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# The Proliferation of Diabetes: A Cultural Epidemiological Review of Type 2 Diabetes in the Global Community

Kelly Heuer

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**The Proliferation of Diabetes:  
A Cultural Epidemiological Review of Type 2 Diabetes in the  
Global Community**

A Capstone Project Submitted in Partial Fulfillment of the  
Requirements of the Renée Crown University Honors Program at  
Syracuse University

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May 2014

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## **Abstract**

Global diabetes is a serious and growing problem, which has quickly turned into a public health crisis. The rapid spread of type 2 diabetes can be contributed to several different factors, including genetics, environmental influences, poor nutrition habits, and sedentary lifestyle. A large part of the proliferation of this disease is the spread of western culture, specifically diet.

A problem faced when addressing this disease from a global standpoint of prevention, control, and treatment is that type 2 diabetes affects different cultures in different manners around the globe due to differences in risk factors (including genetics, age, race, sex, education, socioeconomic status, and income). In order to best prevent the spread of this disease, prevention efforts must have common goals worldwide; however, prevention also needs to be geared towards the culture being addressed.

This capstone is divided in two parts: the first part is a review of what type 2 diabetes is and how it affects individuals with the disease, including symptoms, risk factors, complications, and possible preventions. The second part is an epidemiological review, which seeks to find trends and differences in data among different cultures. Specifically addressed are the United States, China, and India. This review is possible through the Centers for Disease Control and Prevention's Diabetes Public Health National Surveillance, the National Diabetes Fact sheet, the International Diabetes Federation, and other contributing statistical databases.

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## **Executive Summary**

In 2011, Diabetes Mellitus was the seventh leading cause of death, killing 1.4 million people worldwide (World Health Organization, July 2013). To many, this does not come as a surprise. The United States is infamous around the world for the overconsumption and lack of physical inactivity that has led to our obese nation. Today in the United States, 145.7 million adults are overweight or obese (79.9 million men and 74.8 million women); among these, 78.4 million are considered obese, having a BMI greater than 30 kg/m<sup>2</sup> (36.8 million men, 41.6 million women). As of today, all US states have a rate of obesity greater than 20%. 23.9 million children in the US are overweight or obese; this is 30% of all US boys and 30.4% of all US girls. The obesity epidemic in the United States is disproportionately more prevalent in children that live in low-income, low-education, and higher-unemployment households. The cost of this rise in obesity is astronomical; the current estimate of cost is \$254 billion, estimated to reach \$861 to \$957 billion in 2030.

Diabetes rates are growing rapidly along with the rise in obesity in America, as Diabetes Type 2 is linked with high body weight, high levels of inactivity and poor diet. In the US, 25.8 million children and adults (8.3%) of the population have diabetes. 13.0 million men in the United States and 12.6 million women suffer from the disease. Among races, Asian Americans, non-Hispanic blacks and Hispanics experience high rates of diabetes than non-Hispanic whites.

Complications that can rise from the disease include heart disease, stroke, blindness, kidney disease, nervous system disease, and amputation.

While these numbers may be shocking, the United States is actually not the world's leader for diabetes cases. Type 2 Diabetes is a public health crisis that is fueled by urbanization, sedentary lifestyle, and poor nutrition habits. While Type 2 Diabetes was once a disease of the West, it has now spread to every country in the world. According to the International Diabetes Federation, diabetes affects at least 285 million people worldwide. Asia's large population coupled with its economic development has brought it to the center of the epidemic, accounting for 60% of the world's diabetic population. In 1980, less than 1% of Chinese adults had the disease; today, it is estimated that 11.6% of Chinese adults have been diagnosed. Already about 80% of China's government spending on healthcare goes towards chronic diseases, rising questions on how China will hold up with this increasing burden. While lifestyle and diet have a huge role in the onset of this disease, genetics plays a key role. Chinese develop the disease at a lower BMI than white-non-Hispanics of the United States, an interesting factor in the spread and prevalence of the disease.

This capstone project does not only deal with nutrition but also public health, both of which are topics that I am studying at Syracuse University. The project is broken into two separate parts. The first part deals with the epidemiology and social determinants of Diabetes. This is an extensive research project on the disease itself, including social changes that lead to an increase in obesity, eventually leading to the development of Type 2 Diabetes and its



complications. This is focused on evidence and data from the United States. The second part of the project deals with several geographic case studies. Data was compared from The United States, China, and India. Many factors were compared, including social determinants of diabetes, economic growth, genetic predisposition, gender differences, and age differences. Looking at the health crisis from a public health point of view concluded the project, pinpointing specific causes of the epidemic and proposing solutions for each region based on genetic and cultural practices.

This topic is significant because Type 2 Diabetes is now influencing the world in epidemic proportion. Type 2 Diabetes is the number one cause of kidney failure, lower-limb amputations, and new cases of blindness in adults. The American Diabetes Association predicts that if we do not act, one in three Americans will have diabetes by 2050. In order to stop this epidemic, we must advance research and support prevention programs. However, that cannot be done without first raising awareness. The purpose of this research project is to highlight factors that need to become common knowledge of the public through literature review and statistical review.

## **Acknowledgements**

This capstone could not have been completed without the guidance and support of my devoted Capstone Advisor, Dr. Sandra D. Lane. Dr. Lane is a professor of Public Health and Anthropology at Syracuse University, as well as a research professor of Obstetrics and Gynecology at Upstate Medical University. She has truly shaped my view of the world of public health through her course in epidemiology, helping me recognize my natural ability and potential within the field.

I must also acknowledge the faculty and staff of the David B. Falk School of Sport and Human Dynamics for their guidance throughout my career at Syracuse University. Their strong support for the idea of the link between diet and disease has not only molded this capstone, but also my future career goals.

## **Chapter 1**

### **Introduction**

Everyone has at one time been awoken in the middle of the night, whether from a night terror, a family member moving about, or simply a noise outside the window. The irritation of being awoken is understandable in the moment, but luckily within a few short minutes most can find the way back to slumber and forget about the interruption.

Imagine being awoken at 1 a.m. with the intense need to urinate. After relieving the urge, imagine walking into the kitchen and consuming a few glasses of water, unable to control your sudden thirst that will not go away. Now imagine finding the way back to rest in bed, only to discover the presence of an uncomfortably dry mouth. Even though you have just had several glasses of water, your mouth feels as though it is filled with cotton. Trying to ignore the discomfort, you are able to fall back asleep. However, you are once again awoken at 3 a.m. with the same complaints, again going through the motions to relieve them. Imagine then waking up at 5 a.m., and again at 7 a.m. By the time the sun rises, you are exhausted of the cycle and relieved that morning has finally come. Now imagine experiencing the same symptoms throughout the workday, apologizing to those around you for your excessive visits to the lavatory and trying not to take in water until you can no longer stand the discomfort of your dry mouth. The four empty water bottles in the recycling bin are testimony to

just how thirsty you are, unable to quench the thirst. Imagine trying to convince yourself this all because of the warm weather or the dry air, unable to determine exactly why this is happening. That night, you are once again awoken at 1 a.m., frustrated and confused. The three more times you are awoken before dawn only concern you more. As time passes, you notice yourself becoming hungrier at the same time that you are losing weight. Your feet are in constant pain, at times becoming completely numb. Your eyes sometimes seem unable to focus, resulting in blurred vision. Unable to stand the annoying mystery, you finally decide that you should visit the doctor.

Now, imagine your doctor informing you that you are 1 of 5,205 people in America that will be diagnosed with type 2 diabetes today alone. You are 1 of 1.9 million who will be diagnosed this year. You are 1 of 25.8 million Americans total with diabetes, making up 8.3% of the population<sup>1</sup>.

### **A “Western” Disease No Longer**

While type 2 diabetes and other non-communicable diseases used to only be “Western” diseases, it has truly become a global public health

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<sup>1</sup> American Diabetes Association. "Fast Facts: Data and Statistics about Diabetes." 3 2013. [American Diabetes Association](http://professional.diabetes.org). <professional.diabetes.org>.

crisis. Coupled with a worldwide rise in obesity, type 2 diabetes has spread to every country in the world due to urbanization, population growth, nutritional evolution, and physical inactivity<sup>2</sup>. Diet, lifestyle and genetics all play a role in the spread of this disease. While epidemiological evidence has shown that type 2 diabetes is a preventable disease, exercising these findings through diet and lifestyle alterations is often extremely difficult without changes in public policies concerning food, environment, and health care.<sup>2</sup>

The characteristics of type 2 diabetes are changing as it travels throughout the world. While diabetes used to only affect wealthy countries, it is now extremely common among poor and undeveloped nations. It is estimated by the International Diabetes Federation that two-thirds of all diabetes cases will occur in low to middle-income countries by the year 2030.<sup>2</sup> While type 2 diabetes was once unremarkable in children, it is becoming more common in pediatric patients (following a trend of rising obesity rates among children). The American Diabetes Association confirms that there are 3,600 newly diagnosed youth with Type 2 Diabetes annually.<sup>1</sup> Ethnic groups are affected disproportionately, due mostly to phenotypic characteristics and cultural practices.

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<sup>2</sup> Hu, F. B. (2011). Globalization of Diabetes: The role of diet lifestyle and genes. *Diabetes Care* , 34 (6), 1249-1257.

## The Link to Nutrition

Diet alone is a powerful force in the growing cases of Type 2 Diabetes, both in America and Abroad. The well-known Nurses' Health Study showed the link between fats and carbohydrates and the development of diabetes, regardless of the participant's weight, BMI, and other risk factors<sup>3</sup> In this study, researchers followed the consumption of whole grains in more than 16,000 women for up to 18 years. What researchers found was that women were 30 percent less likely to develop type 2 diabetes if they ate two to three serving of whole grain per day than those who seldom ate whole grains. Researchers also found that the consumption of two additional servings of whole grain a day further decreased the risk of developing type 2 diabetes by 21 percent. The Nurses' Health Study also found that for every additional 12-ounce sugar sweetened beverage that is consumed daily, the risk of developing Type 2 Diabetes rose by 25 percent; eating just one 3-ounce serving of red meat a day increased risk by 20 percent, and consuming even smaller portions of processed meat daily increased risk by 51 percent. The switch from whole foods and grains to processed, refined and sweetened foods happened long ago for the United States. As the United States continues to remove the natural nutrients from food for convenience and taste, the rest of the world

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<sup>3</sup> Colditz, GA. (1997, 2). The Nurses' Health Study: 20-year contribution to the understanding of health among women. *Journal of Womens Health* , 49-62.

follows. Fast food establishments have spread throughout the world, creating the globalization of western food culture and practices. The movement of cultures away from indigenous foods towards the western diet only promotes the spread of type 2 diabetes and other non-communicable diseases. This is referred to as the epidemiological transition, which is the change from infectious diseases to chronic diseases as the major cause of death in a population. The link between diet and disease concerning type 2 diabetes is strong; there is evidence that 9 cases out of 10 of type 2 diabetes could be avoided by exercising healthy eating habits with weight control.<sup>4</sup>

### **Obesity and Type 2 Diabetes**

In the United States, more than one-third of adults are obese (34.9%). Obesity affects ethnic groups disproportionately, with non-hispanic blacks having the highest rates (47.8%). Hispanics experience 42.5% obesity rates, followed by non-hispanic whites (32.6%) and non-hispanic Asians (10.8%).<sup>5</sup> As with nutrition, obesity is not just a public health problem faced by the United States. Further studies are needed to understand the complex relationship between obesity and type 2 diabetes,

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<sup>4</sup> Harvard School of Public Health. (2014). *The Nutrition Source: Simple Steps to Prevent Diabetes*. Retrieved from <http://www.hsph.harvard.edu/nutritionsource/preventing-diabetes-full-story/#diet>

<sup>5</sup> Centers for Disease Control. (2014). *Adult Obesity Facts*. Retrieved from Overweight and Obesity: <http://www.cdc.gov/obesity/data/adult.html>

however obesity still remains an important risk factor for the disease. For treatment and prevention, reduction of obesity should be a goal world-wide. Obesity will be reviewed as a risk factor for type 2 diabetes in a later chapter, however it is important to note initially that obesity and Type 2 Diabetes are congruently rising both within the United States and abroad due to the changes in diet and lifestyle, brought about by the globalization of ideas of the West.



## Chapter 2

### **What is Diabetes?**

#### **Types and Definitions**

There are several different types of diabetes, each sharing the common trait: each form is a metabolism disorder, maipulating the way the body uses food for energy and growth. In a healthy digestive system, the body breaks down food consumed into glucose, the main source of energy for the body. The glucose is then transferred to the blood, where it can be taken in by cells. In order for cells to take up and utilize the glucose, insulin must be available for use.<sup>6</sup>

Insulin is a hormone which is produced by the pancreas and is key to reguating metabolism. Insulin starts working as soon as a meal is consumed. During digestion, carbohydrates are broken down into sougar molecules (glucose) and proteins are broken down into amino acids. The glucose and amino acids are then absorbed into the bloodstream, causing blood glucose levels to rise. Glucose levels taken directly after consuming a meal are referred to as postprandial levels. This rise in blood glucose then signals beta cells in the pancreas to secrete insulin, releasing it into

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<sup>6</sup> U.S. Department of Health and Human Services. (2008). *Diabetes Overview*. Retrieved from National Diabetes Information Clearinghouse: <http://diabetes.niddk.nih.gov/dm/pubs/overview/>

the bloodstream. Within 20 minutes, insulin rises to its peak level.<sup>7</sup> Insulin allows the cells to take in glucose, primarily in liver and muscle cells; the glucose is then designated for either use for energy or storage. As blood glucose levels fall, the production of insulin reduces. Within 2-4 hours, both insulin and glucose levels lower.<sup>7</sup>

In a healthy body, the pancreas is able to produce the right amount of insulin in order to allow cells to take in glucose. However, individuals with diabetes are either unable to produce insulin or are unable to respond properly to insulin. As a result the cells are unable to take in the glucose, causing it to build up in the blood. This glucose is then transferred to the urine, where it is excreted out of the body. As a result, the body ultimately loses its main source of energy.

There are three main types of diabetes: type 1 diabetes, type 2 diabetes, and gestational diabetes. A number of other types do exist, including Latent Autoimmune Diabetes, genetic defects of the beta cell, genetic defects in insulin action, diseases of the pancreas, medication interactions which reduce insulin action, certain infections, rare immune-mediated disorders, and genetic syndromes associated with diabetes.<sup>6</sup> Any form of diabetes outside of the main forms is rare and is typically not included in national diabetes statistics.

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<sup>7</sup> University of Maryland Medical Center. (n.d.). *Diabetes- Type 1*. Retrieved from <http://umm.edu/health/medical/reports/articles/diabetes-type-1>

## **Type 1 Diabetes**

Type 1 diabetes is also referred to as insulin-dependent diabetes or juvenile diabetes. Type 1 diabetes is usually onset in childhood or adolescence, hence the name “juvenile diabetes”. Type 1 diabetes accounts for 5-10 percent of all diabetes cases.<sup>7</sup> In Type 1 diabetes, the pancreas either does not produce enough insulin or does not produce insulin at all. It is considered a progressive autoimmune disease which involves the destruction of beta cells in the pancreas, high blood sugar levels (hyperglycemia), excretion of glucose in urine, weakness, weight loss, frequent urination, excessive hunger and thirst, and the need to take daily insulin to survive. Because the disease destroys the beta cells of the pancreas, individuals with this disease eventually become insulin deficient.<sup>7</sup>

Evidence shows that both a genetic predisposition to the disease and environmental factors are involved in the development of the disease. Researchers have found 18 genetic locations (labeled IDDM1-IDDM18) which are related to type 1 diabetes. IDDM1 regions contain HLA genes, genes that encode for proteins (histocompatibility complex) that affect immune response. Other factors are being discovered on an ongoing basis.

However, genetic factors do not tell the entire story for type 1 diabetes. In fact, most people who develop type 1 diabetes do not have a family history of the disease. There is only about a 10 percent chance of inheriting type 1 diabetes if a first-degree relative has the disease; in twin studies, one twin has a 33 percent chance of developing type 1 diabetes if the other twin has it. Further more, children are more likely to inherit type 1 diabetes from a father with the disease as compared to a mother with the disease.<sup>7</sup>

When considering environmental factors which may lead to the development of type 1 diabetes, research suggests that viral infections may be to blame. It has been found that enteric viruses which affect the intestinal tract may be associated; in particular, it has been found that the coxsackie virus (as well as congenital rubella and mumps) trigger the progress of type 1 diabetes.<sup>7</sup> Drinking cow's milk and ingesting excessive vitamin D has also been linked to increased risk of type 1 diabetes, as well as drinking nitrates in water.<sup>8</sup>

Type 1 diabetes has been increasingly prevalent over the last few decades, due to several different risk factors. Studies report that risk factors include being ill in early infancy, having a parent with type 1 diabetes (particularly a father), having a mother considered old at the time of childbirth, having a mother who has preeclampsia during pregnancy

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<sup>8</sup>Mayo Clinic. (n.d.). *Complications*. Retrieved from Type 1 Diabetes: <http://www.mayoclinic.org/diseases-conditions/type-1-diabetes/basics/complications/con-20019573>

(high blood sugar and excess protein in the urine), and having other autoimmune disorders. Being born to a mother less than 25 years of age and being born with jaundice are also major risk factors.<sup>8</sup> Type 1 diabetes also affects different ethnic groups disproportionately, affecting caucasian youth at greater rates than all other races. Interestingly, geography may also be a risk factor for the disease. The incidence of type 1 diabetes increases the further one travels away from the equator. People living in Finland and Sardinia have the highest incidence of type 1 diabetes (which is two to three times higher than the United States).<sup>8</sup>

Symptoms associated with type 1 diabetes are similar to those of type 2 diabetes, however they may progress more quickly and present more intensely. Symptoms include excessive urination, extreme and unusual hunger or thirst, sudden weight loss, weakness and fatigue, blurred vision, irritability, and nausea and vomiting.<sup>7</sup> Children presenting with type 1 diabetes symptoms may be restless and have trouble functioning or focusing during school. In extremely severe cases, the first sign of type 1 diabetes may be diabetic coma.

As with any disease, there are many health complications that come with the development of type 1 diabetes. While complications have been decreasing, it is important to note that preventing complications can be done by controlling blood glucose levels as well as treating risk factors for heart disease, such as blood pressure and cholesterol levels. One serious complication of type 1 diabetes is diabetic ketoacidosis (DKA). It

is caused by a lack of insulin in which the body produces high levels of ketones, which are blood acids. Ketones are produced when the body uses adipose for energy, instead of utilizing glucose. These ketones then build up in the body, causing ketoacidosis. For an individual with type 1 diabetes, this may occur due to a reduction of insulin doses or noncompliance with insulin therapy. Symptoms of DKA include a “fruity” breath odor, confusion, decreased awareness, swelling of the brain, and respiratory distress.<sup>7</sup> A simple urine test can determine if ketone levels are high in an individual.

Another complication of type 1 diabetes is hypoglycemia.

Hypoglycemia is defined as low blood sugar, or blood sugar levels below 70 ml/dL. Hypoglycemia can be caused by decreased intake of food or increased consumption of alcohol, as well as excess exercise. The most common cause of hypoglycemia is taking more insulin than needed. Symptoms of hypoglycemia include sweating, trembling, hunger, rapid heart rate, confusion, weakness, combativeness and coma/seizure in extreme cases.<sup>7</sup>

Other complications of type 1 diabetes include heart and blood vessel damage, neuropathy (nerve damage), kidney damage (nephropathy), eye damage, foot damage, skin and mouth conditions, osteoporosis, hearing problems, and complications during pregnancy. Adolescents can experience a lack of blood glucose control as well as eating disorders; about a third of adolescents with type 1 diabetes under-

use insulin to lose weight. While eating disorders are harmful for everyone, an eating disorder can be especially risky for someone with diabetes.<sup>8</sup>

### **Gestational Diabetes**

Gestational diabetes is a diabetes that only occurs during pregnancy. Too much glucose in the mother's blood can not only harm the mother, but it can compromise the health of the baby. It is usually diagnosed during late pregnancy, within the third trimester. Gestational diabetes occurs when the mother's pancreas cannot produce enough insulin during pregnancy. This is because of hormonal changes; changes in the levels of hormones produced in the mother's body can cause the body to use insulin less efficiently, which is referred to as insulin resistance.<sup>9</sup> Insulin resistance increases the body's need for insulin, and all pregnant women experience some insulin resistance in the late stages of pregnancy. However, some women will have an increased risk of insulin resistance even before they become pregnant, increasing the risk of the development of gestational diabetes greatly.

A mother's chances of developing gestational diabetes are increased if the mother is overweight, has had gestational diabetes before,

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<sup>9</sup> National Diabetes Information Clearinghouse. (n.d.). *Gestational Diabetes*. Retrieved from <http://diabetes.niddk.nih.gov/dm/pubs/gestational/>

has given birth to a baby weighing more than nine pounds, has a parent or sibling with type 2 diabetes, has prediabetes (elevated blood sugar levels not high enough to be diagnosed with diabetes), have the hormonal disorder polycystic ovary syndrome (PCOS), or are of African American, American Indian, Asian American, Hispanic/Latina, or Pacific Islander American descent.<sup>9</sup> A mother can lower her chances for gestational diabetes by losing excess weight and increasing physical activity before she becomes pregnant. It is important that the mother not try to lose weight once she is already pregnant in order to preserve the health of the baby.

A mother will be tested for gestational diabetes between weeks 24 and 28 of the pregnancy, however if the mother has multiple risk factors she may be tested at her very first visit after discovering the pregnancy. A doctor can diagnose a mother with gestational diabetes with a simple blood test.

Gestational diabetes can have multiple affects on the baby if it is not treated and closely controlled. If the mother's blood glucose level is elevated the baby's will be as well. As a result, the baby will produce more insulin to control the hyperglycemia. Excess glucose in the baby's blood is stored as fat. As a result of this, babies born to mothers with uncontrolled gestational diabetes experience larger than normal body size at birth, which is called macrosomia.<sup>9</sup> Macrosomia can cause a very difficult and dangerous delivery, for both the mother and baby. The baby



may also experience hypoglycemia at birth, jaundice (yellowing of eyes and skin), and difficulty breathing. The baby also has a higher chance of dying either before or soon after birth.<sup>9</sup> The baby will also have an increased risk of becoming overweight and developing type 2 diabetes in adulthood. In order to control the baby's health in a mother with gestational diabetes, doctors recommend frequent ultrasound exams to monitor the baby's growth and a nonstress test to show if the baby's heart responds to stress normally.

Gestational diabetes does not only affect the health of the baby; mothers can experience complications from the disease throughout the pregnancy. Gestational diabetes increases the mother's chances of developing high blood pressure, having protein in urine (preeclampsia), delivering the baby via cesarean section surgery, becoming depressed, and developing type 2 diabetes.<sup>9</sup> Mothers who experience preeclampsia often experience it during the second half of the pregnancy, with the only cure being to give birth. Preeclampsia is a serious diagnosis which could be fatal if not treated properly. Mothers who develop preeclampsia early in the pregnancy may need to comply with bed rest and medication therapy. Women with gestational diabetes need to be checked by a doctor frequently, as they often do not experience symptoms. Typically, gestational diabetes subsides after the mother gives birth. However, the mother is still at an increased risk of developing gestational diabetes in subsequent pregnancies and is more likely to have type 2 diabetes later in life.

Gestational diabetes is treated through insulin therapy, healthy eating and physical activity.

### **Type 2 Diabetes: Opening Thoughts**

According to the U.S. Centers for Disease Control and Prevention about 26 million Americans have diabetes; up to 95 percent of these cases are type 2 diabetes.<sup>10</sup> (University of Maryland Medical Center) Type 2 diabetes is rapidly turning from a disease of the aging to a disease of the world's youth. Type 2 diabetes comes with many life threatening symptoms and complications, but can be managed with lifestyle change and medications.

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<sup>10</sup> University of Maryland Medical Center. (n.d.). *Diabetes- Type 2*. Retrieved from Medical Reference Guide:  
<http://umm.edu/health/medical/reports/articles/diabetes-type-2>

## Chapter 3

### Type 2 Diabetes

#### **Definition**

Today in the United States it is hard to come across a person who does not know someone dealing with type 2 diabetes. An estimated 8% of the population suffers from the lifelong condition, but those are only those who are diagnosed. It is estimated that 5.7 million Americans live with the condition but have yet to be diagnosed.<sup>6</sup> Type 2 diabetes is also referred to as noninsulin-dependent diabetes mellitus (NIDDM) as well as maturity onset diabetes. In type 2 diabetes, the body does not respond properly to the insulin being produced. Type 2 diabetes involves three stages of onset. In the first stage, the affected person develops insulin resistance. In insulin resistance (previously discussed, see pg. 13) insulin is prevented from moving glucose from the blood into liver and muscle cells where it can be used. Individuals with type 2 diabetes produce insulin at normal or high levels, however they cannot utilize it.<sup>10</sup> In the second stage, the pancreas is no longer able to produce insulin in the necessary amounts to overcome the resistance. The body may respond to this by presenting with abnormally high blood glucose levels after meals (postprandial hyperglycemia).<sup>10</sup> In the third stage, beta cells in the pancreas become damaged from the heightened glucose levels, reducing insulin production.

This presents with constant elevated blood glucose levels (fasting hyperglycemia).<sup>10</sup>

### **Causes and Risk Factors**

Type 2 diabetes is known to result from a combination of factors, including obesity, diet, alcohol intake, sedentary lifestyle, and genetic factors.<sup>10</sup> Genes and genetic mutations are thought to have an impact on the act of insulin and its regulation of blood sugar. It is also known that type 2 diabetes can be caused by other conditions that damage the pancreas. Examples of this are pancreatitis, pancreatic surgery, and certain chemicals. Genetic and hormonal disorders are also associated with this development of the disease. Ingesting high levels of cholesterol lowering drugs (statins) is also associated with the development of type 2 diabetes.

According to the National Institutes of Health, individuals have an increased risk for type 2 diabetes if they are 45 years of age or older, have a family history of diabetes, lead an inactive lifestyle (exercise less than three times a week), have high blood pressure (140/90 mm Hg and higher) have had diabetes during pregnancy or have given birth to a baby weighing more than nine pounds, have polycystic ovary syndrome, experience acanthosis nigricans (dark pigmented skin around the neck and armpits), have a history of blood vessel diseases, and present with and

HDL level of less than 35 mg/dL with a triglyceride level of 250 mg/dL or higher.<sup>11</sup>

There are several medical conditions that are associated with an increased risk of type 2 diabetes. One condition is obesity. As previously stated, excess body fat contributes to insulin resistance. However, the way that fat is distributed in an individual also plays a role in risk. Individuals with central adiposity (weight in the abdomen, around the abdominal organs, and upper body) experience higher rates of insulin resistance, type 2 diabetes, heart disease, high blood pressure, stroke, and high LDL cholesterol levels.<sup>11</sup> Waist circumference can help determine if someone presents with central adiposity; women present with a waist circumference greater than 35 inches while men present with a waist circumference greater than 40 inches. Polycystic ovary syndrome (PCOS) is experienced by 6 percent of women in the United States. It is the result of high male hormones produced by the ovary, especially testosterone. About half of the women with PCOS also have diabetes, and all women with PCOS are at a higher risk of developing insulin resistance.<sup>11</sup> It has also been shown that those with severe clinical depression and schizophrenia experience increased risk for type 2 diabetes. According to new studies, this may be because antipsychotic medications elevate blood glucose levels.<sup>11</sup>

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<sup>11</sup> National Institutes of Health. (n.d.). *National Diabetes Education Program*. Retrieved from Am I at Risk?: <http://ndep.nih.gov/am-i-at-risk/>

## **Signs and Symptoms**

Type 2 diabetes is a disease that usually progresses very slowly. Because of this, adults experience a slow onset of many symptoms linked with the disease. Symptoms of type 2 diabetes include excessive thirst and urination, fatigue, weight loss, blurred vision, vaginal yeast infections/fungal infections in groin and under breasts in women, erectile dysfunction in men, problems of the gums, excessive itching, and tingling and burning in extremities.<sup>10</sup> Most children with type 2 diabetes present with acanthosis (dark patches of skin) and overweight or obesity. Children generally do not exhibit common signs of adults such as frequent urination.<sup>10</sup>

## **Complications**

Individuals with type 2 diabetes have higher death rates than those without the disease, regardless of age, sex, and ethnicity.<sup>10</sup> Because of this, lifestyle modifications are needed to help prevent the risk for the following conditions. Heart disease and stroke are the leading cause of death in individuals with type 2 diabetes. Heart attacks are the root cause of 60 percent of strokes and 25 percent of deaths in those with type 2 diabetes.<sup>10</sup> Diabetes affects the heart by accelerating the progression of

atherosclerosis, increases the risk of high blood pressure, and increases impaired nerve function related to heart function.

Diabetic nephropathy (kidney disease) is a complication of type 2 diabetes which is the leading cause of end-stage renal disease.<sup>10</sup> In nephropathy, glomeruli in the kidney leak protein into the urine due to damaged structure and function. Eventually this leads to kidney failure. Symptoms of this include itching, fatigue, pale skin, and swelling in the feet and ankles.

Diabetic neuropathy is a disease affecting almost 50 percent of people who have had type 2 diabetes for more than 25 years.<sup>10</sup> Neuropathy is impaired nerve function, which can occur in peripheral nerves or autonomic nerves. Peripheral neuropathy can cause tingling sensations, weakness, burning sensations, loss of sensation, numbness, and pain. Autonomic neuropathy can cause gastrointestinal complications, bladder infections, incontinence, erectile dysfunction in men, and rapid heart rates. It may also cause more serious heart problems, such as angina, a marker for heart disease.<sup>10</sup>

A common complication of type 2 diabetes is problems of the feet. About 15 percent of individuals face this problem and more than half of all lower limb amputations are due to type 2 diabetes, leading it to be the number one cause of hospitalization for these individuals.<sup>10</sup> Individuals at highest risk are those who have had type 2 diabetes for longer than 20 years and are insulin-dependent. Very small infections of the foot may

lead to dramatic complications; because those with type 2 diabetes may experience numbness in the feet, individuals with the disease may not notice infections or injuries of the feet. A degenerative condition associated with type 2 diabetes is Charcot Joint. It affects joints and bones in the feet due to neuropathy. Joints become stiff and bones may erode and crack, leading to unstable, deformed feet.

Another complication of type 2 diabetes is retinopathy, or damage to the retina. Type 2 diabetes is the leading cause of new cases of blindness in adults ages 20-74. This is also linked with the development of cataracts and glaucoma. In the first stage of retinopathy blood vessels of the retina weaken and may rupture and leak. The retina may swell, producing blurred vision. As the swelling develops it may cause retinal detachment or hemorrhage, causing visual loss or complete blindness.<sup>10</sup>

Individuals with type 2 diabetes are at an increased risk for certain infections, including respiratory infections, urinary tract infections, and hepatitis. Because of this, it is recommended that type 2 diabetes patients receive annual vaccinations, as well as vaccinations against hepatitis B and pneumococcal pneumonia. Once infected, patients with diabetes may be more difficult to treat than the general public, making some infections fatal.

Type 2 diabetes is not only associated with diabetic ketoacidosis (DKA) but also hyperglycemic hyperosmolar nonketonic syndrome (HHNS) (see pgs. 11-12 for information on DKA). HHNS is a serious



complication which increases blood glucose levels and dehydration without the production of ketones. It may be caused by infection, illness, or diabetes medications. Symptoms of HHNS are dry mouth, excessive thirst, high fever, hyperglycemia, seizures, coma, and death.<sup>10</sup> HHNS is much more common than DKA in individuals with type 2 diabetes, as DKA mainly affects those with type 1 diabetes.

Diabetes has also been linked to mental function and mental disorders. Studies have shown that individuals with type 2 diabetes face a higher risk of developing dementia than the general public. This may be due to severe low blood sugar<sup>10</sup>. Type 2 diabetes doubles the risk for depression, which may lead to hyperglycemia because of noncompliance to insulin therapy.

Women can face gender-specific complications related to sexual and reproductive health. Women may experience increased risk of yeast infections, decreased vaginal lubrication (leading to painful intercourse), gestational diabetes, and increased risk of premature menopause. Women on oral contraceptives may experience hyperglycemia, as birth control pills can raise blood glucose levels.

Other complications associated with type 2 diabetes are periodontal disease, carpal tunnel syndrome, hearing loss, nonalcoholic fatty liver disease, and cancers of the liver, pancreas, colon, rectum, breast and bladder.<sup>10</sup>

## Testing and Diagnosis

There are three commonly used tests to identify type 2 diabetes in an individual. These tests are the Fasting Plasma Glucose Test, the Oral Glucose Tolerance Test, and the Hemoglobin A1C Test. The Fasting plasma glucose (FPG) test is the standard test for type 2 diabetes, however it is not always dependable. It is performed by taking a blood test after eight hours of fasting. FPG levels above 126 mg/dL indicate the presence of type 2 diabetes (below 100 mg/dL is normal).<sup>10</sup> The Oral glucose tolerance test (OGTT) follows a FPG test and is performed two hours after ingesting a glucose solution. Individuals with type 2 diabetes will present a level of 200 mg/dL or higher (a normal level is below 140 mg/dL).<sup>10</sup> The OGTT may overdiagnose diabetes, and is often only used after a positive FPG test. The last test, Hemoglobin A1C Test tests an individual's levels of glycosylated hemoglobin to estimate an average blood glucose level over the past 2-3 months. Individuals with diabetes will present with 6.5 percent or higher (a normal level is below 5.7 percent).<sup>10</sup>

The American Diabetes Association recommends that individuals with diabetes be screened annually for complications associated with diabetes. Common tests include screenings for kidney damage, retinopathy, neuropathy, and thyroid dysfunctions.

## Current Treatments and Medications

Current treatments for type 2 diabetes surround the goal to control blood glucose levels and relieve complications associated with the disease. Current approaches to treatment include monitoring blood glucose levels, modifying lifestyle, and medication or insulin therapy.<sup>12</sup> Glucose goals for patients must be set by a medical doctor and treatment must target these goals (see figure A for goals). It is important to note that different goals are required for specific populations. The American Diabetes Association notes that the elderly may experience stroke or heart attack if placed on strict glucose control. It is also recommended from the same source that children not be treated with strict glucose control, as glucose is essential for brain development in children.<sup>12</sup>

Many medications are available, most anti-hyperglycemic to help those with type 2 diabetes control blood glucose levels. Doctors recommend biguanides as the first choice for medication, typically prescribing the biguanide Metformin. Metformin does not add weight or cause hypoglycemia, and may have beneficial side effects dealing with cholesterol and lipid levels. It has also been approved for use by children with type 2 diabetes. Side effects include metallic taste in the mouth, gastrointestinal complications, interference with the absorption of vitamin

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<sup>12</sup> American Diabetes Association. (2014). Standard of Medical Care in Diabetes-2014. *Diabetes Care* , 37 (1).

B12 and folic acid, and lactic acidosis. Individuals with heart failure, liver or kidney disease, or who are over the age of 80 should not use Metformin.<sup>12</sup>

Sulfonylureas are a class of drugs that cause the pancreas to release insulin. Common brands of sulfonylureas include chlorpropamide, tolazamide, glipizide, tolbutamide, glyburide, and glimepiride. It should be taken 20-30 minutes before a meal. Common side effects are weight gain, water retention, hypoglycemia, and cardiac complications; it should not be taken by pregnant women and may have interactions with many other drugs. Sulfonylureas typically lose effectiveness in 7 to 10 years.<sup>12</sup>

Meglitinides stimulate beta cells to produce more insulin. Common meglitinides include repaglinide and nateglinide. Side effects include diarrhea and headaches, and could produce cardiac complications. Individuals with health failure or liver disease should not use this medication.<sup>12</sup>

Thiazolidindiones include pioglitazone and rosiglitazone. They are usually taken in combination with another drug or insulin. Side effects are fluid retention, heart attack and failure, weight gain, and blurred vision, as well as liver damaged. Patients on this medication should be check regularly for any cardiac or liver conditions.<sup>12</sup>

Alpha-glucosidase inhibitors include acarbose and miglitol, and reduce glucose levels by preventing the absorption of starch in the small

intestine. This medication needs to be taken with meals, and may produce flatulence and diarrhea. It also interferes with iron absorption.<sup>12</sup>

Two new classes of drugs for the treatment of type 2 diabetes are glucagon-like peptide-1 (GLP-1) inhibitors and dipeptide peptidase-4 (DPP-4) inhibitors. GLP-1 inhibitors are injected, and have a very low risk of hypoglycemia because they only secrete insulin when blood sugar is high. Side effects include nausea, vomiting, and diarrhea.<sup>12</sup> DPP-4 inhibitors are taken in pill form by mouth and work similarly to GLP-1 inhibitors. Common side effects are respiratory infection, sore throat and diarrhea.<sup>12</sup> Other medication include pramlintide and dopamine agonists, which are less likely to be prescribed.

Insulin replacement is utilized when all reserves of insulin are exhausted, and is usually taken with metformin. Many individuals with type 2 diabetes will eventually need insulin replacement, with side effects of hypoglycemia and weight gain. Fast-acting insulins are taken before meals and act like natural insulin. Slow-insulin provide a constant level of insulin throughout the day, with glargine being the most successful to date. There seems to be no advantage to one over the other.<sup>12</sup>

### **Eating with Diabetes: Food as Medicine**

Diabetes can be easily controlled by simply learning, what, how, and when to eat. Healthy eating can help individuals with type 2 diabetes lower risk for complications associated with type 2 diabetes and keep

blood glucose levels within target ranges. Along with physical activity and medications, nutrition plays an essential role in the control of type 2 diabetes.

Individualized plans need to be made for each patient, as there is no one-size-fits-all nutritional intervention for type 2 diabetes. However, each day should have a designated amount of starches, vegetables and fruits to consume. A meal plan should include what and how much of each category to eat (servings), including what time and with what medications.

Starches provide carbohydrates, vitamins, minerals and fiber. Examples are breaks, pasta, corn, pretzels, and rice.<sup>13</sup> One serving of starch is either one slice of bread, one small potato, or one half cup cooked cereal.

Vegetables provide vitamins, minerals and fiber in the diet. Examples are broccoli, spinach, peppers, carrots, and beans. One serving of vegetables could be one half cup cooked carrots, one half cup cooked green beans, or one cup of salad.<sup>13</sup>

Fruits provide carbohydrates, vitamins, minerals and some fiber. Examples are apples, bananas, raisins, oranges and peaches. One serving of fruit could be one small apple or one half of a grapefruit. A banana counts for two servings of fruit.<sup>13</sup>

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<sup>13</sup> National Diabetes Information Clearinghouse. (n.d.). *Eating and Diabetes*. Retrieved from Diabetes Info: [http://diabetes.niddk.nih.gov/dm/pubs/eating\\_ez/index.aspx#1](http://diabetes.niddk.nih.gov/dm/pubs/eating_ez/index.aspx#1)

Milk provides calcium, protein, carbohydrates, vitamins, and minerals. One serving of milk is one cup of skim or 1% milk, or 1 cup of fat-free or low-fat yogurt. Meats and meat substitutes should be consumed in small amounts. Examples are chicken, beef, eggs, tofu, peanut butter and cottage cheese. One serving of meat substitutes is one egg or two tablespoons of peanut butter.<sup>13</sup>

Individuals with type 2 diabetes should limit fats and sweets, as they likely contain saturated fats, trans fats, and cholesterol. Limiting these can help keep blood glucose under control. One serving of fats is equal to one 3-inch cookie, one tablespoon of maple syrup, or one strip of bacon.<sup>13</sup>

Alcoholic drinks have calories but no nutritional value. Drinking alcohol without consuming food may cause blood glucose levels to drop, as well as raise blood lipid levels. A doctor should be consulted before any recommendations for alcohol should be given.<sup>13</sup> It is important to note that this recommendation has been given by the ADA, while different cultures around the world may use diet to control diabetes differently.

### **Primary Prevention of Type 2 Diabetes**

Genes have less influence over the development of type 2 diabetes than diet and lifestyle. The Nurses' Health Study showed that 90 percent of type 2 diabetes cases can be contributed to excess weight, lack of

exercise, unhealthy diet, smoking, and alcohol use.<sup>4</sup> Similarly, the Health Professionals Follow-Up Study showed that the “Western” combined with sedentary lifestyles and excess weight increased the risk of type 2 diabetes in men.<sup>4</sup>

Several clinical trials have shown that type 2 diabetes can be prevented or delayed for many people. The Diabetes Prevention program targeted men and women with elevated blood glucose levels who had not yet been diagnosed with type 2 diabetes. The group assigned to modest exercise and weight loss experienced 58 percent fewer cases of type 2 diabetes after three years than the control group. A Finnish study of exercise, weight loss and dietary change and a Chinese study of exercise and dietary change produced similar results.<sup>4</sup>

In order to prevent type 2 diabetes, individuals should strive to control excess weight as well as get active. Studies have shown that losing 7 to 10 percent of body weight can decrease risk by 50 percent.<sup>4</sup> The Nurses’ Health Study showed that walking for half an hour each day can reduce risk of type 2 diabetes by 30 percent.<sup>4</sup> In contrast, watching television for two hours a day increased the risk of developing type 2 diabetes by 20 percent.<sup>4</sup> Smokers are 50 percent more likely to develop type 2 diabetes, while those who drink alcohol modestly (one drink per day for women, two drinks per day for men) may decrease the risk of type 2 diabetes.<sup>4</sup> A healthy diet with portion controlled starch choices, whole grains, healthy fats, limited sugar-sweetened beverages, and limited red



and processed meats can have a large impact on reducing type 2 diabetes risk.

### **Chapter 3**

#### **Social Determinants of Type 2 Diabetes**

Understanding the social determinants of Type 2 Diabetes is important not only for prevention efforts, but also for health care planning and research. It is vital to know demographic characteristics of individuals who develop type 2 diabetes so that certain populations can be targeted for public health efforts to eliminate the disease.

#### **Age Distribution**

Type 2 diabetes affects the American public in disproportionate age distributions. 3.7 percent of diabetes cases are in Americans age 20-44, 13.7 percent of cases are in those age 45-64, and 26.9 percent of cases are older than the age of 65. Individuals under the age of 20 represent 0.26 percent, although this is only a rough estimate.<sup>14</sup>

Of new cases, 465,000 were 20-44, 1,052,000 45-64, and 390,000 older than 65. About 15,600 new cases of youth diabetes is reported annually.<sup>14</sup>

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<sup>14</sup> Centers for Disease Control and Prevention. (2011). *National Diabetes Fact Sheet, 2011*. Retrieved from National Center for Chronic Disease Prevention and Health Promotion: [http://www.cdc.gov/diabetes/pubs/pdf/ndfs\\_2011.pdf](http://www.cdc.gov/diabetes/pubs/pdf/ndfs_2011.pdf)

From this data it can be concluded that existing cases of type 2 diabetes are disproportionately clustered in those above the age of 65, while new cases are clustered in the 45-65 age group.<sup>14</sup>

### **Racial Minorities**

Racial and ethnic minorities are disproportionately affected by type 2 diabetes. Type 2 diabetes is most prevalent in African Americans, with 12.6 percent of all African Americans diagnosed; on average, African Americans are twice as likely to develop type 2 diabetes than Whites. African American women are the most affected, being more likely to develop type 2 diabetes than non-Hispanic Whites, African American men, or Hispanics.<sup>15</sup> African Americans are also more likely to develop complications from type 2 diabetes.

3.2 million adult Hispanics have been diagnosed with type 2 diabetes. Hispanics are 1.7 times more likely to develop the disease than Whites. Mexican Americans are about 2 times more likely to develop the disease than White Americans. Hispanics also have a 50 percent higher death rate than non-Hispanic Whites.<sup>15</sup>

American Indians and Alaska Natives are twice as likely to have type 2 diabetes than non-Hispanic Whites, as 14.2 percent of the population has been diagnosed.<sup>15</sup>

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<sup>15</sup> U.S. Department of Health and Human Services. (2012, 8 28). *The Office of Minority Health*. Retrieved from Diabetes Data/ Statistics: <http://minorityhealth.hhs.gov/templates/browse.aspx?lvl=3&lvlid=5>

In Asian Americans and Pacific Islanders, type 2 diabetes is the fifth leading cause of death.<sup>15</sup> 9.1 percent of Asian American have type 2 diabetes and are twice as likely to develop type 2 diabetes than American Whites.<sup>15</sup>

### **Sex Distribution**

Women (58.4 percent) are more likely to have type 2 diabetes than men (41.6 percent).

### **Region of Residence**

An equal proportion of adults with type 2 diabetes live in the South, West, and Midwest (26.8-29 percent). 15.9 percent live in the Northeast.<sup>16</sup>

### **Marital Status and Family Size**

The majority of individuals with type 2 diabetes are married (59.1 percent). In addition, most adults with type 2 diabetes live in a household of two (41.6 percent).<sup>16</sup>

### **Education**

For all adults, 21 percent of those diagnosed with type 2 diabetes had completed at least some college education. Individuals with less than

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<sup>16</sup> Cowie, C., & Eberhardt, M. (1995). *Diabetes in America, 2nd Edition* (Vol. 95). NIH Publication.

9 years of education had a greater prevalence rate (9.2-35.7 percent compared to 3.8-26.9 percent).<sup>16</sup>

### **Income**

At all ages in both men and women, those diagnosed with type 2 diabetes are at a lower income level than individuals without.<sup>16</sup>

## **Chapter 4: Epidemiology and Biostatistics of Type 2 Diabetes in the United States**

### **Statistical Findings**

The most comprehensive and up-to-date biostatistics for Type 2 Diabetes are published by the Centers for Disease Control and Prevention in the National Diabetes Fact Sheet, 2011.<sup>14</sup> The fact sheet is the result of the compilation of data from the Centers for Disease Control and Prevention, the Indian Health Service's National Patient Information Reporting System, the U.S. Renal Data System, the National Institutes of Health, and the U.S. Census Bureau. Estimations were also taken from the National Health and Nutrition Examination Survey and National Health Interview Survey.

Epidemiology is defined as a branch of medicine and public health that looks at the incidence, distribution and control of diseases, as well as other factors relating to health. Research in the field determines how many people have a disease, how the numbers are changing, and its affect on civilization. There are several hubs of Type 2 Diabetes that have been identified by epidemiological studies.

The United States of America is one of the global leaders for both the incidence and prevalence of Type 2 Diabetes. Through the use of

national data it can be shown that Type 2 Diabetes and its complications have been steadily rising since the 1980's.

For this section, all data will be derived from the Centers for Disease Control and Prevention's Diabetes Public Health National Surveillance and the National Diabetes Fact sheet. The most available data for Type 2 Diabetes is the prevalence of diagnosed cases. Prevalence is the number of total cases, while incidence is the number of new cases within a given time period.

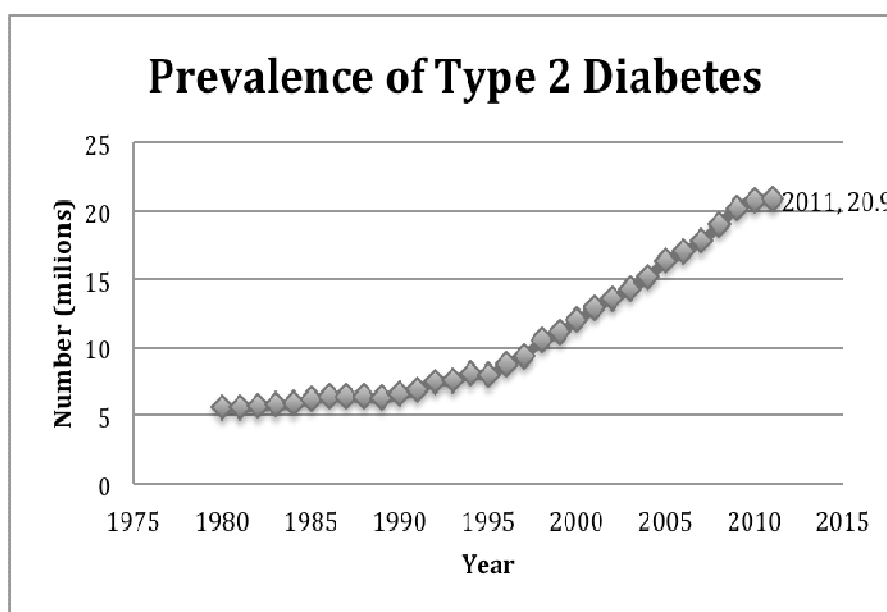
### **Prevalence**

Type 2 diabetes is steadily increasing in the United States. The prevalence of the disease can be shown in the table below, as the number of Americans with diagnosed diabetes has risen from 5.6 million to 20.9 million from 1980-2011.<sup>14</sup> The trend can be better seen in the chart on the following page.

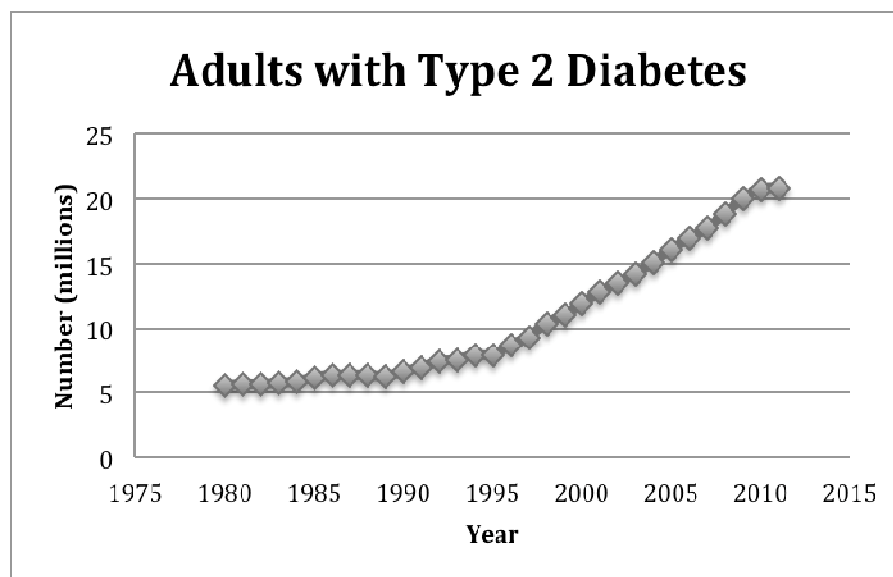
**Table B: Prevalence of Type 2 Diabetes, Diagnosed Cases (Adults and Children)**

<b>Year</b>	<b>Millions of People</b>
1980	5.6
1981	5.6
1982	5.7
1983	5.8
1984	5.9
1985	6.2
1986	6.4
1987	6.4
1988	6.4
1989	6.3
1990	6.6
1991	6.9
1992	7.5

1993	7.6
1994	8.1
1995	8
1996	8.8
1997	9.4
1998	10.5
1999	11.1
2000	12
2001	12.9
2002	13.6
2003	14.3
2004	15.2
2005	16.3
2006	17
2007	17.8
2008	19
2009	20.2
2010	20.8
2011	20.9



The number of adults (age 18 and older) with type 2 diabetes follows a similar trend, displaying an almost identical chart. The number of adults has risen from 5.5 million to 19.6 million.<sup>14</sup>



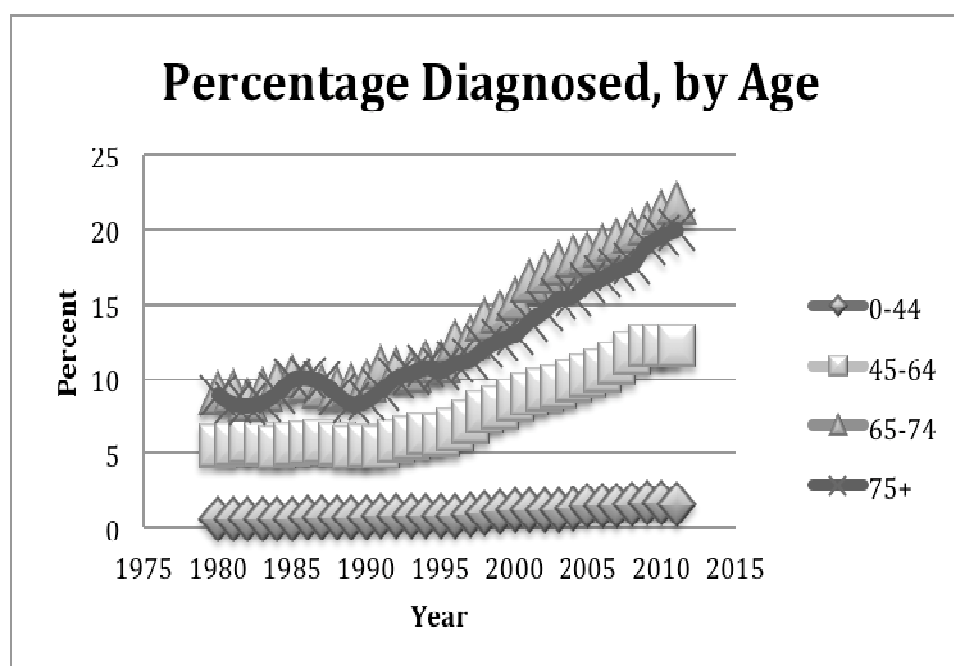
The percentage diagnosed by age shows a clear increase in all age groups. Age 0-44 has increased from 0.6 percent to 1.6 percent ( a 167 percent increase), age 45-64 has increased from 5.5 percent to 12 percent ( a 118 percent increase), age 65-74 has increased from 9.1 to 21.8 percent (a 140 percent increase ), and age 75 and older has increased from 8.9 percent to 20.0 percent (a 125 percent increase). This shows that the number of people diagnosed ages 65-74 was more than 13 times the number of ages 0-45.<sup>14</sup>

**Table C: Percent Diagnosed by Age**

Year	0-44	45-64	65-74	75+
1980	0.6	5.5	9.1	8.9
1981	0.6	5.6	9.2	8.4
1982	0.6	5.8	8.6	8.3
1983	0.6	5.6	9.3	8.5
1984	0.6	5.4	9.8	9.1
1985	0.6	5.6	10.2	10
1986	0.7	5.7	9.9	10.1
1987	0.7	5.8	9.5	9.8
1988	0.7	5.6	9.4	9



1989	0.7	5.4	9.6	8.4
1990	0.7	5.5	9.9	8.6
1991	0.8	5.4	10.7	9.3
1992	0.8	5.8	10.6	10.1
1993	0.8	6	10.5	10.4
1994	0.8	6.3	11.1	10.8
1995	0.8	6.2	11.1	10.6
1996	0.8	6.6	12.5	11.1
1997	0.9	7.1	12.8	11.3
1998	1	7.8	14	12.1
1999	1.1	8.1	14.5	12.6
2000	1.2	8.6	15.4	13
2001	1.2	9	16.5	13.9
2002	1.2	9.3	17.1	14.6
2003	1.2	9.5	17.7	15.4
2004	1.3	9.9	18.2	15.6
2005	1.5	10.3	18.4	16.4
2006	1.5	10.5	18.9	16.8
2007	1.5	11	19.3	17.3
2008	1.6	11.7	19.9	17.7
2009	1.7	12.2	20.4	19
2010	1.7	12.2	21.2	19.6
2011	1.6	12.2	21.8	20

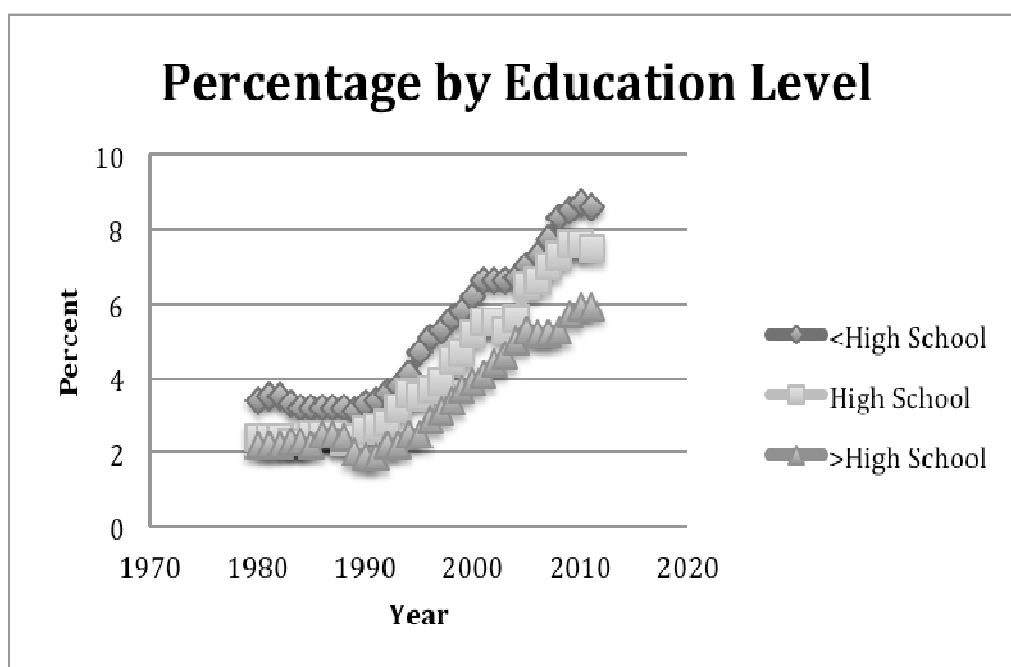


It seems that level of education also plays a role in the distribution of type 2 diabetes cases in the United States. The age-adjusted data shows that diabetes cases increased from 3.4 percent to 8.6 percent for those with less than high school education (153% increase), 2.4 percent to 7.5 percent for those with a high school education (213 percent increase), and 2.2 percent to 5.9 percent for those with more than a high school education (168 percent increase).<sup>14</sup> From this data it can be concluded that in general the lower the education level, the higher the number of type 2 diabetes cases there are. The table and chart below show this data.

**Table D: Age-Adjusted Percentage by Education Level**

Year	<High School	High School	>High School
1980	3.4	2.4	2.2
1981	3.5	2.4	2.2
1982	3.5	2.4	2.2
1983	3.3	2.3	2.3
1984	3.2	2.3	2.3
1985	3.2	2.5	2.2
1986	3.2	2.5	2.5
1987	3.2	2.5	2.5
1988	3.2	2.3	2.4
1989	3.1	2.4	2
1990	3.3	2.6	1.9
1991	3.4	2.7	1.9
1992	3.6	2.8	2.2
1993	3.8	3.2	2.2
1994	4.1	3.6	2.5
1995	4.7	3.5	2.5
1996	5.1	3.7	2.9
1997	5.3	3.9	3.1
1998	5.6	4.5	3.4
1999	5.8	4.7	3.7
2000	6.2	5.2	3.9
2001	6.6	5.5	4.1

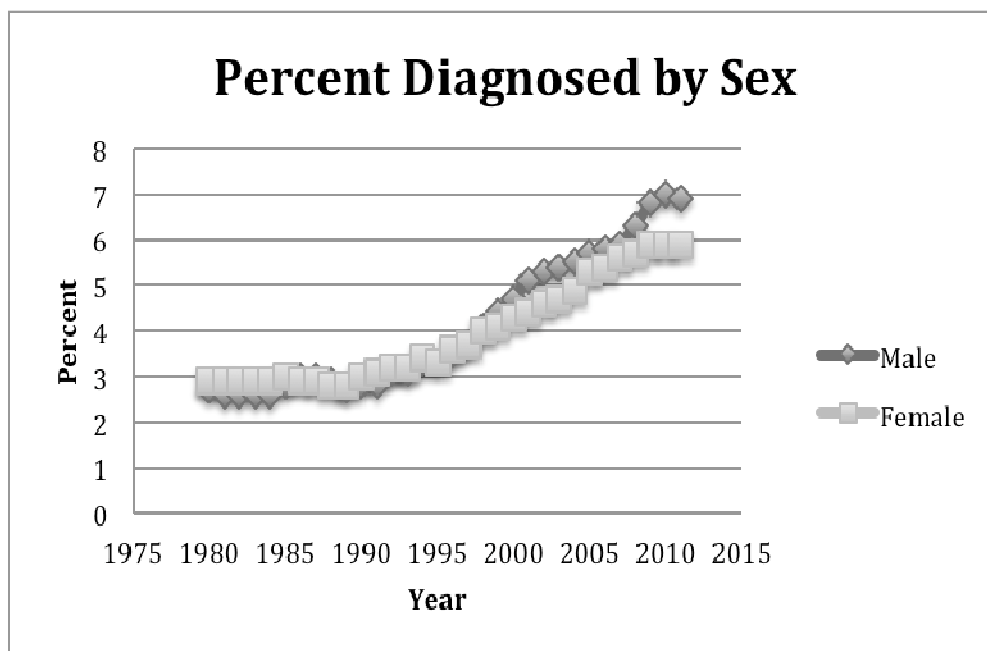
2002	6.6	5.5	4.4
2003	6.6	5.3	4.6
2004	6.7	5.6	5
2005	7	6.5	5.3
2006	7.3	6.6	5.2
2007	7.7	7	5.2
2008	8.3	7.3	5.3
2009	8.5	7.6	5.7
2010	8.7	7.6	5.9
2011	8.6	7.5	5.9



Type 2 Diabetes affects sex disproportionately in the United States as well. Until the 2000's men and women had similar diagnosis rates, however after that time type 2 diabetes became more prevalent in men. Over time type 2 diabetes has increased from 2.7 percent to 6.9 percent in men and 2.9 to 5.9 percent in women. This is a 156 percent increase for men and a 103 percent increase for women.<sup>14</sup>

**Table E: Age-Adjusted Diagnosis by Sex**

<b>Year</b>	<b>Male</b>	<b>Female</b>
1980	2.7	2.9
1981	2.6	2.9
1982	2.6	2.9
1983	2.6	2.9
1984	2.6	2.9
1985	2.8	3
1986	3	2.9
1987	3	2.9
1988	2.9	2.8
1989	2.7	2.8
1990	2.8	3
1991	2.8	3.1
1992	3.1	3.2
1993	3.1	3.2
1994	3.3	3.4
1995	3.3	3.3
1996	3.5	3.6
1997	3.7	3.7
1998	4.1	4
1999	4.4	4.1
2000	4.7	4.3
2001	5.1	4.4
2002	5.3	4.6
2003	5.4	4.7
2004	5.5	4.9
2005	5.7	5.3
2006	5.8	5.4
2007	5.9	5.6
2008	6.3	5.7
2009	6.8	5.9
2010	7	5.9
2011	6.9	5.9

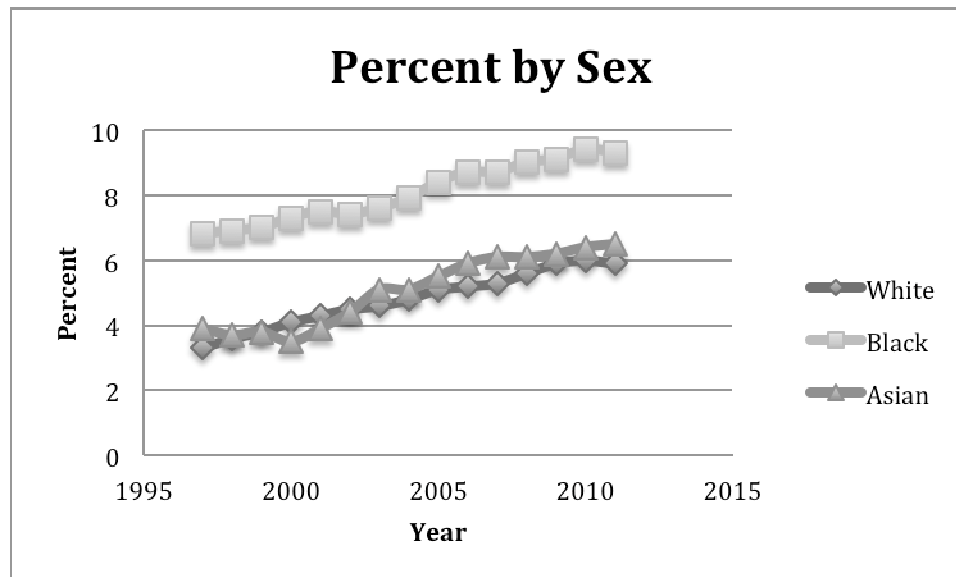


By race, whites experienced an increase in cases from 2.6 percent to 5.9 percent (a 127 percent increase), and blacks experienced an increase from 4.5 percent to 9.3 percent (a 107 percent increase). Data for Asians started being collected in 1997 and has increased from 3.9 percent to 6.5 percent (a 67 percent increase). From this data it can be concluded that blacks have the highest prevalence of type 2 diabetes.<sup>14</sup>

**Table F: Age-Adjusted Diagnosis by Race**

Year	White	Black	Asian
1980	2.6	4.5	-
1981	2.6	4.7	-
1982	2.5	4.8	-
1983	2.5	5.2	-
1984	2.6	5.2	-
1985	2.7	5.2	-
1986	2.8	5	-
1987	2.7	5.2	-
1988	2.6	5.2	-
1989	2.5	5	-
1990	2.7	4.8	-

1991	2.8	4.8	-
1992	3	5	-
1993	2.9	5.4	-
1994	3	5.7	-
1995	2.9	6.1	-
1996	3.1	6.6	-
1997	3.3	6.8	3.9
1998	3.6	6.9	3.7
1999	3.8	7	3.8
2000	4.1	7.3	3.5
2001	4.3	7.5	3.9
2002	4.5	7.4	4.4
2003	4.6	7.6	5.1
2004	4.8	7.9	5.1
2005	5.1	8.4	5.5
2006	5.2	8.7	5.9
2007	5.3	8.7	6.1
2008	5.6	9	6.1
2009	5.9	9.1	6.2
2010	6	9.4	6.4
2011	5.9	9.3	6.5



## Incidence

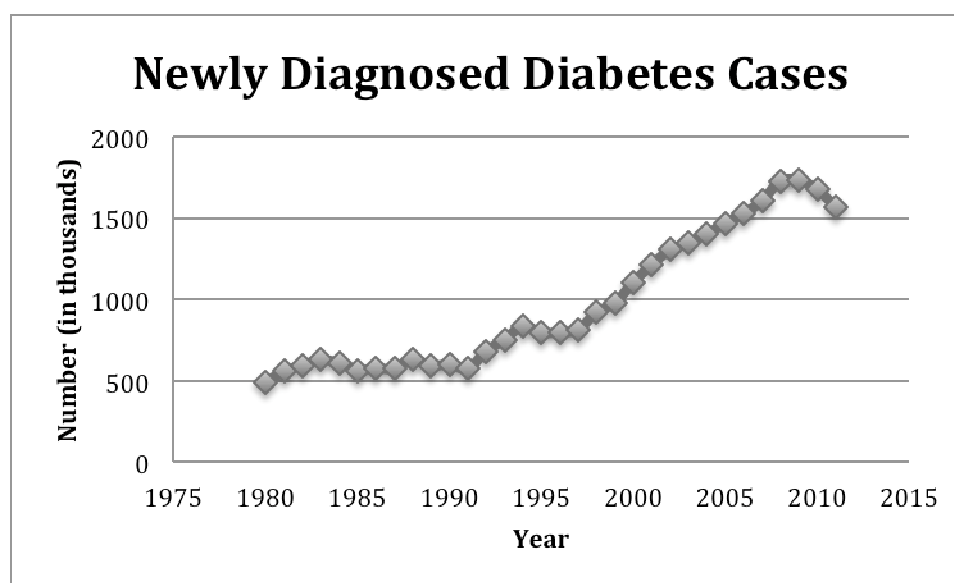
Incidence is the number of new cases of a disease within a given time period. For this section, all number represent new cases within one year.

The number of new cases in American adults has increased from 493,000 to 1,568,000 from 1980 to 2011. The most steady increase was found from 1990 to 2006, however from 2006 to 2011 the data has remained consistent, dropping slightly. This shows that new prevention and education efforts are making an impact on the population.<sup>14</sup>

**Table G: Incidence of Type 2 Diabetes**

Year	New Cases
1980	493
1981	557
1982	595
1983	628
1984	611
1985	564
1986	578
1987	574
1988	635
1989	591
1990	603
1991	573
1992	682
1993	752
1994	838
1995	796
1996	799
1997	813
1998	921
1999	979
2000	1104
2001	1213

2002	1304
2003	1349
2004	1403
2005	1468
2006	1528
2007	1605
2008	1728
2009	1732
2010	1678
2011	1568

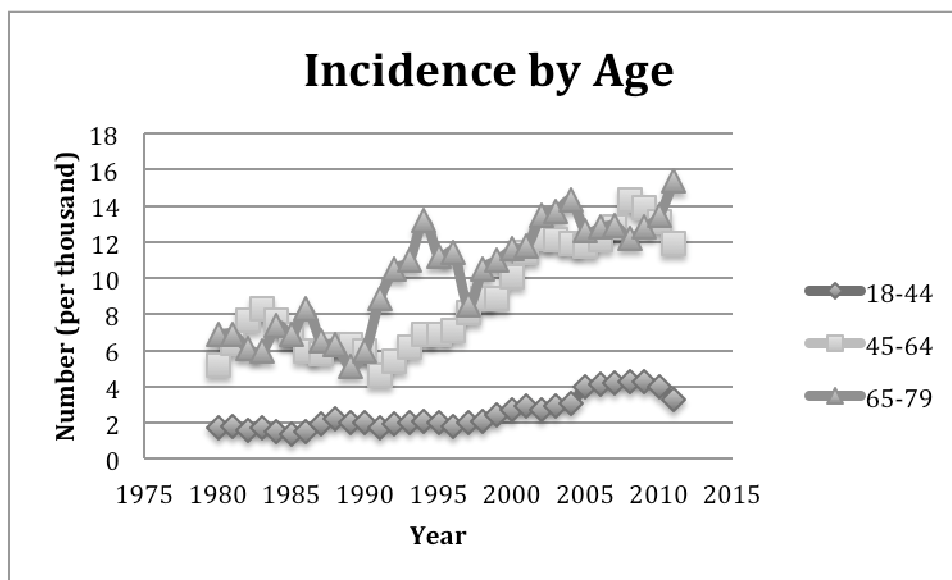


Incidence of age group follows the trend of prevalence by age group. The most significantly affected age group of age 65-79, which showed an increase from 6.9 per thousand to 15.4 per thousand. Ages 18-44 showed an increase from 1.7 to 3.3 per thousand while ages 45-64 showed an increase from 5.2 to 11.9 per thousand, both less significant than that of age group 65-79.<sup>14</sup>



**Table H: Incidence by Age Group**

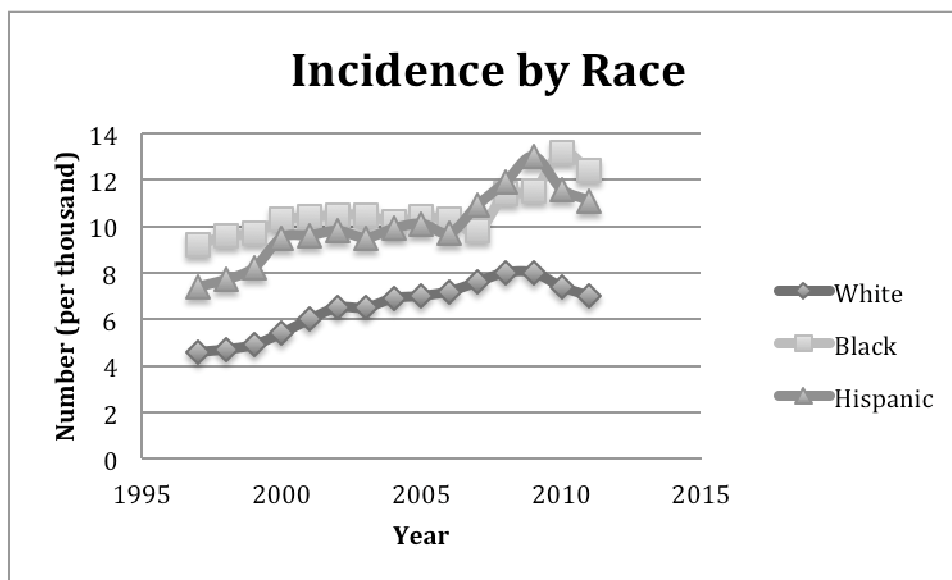
<b>Year</b>	<b>18-44</b>	<b>45-64</b>	<b>65-79</b>
1980	1.7	5.2	6.9
1981	1.8	6.4	6.9
1982	1.6	7.7	6.1
1983	1.7	8.3	6
1984	1.5	7.7	7.4
1985	1.4	6.9	6.9
1986	1.5	6	8.3
1987	1.9	5.8	6.5
1988	2.2	6.3	6.3
1989	2	6.3	5.1
1990	2	6	6
1991	1.7	4.6	8.9
1992	1.9	5.4	10.5
1993	2	6.2	11
1994	2.1	6.9	13.2
1995	2	6.9	11.2
1996	1.8	7.1	11.4
1997	2	8.1	8.5
1998	2.1	8.9	10.5
1999	2.4	8.9	11
2000	2.7	10.1	11.6
2001	2.9	11.4	11.8
2002	2.7	12.2	13.5
2003	2.9	12.1	13.7
2004	3.1	11.9	14.3
2005	4	11.8	12.6
2006	4.1	12.1	12.8
2007	4.2	12.8	12.9
2008	4.3	14.3	12.2
2009	4.3	13.9	12.8
2010	4	13.1	13.5
2011	3.3	11.9	15.4



Incidence by race follows trends in prevalence, as the most new cases are those of blacks. Incidence in blacks and hispanics is noticeably higher than that of whites.<sup>14</sup>

**Table I: Incidence by Race**

Year	White	Black	Hispanic
1997	4.6	9.2	7.4
1998	4.7	9.6	7.7
1999	4.9	9.7	8.2
2000	5.4	10.3	9.5
2001	6	10.4	9.6
2002	6.5	10.5	9.8
2003	6.5	10.5	9.5
2004	6.9	10.2	9.9
2005	7	10.4	10.1
2006	7.2	10.3	9.7
2007	7.6	9.8	10.9
2008	8	11.4	11.9
2009	8	11.5	13
2010	7.4	13.2	11.6
2011	7	12.4	11.1



### Age at Diagnosis and Duration of Disease

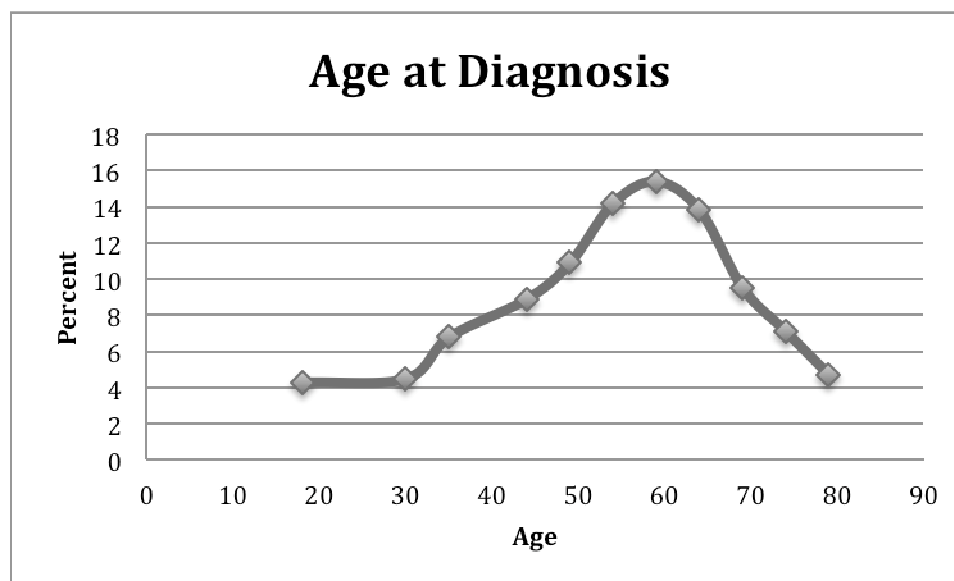
It is important to note when the population is being diagnosed and how long symptoms are being experienced to better prevent and treat the disease.

While data shows that the most number of cases are found in those aged 65 and older, most of the population is diagnosed with type 2 diabetes between the ages of 40 and 65 (63 percent in 2011). About 16 percent are diagnosed between the ages of 18 and 39, while about 21 percent of the population is diagnosed between the ages of 65 and 79.<sup>14</sup>

**Table J: Age at Diagnosis**

Age at Diagnosis	Percent
18–29	4.3
30–34	4.5
35–39	6.8
40–44	8.9
45–49	10.9
50–54	14.2
55–59	15.4

60–64	13.8
65–69	9.5
70–74	7.1
75–79	4.7



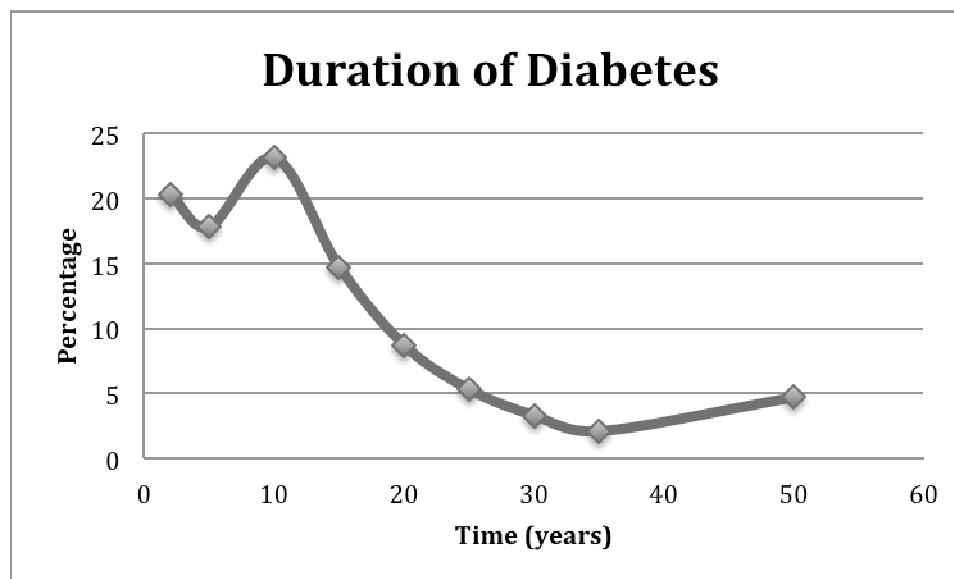
Duration of disease is also important for care methods. 61.2

percent of Americans report having been diagnosed with type 2 diabetes for ten years or less. 6.8 percent of all Americans diagnosed have had the disease for more than 30 years. From this data it can be concluded that many cases of diabetes in the United States are recent.<sup>14</sup>

**Table K: Duration of Diabetes in Adults**

Duration of Diabetes (Years)	Percentage
0–2	20.3
3–5	17.8
6–10	23.1
11–15	14.7
16–20	8.7
21–25	5.3
26–30	3.3
31–35	2.1

>35	4.7
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### Implications on United States Health Care

Type 2 diabetes has a large impact on the health care system in the United States, affecting the economy both directly and indirectly. Direct costs include medical care and hospital stays, while indirect costs include diminished quality of life and diminished productivity.

As of March 6, 2013 the cost of all diagnosed diabetes cases totaled \$245 billion, with direct costs totaling \$176 billion and indirect totaling \$69 billion.<sup>17</sup> It was found that the medical expenses of those with type 2 diabetes are 2.3 times higher than for those without, and that 1 in 10 health care dollars in the United States is spent on diabetes care.<sup>17</sup>

Hospitalization for inpatient care has risen to \$76 billion. Between states,

<sup>17</sup> American Diabetes Association. (2013). Economic Costs of Diabetes in the U.S. in 2012. *Diabetes Care*, 36, 1-10.

California spends the most on type 2 diabetes, totaling \$27.6 billion. The next highest is Texas, totaling \$18.9 billion.<sup>17</sup> Knowing where and how money is being spent can help aid in the direction of prevention measures.

## **Chapter 5: The Globalization of Type 2 Diabetes**

### **The Spread of Food, Culture, and Disease**

Normally when one thinks of the spread of disease it is associated with communicable disease, diseases that can be spread from one person to another. For example, it is well known that when the Americas were colonized by Europe many infectious diseases were spread to the natives, such as smallpox. In today's world it is even easier to spread infection and disease due to advances in international travel.

It is not usually thought that globalization, communication and technology have much to do with the spread of noncommunicable diseases, such as cancer. However, there is a strong association between globalization of food and culture with the recent increase in type 2 diabetes abroad.

As America spreads diets excessively high in calories as well as diets poor in quality, the world is seeing an increase in type 2 diabetes. Specifically, diets with a high glycemic load and high in trans fats are associated with increased risk for type 2 diabetes, as well as diets that include sugar sweetened beverages.<sup>4</sup> Diets with a high glycemic index and 1-2 servings of sugar sweetened beverages a day have been shown to increase the demand for insulin as well as drain beta cells of the pancreas.

Consuming only 1-2 servings of sugar sweetened beverages a day increases the risk of developing type 2 diabetes by 26 percent.<sup>4</sup>

Globalization and economic growth have made a transition to western food not only more available but also less expensive. Traditional diets are being forgotten while living environments are becoming sedentary, creating overnutrition and a change in energy balance. The nutritional changes being seen usually involve increased consumption of animal fat, increased consumption of high calorie foods, decreased consumption of fiber, and a more frequent intake of fast food. These dietary patterns are associated with systemic inflammation which is a marker for type 2 diabetes.

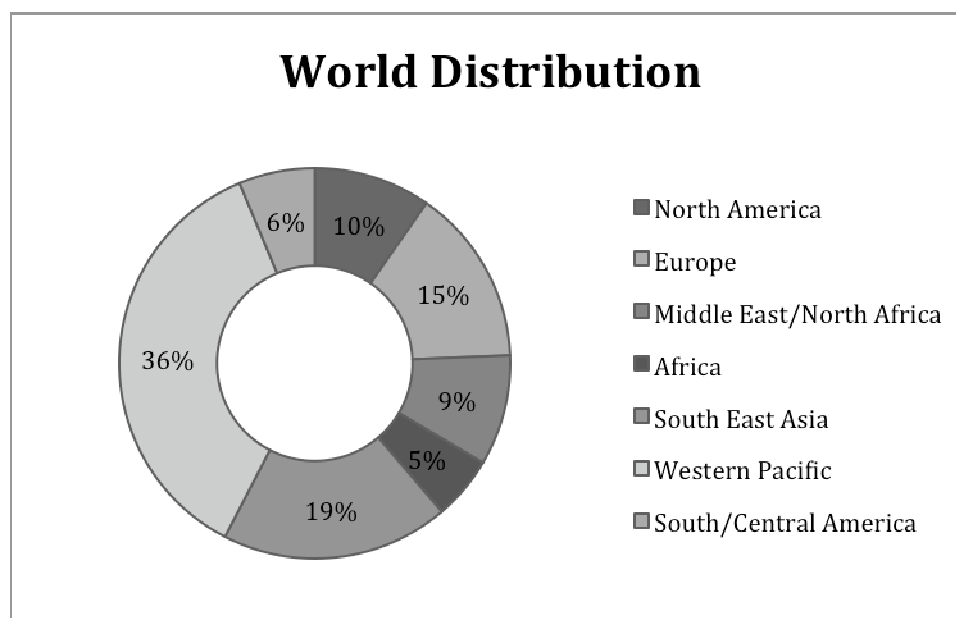
Two major areas of global concern are China and India. In China, data shows that the percentage of diet devoted to energy from animal foods has increased from 9.3 percent to 12.7 percent.<sup>4</sup> In India, this percentage has increased to 32 percent in urban residents and 17 percent in rural residents. Global trade has created a shift from coarse grains to rice and refined wheat in these areas, reduced intake of cereals, higher energy intake, higher consumption of fats, increased intake of meats and oil, increased consumption of dairy, and increased consumption of sugar.

In Asia, diabetes rates do not correspond with obesity rates, as many areas have low obesity rates coupled with high diabetes rates. However, Asian populations tend to develop diabetes at a lower body mass index (BMI) than Western populations.<sup>4</sup> Additionally, Asian



populations tend to have less muscle mass and a higher percentage of abdominal obesity than Western populations, both of which can result in increased insulin resistance. Because of these factors, even modest weight gain in Asian populations can create an increased risk for the development of type 2 diabetes. All data for this portion will be derived from the IDF Diabetes Atlas, 6<sup>th</sup> Edition.

By region, North America and the Caribbea have 37 million cases South and Central America 24 million, Europe 56 million, the Middle East and North Africa 35 million, Africa 20 million, South East Asia 72 million, and the Western Pacific 138 million. This totals 382 million people living with diabetes world wide. It is estimated that an additional 46 percent are not diagnosed, therefore not reported in these statistics.<sup>18</sup>



<sup>18</sup> International Diabetes Federation. *IDF Diabetes Atlas, 6th edn.* Brussels, Belgium: International Diabetes Federation, 2013.  
<http://www.idf.org/diabetesatlas>

**China**

China has 98.4 million people diagnosed and living with type 2 diabetes, making it the country with the highest prevalence in the world. The national prevalence percentage is 9.62 percent, while there have been 1,271,003 diabetes related deaths.<sup>18</sup> China is part of the Western Pacific, where there are 138 million adults with diabetes. Within this statistic, 1,080,000 men have the disease while 788,900 women have it. 44.3 percent who die from the disease are under the age of 60.<sup>18</sup>

**India**

India has the second largest prevalence rate of type 2 diabetes in the world behind China. It is reported that 65.1 million are diagnosed with type 2 diabetes, with a national prevalence percentage of 8.56. There have been 1,065,053 diabetes related deaths in this area. India is a part of the South East Asia region. In this region there are 72.1 million reported cases of type 2 diabetes, however it is estimated that about half of the people with type 2 diabetes in this region are undiagnosed. Within this statistic, 519,500 men have the disease while 680,500 women have it. 55.1 percent of those who die from the disease are under the age of 60.<sup>18</sup>

## Chapter 6: Looking to the Future

### Global Action

There are several global issues that need to be addressed in the care and prevention of the global growth of type 2 diabetes. Noncommunicable diseases are now under close surveillance by the World Health Organization, with grassroots advocacy groups being a crucial component of the prevention effort. Under the World Health Organization's Global Action Plan, countries will have to take action on prevention and provide access to treatment for those in need.

Objectives that countries need to achieve are 1) to raise the priority of the prevention and treatment of non-communicable diseases, 2) to strengthen partnerships in the prevention effort, 3) to reduce risk factors for the disease through environmental change, 4) to reinforce health care systems to treat and prevent these diseases, 5) to support research for prevention and treatment, and 6) to monitor trends to evaluate the success of interventions on a global scale.<sup>18</sup>

To meet these objectives, countries should seek to 1) reduce risk of mortality from type 2 diabetes by 25 percent, 2) reduce inactivity by 10 percent, 3) reduce salt/sodium intake by 30 percent, 4) reduce the number of cases of high blood pressure by 10 percent, 5) stop rising trends of obesity,

and 6) provide 80 percent of the needed technology and medicine to treat non-communicable diseases.<sup>18</sup> New degree programs also need to be created to rise the number of health professionals with experience treating and preventing type 2 diabetes.

## **Chapter 7: Conclusion**

As reported by this paper, type 2 diabetes is truly a global health crisis. While this is obvious in the United States, the US only contributes to about 10 percent of the world's prevalence.<sup>18</sup> What is important to note is that the prevention, control and care of type 2 diabetes needs to be approached from a culturally competent view. Without understanding the different risk factors associated with different ethnicities, cultures, and global regions, the prevention of type 2 diabetes is essentially hopeless. Providing prevention measures that are not only obtainable but also culturally appealing is crucial in the fight against this disease. It has been estimated that by the year 2050, one in three adults worldwide will be diagnosed with diabetes.<sup>18</sup> This public health crisis must be stopped, but can only be attacked through culturally sound measures.

## Appendices

**Figure A**

<b>Blood Glucose Goals for Patients with Type 2 Diabetes</b>		
<b>Source:</b> American Diabetes Association. (2014). Standard of Medical Care in Diabetes- 2014. <i>Diabetes Care</i> , 37 (1).		
	<b>Normal</b>	<b>Goal for adults (ml/dL)</b>
<b>Before Meals</b>	< 100 mg/dL	70-130
<b>At Bedtime</b>	< 120 mg/dL	< 180
<b>Hemogloin A1C</b>	< 5.7%	7%

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