potentially lower the risks of acquiring cancer.

Based upon the implications of the Western diet (increased risk obesity, diabetes, heart disease, and cancer), actions made to change these deleterious habits could have a positive effect on the incidence of the Diseases of Civilization. The Paleolithic diet provides healthy macronutrient distribution, energy, satiety, and protective benefits for the modern day human.

VI: CONCLUSION

Only a century ago, 46% of all deaths were attributable to infectious disease in the United States. In 2010, infectious diseases caused only 3% of deaths, which is due to the advancements in sanitation, medicine, vaccinations, and public health. However, in 2010, heart disease and cancer accounted for 47% of deaths, compared to 12% in 1900 (Tippett, 2014). Despite the advancements in medicine and technology in the last century, these diseases continue to increase and cause harm and death. The spread of noncommunicable diseases is credited to the expansion of the Western diet. Today, diseases such as diabetes mellitus, heart disease, and cancer affect a large percentage of people. About 35% of adults over the age of twenty are obese (Ogden et al., 2014). Diabetes affects 9.3% of the United States population and is currently the 7th leading cause of death. Diabetes is predicted to increase with 86 million people diagnosed with prediabetes in 2012, according to the American Diabetes Association. Cancer affects 8.5% of the United States, and is highly influenced by diet (National. 2015). The Western diet and lifestyle damages the health of citizens, and the prognosis for future generations is not good.

The research found from this investigation points to Western diet as the source of the overwhelming abundance of cases of noncommunicable diseases. Stated by Loren Cordain (2005), "evolutionary collision of our ancient genome with nutritional qualities of recently introduced foods may underlie many of the chronic diseases of Western civilization." The Western diet could not exist without the nature of Western lifestyle.

Today, people focus their lives outside of their homes. A typical working person may wake up early, pick up coffee at their local Starbucks, eat a catered lunch in the conference room, and make it home just in time to order pizza or heat a frozen dinner. The Western lifestyle is about convenience. It is about sacrificing important things like healthy meals and rest for the constant desire to succeed. Fast food and processed food can only provide quick energy and few nutritional benefits. Although some people purchase food based on convenience, others purchase it based on limited availability and access. Food deserts are locations where the availability of healthy food is sometimes scarce. People that live in these locations are at a higher risk for eating unhealthy foods and contracting noncommunicable diseases.

Humans are not biologically wired to consume and function off of processed, Western foods. According to Eaton and Konner in 1985, "profound changes in diet and lifestyle that occurred after the Neolithic Revolution are too recent on an evolutionary timescale for the human genome to have fully adapted." This is based upon the "thrifty" genotype hypothesis proposed by James V. Neel in 1962: people that are more susceptible to obesity and diabetes mellitus have a gene that previously served as advantageous during Paleolithic times. Hominids with this gene were able to quickly store fat during periods of abundance for use during times of famine. In modern, Westernized countries, famine no longer occurs due to the abundance of processed foods. Therefore, the body is storing fat for a famine that never arises, and this excess consequently causes disease.

Studies have shown that Paleolithic diets can improve the prognosis for people who suffer from noncommunicable diseases (Klonoff, 2009; Boers et al., 2004). Due to limited access to healthy foods in food deserts and the severity of the condition and extent of disease, execution of this diet is sometimes difficult. Small steps toward a Paleolithic diet can affect dietary habit change. Proposed education of the benefits of whole, natural, and unprocessed foods in the public schools would instill a healthy relationship with food at a young age. Government literature on the effects of processed foods and other foods characteristic of the Western diet should be prominently published and widely distributed to the general public. In addition, government regulation of processed and manufactured food and drink should be proposed and enacted to protect the citizens from noncommunicable diseases. Citizens should have the right to be informed of the harmful effects of Western diet foods. Westerners ought to learn to buy local, seasonal, fresh foods, and be able to prepare this food safely through home cooking. Lifestyles and attitudes must be altered in order to restore health and vitality to citizens of Westernized countries. The United States and other Westernized countries are in the midst of a public health crisis that has emerged during the most abundant century in human history. Sincere leadership and effective change is necessary to embrace the challenge of transformation.

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