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BURDEN OF DIABETES IN INDIANA

Indiana State
Department of Health

BURDEN OF DIABETES IN INDIANA

INDIANA STATE DEPARTMENT OF HEALTH

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INTRODUCTION

Diabetes is a serious, costly and growing public health problem in the United States and Indiana. Diabetes mellitus is a group of diseases characterized by high levels of glucose (sugar) in the blood, resulting from defects in insulin production, insulin action, or both. Insulin is necessary for the body's regulation of blood glucose levels. It is a hormone produced in the pancreas and contributes to the metabolism of sugars, starches, and other foods into energy. Without a properly functioning insulin signaling system, blood glucose levels become elevated and other metabolic abnormalities occur, leading to the development of medical complications. These complications may lead to diminished quality of life, disability, or even death.

The World Health Organization estimates that the number of adults in the United States with diabetes will double by the year 2030.[1] Nationally, the prevalence of diabetes has reached epidemic levels and has been increasing by almost 5% each year since 2000.[2] In Indiana, the prevalence of diabetes has also grown, increasing by over 50% from 2000 to 2009.[3]

Types of Diabetes

Type 1 diabetes, formerly known as juvenile-onset diabetes or insulin-dependent diabetes mellitus, most often appears during childhood or adolescence and accounts for 5-10% of all diagnosed cases of diabetes. In type 1 diabetes, the body's immune system destroys the cells that produce insulin. Since the body produces little or no insulin, individuals with type 1 diabetes must take insulin daily to survive. Type 1 diabetes is usually diagnosed within a short time of onset because the symptoms are severe and occur rapidly.[4]

Type 2 diabetes, formerly called adult-onset diabetes or non-insulin-dependent diabetes, usually begins as insulin resistance, a disorder in which cells do not use insulin properly. Over time, the resulting inefficiency contributes to a loss of insulin production capacity by the pancreas. Type 2 accounts for 90–95% of individuals diagnosed with diabetes. Some individuals control their blood glucose by exercising regularly and maintaining a healthy diet, but many require medical intervention to achieve recommended blood glucose levels. Type 2 diabetes most often appears in individuals older than 40 years of age, but is increasingly being diagnosed in children and teens and is no longer considered a disease exclusive to adults.[4]

Gestational diabetes is a form of glucose intolerance diagnosed in 2-10% of women during pregnancy. This type of diabetes will increase a woman's risk of developing type 2 diabetes in the future, and place the child at greater risk of being overweight and developing diabetes later in life. Gestational diabetes requires treatment during pregnancy to normalize maternal blood glucose levels to avoid medical complications in the infant.[4]

Other types of diabetes may result from specific genetic conditions, immune or endocrine dysfunction, surgery, drugs, infections, or malnutrition. Such forms of diabetes only account for 1-5% of all diagnosed cases.[4]

Pre-diabetes is a term used to describe individuals who are at increased risk of developing type 2 diabetes. Individuals with pre-diabetes have higher blood sugar levels than normal, though not high enough to be diagnosed with diabetes. Pre-diabetes is characterized by impaired fasting glucose (IFG) or impaired glucose tolerance (IGT) and in some cases both. IFG is a condition in which the fasting blood sugar level is 100 to 125 milligrams per deciliter (mg/dl) after an overnight fast, and IGT is a condition where the blood sugar level is 140 to 199 mg/dl after a two-hour oral glucose tolerance test. Those with pre-diabetes are likely to develop type 2 diabetes within 10 years, unless active steps are taken to prevent or delay diabetes.[4]

Economic Impact

A major consequence of diabetes is the utilization of healthcare resources. Diabetes is an expensive chronic disease to manage. The average annual health care cost for a person with diabetes in the United States is $11,744, compared with $2,935 for a person without diabetes. Costs include regular health care visits, medications, supplies, treatment and hospitalizations for complications, and educational programs. In 2007, the total annual economic cost of diabetes in the United States was estimated at $218 billion, including $174.4 billion for diagnosed diabetes. This figure is composed of $116 billion in excess medical expenditures and $58 billion in reduced national productivity. The remaining cost resulted from $18 billion spent on undiagnosed diabetes, $25 billion for pre-diabetes, and $636 million for gestational diabetes.[5]

Of the $116 billion spent on medical expenditures, $27 billion was for diabetes-specific direct care, $58 billion was spent on complications due to diabetes, and $31 billion was associated with excess general medical care. The largest components of this spending were for inpatient hospital care (50%), medication and supplies (12%), retail medications to treat complications (11%), and physician office visits (9%). One out of every five health care dollars spent in the United States is spent on caring for an individual with diabetes while one in every ten dollars is attributed to diabetes. This cost data does not include social costs such as pain and suffering or care provided by nonpaid caregivers. The total estimated cost incurred by the state of Indiana approaches $4 billion.[5]

Both ambulatory and in-patient care contribute to the significant cost associated with diabetes care. Diabetes is the seventh leading reason for ambulatory care visits, which includes visits to health care provider offices, out-patient care and emergency services.[6] Furthermore, poorly controlled or progressive diabetes may lead to lengthy in-patient care. Nationally, the average hospital stay is 4.8 days for all diagnoses. In Indiana, the average hospital length of stay associated with diabetes is 4.9 days.[7]

Diabetes is a public health concern not only because of its significant complications and cost, but also because many cases are preventable. The Cardiovascular Health and Diabetes Section (CHDS) at the Indiana State Department of Health (ISDH) includes the Diabetes Prevention and Control Program (DPCP) which compiles and analyzes diabetes data based on the most recent mortality and morbidity data available, as well as Behavior Risk Factor Surveillance System (BRFSS) information. The majority of data available on diabetes relates to adults, and unless specified otherwise, combines type 1 and type 2 when discussing issues of prevalence.

YEAR 2020 GOALS

Indiana incorporates *Healthy People* goals into its public health strategies and activities. Broadly speaking, the DPCP strives to reduce the incidence of diagnosed diabetes, lessen the complications associated with diabetes, and lower the mortality due to diabetes. Strategies for achieving these goals include primary prevention efforts geared toward preventing or delaying the onset of type 2 diabetes and secondary prevention activities to properly manage type 1 and type 2 diabetes, while preventing complications, comorbidities, and mortality.

Several strategies are incorporated into care guidelines to achieve these goals. Improved glycemic control among individuals with diagnosed diabetes, which includes reducing the proportion of this population with hemoglobin A1C (A1C) values greater than 9% and increasing the proportion with an A1C lower than 7%. As part of this effort, the proportion of adults with diabetes who have an A1C measurement at least twice a year must increase. The A1C measures average blood glucose levels over a two to three month period, and is an important measure for assessing the effectiveness of a diabetes treatment plan. A second strategy is to increase the proportion of individuals with diabetes who monitor their own blood glucose-levels at least once a day. A final diabetes- specific strategy is to increase the proportion of individuals with diagnosed diabetes who receive formal diabetes education.

Additional management activities are associated with related health issues and common complications of diabetes. Because of associated cardiovascular risk factors, improved blood lipid and blood pressure control are desired. Due to the high risk of poor wound healing, it is important that there is an increase in the proportion of individuals with diabetes who annually have a foot examination. Also, since oral, renal and vision problems are common in individuals with diabetes, increases in rates of annual dental exams, annual urinary micro-albumin measurement, and annual dilated optical exams are desired. Detailed *Healthy People* goals and objectives can be found at www.healthypeople.gov. Specific disease-management recommendations are published by the American Diabetes Association and can be found at Living with Diabetes.

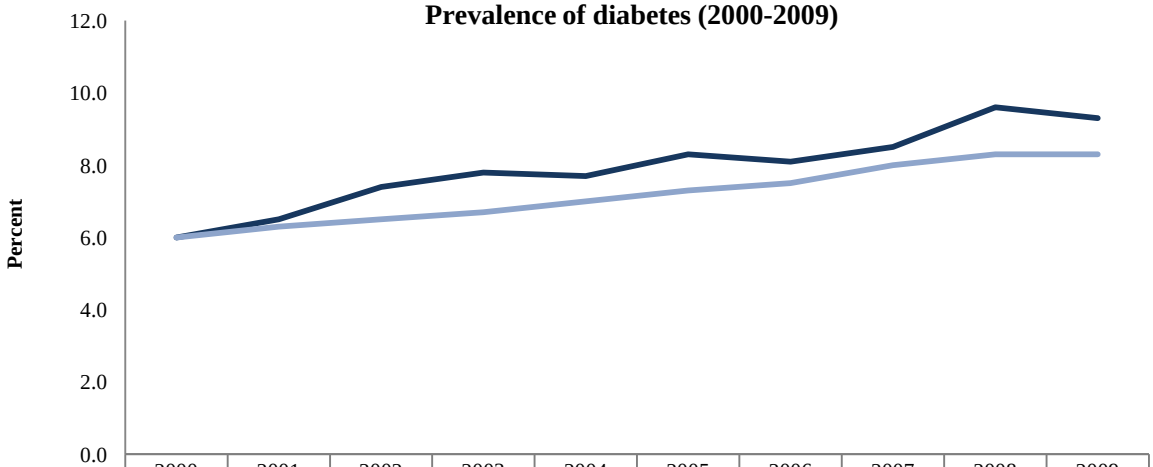
Prevalence

In 2009, an estimated 9.3% of the adult population in Indiana, over 447,000 individuals, reported that they had been diagnosed with diabetes. This rate exceeds the diabetes prevalence of the United States, 8.3%. This current rate is reflective of a long term trend of state and national increases in diabetes prevalence. Indiana's age-adjusted diabetes prevalence increased by over 50% during the period from 2000 to 2009 (Figure 1).[3,8]

Based on national findings, it is estimated that over 3% of Indiana's adult population has undiagnosed diabetes. A further issue of concern stems from the growing number of individuals with IGT or IFG, which places them at risk for developing type 2 diabetes. Research estimates that 35% of U.S. adults, 20 years or older, fall into this classification, which is referred to as pre-diabetes. In addition to the diabetes risk, there is higher risk of heart disease and stroke.[2,4,9] As people develop diabetes, medical and lifestyle interventions are typically necessary to optimize health outcomes. Lack of interventions or unsuccessful interventions often results in poorly controlled diabetes, which frequently leads to serious complications and higher health care costs.

National information provides insight into patterns of complications due to diabetes. Hypertension can be found in 66.7% of adults with diabetes. This, along with other factors, contributes to adults with diabetes experiencing rates of heart disease mortality and stroke incidence that are two to four times higher than in adults without diabetes. Diabetes is the leading cause of kidney failure, accounting for 44% of all new cases in 2008. Diabetes is also the leading cause of new cases of blindness among adults. Another consequence of diabetes is the potential for nervous system damage. Mild to severe neuropathy is found in 60-70% of individuals with diabetes. This may result in impaired sensation or pain in the feet or hands, slowed digestion of food, carpal tunnel syndrome, erectile dysfunction, and other nerve problems. Severe forms of nerve disease can lead to amputations, with more than 60% of non-traumatic lower extremity amputations occurring in individuals with diabetes.[2]

Figure 1.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
IN	6.0	6.5	7.4	7.8	7.7	8.3	8.1	8.5	9.6	9.3
US	6.0	6.3	6.5	6.7	7.0	7.3	7.5	8.0	8.3	8.3

Data Source: Behavioral Risk Factor Surveillance System, Indiana State Department of Health

Hospitalization

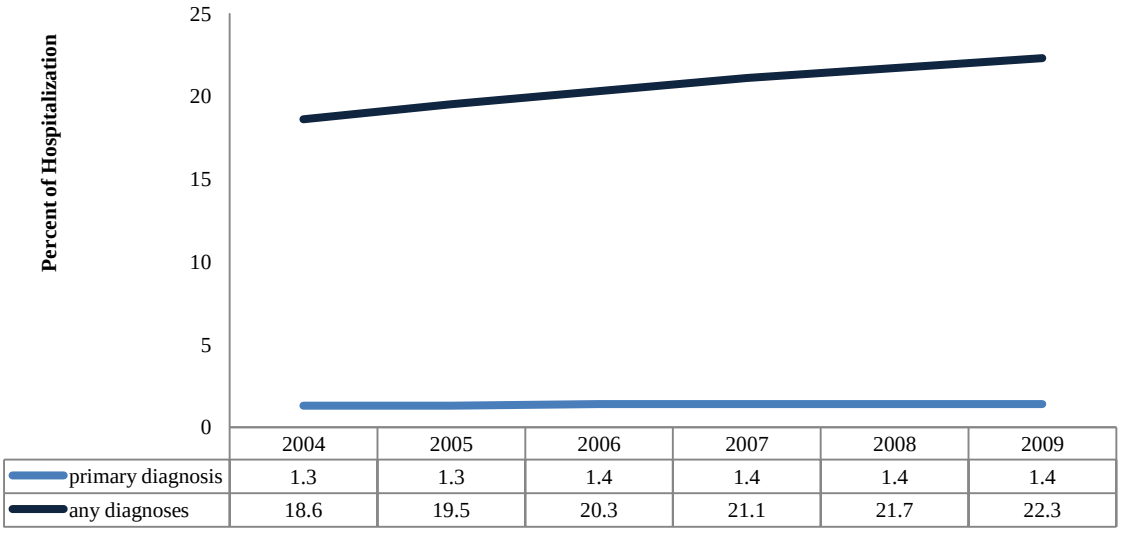
In those individuals with poorly controlled diabetes, complications which require hospitalization may arise. Examples of such complications include biochemical imbalances, renal failure, and amputations. Biochemical problems such as ketoacidosis and nonketotic hyperosmolar coma are very serious and may result in death. Renal failure typically requires dialysis or kidney transplant before waste products can be effectively filtered from circulating blood. Despite the increase in the prevalence of diagnosed diabetes from 2004 to 2009, the percentage of hospitalizations with diabetes as the primary diagnosis remained relatively flat during that same time period (Figure 2).[2,10]

Common complications of diabetes	
• Heart disease	• Stroke
• Hypertension	• Vision problems
• Kidney disease	• Nervous system disease
• Amputations	• Dental disease
• Pregnancy complications	• Depression
• Biochemical imbalance	• Susceptibility to infection

However, since diabetes is often associated with multiple co-morbidities and complicates many health outcomes, it may be part of an individual's overall hospital diagnostic profile, although not their primary diagnosis. For example, in 2009, 16% of individuals with diabetes reported having had a heart attack, and 8.7% reported having had a stroke.[3] Hospitalizations with diabetes diagnoses of any type have increased in recent years (Figure 2). In 2009, such hospitalizations accounted for 22.3% of all inpatient discharges.[10]

Figure 2.

Diabetes associated hospitalization (2004-2009)



	2004	2005	2006	2007	2008	2009
primary diagnosis	1.3	1.3	1.4	1.4	1.4	1.4
any diagnoses	18.6	19.5	20.3	21.1	21.7	22.3

Data Source: Hospital Discharge Data, Indiana Hospital Association

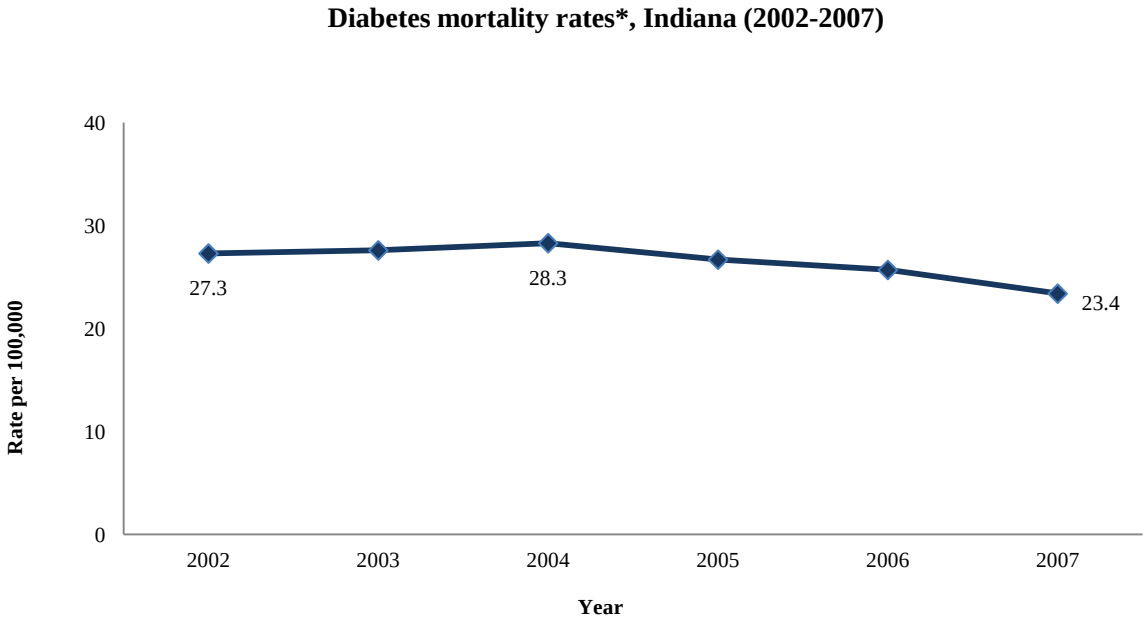
Mortality

While most diabetes complications impact quality of life, several can lead to pre-mature mortality. Diabetes can also lead to death even in those who have not developed complications. In 2007, diabetes was the seventh leading cause of death in the United States. This ranking was based on the 73,507 death certificates that identified diabetes as the underlying cause of death. According to death certificate reports, diabetes contributed to 233,619 deaths in the United States. However, this number is likely to be underreported, because studies have found that only 35-40% of decedents with diabetes had it listed anywhere on the certificate, and only 10-15% had it listed as the underlying cause of death. Cardiovascular complications are the leading cause of mortality and long-term morbidity for individuals with diabetes. [3,11]

The overall age-adjusted diabetes mortality rate in Indiana for 2007 was 23.4 per 100,000 adults. Indiana mortality rates from diabetes as an underlying cause of death have gradually decreased in recent years (Figure 3). [11]

Mortality data in this report came from death certificates that listed diabetes as the underlying cause of death, meaning that diabetes was the disease which initiated the chain of morbid events leading directly to death. This is a small portion of the number of deaths where diabetes played a role. Overall, the risk of death among individuals with diabetes is almost twice that of individuals of similar age, but who do not have diabetes. [2,11]

Figure 3.



Data Source: Indiana Vital Records, Indiana State Department of Health
*Age-adjusted rate per 100,000 population

Geographic Distribution

Current diabetes data in Indiana does not offer county level prevalence. However, county level estimates have been developed using BRFSS data and population statistics by the Centers for Disease Control and Prevention (CDC) (Table 1). Currently, every county in Indiana has an estimated diabetes prevalence higher than the national rate of 8.3%. Since these values are model-based estimates, the rates are not used to rank the counties.[3,12]

Table 1. Indiana county-level prevalence estimates for adult diabetes

County	Diagnosed Diabetes (%)	County	Diagnosed Diabetes (%)	County	Diagnosed Diabetes (%)
Adams	8.7	Hendricks	8.8	Pike	9.1
Allen	9.5	Henry	9.0	Porter	9.2
Bartholomew	9.1	Howard	9.8	Posey	9.1
Benton	9.1	Huntington	9.6	Pulaski	9.0
Blackford	9.6	Jackson	9.0	Putnam	9.0
Boone	9.4	Jasper	8.8	Randolph	9.4
Brown	9.0	Jay	8.9	Ripley	8.9
Carroll	9.5	Jefferson	8.8	Rush	8.8
Cass	9.0	Jennings	8.8	Scott	9.4
Clark	9.2	Johnson	8.7	Shelby	9.4
Clay	8.4	Knox	8.6	Spencer	9.0
Clinton	10.7	Kosciusko	9.3	St. Joseph	8.9
Crawford	9.4	LaGrange	9.2	Starke	9.6
Daviess	9.1	Lake	10.3	Steuben	9.6
Dearborn	8.8	LaPorte	10.0	Sullivan	9.0
Decatur	8.9	Lawrence	9.6	Switzerland	9.3
DeKalb	8.9	Madison	9.8	Tippecanoe	9.0
Delaware	9.8	Marion	9.8	Tipton	9.1
Dubois	8.5	Marshall	8.6	Union	8.9
Elkhart	9.5	Martin	9.1	Vanderburgh	8.7
Fayette	9.0	Miami	9.3	Vermillion	9.3
Floyd	9.2	Monroe	8.9	Vigo	9.2
Fountain	8.6	Montgomery	9.0	Wabash	9.1
Franklin	9.5	Morgan	9.1	Warren	9.5
Fulton	9.2	Newton	9.1	Warrick	8.7
Gibson	8.7	Noble	8.8	Washington	9.2
Grant	9.2	Ohio	9.2	Wayne	8.5
Greene	9.3	Orange	9.7	Wells	8.8
Hamilton	8.5	Owen	9.0	White	9.1
Hancock	8.9	Parke	9.2	Whitley	8.5
Harrison	9.5	Perry	8.7		

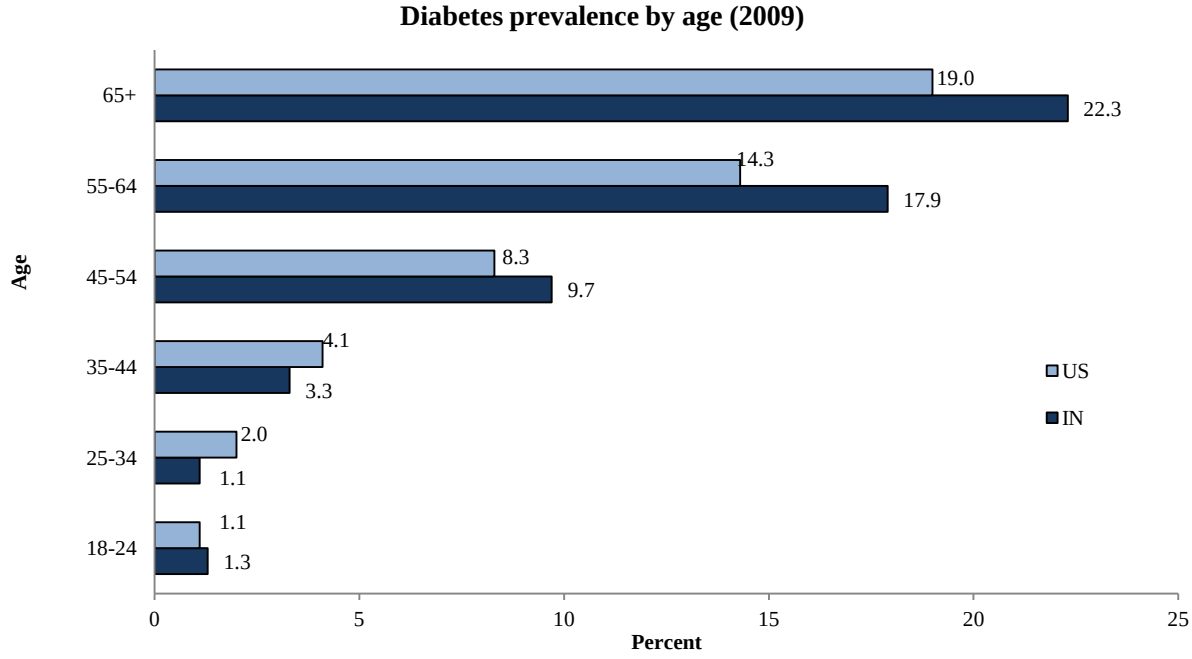
Data Source: Centers for Disease Control and Prevention, BRFSS

Despite advances in diabetes care, some populations experience the disease at higher rates or at greater severity than the general population. While disparities in health are often associated with race and ethnicity, they can also be associated with numerous factors, including age, gender and socioeconomic status. It is important to comprehensively understand all social determinants of health in order to plan public health interventions and inform public health decisions such as planning and resource allocation.

Age

In Indiana, individuals 65 years and older currently have the highest diabetes prevalence, 22.3%, of all age groups (Figure 4). The majority of adults with diabetes reported that they were first diagnosed between 46 and 60 years of age, which has remained consistent since 2006.[3] However, recent trends indicate that prevalence in younger populations is increasing. This is primarily due to the increased incidence of type 2 diabetes. Diabetes is the fourth leading cause of death among Indiana residents aged 55-64 years and the fifth leading cause of death for those 65 years and older.[11]

Figure 4.



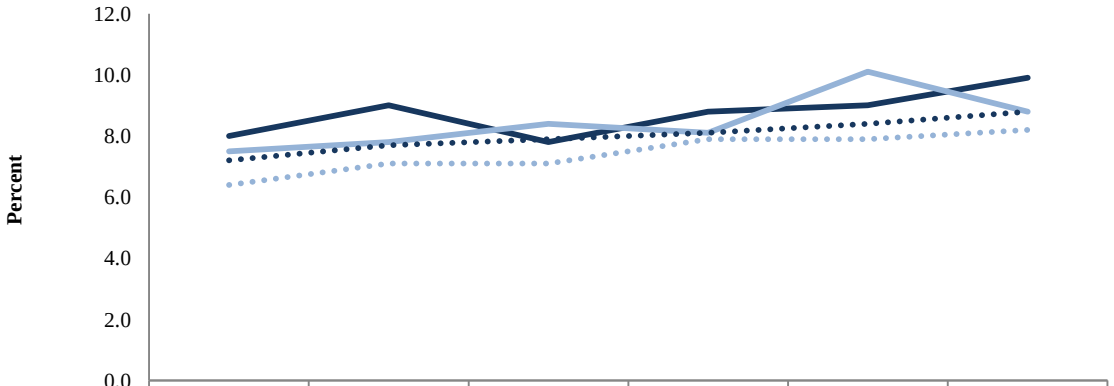
Data Source: Behavioral Risk Factor Surveillance System, Indiana State Department of Health

Gender

In 2009, the estimated prevalence of diabetes in adult females in Indiana was 8.8%, while that of adult males was 9.9%. Both genders maintain rates higher than U.S. estimates. These values represent an overall increase in diabetes prevalence between 2004 and 2009 (Figure 5).[3,8] Males have a higher age-adjusted mortality rate (25.9 per 100,000) than females (21.3 per 100,000) (Figure 6).[11]

Figure 5.

Diabetes prevalence in adults by gender

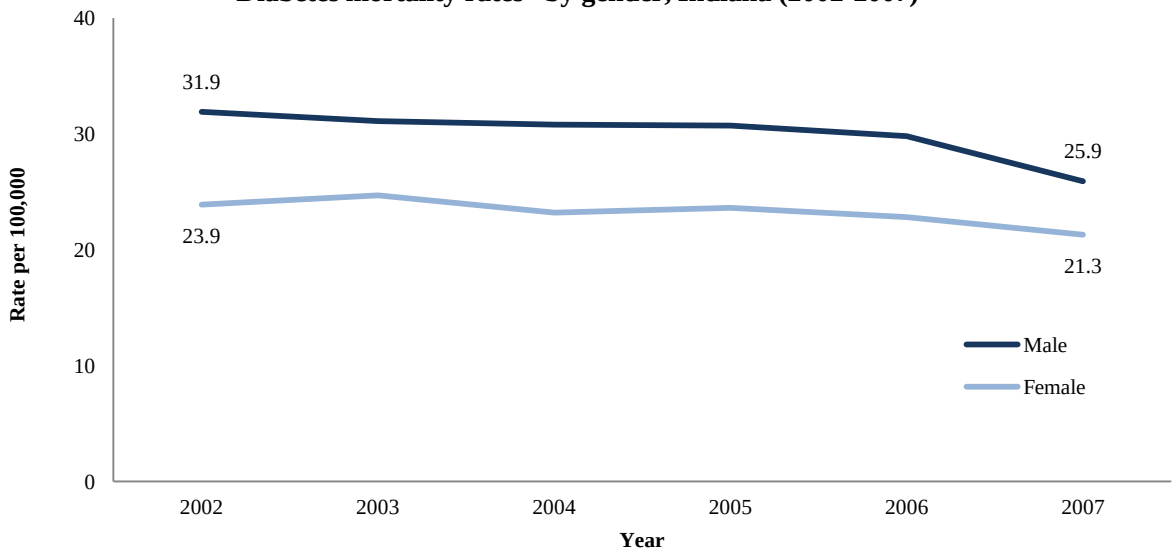


	2004	2005	2006	2007	2008	2009
IN-Males	8.0	9.0	7.8	8.8	9.0	9.9
IN-Females	7.5	7.8	8.4	8.1	10.1	8.8
US-Males	7.2	7.7	7.9	8.1	8.4	8.8
US-Females	6.4	7.1	7.1	7.9	7.9	8.2

Data Source: Behavioral Risk Factor Surveillance System, Indiana State Department of Health

Figure 6.

Diabetes mortality rates* by gender, Indiana (2002-2007)



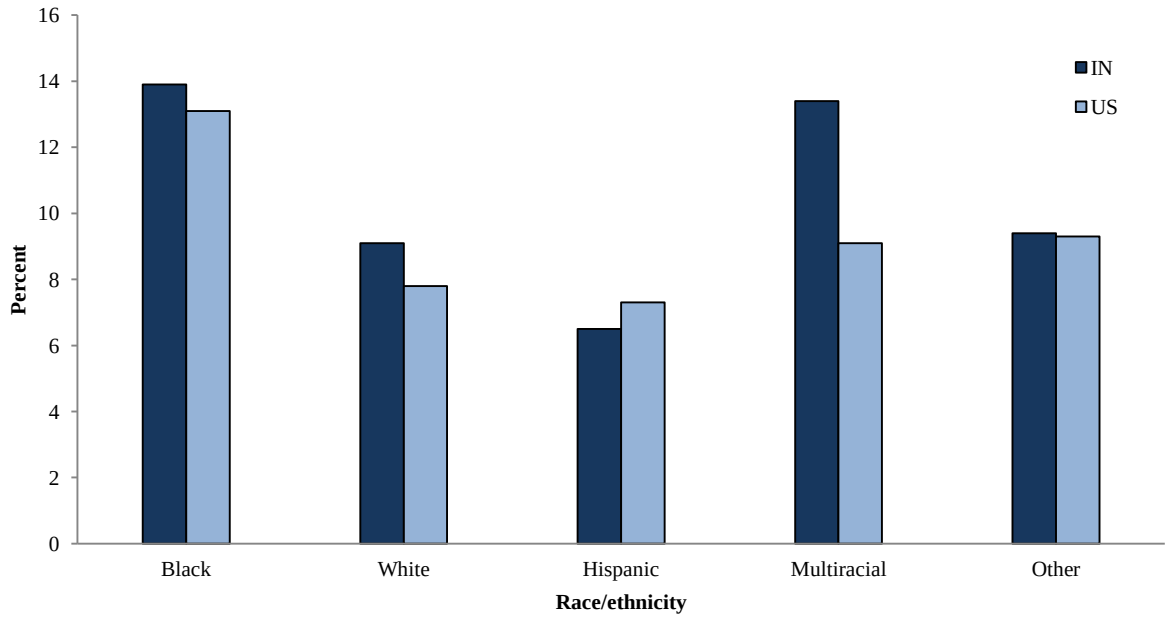
Data Source: Indiana State Department of Health, Vital Records
*Age-adjusted rates, per 100,000 population

Race/Ethnicity

Non-Hispanic blacks in Indiana are at higher risk of having diabetes, developing complications, and dying from the disease at earlier ages when compared to their non-Hispanic white counterparts. According to estimates from the 2009 BRFSS, non-Hispanic blacks in Indiana have a diabetes prevalence of 13.9%, while non-Hispanic whites have a prevalence of 9.1% (Figure 7). Non-Hispanic whites and non-Hispanic blacks in Indiana have higher diabetes prevalence than national estimates; however these differences were not significant. When compared over time, nearly all racial and ethnic groups demonstrate an increase in diabetes prevalence.[3,8]

Figure 7.

Diabetes prevalence by race/ethnicity, Indiana and U.S. (2009)

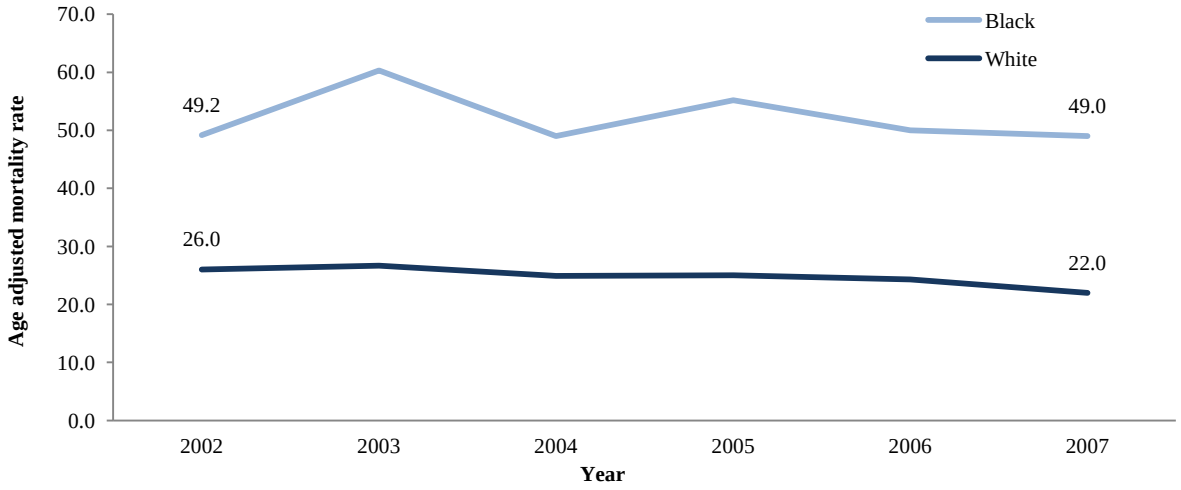


Data Source: Behavioral Risk Factor Surveillance System, Indiana State Department of Health

In 2007, diabetes was the fourth leading cause of death for non-Hispanic blacks, third for Asian/Pacific Islanders, seventh for non-Hispanic whites, and eighth for Hispanics in Indiana. The number of deaths in the non-Hispanic white population is higher than in the non-Hispanic black population. However, when comparing diabetes mortality rates, the non-Hispanic black rate was almost twice as high as the non-Hispanic white rate (Figure 8). Although the age-adjusted death rate for Hispanics in 2006 was 25.7 per 100,000, a small response rate in 2007 renders the data insufficient for comparative analysis. When comparing rates from 2002 through 2007, non-Hispanic black males and females have the highest mortality rates (Figure 9). Non-Hispanic whites of both genders have displayed relatively stable mortality rates over this time period despite the growing prevalence of diabetes.[11]

Figure 8.

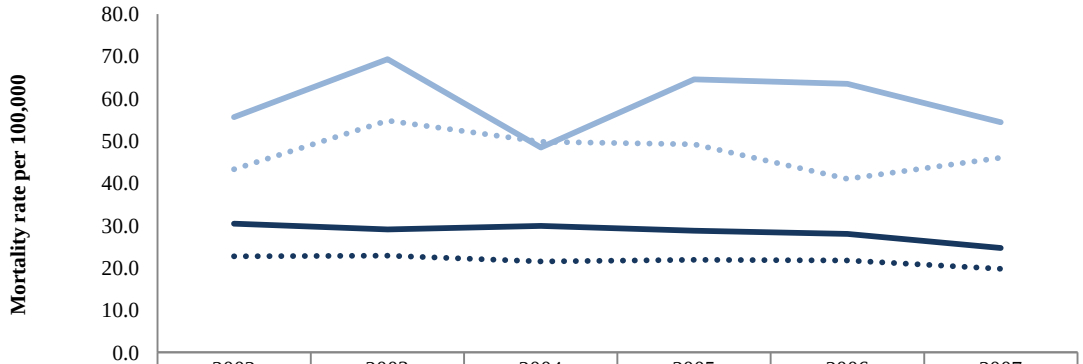
Diabetes mortality rates by race*, age-adjusted, Indiana (2002-2007)



Data Source: Indiana State Department of Health, Vital Records
*Age-adjusted rates, per 100,000 population

Figure 9.

Diabetes mortality rates by race and gender*, Indiana (2002-2007)



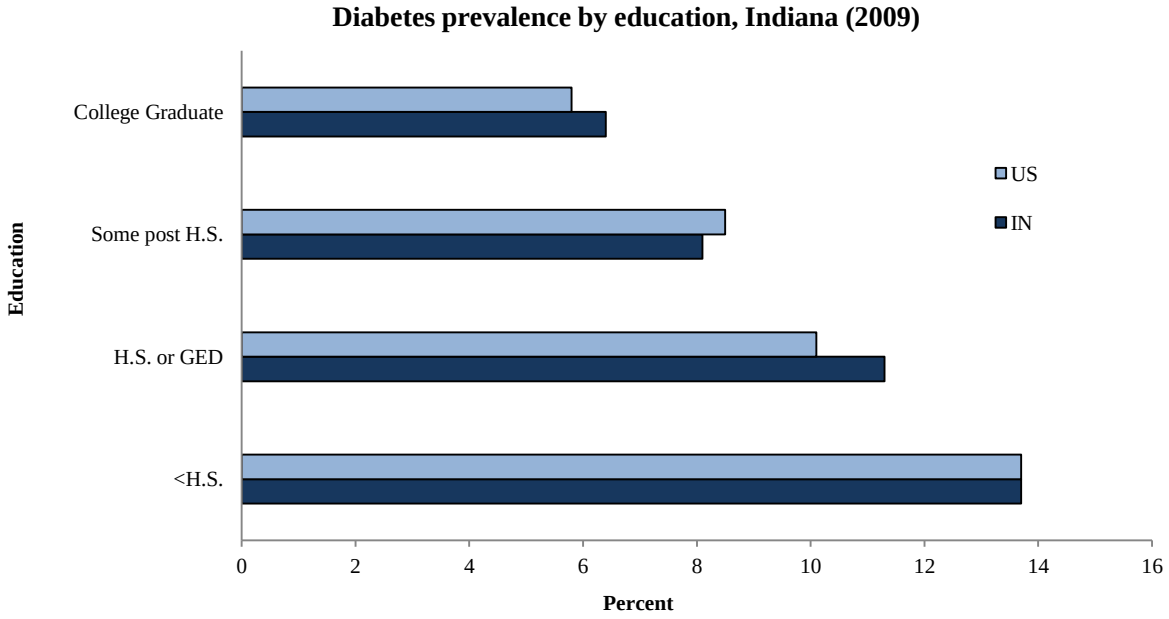
	2002	2003	2004	2005	2006	2007
Females-Black	43.3	54.8	49.8	49.2	41.0	46.0
Females-White	22.7	22.9	21.5	21.9	21.7	19.8
Males-Black	55.6	69.3	48.4	64.5	63.5	54.4
Males-White	30.4	29.1	29.9	28.8	28.0	24.7

Data Source: Indiana State Department of Health, Vital Records
*Age-adjusted rates, per 100,000 population

Education and Income

The prevalence of diabetes is associated with education and income level. In 2009, the prevalence of diabetes was greatest among adults with less than a high school diploma, 13.7%, and the prevalence was the lowest, 6.4%, among those with a college degree (Figure 10). The differences between educational attainment and diabetes prevalence are significant, and this trend in Indiana has been consistent over time and consistent with national trends.[3]

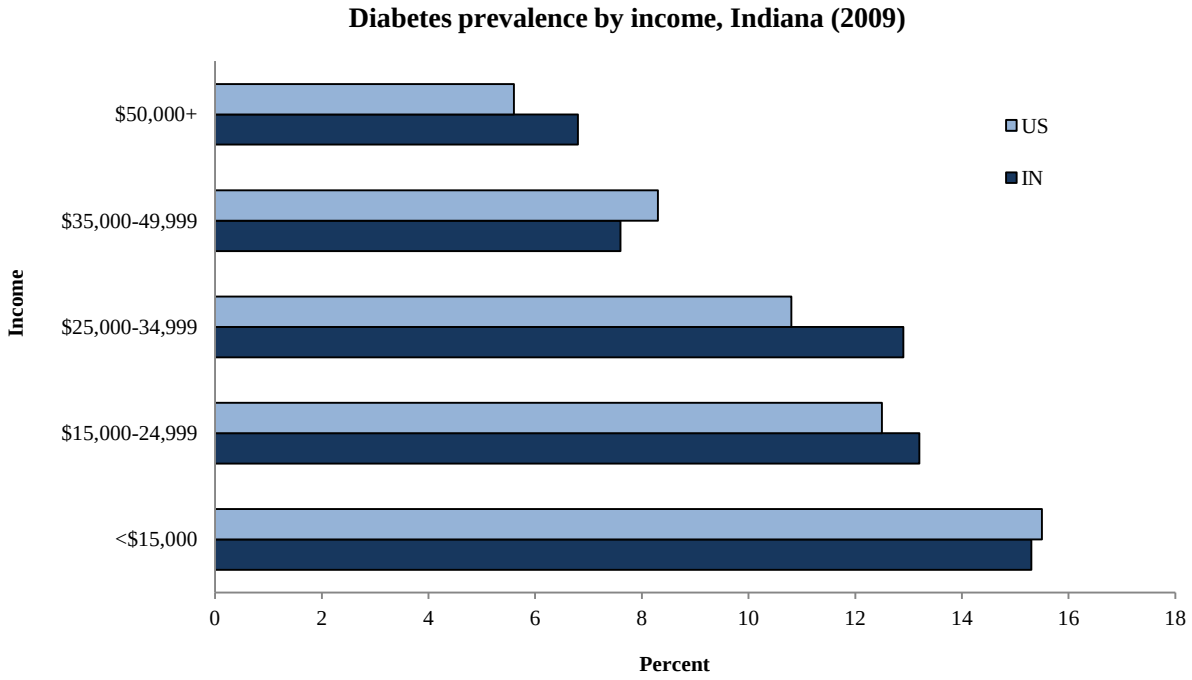
Figure 10.



Data Source: Behavioral Risk Factor Surveillance System, Indiana State Department of Health

Individuals with lower income exhibit a higher prevalence of diabetes. In addition to individual income, household income is a predictive factor.[13] Individuals in lower income households are more likely to have diabetes compared to their higher income peers, which is consistent with national data. In 2009, the prevalence for those with an annual household income (from all sources) of less than $15,000 was 15.3% compared to only 6.8% prevalence in those that had a yearly income of $50,000 or higher (Figure 11).[3]

Figure 11.



Data Source: Behavioral Risk Factor Surveillance System, Indiana State Department of Health

The exact mechanisms for developing either type 1 or type 2 diabetes are unclear, although it appears to differ for each form of the disease. Risk factors for type 1 include autoimmune, genetic, and environmental factors. Possible explanations for the onset of type 1 diabetes are environmental triggers which stimulate an immune response against the insulin-producing pancreas. Risk factors for type 2 diabetes include both genetic and lifestyle factors that are classified as either non-modifiable or modifiable. Non-modifiable risk factors for type 2 diabetes include gender, age, and genetic factors such as race/ethnicity. Additionally, family history is highly predictive for type 2 diabetes. Modifiable risk factors include obesity, physical inactivity, tobacco use and dietary habits. Although less clear, education and income levels play a role in type 2 diabetes, as those with lower education and income tend to have a higher prevalence of diabetes.[4,13,14]

Although these factors are considered distinct classifications, interactions can occur between the two. For example, genes can predispose an individual to developing diabetes but may require environmental and behavioral factors for activation. Consequently, the development of type 2 diabetes is not inevitable, and may be prevented or delayed with effective intervention.[15,16,17]

Obesity and overweight are significant risk factors for the development of type 2 diabetes. Additionally, women who give birth to large-for-gestational-age* babies are at increased risk of developing type 2 diabetes later in life. Other factors worth noting include low birth weight, exposure to a diabetic environment *in utero*, and inflammatory response, but additional research is needed in these areas to clarify the mechanisms that lead to disease onset.[15,16]

Women who experience gestational diabetes are an additional high-risk population. Research has shown that the risk of developing type 2 diabetes increases with time, and is almost ten times greater for women who had gestational diabetes than those who did not. The cumulative risk of developing type 2 diabetes for those women is 25.8% at 15 years post-diagnosis.[18] Information from vital records offers a broader assessment of gestational diabetes in Indiana than the BRFSS, as it includes all female residents who gave birth during the calendar year. In 2007, there were 3,989 births where the mother was diagnosed with gestational diabetes, which accounted for 4.45% of births in Indiana.[19]

Clinical research has shown that type 2 diabetes can be delayed, or even prevented, in high-risk populations by lifestyle modification which includes dietary alteration, exercise and moderate weight loss.[17,20,21] Further investigation is needed to determine how such interventions may influence diabetes complications and co-morbidities.[22] A significant contributing factor to the success of lifestyle intervention is the early identification of those with pre-diabetes, or those who are generally at high-risk for the development of type 2 diabetes.[23]

Common risk factors for diabetes	
• Pre-diabetes	• Age over 45 years
• Family history of diabetes	• Overweight or obese
• Physical inactivity	• High blood pressure
• Low HDL and high triglycerides	• Certain racial and ethnic groups
• Pregnancy complications	• Women who have had gestational
• Biochemical imbalance	diabetes

*Birth weight at or above 90th percentile for given gestational age

Diabetes can affect many parts of the body and can lead to serious complications if not managed well. A team-based health care approach for the care and treatment of individuals with diabetes is best. The individual should also take an active role in self-management. It is important for individuals with diabetes to learn about their condition, treatment goals, and preventive measures. Self-management courses, active engagement with a physician, and diabetes educators are resources which can assist those affected by diabetes and those at high risk of developing the disease. Due to common comorbidities, many individuals with diabetes need to take medication to control high blood pressure and cholesterol in addition to medication to control blood glucose levels. Controlling blood glucose, blood pressure, and blood lipids may reduce the likelihood of developing complications.[14,15,16]

Prevention

The onset of type 2 diabetes is not an inevitability of age. A key component of improving the outcomes associated with type 2 diabetes is preventing or delaying the onset of the disease. Intervention with at-risk individuals or those who have been diagnosed with pre-diabetes is an important key to modifying diabetes morbidity and mortality. Currently, 35% of the adult population in the United States is estimated to have pre-diabetes.[2] However, pre-diabetes research indicates that as few as 7.3% of adults reported being informed that they had pre-diabetes.[24] This disparity in awareness may make targeting interventions difficult. Strategies for preventing type 2 diabetes include maintaining a healthy weight, eating a healthy diet, and exercising at least 150 minutes a week. Lifestyle changes coupled with weight loss of 5-7% has been shown to reduce the risk of onset of type 2 diabetes by 58%.[17,18]

The concept of prevention is not limited to the prevention of disease onset. Initiation of lifestyle and medical interventions is important to achieve optimal health outcomes. As mentioned earlier, approximately 25% of individuals with diabetes are undiagnosed.[2] To optimize the impact of care, it is crucial to identify these individuals and bring them into a care setting and initiate intervention. Once identified, the care for individuals with diabetes focuses largely on mechanisms that will prevent the development of complications such as cardiovascular disease, blindness, neuropathy and renal disease. In addition to lifestyle changes, medical intervention to maintain blood glucose, blood lipids and blood pressure at optimal levels is often initiated. Also, specialized monitoring and treatment protocols are recommended for the prevention of specific negative outcomes, including wound care, vision assessment, and kidney monitoring.[14] Further details on targets and protocols for treatment and monitoring can be found in subsequent sections.

Treatment Goals

Individuals with diabetes should receive medical care from a physician-coordinated team of health care professionals. There are specific steps that should be taken during an individual's lifetime in order to maintain health and avoid diabetic complications. Appendix A outlines recommended treatment strategies that are used to guide health care professionals when working with individuals who have diabetes. Comprehensive diabetes management focuses on the "ABCs": A1C, blood pressure, cholesterol, and smoking cessation. Each of these items is important for managing diabetes and improving long-term health outcomes. Specific recommendations for clinical management of all forms of diabetes are published annually by the Professional Practice Committee of the American Diabetes Association as the *Standards of Medical Care in Diabetes*. [14]

Glucose Control

Studies have shown that improved glucose control benefits individuals with type 1 and type 2 diabetes. For every percentage point drop in A1C blood test results, the risk of micro-vascular complications, such as eye, kidney, or nerve disease, is reduced by 40%.[4] Individual treatment goals include achieving A1C results as close to normal (<6% in individuals without diabetes) as possible without significant hypoglycemia. Less stringent goals are set for those with severe or frequent hypoglycemia, advanced microvascular or macrovascular complications, limited life expectancy, or other significant comorbidities. Daily glucose checks and A1C testing (twice a year at least three months apart if meeting treatment goals and quarterly if not meeting goals) helps those with diabetes monitor their glucose levels so they know if, and when, adjustments are necessary.[14]

According to the 2009 BRFSS, 67% of Indiana adults with diabetes reported checking their glucose level at least once a day. However, 24.1% failed to check their glucose levels daily, and 9% never checked their levels.[3] Over 84% of adults with diabetes reported having received the A1C test in the previous year. Almost 16% of those surveyed did not know when they last had the test or have never heard of the test.[3]

A key component of treatment for most people with diabetes is medical management through pharmacologic therapy. The recommended therapy for most individuals with type 1 diabetes is multiple daily doses of insulin. Treatment for type 2 diabetes includes a healthy diet, regular exercise, and oral medications. Those with type 2 diabetes may take insulin as well, alone or in combination with oral medications. As with primary prevention, attaining and maintaining a healthy weight is beneficial for successful treatment of diabetes.[14]

Among Indiana adults with diabetes, oral medications were the most common form of treatment (72.6%). Insulin was used by 29.4%. A combination of therapies was used by 57.3% of individuals. However, 21.0% did not use either insulin or oral medications. The type of treatment used by adults in Indiana with diabetes has remained consistent over time.[3]

Blood Pressure and Lipid Control

Hypertension and dyslipidemia commonly occur with type 2 diabetes and contribute to negative health outcomes. Controlling blood pressure among individuals with diabetes helps to reduce macrovascular complications of diabetes, including reducing the risk of heart disease and stroke by 33-50%. It also reduces the risk of microvascular complications (eye, kidney, and nerve diseases) by about 33%. For every 10 mmHg reduction in systolic blood pressure, the risk of complications is reduced by 12%.[4,14] Of Indiana adults with diabetes, 71.8% of adults with diabetes have high blood pressure.[3] Improving cholesterol or blood lipids can reduce cardiovascular complications by 20-50%.[2,4,14] Of Indiana adults with diabetes, 68.3% reported that they had high cholesterol.[3]

Kidney Disease Management

Diabetic nephropathy is a common long-term complication of diabetes. Damage to the kidneys results in the inability of the body to properly filter waste from the blood. When the kidneys fail, dialysis is necessary to filter the blood. Diabetes is the primary cause of kidney failure. Good glycemic control and early detection and treatment of diabetic kidney disease by lowering blood pressure can reduce the decline in kidney function by 30-70%.[4] Annual tests to monitor kidney damage (urine albumin-to-creatinine ratio) and kidney function (glomerular filtration rate) are recommended.[14]

Regular Visits to Health Care Providers

Diabetes is a complex disease which requires a comprehensive treatment protocol. It is important for individuals with diabetes to see a health care professional regularly to monitor their disease and to detect and prevent complications. According to the 2009 BRFSS, an estimated 86.9% of Indiana adults with diabetes saw a health care professional for their diabetes at least once in the previous year. However, 13.4% reported not seeing any health care professional in the previous year.[3]

Self-Management

Because of its complexity, individuals with diabetes who are actively engaged with a management plan and a coordinated care team improve their chances for positive outcomes. Diabetes self-management education is a means to facilitate such engagement. Diabetes self-management classes are essential for helping those with diabetes understand their condition and how to care for themselves. These courses are offered at local health departments, clinics, hospitals and in community settings. Topics include understanding diabetes and its effects on the body; monitoring blood glucose; nutrition; understanding the role of medications; exercise and the importance of maintaining a healthy weight; preventing complications by detecting problems early; proper foot, skin, and dental care; and working with health care providers. The current best practice involves a skill-based approach that focuses on assisting those with diabetes to make informed self-management decisions.[14] In 2009, 60.5% of Indiana adults with diabetes reported that they had ever taken a course or class to help them manage their diabetes at some time since their diagnosis.[3]

Eye Exams

Individuals with diabetes are at increased risk of vision problems, including blindness. Diabetes is the leading cause of blindness among adults aged 20-74.[2] Most individuals with diabetes eventually develop some form of retinopathy. Early detection and treatment of diabetic eye disease can reduce the development of severe vision loss by 50-60%.[14,25,26] A key component to achieving this result is regular eye exams. Recommendations suggest that individuals with diabetes see an eye care professional each year for a dilated eye exam. In 2009, 70.1% of Indiana adults with diabetes reported having a dilated eye exam in the previous year. Only 4.1% had never had a dilated eye exam. However, 15.5% of respondents stated that it had been more than two years since their last exam.[3]

Foot Exams

Regular comprehensive foot exams can reduce amputation rates by 45-85%.[2] In 2009, 73.6% of Indiana adults with diabetes reported that they had at least one foot exam performed by a health care professional in the previous year. In addition to seeing a doctor for a yearly foot exam, recommendations suggest that adults with diabetes check their feet daily for sores or irritations to reduce the risk of infection and amputation. In 2009, 83.2% of Indiana adults with diabetes checked their feet daily or weekly. However, 10.2% never check their feet.[3]

Dental Exams

Regular dental exams are important to detect and prevent periodontal disease.[2] Poor glycemic control may complicate oral health, and conversely periodontal disease may hinder diabetes management.[27] Although individuals with diabetes are at a higher risk of having dental disease, they are less likely to receive regular dental care. In 2008, only 53.8% of Indiana adults with diabetes reported that they had a dental exam in the previous year, compared to 67.9% in those without diabetes.[3]

Other Preventive Measures

Overall, individuals with poorly controlled diabetes are more susceptible to illness, and once they become sick, they often have a worse prognosis. For example, those with diabetes are more likely to be hospitalized or die because of pneumonia or influenza than individuals without diabetes.[2] Individuals with diabetes have worse outcomes when they become ill with influenza and/or pneumonia compared to the general population. Consequently, yearly influenza vaccinations and a pneumonia vaccination are recommended to help to prevent illness. Smoking cessation, regular exercise, a healthy diet, and maintaining a healthy weight are also important for reducing complications. Additionally, there are several other components to comprehensive diabetes care: aspirin therapy to reduce cardiovascular risk, depression management, and neuropathy management.[14, 27]

Diabetes represents a tremendous challenge for Indiana and the United States. The World Health Organization estimates that the number of adults in the United States with diabetes will double by the year 2030.[1] The rates of obesity and diabetes are on the rise in Indiana, as well as, the rate of individuals developing complications due to diabetes. Diabetes-related mortality and morbidity, amputations, blindness, and kidney disease cause needless suffering and unnecessary financial burden on individuals and Indiana's economy. The DPCP works to remove barriers associated with preventing, detecting and managing diabetes, and supports initiatives to improve the health outcomes and quality of life of those with diabetes and those at-risk for developing diabetes.

The DPCP's mission is to reduce the burden of diabetes in Indiana through data surveillance, health systems development, health communications, and the development and implementation of community interventions and programs. To achieve its mission, the DPCP works closely with the Indiana Diabetes Advisory Council (DAC), a group composed of clinicians, state agencies, health insurers, not-for-profit organizations, commercial enterprises, resource providers, advocacy groups and concerned citizens. The focus of the DAC is to increase public awareness of the impact of diabetes, to improve the quality of life for those who are affected by diabetes, to improve the quality of care for patients with diabetes, and to reduce the burden imposed by diabetes in Indiana. Currently the DAC is developing a strategic plan to guide Indiana's diabetes efforts.

A primary function of the DPCP is to provide technical assistance to entities interested in addressing diabetes. This is achieved through assisting in program development, evaluation and outcome analysis, as well as support in applying for grants. Additionally, the DPCP serves as a resource for organizations, local coalitions and media outlets, in an effort to provide accurate diabetes information to the public. The DPCP also supports the implementation of several interventions throughout the state that attempt to address areas of health inequity:

Living a Healthy Life with Chronic Conditions is a chronic disease self management program developed by the Stanford University's Patient Education Research Center. The program is a six session evidence-based workshop delivered in community settings. People with chronic health problems, including diabetes, attend together. Workshops are facilitated by non-health professionals who have received specific training to deliver this program. The subjects covered include: coping techniques, appropriate exercise for maintaining and improving strength, flexibility, and endurance, appropriate use of medications, communication skills, nutrition, and how to evaluate new treatments.[28]

Enhanced Fitness is an evidence-based exercise program designed to help older adults at all levels of fitness become more active, energized, and empowered to sustain independent lives. These activities support the concept of physical activity as a means of improving diabetes outcomes. The program focuses on stretching, flexibility, balance, low impact aerobics, and strength training exercises, tools that health professionals say that people need to maintain health and function as they grow older.

The ***Diabetes Prevention Program (DPP)*** was a major multicenter clinical research study aimed at discovering whether modest weight loss through dietary changes and increased physical activity could prevent or delay the onset of type 2 diabetes in individuals who are diagnosed with pre-diabetes. As mentioned previously, lifestyle intervention was proven to be an effective strategy for primary diabetes prevention in at-risk individuals. The intervention developed during the DPP study is now delivered in community settings, such as the YMCA. The program is lead by certified DPP instructors and meets for 16 weeks in a group setting where lifestyle goals are set for each individual. The two major goals of the DPP lifestyle intervention are to reduce and maintain individual weight loss by 5-7% through basic nutrition education, and to increase physical activity to 150 minutes per week. [17]

The ***Diabetes Empowerment Education Program (DEEP)*** was developed and evaluated by the University of Illinois at Chicago to provide community residents with the tools to better manage their diabetes in order to reduce complications and lead healthier, longer lives. Based on principles of empowerment and adult education, DEEP has two components. The *Training of Trainers Program* is a 20 hour workshop to train community health workers (lay health educators, lay health promoters) on providing diabetes education to members of their community. The training stresses the development of skills and knowledge related to diabetes by using interactive group activities and adult education methods. Once they complete the training, health workers are prepared to deliver diabetes education and self-management classes in their communities.

The second DEEP component, *The Diabetes Patient Education Program* is designed as an 8-10 week curriculum for diabetes self-management education. The curriculum is divided into eight modules covering topics that include diabetes risk factors, complications, nutrition, physical activity, use of the glucose meter and medications, building partnerships with a diabetes health care team, psychosocial effects of illness, problem-solving strategies, and how to access community diabetes resources. The curriculum is based on national medical care and diabetes self-education guidelines and recommendations, and is revised to reflect the most current knowledge and care information.

To better address additional strategies of diabetic management, Indiana has worked with the University of Illinois at Chicago to add a tobacco cessation component to the DEEP curriculum (DEEP TC). Racial and ethnic minority advocacy groups were primary participants in the revised DEEP TC curriculum.

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For further information on diabetes in Indiana or community intervention programs, please contact the ISDH Diabetes Prevention and Control Program at diabetes@isdh.in.gov. For free education materials please contact the National Diabetes Education Program at ndep.nih.gov. Additional information on diabetes can be found at the Centers for Disease Prevention and Control at cdc.gov/diabetes and the American Diabetes Association at diabetes.org.

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Appendix A.

Treatment Measures	Frequency
Measure weight and blood pressure	**Every regular physician visit**
Inspect feet	**Every regular physician visit**
Review self-monitoring glucose record	**Every regular physician visit**
Review/adjust medications to control glucose, lipids, and blood pressure	**Every regular physician visit**
Review self-management skills, dietary needs, and physical activity	**Every regular physician visit**
Assess for depression or other mood disorders	**Every regular physician visit**
Counsel on smoking cessation and alcohol use	**Every regular physician visit**
Refer to Medical Nutrition Therapy with a registered dietitian, preferably a Certified Diabetes Educator (CDE); at diagnosis, then every 6-12 months, or as needed	**Every regular physician visit**
Refer to Self-Management Education with a diabetes educator, preferably a CDE; at diagnosis, then every 6 to 12 months, or as needed	**Every regular physician visit**
Assess for aspirin therapy *(unless otherwise contraindicated)*	**Every regular physician visit**
Obtain A1C in patients whose therapy has changed or who are not meeting glycemic goals *(if meeting goals, twice a year at least 3 months apart)*	**Quarterly**
Obtain fasting lipid profile (every two years if at goal)	**Annually**
Obtain serum creatinine and estimate glomerular filtration rate	**Annually**
Perform urine test for albumin-to-creatinine ratio in patients with Type 1 diabetes ≥5 years and in all patients with Type 2 diabetes	**Annually**
Refer for dilated eye exam (if normal, an eye care specialist may advise an exam every 2-3 years)	**Annually**
Perform a comprehensive foot exam	**Annually**
Refer for dental/oral exam at least once a year	**Annually**
Administer influenza vaccination	**Annually**
Review need for other preventative care or treatment	**Annually**
Administer pneumococcal vaccination (repeat if over 64 years of age or immunocompromised and last vaccination was more than 5 years ago	**Lifetime**

Data Source: American Diabetes Association