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The Prevalence of Impaired Type 2 Fasting Blood Glucose Concentrations Among College-Aged Individuals

Elizabeth Graham

THE PREVALENCE OF IMPAIRED TYPE 2 FASTING BLOOD GLUCOSE CONCENTRATIONS AMONG COLLEGE-AGED INDIVIDUALS

by

ELIZABETH GRAHAM

(Under the Direction of Amy Jo Riggs)

ABSTRACT

Impaired fasting glucose (IFG) is a condition where fasting blood glucose (FBG) is above normal but not high enough to be considered diabetic. IFG is linked with many co-morbid diseases such as obesity, dyslipidemia, and hypertension. The purpose of this study was to observe anthropometric values including weight, height, body mass index (BMI), and waist circumference and assesses the prevalence of IFG concentration in college-aged students. One hundred and ninety-eight students participated in a one-time assessment. The subjects completed a physical activity questionnaire, current medical history, FBG, and anthropometric values following an overnight fast. The prevalence of IFG was low with 12.6% (n=25) of total participants. Results showed that 41.9% (n=83) of participants were overweight/obese when classified according to BMI. Seventeen (60.7%) of those with IFG were classified as overweight/obese. There were no significant differences between FBG groups and weight (p=0.373), waist circumference (p=0.412), and BMI (p=0.114). However, there were significant correlations between FBG and weight (r=0.160, p=0.024), and waist circumference (r=0.173, p=0.015). In conclusion, the majority of these subjects had a normal FBG (87.4%, n=173) however almost half (41.9%, n=83) were considered overweight/obese and this is due to a drastic increase in an overweight younger population. Among the participants with IFG, 40.0% (n=10) participated in <3 days of aerobic activity per week while those with a normal FBG, 62.4% (n=108) participated in ≥3 days of aerobic activity per week. This suggested that healthy lifestyle choices may improve parameters of chronic disease.

INDEX WORDS: Impaired fasting glucose, college, Fasting blood glucose, Body mass index, Waist circumference

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by

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B.S., Georgia Southern University, 2009

A Thesis Submitted to the Graduate Faculty of Georgia Southern in Partial

Fulfillment

of the Requirements for the Degree

MASTER OF SCIENCE

STATESBORO, GEORGIA

2011

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Fall 2011

DEDICATION

I would like to dedicate this thesis to my parents, Michael and Terry Graham. It was their continued support and encouragement that allowed me to complete what I set out to achieve. They taught me that even the largest task can be accomplished if it is done one step at a time. It is for these reasons, and many more, that I will forever be thankful to them.

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to my advisor, Dr. Amy Jo Riggs, for her continued guidance, patience, and support throughout the preparation of my thesis. I would also like to thank the members of my graduate committee, Dr. Jim McMillan and Dr. Barry Joyner, for their direction and suggestions.

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CHAPTER 1

Introduction

It is estimated that 171 million people in the world have diabetes, and this number is expected to increase to 366 million by the year 2030 (Gill & Cooper, 2008). Although many lifestyle choices, such as diet and activity level contribute to Type 2 diabetes, these factors can also be used to control or prevent this disease. With proper education and healthier lifestyle choices, individuals can control their blood glucose concentrations and improve their lives. As seen by the Center for Disease Control and Prevention (CDC), obesity and diabetes trends among adults have risen throughout the nation. A strong prevalence has been seen in the Southeast region where obesity rates have gone from 10-14% in 1990 to 25% and higher in 2009 (CDC, 2009; CDC, 2011). The same lifestyle choices used to treat Type 2 diabetes can also be used in preventing the disease.

Impaired fasting glucose (IFG) is a condition where fasting blood glucose (FBG) is above normal but not high enough to be considered diabetic. This condition is also known as "pre-diabetes" and is categorized with a FBG level of 100-125mg/dL (American Diabetes Association, 2011). IFG is linked with many co-morbid diseases such as obesity, dyslipidemia, and hypertension ("Standards of medical care", 2011). In overweight and obese individuals, modest weight loss has been shown to reduce insulin resistance (Castaneda, 2003; Gill & Cooper, 2008; Nathan et al., 2007; Pi-Sunyer, 2007). Thus, weight loss is recommended for all overweight or obese individuals who are at risk for Type 2 diabetes. Past research studies have examined the effects of body weight, waist circumference, and physical activity on FBG and how it may potentially help prevent and treat chronic disease (Alexander, Landsman & Grundy, 2008; Castaneda, 2003; Gautier et al., 2010; Gill & Cooper, 2008; Mellinger, 2003; Nathan et al., 2007; Pi-Sunyer, 2007; “Standards of medical care”, 2011).

Assessing body mass index (BMI) is a moderately reliable indicator of body fat for most people. It is not a direct measure of body fat; however, it does correlates to direct measures of body fat such as underwater weighing (Division of Nutrition, Physical Activity, and Obesity, 2011). Alexander, Landsman & Grundy (2008) reported a linear relationship between age and BMI to FBG, diabetes, and systolic blood pressure**.** The higher an individual’s BMI, the higher one’s risk for chronic disease, including hypertension and increased FBG.

The National Heart, Lung, and Blood Institute (NHLBI) examines factors such as BMI, physical inactivity, and waist circumference for obesity-related diseases (CDC, 2011). The risk of Type 2 diabetes is linearly related to obesity and since waist circumference is an alternative measure that reflects abdominal fat, waist circumference can be used as an indicator for obesity. Increased waist circumference is also associated with an elevated risk of Type 2 diabetes. According to the World Health Organization (WHO), a normal waist circumference for men is <40 inches and <35 inches for women. Any value over this cut off point increases the risk for chronic disease (WHO, 2008).

In addition to BMI and waist circumference, physical activity and exercise have also shown to be crucial and effective in controlling major recurring conditions. Sedentary lifestyles have been linked to 23% of deaths from leading chronic diseases, including heart disease and Type 2 diabetes (Castenada, 2003). Despite major advances for improved health and fitness, most college students continue sedentary behavior (Buckworth & Nigg, 2004). Physical activity is clearly declining in adolescence and adulthood (Douglas et al., 1997; Huang, Harris, Lee, Nazir, Born & Kaur, 2003; Pribis, Burtnack, McKenzie & Thayer, 2010; Racette, Deusinger, Strube, Highstein & Deusinger, 2005). With this decline, come many connected issues, such as poor nutrition and increased alcohol and tobacco use (Douglas et al., 1997; Huang et al., 2003; Racette et al., 2005). These lifestyle choices have been linked to many chronic diseases previously discussed.

Because physical activity can help control weight, it can be utilized in preventing and treating chronic disease. Resistance and aerobic training can be beneficial for different reasons. Resistance training is important in preserving and developing lean body mass while also improving muscular strength and endurance. (Hass, Feigenbaum & Franklin, 2001). This plays a key role in improving quality of life. Aerobic exercise is associated with increased insulin sensitivity, increased endogenous glucose production, decreased FBG and fasting plasma insulin concentrations and improved glycemic control (Castenada, 2003). The advantages of aerobic activity are numerous and play an effective role in preventing and treating type 2 diabetes.

Many measures can be used to assess risk factors for Type 2 diabetes. FBG is used to determine whether the production and the utilization of glucose are equal. (Giugliano, Ceriello, & Esposito, 2008). Testing for this biomarker is less expensive, easily replicated, and more convenient than the Oral Glucose Tolerance Test (OGTT). Because of this, FBG is recommended by American Diabetes Association (ADA) for diabetes screening (Barr, Nathan, Meigs, & Singer, 2002).

Because the college-age population falls between adolescence and adulthood, difficulties arise in creating a healthy lifestyle. Students who are leaving home for the first time may not eat well-balanced diets or participate in physical activity Healthy lifestyle changes decrease the risk of chronic disease, reduce stress, and promote overall well-being. College students as a population are difficult to categorize because they are in a transitional stage. This stage can be negatively coerced into unhealthy habits or positively changed to healthier lifestyle choices. College campuses offer courses for students to gain knowledge about the importance of physical activity and a healthy diet. This may help promote healthy lifestyle choices among the college-age population.

Problem Statement

Despite the growing obesity epidemic, college students are participating in less physical activity than before (Buckworth & Nigg, 2004; Douglas et al., 1997; Huang et al., 2003; Pribis, Burtnack, McKenzie & Thayer, 2010). Inactive lifestyles can lead to unfavorable weight gain and increase the risk for chronic diseases, including Type 2 diabetes. The purpose of this study was to observe anthropometric values including weight, height, body mass index (BMI), and waist circumference and assesses the prevalence of IFG concentration in college-aged students.

Rationale

As the obesity epidemic continues to escalate, chronic diseases will also rise. Although many young adults have not been diagnosed with Type 2 diabetes, they may have risk factors for this condition. Individuals who make healthy lifestyle choices, such as participating in physical activity and eating a balanced diet, are likely to improve their health status and quality of life. By examining FBG levels and anthropometric parameters in college students, the incidence of IFG can be observed.

Assumptions

1. The researcher was under the assumption that all instruments were accurately calibrated.
2. The researcher was under the assumption that all participants were answering the questionnaire honestly.
3. The researcher was under the assumption that all participants were fasted for 12 hours prior to the FBG test.

Limitations

1. Not having a control group for this study promoted an observation in FBG and anthropometric measures among college-aged students rather than a showing a change throughout the semester.
2. The classification of BMI is not always appropriate because BMI does not differentiate between fat and fat-free mass.
3. Self-reported questionnaires can rarely be independently verified, and therefore have to be taken at face value.
4. Lack of randomization among participant selection may potentially cause a bias despite not having an intervention.

Delimitations

1. The participants were Georgia Southern University students, aged 18-25 years old, and were enrolled in classes during the summer or fall of 2011.

Research Questions

1. What was the prevalence of elevated FBG among college-aged students?
2. What was the observation of weight, BMI, and waist circumference in college-aged students?

CHAPTER 2

THE PREVALENCE OF IMPAIRED TYPE 2 FASTING BLOOD GLUCOSE CONCENTRATIONS AMONG COLLEGE-AGED INDIVIDUALS

Literature Review

College students are an understudied population that potentially have emerging risk factors for the prevalence of obesity and chronic disease. In order to promote a healthy lifestyle, many medical professionals recommend proper education along with diet and exercise changes to help decrease the risk of chronic disease. Exercise, which is cost-effective, can favorably change body composition and improve fasting blood glucose concentrations associated with type 2 diabetes. In the following paragraphs, studies that have examined the relationships between exercise, body composition, and biochemical markers will be discussed.

Influence of Body Mass Index on Health in College-Aged Individuals

Hajosseini et al. (2006) observed changes in body weight, body composition, and resting metabolic rate (RMR) in college freshman at San Jose State University. Twenty-seven males and females, with an average age of 18.3 ± 0.2 years, participated in a 16-week study. Subjects completed three-day food records each week, which included two weekdays and one weekend day. Subjects were seen three times: at baseline, between week seven and eight, and between week 14 and 16. At the first visit, height, weight, RMR, and body composition were evaluated. The second and third visits consisted of evaluating weight, body composition, and three-day food records. RMR was repeated only during the third visit. After the end of the study, mean body weight significantly increased ($p=0.001$) with an average weight gain of 3.0 ± 0.7 lbs. Variations in weight changes were also seen among participants. 59% (n=16) gained ≥3 lbs, 22% (n=6) gained ≥6 lbs, 26% (n=7) remained within one pound or less of original weight, and 7% (n=2) lost weight. Percent body fat also significantly increased (p=0.001) over time with an initial mean of 30.1 ± 1.1% and a post body fat mean of 32.2 ± 1.3%. There were no significant changes seen in RMR throughout the study. These results found that the transition from home to college life is not favorable to healthy lifestyle choices. It would be beneficial for college freshmen to engage in healthier habits to avoid weight gain.

Alexander, Landsman & Grundy (2008) investigated the influence of aging and body mass index (BMI) on metabolic syndrome. This study defined metabolic syndrome according to the National Cholesterol Education Program (NCEP). Assessments from the Third National Health and Nutrition Examination Survey (NHANES III), a 6-year cross-sectional study, were used in this study. Only adults aged 20 years and older who received a physical exam after a 9-hour fast were included in this study (n=7959). BMI was categorized as normal (18.5-24.9 kg/m^2), overweight (25.0-29.9 kg/m^2), and obese (≥30.0 kg/m^2). Serum lipoproteins, blood pressure, and fasting blood glucose were also examined. Results of this study indicated a linear relationship between age and BMI to fasting blood glucose, diabetes, and systolic blood pressure. This means that as BMI increases, the NCEP cut point (100mg/dL) also increases. Despite BMI among participants, the incidence of diabetes and hypertension increased with age, while fasting insulin and C-Reactive protein levels associated better with BMI and age. Each parameter of metabolic syndrome can be associated with obesity, age, or both.

Influence of Waist Circumference on Fasting Blood Glucose

Gautier at al. (2010) conducted a study to look at the importance of waist circumference and body weight on impaired fasting glucose (IFG) and its development to type 2 diabetes. Participants from the Data from an Epidemiological Study on Insulin Resistance Syndrome (DESIR) cohort who had a baseline IFG (5.6-6.9 mmol/l) were included in this study. DESIR is a nine-year follow up study used to clarify the development of insulin resistance syndrome and type 2 diabetes. A total of 979 participants, males and females, ages 30-64 years were included in the study. Interactions between initial body mass index (BMI) categories (<25 kg/m^2 and ≥ 25 kg/m^2) and increases in waist circumference were tested on the prevalence of type 2 diabetes. Of the participants, 576 had a post BMI ≥ 25 kg/m^2, while 433 had a post BMI of <25 kg/m^2. After the nine-year follow up, there were 142 cases of type 2 diabetes. Results showed that those who became diabetic had a greater increase in waist circumference and body weight than those without diabetes. There was an interaction between the BMI categories and an increase in waist circumference ($p=0.049$) for progression to type 2 diabetes. In other words, the impact of increased waist circumference was greater in those with a BMI <25 kg/m^2 than those with a BMI ≥ 25 kg/m^2. Results of this study indicated that an increase in waist circumference was a major risk factor for type 2 diabetes in people with IFG, independent of initial BMI. This study emphasized the importance of monitoring and preventing an increase in waist circumference in individuals with IFG, in particular those with a BMI <25 kg/m^2.

Janssen, Katzmarzyk & Ross (2004) evaluated whether waist circumference (WC) alone was a predictor for assessing obesity-related health risk. This study reviewed participants from the Third National Health and Nutritional Examination Survey

(NHANES III), a 6 –year cross-sectional survey. The sample was comprised of 14,924 participants, aged ≥17 years old. Assessments included weight and height to calculate body mass index (BMI), waist circumference, blood pressure, serum cholesterol, triacylglycerol, lipoproteins, blood glucose, and demographic variables (age, race, & health behaviors). Participants were classified according to the National Institute of Health (NIH) into 2 WC groups and 3 BMI groups. Men and women with a WC ≤102 cm and ≤88 cm were considered to have a normal WC, whereas a high WC was considered >102 cm and >88 cm. For BMI, participants were classified as normal (18.5-24.9 kg/m^2), overweight (25.0-29.9 kg/m^2), and obese class I (30.0-34.9 kg/m^2). Underweight BMI (<18.5 kg/m^2) and obese class II and III (>35.0 kg/m^2) were excluded from the study because all underweight participants had a normal WC and almost all obese class II and III had a high WC. The average WC for males was 93.3 ± 11.3 cm, and 85.9 ± 12.0 cm for women. Results of this study indicated that overweight participants had a lower BMI and WC than obese participants. Results also revealed that BMI and WC were higher in overweight and obese participants than in those with a normal BMI. Overall, this study showed that BMI and WC together did not predict obesity-related health risk better than WC alone. However, results also showed that when WC was categorized as normal or high, BMI continued as a significant indicator of health risk.

Influence of Physical Activity on Health in College-Aged Individuals

College-aged individuals have the tendency to develop sedentary behaviors. It is lack of physical activity, in combination with other factors that increases the risk for chronic diseases. Buckworth & Nigg (2004) analyzed connections between physical activity, exercise, and sedentary manners in college students. The average age of the participants was 21.0 ± 4.0 years. Questionnaires, distributed during the first class, included questions from the National College Health Risk Behavior Survey (NCHRBS) to assess exercise participation, and Coronary Artery Risk Development in Young Adults (CARDIA) was used to evaluate physical activity history in participants. Lastly, to measure sedentary behaviors, participants were asked to report the number of hours spent watching TV per week, and/or playing video games or studying. Results showed that students spent almost 30 hours per week engaging in sedentary activities. Compared to the 1995 NCHRBS, more students participated in acceptable amounts of moderate- and vigorous-intense physical activity. It was found that males participated in more sedentary behaviors than women ($p<0.05$). Older students spent significantly more time using the computer than younger students ($p<0.05$). For women, studying was positively correlated with duration of exercise and strength training. Men reported greater participation in physical activity and exercise than did women, and they also spent more time watching television and using the computer, This study demonstrated how sedentary behaviors, such as video games, can be used in moderation with physical activity, to positively influence overall health.

Pribis, Burtnack, McKenzi, & Thayer (2010) evaluated the trends of physical fitness related to body weight and body composition. Over the 13 year study, 5101 students (55% female, 45% male) completed the study. The Microfit test was administered during a required physical activity class. This test estimated total fitness using the following assessments: anthropometrics, blood pressure, muscular strength, flexibility, resting heart rate, and aerobic fitness (VO_{2max}). There was a significant linear trend between VO_{2max} and age for males ($p<0.001$) and females ($p<0.001$). This trend showed that VO_{2max} decreased over the years by 0.812 mL/kg/min per year for men and

0.414 mL/kg/min per year for women. The trend for BMI by year was not significant for either males ($p=0.772$) or females ($p=0.253$). Even though BMI did not show a correlation, percent body fat had a significant linear correlation among males ($p<0.001$) and females ($p<0.001$). This trend illustrated that percent body fat increased over the years by 0.513% per year for males and 0.654% for females. In conclusion, this study found that college students are less fit and have a higher body fat percentage.

Racette, Deusinger, Strube, Highstein, & Deusinger (2005) observed changes in body mass index (BMI), participation in exercise, and alterations in diet during freshman and sophomore years in college. A sample of 764 students, aged 18.1 ± 0.3 years, participated in a stages-of-change questionnaire which assessed self-reported exercise, and a dietary questionnaire that reviewed their food intake of fruits and vegetables, fast food, fried foods, and beverages. At the beginning of freshman year, according to BMI criteria, 5% of students were underweight, 76% were normal weight, and 18% were overweight. The questionnaires depicted that at the beginning of freshman year, men participated in significantly more strength training than women ($p<0.001$) while women ate significantly more fried foods and fast food than men ($p<0.001$). At the end of sophomore year, only 290 students returned for follow-up assessments. Of these returning students, 70% gained a significant amount of weight ($p<0.001$). Over the two years, aerobic exercise significantly decreased ($p=0.039$) and stretching significantly increased ($p=0.007$). Consumption of fruits/vegetables and fast food did not significantly change throughout the study, however, there was a significant decrease in fried foods ($p=0.004$). The researchers concluded that students were not participating in adequate amounts of physical activity and were not consuming a balanced diet. Unhealthy eating patterns and sedentary lifestyle were factors contributing to weight gain.

Jackson & Howton (2008) observed the effects of a 12-week walking intervention in college students and how it correlated to body mass index (BMI). A sample of 326 students enrolled in a health and fitness course participated in this walking program. On average, participants were 24.3 ± 7.8 years old and about 70% were women. Students were asked to wear a pedometer five days a week for 12 weeks. The first week was used for baseline measurements where students received no information on recommended number of daily steps. After week one, instructors gave proper recommendations and behavior-change strategies. Those who took less than 1500 steps during week one were excluded, leaving only 290 students for data analysis. According to their BMI, students were classified as underweight (UW; n=41), normal weight (NW; n=147), or overweight/obese (OW; n=102). Week one demonstrated that there was no significant difference among the groups for average number of steps (p=0.27). All groups indicated a significant increase over the 12 weeks for steps taken (p<0.001). On average, it was reported that UW students took fewer steps than NW (p=0.03) and OW (p=0.26) students. Awareness of steps taken throughout the day may increase physical activity and acknowledgement to meet recommended steps per day. Being aware of steps taken throughout the day may increase daily physical activity and potentially lead to a healthier lifestyle.

Questionnaires in College Students

Many cases of type 2 diabetes go undiagnosed throughout the United States. In order to evaluate awareness of type 2 diabetes among college students, baseline research studies must be developed. Seo et al. (2008) recruited 701 college students to participate in a study to evaluate their perceived susceptibility to diabetes. A 41-item questionnaire was developed to determine body mass index (BMI), attitudes, and behavioral factors associated with diabetes in the students. Subsections of this survey consisted of: demographics, familial history of diabetes, health status of respondents, attitudes toward diabetes, and lifestyle behaviors. Mean BMI of the participants was 23.3 ± 3.78 kg/m^2. Thirty-one percent of participants reported having at least one family member with diabetes and only eight percent knew their current blood glucose level. Participants who knew their blood glucose level had at least one direct family member with diabetes. 32% (n=218) strongly agreed or agreed with the statement “I am at risk for developing diabetes” while about an equal percentage strongly disagreed with the same statement. Another surprising correlation was students who were familiar with their blood glucose level were less likely to be at risk for developing diabetes. This study emphasized the need for early intervention on diabetes education and college students.

Huang, Shimel, Lee, Delancey, & Strother (2007) examined the metabolic risks among college students and the differences between men and women. Participants included 300 undergraduate students (66% female, 34% male) aged 18 to 24 years old. Assessments obtained from each participant included: weight, height, body mass index (BMI), waist and hip circumference, systolic and diastolic blood pressure, fasting blood glucose, fasting blood insulin, triglycerides, total cholesterol, HDL, LDL, and an oral glucose tolerance test (OGTT). By the World Health Organization (WHO) definition, metabolic syndrome is having three of the following five components: central obesity, high triglycerides, low high-density lipoprotein cholesterol (HDL), hypertension, and impaired glucose tolerance. Within the study, 1.7% of the subjects had metabolic syndrome, 17% had one symptom, and 5.3% had two symptoms. Of the 300 students, 29% were overweight and 6% were obese. The results of this study indicated that men had a significantly higher BMI, waist-to-hip ratio, and waist circumference compared to women ($p<0.01$). Fasting and 2-hour glucose, fasting insulin, and blood pressure were also significantly higher in men ($p<0.01$). In addition, men had significantly lower HDL than women ($p<0.01$). Females were more likely to have significantly impaired glucose tolerance ($p=0.03$) compared to males. As depicted by the results of this study, obesity rates and incidences of chronic diseases were noticeably increasing among college students.

Troxell et al. (2008) conducted a study to analyze health status and physical activity of freshmen college students and the difference between self-reported health and actual health. Participants included 48 males and 53 females from a Midwestern University. Assessments included: body mass index (BMI), percent body fat, blood pressure, and fasting blood glucose. To show whether self-reported questionnaires were accurate compared to actual results, participants completed a health and physical activity questionnaire. Using American Heart Association (AHA) standards, participant's cardiovascular risks were calculated. The BMI, body fat percentage, total cholesterol, triglycerides, high-density lipoprotein cholesterol (HDL), low-density lipoprotein cholesterol (LDL), and fasting blood glucose all fell within desirable ranges among all participants. Self-reported questionnaire demonstrated that only 4% of participants had increased total cholesterol, while actual tests indicated that 30% had elevated total cholesterol. According to AHA, risk factors for cardiovascular disease include age, race, gender, smoking, high blood cholesterol, high blood pressure, physical inactivity, type 2 DM, stress, and increased alcohol consumption. Within the study, 46.3% of students had at least two cardiovascular risk factors while the majority reported being in excellent (12.9%) or very good (47.5%) health. Results of this study found that students were unaware of the risk factors of cardiovascular disease. Education and early intervention may help lower the risk of cardiovascular disease in young adults.

CHAPTER 3

Methodology

The purpose of this study was to observe anthropometric values including weight, height, body mass index (BMI), and waist circumference and assesses the prevalence of IFG concentration in college-aged students.

Subjects

Two hundred and two, males and females, between the ages of 18 and 25 years were recruited from Georgia Southern University. These subjects were enrolled in kinesiology and health classes during the summer and fall semesters in 2011. Kinesiology classes included: aerobics, body conditioning, fitness walking, ballet, weight training, social dance, and swing dance. Data was collected within a short period of time with summer classes consisting of four weeks and fall assessments held within the first four weeks of the semester. Students completed sections from the National College Health Risk Behavior Survey (NCHRBS) (Douglas et al., 1997) (Appendix A). They were also asked about medical history and current medications (Appendix B). Participants gave their consent and cooperation for this study according to the Institutional Review Board and Institutional Biosafety Committee at Georgia Southern University (Appendix C).

Anthropometric Measures

Height and weight for each participant was obtained to determine BMI. As stated by the Center of Disease Control, the following equation was used to determine BMI: weight (kg)/[height (m)]^2. Weight was determined by a calibrated balance beam scale and measured to the nearest 0.1 kilogram. A stadiometer was used to obtain height on all subjects. Subjects stood with their shoes off, back to the stadiometer, feet placed together and touched the base of the vertical board. Buttocks, shoulder blades, and head were in contact with the stadiometer, arms were at sides, head was held upright with eyes looking forward, and hair did not obscure the measurement. The arm of the stadiometer was moved down until it touched the crown of the subject's head (National Center for Health Statistics, 2011). In addition, waist circumference was obtained with a non-stretch measuring tape. The subject was in standing position with arms at their sides, feet positioned close together, and weight evenly distributed. The measurement was made at the approximate midpoint between the lower margin of the last palpable rib and the top of the iliac crest. The examiner ensured the tape was parallel to the floor and that the tape was snug but did not compress the skin. The measurement was made at the nearest 0.1 centimeter (WHO, 2008).

Biochemical Analysis

FBG is used to determine whether the production and the utilization of glucose are equal (Giugliano, Ceriello, & Esposito, 2008). Prior to measurements, subjects were asked to refrain from food and beverages (except water) for at least twelve hours. Participants were given instructions on what fasting entailed when they signed up for the study. A reminder email was sent out the day before the appointment to increase compliance. Samples were drawn in the Human Performance lab between the hours of 7:30am and 10:30am by the lead investigator using a ReliOn Ultima glucometer (*Relion ultima user's guide*, 2006). In order to ensure accurate readings, the glucomter needed to be calibrated each time a new box of test strips were used. Upon opening each new box of test strips, the appropriate LOT number was entered per manufacturer's instructions (*Relion ultima user's guide*, 2006).

The researcher removed the test strip from the packet and inserted the end with three black lines into the strip port. A new set of gloves were used for each participant's assessment. The researcher cleaned the subject's index finger with an alcohol swab, discarded it into the trash, and then pricked the finger with a spring-loaded lancet (*Lancing device instructions for use,* 2009), which was then discarded into a Sharps container. A drop of blood was placed on the white area of the testing strip ("Relion information center," 2010). The glucose in the blood caused a reaction with chemicals on the test strip. The glucose passed through a selectively permeable membrane, which controlled the transport of analytes to a metabolizing enzyme. Enzymes used in glucometers were oxidoreductases. This generated an electrical signal and eventually amplified and translated into glucose concentration on the digital display (Bimenya, Nzaruara, Kiconco, Sabuni & Byarugaba, 2003). Once the test results were displayed, the test strip was disposed of in the Biohazard waste container and a bandage was placed on the tested finger.

FBG and other anthropometric measures were taken at the Hanner building on the Georgia Southern campus. It was necessary to control the area where FBG was drawn and this was called the "Clean Zone". There was a station set-up for efficient and clean collection, which included the following material: Sharps container, Biohazard waste container, trash can, gloves, cotton gauze, bandages, glucometer, test strips, and lancets. Hanner has previously set up a process to dispose of the sharps and biohazard materials though Georgia Southern University's Environmental Protection Agency (EPA). After the completion of the assessment, participants were given a handout from the American

Diabetes Association on pre-diabetes and FBG testing (Appendix D) (*All about pre-diabetes*, 2004).

Data Analysis

Data was analyzed using SPSS software version 18 (SPSS Inc, Somers, NY, June 2009). Variables were grouped for data analysis. FBG was classified as under/normal concentrations with <100mg/dL and increased FBG as ≥100mg/dL. BMI was categorized as under/normal weight with ≤ 24.9 kg/m^2 while overweight/obese was set at ≥ 25.0 kg/m^2. Waist circumference was grouped as <35 inches, or ≥ 35.0 inches in females, and ≥40.0 inches in male. This variable grouping was chosen on the basis of disease risks associated to waist circumference by gender (WHO, 2008). Race group was classified as White-not Hispanic, Black-not Hispanic, and Other (which included Hispanic, Pacific Islander, and American Indian). Descriptive statistics were used to compare demographic variables. Correlations statistics were used to describe the relationship between FBG and anthropometric variables. Crosstab statistics displayed the relationship between FBG and self-reported questionnaire responses. FBG group was used as the independent variable in the independent t-tests to assess body mass index, waist circumference, fasting blood glucose, and self-reported questionnaires in the participants. The statistical significance level was set at $p < 0.05$.

Study Timeline

May- June: Researcher recruited participants from classes offered during term A and term B of summer 2011. Participants signed up for a time to report to the laboratory to have their weight, height, waist circumference, and FBG concentration measured.

Participants were reminded via email to come in a fasted state to their appointment.

August- September: Researcher recruited participants from classes offered during Fall semester 2011. Participants signed up for a time to report to the laboratory to have their weight, height, waist circumference, and FBG concentration measured. Participants were reminded via email to come in a fasted state to their appointment.

CHAPTER 4

Results

Subjects/Characteristics

The characteristics of the study population are presented in Table 1. Of the 202 participants, 198 were included. Four were excluded because they had been diagnosed with diabetes, type 1 or type 2. Of the included participants, 37.4% (n=74) were males and 62.6% (n=124) were females, with an average age of 20.00 ± 1.86 years. The mean weight among male participants was 179.60 ± 36.12 pounds with an average body mass index (BMI) of 25.86 ± 4.84 kg/m^2. The mean weight of female participants was 142.75 ± 32.20 pounds with an average BMI of 24.22 ± 4.97 kg/m^2. The mean waist circumference among male participants was 26.99 ± 3.73 inches and had an average fasting blood glucose (FBG) of 83.81 ± 16.95 mg/dL. Female participants had a mean waist circumference of 24.99 ± 4.23 inches and an average FBG of 83.44 ± 15.28 mg/dL.

The participants were evenly distributed among class standing with 27.8% (n=55) freshman, 25.8% (n=51) sophomores, 21.2% (n=42) juniors, 24.7% (n=49) seniors, and 0.5% (n=1) graduate students. The participants were classified according to race with 62.6% (n=124) representing White-non Hispanic, 24.7% (n=49) representing Black-non Hispanic, and 12.6% (n=25) representing Other. Fifty-five different majors participated in the study, including Nursing, Biology, Business, Early Childhood Education, Electrical Engineering, Spanish, and Athletic Training.

The results showed that 95.5% (n=189) of participants reported no medical problems while 4.5% (n=9) reported having at least one medical problem. These consisted of heart murmurs, and Methicillin-resistant Staphylococcus Aureus (MRSA). Participants also reported prescription and over-the-counter medication usage. Eightyfive participants (42.9%) reported usage of prescription and/or over-the-counter medications. Some common medications among these participants include oral contraceptives, cold medications, allergy medications and Metformin.

Table 1: Characteristics of the Study Population		
	Males (n=74)	Females (n=124)
Gender (%; n)	37.4%	62.6%
Weight (pounds; mean ± SD)	179.60 ± 36.12*	142.75 ± 32.20
BMI (kg/m^2; mean ± SD)	25.86 ± 4.84	24.22 ± 4.97
Waist Circumference (inches; mean ± SD)	26.99 ± 3.73	24.99 ± 4.23
FBG (mg/dL; mean ± SD)	83.81 ± 16.95	83.44 ± 15.28
*Significantly greater than females (p<0.05) BMI: Body Mass Index; FBG: Fasting Blood Glucose		

Demographic Characteristics Associated with Fasting Blood Glucose

Among the participants, the average FBG was 83.58 ± 15.88 mg/dL. Results indicated that 12.6% (n=25) of the participants had an increased FBG (≥100 mg/dL) consisting of 10 male participants and 15 female participants. There was no significant difference between FBG groups for age (p=0.646). Of those with an increased FBG, 44.0% (n=11) were White- non Hispanic, 32.0% (n=8) were Black- non Hispanic, and 24.0% (n=6) were other.

Anthropometric Measures Associated with Fasting Blood Glucose

Results showed that 41.9% (n=83) of the participants were considered overweight/obese when classified by BMI (≥ 25.0 kg/m^2) while the remaining participants were considered under or normal weight (BMI ≤ 24.9 kg/m^2; 58.1%, n=115)). Results depicted that 60.7% (n=17) of participants with an elevated FBG were classified as overweight/obese, illustrating that participants are more likely to have a high FBG if they are overweight/obese.

Table 2 represents differences between FBG and other anthropometric measures. There was no significant difference between FBG groups and weight (p=0.373), waist circumference (p=0.412), and BMI (p=0.114).

Table 3 represents correlations between FBG and other anthropometric measures. There was a significant correlation between FBG and weight (r=0.160, p=0.024), which suggests that 2.5% (r^2=0.0.25) of FBG was explained by weight. Also, there was a significant correlation between FBG and waist circumference (r=0.173, p=0.015), which suggests that 2.9% (r^2=0.029) of FBG was explained by waist circumference. Lastly, there was a significant correlation between FBG and BMI (r=0.238, p=0.001), which suggests that 5.6% (r^2=0.056) of FBG was explained by BMI.

The results of this study illustrated that only 5.4% (n=4) of the males had a waist circumference of ≥40.0 inches and only 3.2% (n=4) of the females had a waist circumference of ≥35.0 inches. Among the male and female participants with a waist circumference <35.0 inches, 28.4% (n=54) participated in one or more sport activities. Of the participants with a normal FBG, 87.4% (n=166) had a waist circumference <35.0 inches. Of the females with an increased FBG, none had a waist circumference ≥35.0 inches while of the males with an increased FBG, 25% (n=1) had a waist circumference ≥40.0 inches.

Table 2: Difference between Fasting Blood Glucose and Anthropometrics

Parameter	<100mg/dL	≥100 mg/dL
Weight (pounds; mean ± SD)	155.60 ± 38.13	162.88 ± 38.04
Waist Circumference (inches; mean ± SD)	25.64 ± 4.24	26.38 ± 3.78
Body Mass Index (kg/m^2; mean ± SD)	24.62 ± 4.97	26.30 ± 4.79

Table 3: Correlations between Fasting Blood Glucose and Anthropometrics	
Parameter	Correlations (r-values)
Weight	0.160*
Waist Circumference	0.173*
Body Mass Index	0.238*
* Indicates significance, p<0.05	

Physical Activity Associated with Fasting Blood Glucose and Body Weight

The results of self-reported questionnaires related to FBG are presented in Table 4. The results showed no significant difference among FBG groups for aerobic activity (p=0.680), stretching activity (p=0.465), weight lifting days (p=0.073), or bicycle activity (p=0.888). Among the participants with a normal FBG, 62.4% (n=108) participated in three or more days of aerobic activity per week and within those with an increased FBG, 40.0% (n=10) participated in less than three days of aerobic activity per week. Among the participants with a normal FBG, 57.8% (n=100) participated in three or more days of weight lifting per week and those with an increased FBG, 60.0% (n=15) participated in less than three days of weight lifting per week. Among the participants classified as under or normal weight, 61.7% (n=71) participated in three or more days of aerobic activity and those classified as overweight/obese, 37.3% (n=31) reported participating in less than three days per week of aerobic activity.

Table 4: Self-reported Questionnaire Responses		
	<100 mg\dL	≥100 mg/dL
Aerobic Activity (days/week)	3.06 ± 1.74	3.28 ± 1.75
Stretching Activity (days/week)	2.69 ± 1.82	2.96 ± 1.59
Weight Lifting (days/week)	2.03 ± 1.80	2.28 ± 1.95
Bicycling Activity (days/week)	3.54 ± 2.05	3.12 ± 1.88
Sport Team Activity (# of teams)	0.44 ± 0.82	0.60 ± 0.87

CHAPTER 5

Discussion

According to the American Diabetes Association (ADA), Type 2 diabetics do not produce enough insulin or the cells ignore insulin. Many complications arise from type 2 diabetes, such as retinopathy, heart disease, neuropathy, and nephropathy (ADA, 2011). The number of young adults who are diagnosed with type 2 diabetes is rapidly growing due to an increase in body weight and body fat percentage.

Influence of Body Mass Index on Fasting Blood Glucose

The incidence of chronic disease is elevated with an increase in body mass index (BMI). Hajosseini et al. (2006) reported an increase in weight and body fat percentages in college freshman. Because of this increase in body weight, BMI was also increased. This study correlates to the present study that 41.9% were overweight or obese according to BMI of >25 kg/m^2. This number is greater than the 1995 National College Health Risk Behavior Survey (NCHRBS) (Douglas et al., 1997) as 20.5% of 4,609 undergraduate students were classified as overweight. Given the time difference, this increased percentage can be correlated to the dramatic increase in an overweight younger population.

The results of this study support the notion that college students need to monitor lifestyle choices to decrease their risk of chronic disease. Similar to this study, Sacheck, Kuder & Economos (2010) found that in a college population, 16.2% were overweight and those with increased fitness levels had lower blood glucose.

Influence of Waist Circumference on Fasting Blood Glucose

Increased waist circumference is associated with obesity-related diseases, such as Type 2 diabetes, hypertension, and coronary heart disease. By monitoring an individual's waist circumference, they will be able to assess their own risk for these diseases. Type 2 diabetes is linearly related to obesity and measuring waist circumference is an indicator of obesity. Gautier et al. (2010) reported an increase in waist circumference as a major risk factor for type 2 diabetes in people aged 30-64 years with impaired fasting glucose. However, results of the present study indicated that only 5.4% of the male participants had a waist circumference ≥40.0 inches and only 3.2% of the females had a waist circumference ≥35.0 inches, all aged 18-25 years. This could be due to the younger age group of the present study compared to Gautier et al. (2010). This low percentage may also be due to 58.1% (n=115) of the participants have a under/normal BMI. By monitoring waist circumference, students can evaluate their health risk.

Influence of Physical Activity on Fasting Blood Glucose

Many of the nation's college students have been placing their health at risk through lifestyle choices. Being physically fit can contribute to a healthy body weight composition. Therefore, it is important to encourage both healthy weight and physical activity throughout life as each play an important role in risks associated with increased incidence of chronic disease. The results of this present study indicated the need for early intervention to help college students be aware of diabetes and engage in healthy choices to prevent them from developing diabetes. Among the participants with a normal FBG, 62.4% (n=108) participated in three or more days of aerobic activity per week and those with an increased FBG, 40.0% (n=10) participated in less than three days of aerobic activity per week. This suggests that healthy lifestyle choices may improve the parameters of chronic disease, while those that do not engage in healthy lifestyle choices may see an increase in risk factors.

The college atmosphere promotes changes in many aspects of a student's life. The NCHRBS indicated that 19.5% of students engaged in moderate physical activity (Douglas et al., 1997). For participants with a normal FBG, 26.7% participated in at least one sport activity while those with an increased FBG, 60% did not participate in a sports activity. Clearly, if students are not participating in physical activity or sports it correlates to a higher FBG and therefore increased risk of chronic disease. One study reviewed data at a university student health center to indicate that 30-35% of these students were classified as overweight (Keown, Smith & Harris, 2009). It is suggested that colleges implement new programs or improve existing programs to increase student awareness of healthy lifestyles.

Limitations

Before considering the implications of the findings of this study, several limitations must be acknowledged. First, not having a control group promoted only an observation in fasting blood glucose and anthropometrics values rather than showing a change. Even though the sample size is large, a change over time could not be seen; therefore, this study indicates the current status of the participants. Second, the classification of BMI is not always appropriate because this does not differentiate between fat and fat-free mass. As a result, some participants with a BMI >25 kg/m^2 could have increased fat-free mass causing them to weight more. BMI is a convenient and quick measurement. Involvement is not time consuming for participants, thus promoting incentive to participate. Third, self-reported questionnaires are easily skewed by participant responses and have to be taken at face value. The questionnaires were used due to the simplicity of added information. They were easy, quick, and provided material to assess based on the participants, such as physical activity, age, race, class standing, and major. Lastly, the lack of randomization among participant selection may potentially cause a bias within the study as well as generalizability among participants.

Conclusion

As FBG levels rise among all ages, evidence of overweight and obesity along with incidence of chronic disease also accelerate accordingly. College students have the ability to make responsible lifestyle choices. If universities and colleges provide adequate information and appropriate programs, students will more likely make healthier decisions. As a nation, one of our main goals is to decrease the incidence of chronic disease. By knowing and understanding values associated with FBG, BMI, and waist circumference, college-aged individuals are more likely to improve and maintain overall health.

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APPENDIX A

Questions taken from the 1995 National College Health Risk Behavior Survey (NCHRBS)

1. Are you a full-time student? Yes ____ No____

2. How would you describe yourself?
    a. White- not Hispanic ____
    b. Black- not Hispanic ____
    c. Hispanic or Latino ____
    d. Asian or Pacific Islander ____
    e. American Indian or Alaskan Native ____
    f. Other ____

3. What is your marital status?
    a. Never been married ____
    b. Married ____
    c. Separated ____
    d. Divorced ____
    e. Widowed ____

4. What is your class standing?
    a. Freshman ____
    b. Sophomore ____
    c. Junior ____
    d. Senior ____
    e. Graduate Student ____
    f. Other ____

5. Where do you currently live?
    a. College dorm or residence hall ____
    b. Fraternity or sorority house ____
    c. Other university housing ____
    d. Off-campus house or apartment ____
    e. Parent/guardian's home ____
    f. Other ____

6. On how many of the past 7 days did you exercise or participate in sports activities for at least 20 minutes that made you sweat and breathe hard, such as basketball, jogging, swimming laps, tennis, fast bicycling, or similar aerobic activities?
    a. 0 days ____
    b. 1 day ____
    c. 2 days ____
    d. 3 days ____
    e. 4 days ____
    f. 5 days ____
    g. 6 days ____
    h. 7 days ____

7. On how many of the past 7 days did you do stretching exercises, such as toe touching, knee bending, or leg stretching?
    a. 0 days _____
    b. 1 day _____
    c. 2 days _____
    d. 3 days _____
    e. 4 days _____
    f. 5 days _____
    g. 6 days _____
    h. 7 days _____

8. On how many of the past 7 days did you do exercises to strengthen or tone your muscles, such as push-ups, sit-ups, or weight lifting?
    a. 0 days _____
    b. 1 day _____
    c. 2 days _____
    d. 3 days _____
    e. 4 days _____
    f. 5 days _____
    g. 6 days _____
    h. 7 days _____

9. On how many of the past 7 days did you walk or bicycle for at least 30 minutes at a time? (Include walking or bicycling to or from class or work.)
    a. 0 days _____
    b. 1 day _____
    c. 2 days _____
    d. 3 days _____
    e. 4 days _____
    f. 5 days _____
    g. 6 days _____
    h. 7 days _____

10. During this school year, have you been enrolled in a physical education class?
    a. Yes _____
    b. No _____

11. During this school year, on how many college sport teams (intramural or extramural) did you participate?
    a. 0 teams _____
    b. 1 team _____
    c. 2 teams
    d. 3 or more teams _____

APPENDIX B

Assessments

Name ____ Date __________________
Phone Number ______________________________ Code ___________
Email ____

Major: _______________________________
Age ______
Gender: _____ Male _____ Female

Anthropometric Assessments:

Height _________ (in) Weight ________ (lb)
BMI _________ kg/m^2 Waist Circumference _________ (in)

Biochemical Assessments:

Fasting blood glucose _________ mg/dL

Clinical Assessments:

Do you have any of the following medical problems?
Cardiovascular Disease _____
Coronary Heart Disease _____
Diabetes Mellitus _____
Hypertension _____
Other ____

Are you currently prescribed medications or taking any over the counter (OTC) medications?
_____Yes _____ No
If yes, please explain ____
____

APPENDIX C

COLLEGE OF HEALTH AND HUMAN SCIENCES

DEPARTMENT OF HEALTH AND KINESIOLOGY

INFORMED CONSENT

The prevalence of high fasting blood glucose concentrations among college-aged individuals

1. **Principal Investigators**: Elizabeth Graham, (678) 852-1220, egraham5@georgiasouthern.edu, and Amy Jo Riggs, Ph.D., RD, LD, Assistant Professor, 486-7753, ajriggs@georgiasouther.edu, Department of Health and Kinesiology, P.O. Box 8076, Statesboro, GA 30460

2. **Purpose of the Study:** The purpose of this study is to assess fasting blood glucose concentration and anthropometric values such as weight, height, body mass index (BMI), and waist circumference in college-aged students who are participating in kinesiology and health classes.

3. **Procedures to be followed:** You will report to Georgia Southern University's Human Performance laboratory after an overnight fast to have your height, weight, waist circumference and fasting blood glucose measured. In addition, you will complete two brief questionnaires regarding medical history, medication usage, exercise habits, and daily physical activity.

4. **Discomforts and Risks:** Risks associated with blood glucose collection include a small amount of bleeding at the puncture site as well as minimum risk of infection and discomfort on the finger. Alcohol swabs will be used prior to puncturing to help reduce contamination and bandages will be provided after blood has been collected. You will sit quietly during blood collection, which will minimize risks, and the researcher will obtain the blood sample. This procedure only requires one small droplet of blood.

5. **Benefits:** The present study hopes to emphasize the importance of a healthy lifestyle in college-aged individuals to improve overall quality of life. Each participant will be informed on their individual assessments and whether these values fall within normal ranges or not.

6. **Duration/Time:** You will report to the laboratory one time for measurements to be collected. The estimated total time commitment is approximately 15 minutes.

7. **Statement of Confidentiality:** All data collected on subjects will be kept confidential and stored in a locked file drawer in Hollis 2118A. This information will be available only to the principal investigators. Your identity will not be revealed in publications or presentations that result from this study so as to protect your privacy and confidentiality. All data will be reported as means and standard errors.

8. **Right to Ask Questions:** You have the right to have all of your questions answered. Please contact Elizabeth Graham, (678) 852-1220, egraham5@georgiasouthern.edu or Amy Jo Riggs, Ph.D., RD, LD Assistant Professor, 486-7753, ajriggs@georgiasouthern.edu with questions regarding the study protocol. For questions concerning your rights as a research participant, contact Georgia Southern University Office of Research Services and Sponsored Programs at 912-486-7758.

9. **Compensation:** There is no compensation for participating in the present research project.

10. **Voluntary Participation:** Your participation in this study is entirely voluntary. If you decide to participate, you are free to withdraw your consent and stop participating at any time without penalty or loss of benefits to which you are otherwise entitled.

11. **Penalty:** If you decide not to participate, you will not be penalized, and you will not lose any benefits or services to which you are otherwise entitled.

12. You must be 18 years of age or older to consent to participate in this research study. If you consent to participate in this research study and to the terms above, please sign your name and indicate the date below.

You will be given a copy of this consent form to keep for your records.

Title of Project: The prevalence of high fasting blood glucose concentrations among college-aged individuals

Principal Investigators: Elizabeth Graham and Amy Jo Riggs, Ph.D., Assistant Professor

__________________________________ ____________________
Participant Signature Date

I, the undersigned, verify that the above informed consent procedure has been followed.

__________________________________ ____________________
Investigator Signature Date

All About Pre-Diabetes

Toolkit No. 1

What is pre-diabetes?

Pre-diabetes is a condition that comes before type 2 diabetes. Blood glucose (sugar) levels are higher than normal but aren't high enough to be called diabetes. Pre-diabetes is a silent disease, meaning you can have it but not know it. The good news is that cutting back on calories and fat, being physically active, and losing weight can reverse pre-diabetes and therefore delay or prevent type 2 diabetes. **Diabetes doesn't go away once you have it, so it's better to prevent it in the first place.**

How can type 2 diabetes be delayed or prevented?

In a recent study, people at high risk for type 2 diabetes greatly reduced their risk of getting it by eating less than usual, increasing their physical activity, and losing weight. They

- cut down on fat
- cut back on calories
- exercised about 30 minutes a day, 5 days a week, usually by brisk walking
- lost weight—an average of 15 pounds in the first year of the study

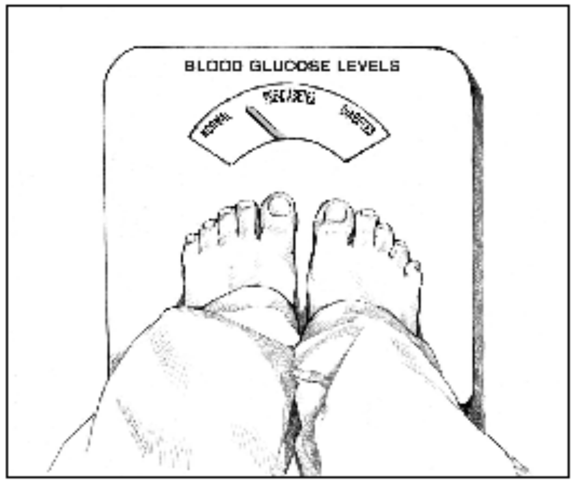
These strategies worked equally well for men and women and particularly well for people aged 60 and older. Several other studies also have shown that type 2 diabetes can be delayed or prevented.

Am I likely to have pre-diabetes?

As you get older, especially if you're overweight, your chances of having pre-diabetes increase. Your doctor should check your blood glucose level if you are

- 45 or older and overweight
- under age 45 and overweight and have other risk factors for diabetes

If you are 45 or older and your weight is normal, ask your doctor if you need to be checked for pre-diabetes.



Pre-diabetes is a condition that comes before type 2 diabetes.

Are you at increased risk for diabetes?

You're at risk for diabetes if you

- are overweight
- are physically inactive
- have a parent, brother, or sister with diabetes
- are African American, Native American, Asian American, Pacific Islander, or Hispanic American
- have had a baby weighing more than 9 pounds or have had gestational diabetes
- have high blood pressure (over 140/90 mmHg)
- have low HDL cholesterol (35 mg/dl or lower) or high triglycerides (250 mg/dl or higher)

How can I find out whether I have pre-diabetes?

Pre-diabetes has no symptoms. You'll need a blood test to check your blood glucose level. Your doctor will use one of these two tests:

The **fasting plasma glucose test** measures your blood glucose after you have gone overnight without eating. This test is most reliable when done in the morning. Pre-diabetes is diagnosed when fasting glucose levels are between 100 and 125 mg/dl. These glucose levels are above normal but not high enough to be called diabetes. A fasting plasma glucose of 126 mg/dl or higher means diabetes.

The **oral glucose tolerance test** measures your blood glucose after an overnight fast and 2 hours after you drink a sweet liquid provided by the doctor or laboratory. Pre-diabetes is diagnosed when blood glucose is between 140 and 199 mg/dl 2 hours after drinking the liquid. These glucose levels are above normal but not high enough to be called diabetes. A 2-hour blood glucose of 200 mg/dl or higher means diabetes.

How can I reverse pre-diabetes?

To help bring your blood glucose levels back to normal, you can

- cut back on calories and fat
- increase your physical activity

Doing so will make it more likely that you'll lose weight. If you're overweight, losing 5 to 7 percent of your total weight can help you a lot. For example, if you weigh 200 pounds, your goal would be to lose 10 to 15 pounds.

Cutting Back on Calories and Fat

Place a check mark next to steps you'd like to try for cutting down on calories and fat.

❒ I'll cut back on my usual serving sizes.

❒ I'll order the smallest portion size when I'm eating out. Or I'll share an entree.

❒ I'll try calorie-free drinks or water instead of regular soft drinks and juice.

❒ I'll try low-fat versions of the foods I usually eat. I'll check the labels to make sure the calories are reduced too.

❒ When cooking, I'll bake, broil, or grill and use nonstick pans and cooking sprays.

❒ I'll eat more vegetables and whole grain foods.

❒ Other steps I'll take to cut down on calories and fat are

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Increasing Your Physical Activity

Place a check mark next to the ways you'll try to add physical activity to your daily routine.

❒ I'll take the stairs instead of the elevator.

❒ I'll park at the far end of the parking lot.

❒ I'll find an activity I enjoy, such as working in the yard or riding a bike.

❒ I'll take a walk every day, working up to 30 minutes of brisk walking, 5 days a week. Or I'll split the 30 minutes into two or three walks.

❒ I'll try strength training by lifting light weights several times a week.

❒ Other ways I'll try to add physical activity to my daily routine are

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Are there any medications to treat pre-diabetes?

No drug has been approved by the U.S. Food and Drug Administration specifically for pre-diabetes. However, several medications available by prescription for diabetes or weight loss have been used in studies. Though certain drugs do seem to delay or prevent diabetes, they don't work nearly as well as eating less, being active, and losing weight. At this time, experts recommend eating less, increasing physical activity, and losing weight as the best ways to treat pre-diabetes, instead of taking medications.

Make The Link! Diabetes Heart Disease and Stroke

American Diabetes Association
1–800–DIABETES (342–2383) www.diabetes.org