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Prevention of type 2 diabetes through proper nutrition and exercise

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PREVENTION OF TYPE 2 DIABETES THROUGH PROPER NUTRITION AND EXERCISE

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ABSTRACT

PREVENTION OF TYPE 2 DIABETES THROUGH PROPER NUTRITION AND EXERCISE

by Miguel Andres Camacho

Type 2 diabetes, which is related to lifestyle factors, is a major public health problem in the United States. Preventing excessive weight gain, through proper nutrition and exercise over the lifespan of individuals, may reduce the risk of the disease. Because research studies remain inaccessible to the lay public, one purpose of this study was to provide easily understood nutritional and exercise guidelines for sedentary and obese men and women aged 40-60 years. Secondary to that purpose was development and evaluation of a nutritional and exercise manual with preventive guidelines aimed at this target group.

Twenty health professionals and 20 "at risk" individuals received evaluation questionnaires germane to the manual. Quantitative and qualitative statistics (comments) showed support from both groups for the manual. Quantitative and qualitatively, evaluators judged the concepts and preventive guidelines appropriate for the intended audience. The evaluators' feedback was used to revise the manual.

Acknowledgments

I would like to thank all members of my family for their love and support throughout this project. Special thanks to my mother for her endless help through the hard times. Special thanks to my girlfriend Michelle who had to live with me through the whole process and for her expertise in developing the format of the manual.

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CHAPTER I

Introduction

Historically, diabetic researchers have advocated diet and exercise as a means for diabetes therapy. Before the discovery of insulin, Allen, Stillman and Fitz (1919) showed that aerobic exercise lowered blood sugar in individuals with diabetes. Furthermore, Himsworth (1935) reported the association between overweight and the development of diabetes. Following the discovery of insulin, diet and exercise remained the foundations of diabetes treatment. Even though early researchers recognized that diet and exercise benefitted diabetes treatment, few researchers acknowledged the role of lifestyle in preventing diabetes. And today, the impact of nutrition and exercise on the development of type 2 diabetes remains controversial but noteworthy.

The impact of lifestyle on the incidence of type 2 diabetes in societies has been researched worldwide. Epidemiological researchers found higher incidences of type 2 diabetes after populations migrated from a rural to an urban setting (Zimmet et al., 1981). Similar trends existed among groups migrating from their native countries to other countries (Kawate et al., 1979). Among certain ethnicities (i.e., Pacific Islanders, Japanese, and American Indians), the incidence of type 2 diabetes increased after acclimating to the American lifestyle. Researchers have often used the term "westernization" to explain the increased incidences of type 2 diabetes. "Westernization" refers to eating a higher saturated fat diet and decreased physical activity levels, both remain associated with an American lifestyle.

Worldwide, type 2 diabetes mellitus has become epidemic, especially in western industrialized nations. The incidence of type 2 diabetes continues to rise in the United States. During the 10 year period from 1987-1996, type 2 diabetes rose 9% per year (Rise in Type 2 Diabetes, 1998). Currently, 8% of the American population over 45 years of age has type 2 diabetes, and another 20% has undiagnosed type 2 or impaired glucose tolerance (IGT) (Harris, Klein, Welborn, & Knuiman, 1992). Lifestyle factors such as a high fat diet and a sedentary lifestyle have been implicated in the increased incidence of type 2 diabetes and impaired glucose tolerance (IGT). IGT occurs as an intermediate stage in the development of type 2 diabetes, and increases the risk for developing type 2 diabetes (Garber, Gavin & Goldstein, 1996).

Type 2 diabetes accounts for greater than 90% of the individuals with diabetes worldwide. Previously, the term noninsulin dependent diabetes mellitus (NIDDM) was used to describe type 2 diabetes. However, NIDDM remains inaccurate because an estimated 40% of type 2 patients also take insulin injections (American Diabetes Association Homepage, 1999). Type 2 diabetes is considered a “metabolic syndrome” because individuals with diabetes improperly utilize or produce insulin.

Early researchers presumed that type 2 diabetes naturally resulted from aging. In contrast, current knowledge concludes that decreases in activity and concomitant increases in body mass index (BMI) heighten the risk for developing type 2 diabetes. Furthermore, the improper utilization of insulin coincides with other metabolic conditions such as hypertension and dyslipidemia. Researchers refer to the assortment of metabolic conditions associated with improper insulin utilization as "Syndrome X". Reaven (1988) noted that insulin resistance has been implicated as one of the underlying factors in heart disease and hypertension as well as type 2 diabetes.

Type 2 diabetes gradually develops through multiple stages such as insulin resistance, hyperinsulinemia, IGT, and hypoinsulinemia (Garber et al., 1996; Reaven, 1988). The order and the inclusion of each stage does not follow any set pattern. Saad et al. (1991) hypothesized that type 2 diabetes resulted from a two-step process. Insulin resistance generally occurs first followed by beta cell dysfunction, which results in hypoinsulinemia and fasting hyperglycemia.

However, since insulin resistance remains asymptomatic, detecting it among the general public poses a problem. Over long periods of time, insulin resistance develops from the body's inability to properly utilize or produce insulin. Although a genetic aspect of insulin resistance exists, genetics are beyond the focus of this paper.

However, environmental factors such as obesity (i.e., abdominal fat deposits) and physical inactivity enhance insulin resistance. Researchers have estimated that insulin resistance affects an estimated 25% of the American population (Garber et al., 1996; Reaven, 1988). Additionally, obesity and physical inactivity remain two of the primary risk factors in the United States for type 2 diabetes, insulin resistance, and heart disease (Clarke, 1997; Garber et al., 1996).

The major sites of insulin resistance are the peripheral muscle and the liver. Consequently, muscle tissue becomes less sensitive to insulin-mediated glucose disposal, resulting in mild hyperglycemia. The body may compensate by producing more insulin (hyperinsulinemia) to maintain normal blood sugars between 70-110 mg/dl (American Diabetes Association Homepage, 1999). As long as the pancreas remains capable of producing enough insulin, blood sugar will reflect "normal levels." If the pancreas cannot sustain hyperinsulinemia, glucose tolerance will deteriorate. Without proper glucose tolerance, IGT may result. Further glucose intolerance may lead to type 2 diabetes in susceptible people (Garber et al., 1996; Reaven, 1988).

Lifestyle factors such as weight gain (Everson et al., 1998), smoking, and decreased exercise (Kahn et al., 1990) promote insulin resistance. However, lifestyle factors can be modified. Exercise and insulin work together or independently to remove glucose from the bloodstream. Insulin becomes more efficient when insulin sensitivity is high (i.e., cells become more responsive to decreased amounts of insulin). Consequently, when exercise removes glucose from the bloodstream, less insulin is needed to facilitate glucose movement into the cells.

Conversely, when less glucose is removed from exercising muscle, insulin becomes the main hormone to facilitate glucose uptake (i.e., decreased insulin sensitivity). Inactivity and weight gain work together to decrease insulin sensitivity, thereby requiring more insulin to facilitate the removal of glucose from the blood. As muscle becomes more resistant to insulin, increasing amounts of insulin become necessary to maintain homeostatic glucose levels between 70-110 mg/dl (Garber et al., 1996). Even if type 2 diabetes remains undiagnosed, the intermediate stages of diabetes development are not benign. High levels of plasma insulin have been implicated in an increased risk for heart disease and remain a central factor in the development of obesity (Harris, Hadden, Knowler & Bennett, 1987; Reaven, 1988).

Macrovascular changes, which can stay undetected for an average of 12 years, remain a potential consequence of IGT or undiagnosed diabetes (Harris et al., 1992). Consequently, undiagnosed diabetes results in significant morbidity and mortality in the United States (Harris et al., 1987). But, current researchers (Burchfiel et al., 1995; Lynch et al., 1996; Manson et al., 1992; Smutok et al., 1994) have shown that aerobic exercise and weight training can minimize the body's insulin response to a glucose load (i.e., oral glucose tolerance test), while increasing insulin sensitivity.

Therefore, the primary prevention of type 2 diabetes depends on early recognition of prediabetic stages (i.e., insulin resistance, IGT, and a genetic history). Lifestyle interventions such as exercise and nutritional therapy should be implemented when multiple risk factors exist (i.e., sedentary lifestyle, obesity, IGT, or dyslipidemia). Lifestyle changes remain a viable intervention, but only while an individual has sufficient endogenous insulin production. If beta cell dysfunction occurs, hypoinsulinemia will result. Lifestyle changes at this juncture will result in little preventive benefit because insulin therapy or oral agents will be needed.

Although early intervention remains the key to preventing type 2 diabetes, routine early screening for diabetes does not occur in the United States. A report by the Centers for Disease Control Diabetes Cost-Effectiveness Group (1998) found that screening of "at risk individuals" may be a cost-effective measure. Furthermore, researchers acknowledged that screening younger rather than older individuals may be more cost-effective. The researchers stated that associated complications may be reduced and quality of life might be improved as a result of preventive screening. The former statements imply that health preventive measures might be useful for individuals at risk of type 2 diabetes. However, the American Diabetes Association (ADA) still refrains from broaching the subject of using early, mass screening to prevent type 2 diabetes. The 1999 position statement by the American Diabetes Association advocates more frequent testing, but only for individuals at highest risk for type 2 diabetes.

Powell and Blair (1994) stated that a sedentary lifestyle remains a significant risk factor for chronic diseases such as coronary heart disease, diabetes mellitus, and colon cancer. Still, most Americans remain relatively inactive. Although Americans are more active during youth, leisure time activity levels decrease with age. Consequently, the rates of obesity tend to increase with age and inactivity. Furthermore, a sedentary lifestyle coupled with obesity further heightens the risk for insulin resistance and type 2 diabetes.

Exercise remains a viable, inexpensive, preventive measure to minimize certain chronic diseases such as type 2 diabetes, but 60% of Americans do not receive the minimum recommended amount of exercise (United States Department of Health and Human Services, 1996). Powell and Blair (1994) estimated that if sedentary Americans increased activity to moderate levels, the incidence of type 2 diabetes could be decreased. Further reductions remained possible if individuals increased activity levels from moderate to vigorous levels. Kohl, Gordon, Villegas and Blair (1992) reported that higher blood sugar levels were associated with lower levels of cardiorespiratory fitness. As a result, men with blood sugar abnormalities (i.e., IGT and type 2 diabetes) had an increased risk of death associated with an inactive lifestyle. Furthermore, Clarke (1997) reported that 24% of type 2 diabetes cases were associated with physical inactivity.

Obesity, inactivity, and type 2 diabetes share common factors such as decreased sensitivity to insulin and higher levels of circulating insulin. Researchers have estimated that 33% of the United States population is obese, while 50% of Americans are considered to be overweight (Clarke, 1997; Garber et al., 1996). Furthermore, childhood obesity has become widespread, resulting in type 2 diabetes during adolescence (American lifestyle leading to type 2 diabetes, 1999). Environmental factors such as lack of exercise and food consumption patterns help explain the prevalence of obesity and the resulting chronic diseases. Consequently, the prognosis of greater numbers of individuals with type 2 diabetes remains likely, if no solutions are proposed.

The precise impact of nutrition on the development of type 2 diabetes remains controversial. However, increased dietary fat or excessive carbohydrate intake in relation to weight gain have been implicated as associated risks (National Heart, Lung, and Blood Institute, 1999). However, the nutritional aspect of this paper will focus on total caloric intake in relation to obesity. Regardless of the source of extra calories, the excessive intake will result in weight gain. Weight gain and obesity remain risk factors for the development of type 2 diabetes. The National Diabetes Data Group (1979) has estimated that 60-90% of individuals with type 2 diabetes are obese at the onset of the syndrome.

Even with mounting scientific evidence, the incidence of type 2 diabetes continues to escalate. Consequently, present day research remains focused on alleviating complications associated with diabetes. Clarke (1997) noted that expenditures due to diabetic complications totaled $100 billion a year in the United States. Diabetic complications (i.e., hypertension, neuropathy, nephropathy, retinopathy, and heart disease) compromise the quality of life for many individuals with type 2 diabetes. Consequently, diabetes remains the leading cause of kidney failure, blindness, and amputations among older adults (American Diabetes Association Homepage, 1999). Medical statistics alone provide substantial evidence that efforts should concentrate on preventing type 2 diabetes.

Purpose of Study

The purpose of this creative project included, 1) a review of current literature describing the use of nutrition and exercise in the prevention of type 2 diabetes, 2) synthesis of the reviewed literature, 3) development of a manual for the prevention of type 2 diabetes, 4) inclusion of feedback questionnaire for the manual, 5) quantitative and qualitative analyses of the feedback from returned evaluation forms, and 6) use of the feedback to revise the manual. Furthermore, current research suggests that type 2 diabetes may be preventable if lifestyle changes (i.e., diet and exercise) are enacted early in the development of the metabolic syndrome (Eriksson & Lindegarde, 1991; Pan et al., 1997; Yamanouchi et al., 1995).

Approach to Problem

Epidemiological researchers have promoted exercise as a viable method for decreasing the incidence of type 2 diabetes mellitus. Long-term studies have shown that active populations have a decreased incidence of type 2 diabetes (Helmrich, Ragland, Leung, & Paffenbarger, 1991; Manson et al., 1992). The creation of an intervention manual may facilitate decreases in BMI, increases in insulin sensitivity, or both while decreasing the risk for type 2 diabetes.

Limitations

The project outcomes will be limited by the previous nutritional and exercise experiences of the reviewers. Therefore, a wide assortment of evaluators (exercise physiologists, nutritionists and diabetic educators) will be chosen to review the manual and provide perspectives from different backgrounds.

Definitions

Body Mass Index (BMI) - An index calculated by a ratio of height to weight and used as a measure of obesity (Williams, 1995).

Hyperglycemia - An abnormally high concentration of glucose in the circulating blood, seen especially in patients with diabetes mellitus (Spraycar, 1995).

Hyperinsulinemia - Increased levels of insulin in the plasma due to increased secretion of insulin by the beta cells of the pancreatic islets, usually associated with insulin resistance and commonly found in obesity and in association with varying degrees of hyperglycemia (Spraycar, 1995).

Impaired glucose tolerance (IGT) - A term developed by the National Diabetes Data Group (NDDG) and the World Health Organization (WHO) in 1979 to replace other descriptors such as "chemical diabetes and borderline diabetes." The term was developed to avoid social and psychological sanctions associated with the term diabetes. Clinically, an oral glucose tolerance test that falls between average and diabetes is considered IGT. Individuals with IGT show little if any microvascular changes but do show macrovascular changes. IGT increases the risk of becoming diabetic, but does not guarantee it (Harris, 1989).

Insulin resistance - A condition in which a given concentration of insulin produces a less than normal biologic response. Insulin resistance can be due to three general categories of causes: 1) abnormal beta cell secretion, 2) a circulating insulin antagonist, or 3) a target tissue defect in insulin action (Porte & Sherwin, 1997).

Metabolic syndrome (Syndrome X) - The association of numerous metabolic conditions (hypertension, dyslipidemia and type 2 diabetes) that increase the risk of heart-related abnormalities. Insulin resistance is hypothesized to be the common factor in the aforementioned metabolic abnormalities (Porte & Sherwin, 1997).

Oral glucose tolerance test (OGTT) - A clinical test used to diagnose diabetes mellitus in people with high normal or slightly increased blood glucose values.

Hyperinsulinemia may also be diagnosed with the OGTT, which may be an indicator of initial stages of diabetes development (Kee, 1999).

Type 2 diabetes mellitus (NIDDM) - A mild form of diabetes mellitus of gradual onset, usually in obese individuals over 35 years; absolute plasma insulin levels are normal to high, but relatively low in relation to plasma glucose levels. The condition responds well to dietary regulation, oral hypoglycemic agents, or both, but complications and degenerative changes can develop (Spraycar, 1995).

Summary

Recent research has shown that environmental aspects of disease development can be modified through lifestyle intervention. The development of type 2 diabetes remains closely associated with lifestyle factors such as diet and exercise. Several epidemiological and clinical studies have shown a decreased incidence of diabetes when lifestyle modifications occurred.

Type 2 diabetes results in significant health care costs and emotional burdens for individuals. Clarke (1997) noted that almost 25% of type 2 cases are related to inactivity, while nutritional-related causes remain controversial. Mortality and morbidity statistics show that type 2 diabetes results in major health care expenditures. Therefore, the primary goal of this project will be to develop a manual which may minimize the incidence of type 2 diabetes in "at risk" middle-aged men and women.

CHAPTER II

Review of Literature

This chapter is divided into six sections. The review details current epidemiological and clinical evidence about the effects of diet and exercise in preventing the development of type 2 diabetes. The literature review focuses on 1) epidemiological evidence, 2) insulin resistance and insulin sensitivity, 3) fitness levels of "at risk individuals" and incidence of type 2 diabetes, 4) diet and exercise interventions, 5) obesity and weight loss in relation to a decreased risk for type 2 diabetes and, 6) a brief overview on adherence to exercise and nutrition recommendations. Lastly, a chapter summary will synthesize each of the sections and provide the basis for the development of the exercise manual.

The purpose of this creative project involved 1) a review of current literature describing the use of nutrition and exercise in the prevention of type 2 diabetes, 2) synthesis of the reviewed literature, 3) development of a manual for prevention of type 2 diabetes, 4) inclusion of a feedback questionnaire for the manual, 5) quantitative and qualitative analyses of the feedback from returned evaluation forms and, 6) use of the feedback to revise the manual.

Epidemiologic Evidence

Frisch, Wyshak, Albright, Albright and Schiff (1986) determined the incidence of diabetes among 5,398 former female collegiate athletes and nonathletes aged 21-80 years. Researchers sent questionnaires to the alumni to determine past and current athletic status.

Alumni diagnosed with diabetes after the age of 40 years were considered type 2 diabetics. After the age of 40 years, nonathletes became diabetic sooner than former athletes. Former collegiate athletes had reduced incidences of diabetes in every age group except athletes less than 30 years-old. The researchers determined that 82% of former college athletes participated in sports before college and 74% continued exercising throughout the lifespan. Therefore, Frisch et al. (1986) concluded that lifetime exercise habits conferred preventive benefits by decreasing the incidence of type 2 diabetes.

Similarly, Helmrich, et al. (1991) used questionnaires which assessed the exercise habits of 5,990 male alumni and related incidence of type 2 diabetes. The participants' total weekly energy expenditure was determined from physical activity variables. Specific activities such as walking, stair climbing, and moderate or vigorous sports activity had specific caloric values assigned for each activity. Alumni who developed type 2 diabetes also had increased body mass index scores. Men with the highest BMI had three times the risk for developing type 2 diabetes compared to men with the lowest BMI. Older men (> 55 years) had twice the risk of developing type 2 diabetes compared to younger men (< 45 years).

Helmrich et al., (1991) determined that greater caloric expenditure had protective effects, thereby decreasing the likelihood of developing type 2 diabetes. Incidence of type 2 diabetes decreased by 50% (i.e., 26.3 to 13.7 cases per 10,000 man-years of observation) as energy expenditure increased from less than 500 kcal/wk to greater than 3,500 kcal/wk ($p < .01$). For each increase of 500 kcal/wk of physical activity, a 6%

decrease in the risk of type 2 diabetes resulted. Furthermore, vigorous exercise conferred a greater protective effect than moderate exercise intensity. Protective effects remained independent of obesity, age, genetic background, and history of hypertension.

Helmrich et al. (1991) concluded that increased energy expenditure resulted in greater protection than reductions in BMI in decreasing the risk of type 2 diabetes. Furthermore, hypertension, a suspected risk factor associated with type 2 diabetes, decreased as levels of energy expenditure increased. Hypertension and physical inactivity contributed independently to the occurrence of type 2 diabetes.

In a prospective study, Manson et al. (1992) examined the occurrence of type 2 diabetes among 21,271 male physicians. Researchers used questionnaires to determine incidences of medical conditions, including type 2 diabetes. Physicians who exercised vigorously and more frequently had lower BMIs. Following the initial questionnaire, and then biannually for the first year, and annually thereafter, physicians received questionnaires. During the 5 year follow-up, 285 physicians became diabetic. However, type 2 diabetes occurred less often in physicians who exercised vigorously and more frequently. Consequently, researchers determined that the frequency of vigorous exercise affected the incidence of diabetes. Manson et al. (1992) determined that a dose-response gradient existed between higher levels of exercise and lower incidence of type 2 diabetes. Age-adjusted relative risk decreased from 1.0 for physicians who exercised less than once per week to .58 for physicians who exercised more than five times per week.

The researchers concluded that increases in BMI were related to the incidence of type 2 diabetes. Pronounced decreases in diabetes occurred among obese individuals (BMI > 26.4 kg/m^2) who exercised, compared to obese individuals who did not exercise. Participants who exercised vigorously ($\geq$ 5 times per week) had a 42% decrease in age-adjusted risk of type 2 diabetes, compared to individuals who exercised less than once per week.

Burchfiel et al. (1995) evaluated the incidence of heart disease in 6,815 Japanese-American men aged 45-68 years. Since heart disease and diabetes commonly coincide, researchers also examined the occurrence of type 2 diabetes in susceptible individuals. Participants' activity levels consisted of basal, sedentary, low, moderate or heavy activity.

When adjusted for age, Burchfiel et al. (1995) found an inverse relationship with the level of physical activity. A 45% lower risk for developing type 2 diabetes resulted when comparing the highest activity level with the four lowest activity levels. Multiple risk factor adjustments (i.e., BMI, weight gain since age of 25 years, parental history of diabetes or systolic blood pressure) made no significant reductions in risk. A two-fold reduction in risk became associated with higher activity level versus lower activity. Men with better glucose control (40-167 mg/dl) gained more protective effects from physical activity than men with poorer glucose control (168-532 mg/dl).

Clinical Exercise Studies

Epidemiological researchers have defined characteristics associated with the development of type 2 diabetes. However, the design of epidemiological studies cannot control external or internal variables. Therefore, clinical studies will add further evidence in support of epidemiological findings while controlling more of the external and internal variables. Since the etiology of type 2 diabetes results from insulin resistance, clinical studies examining insulin resistance, insulin sensitivity and the effect of fitness levels remain relevant in preventing type 2 diabetes.

Insulin Resistance

Resistance to insulin-stimulated glucose uptake (insulin resistance) remains a contributing factor for type 2 diabetes, but insulin resistance alone does not guarantee that diabetes will develop. According to Tonino (1989), insulin resistance is not a natural progression due to aging. Physical training can induce metabolic changes that can improve insulin resistance and increase insulin sensitivity. Healthy subjects aged 60-80 years, with normal glucose tolerance, participated in the study. Participants completed calisthenics, walked, or jogged at 80-85% of maximum heart rate three times per week for 12 weeks. Following the 12-week training session, participants remained inactive for 1 week.

No participants showed any signs of glucose intolerance in response to an oral glucose tolerance test. However, Tonino (1989) determined that individuals had peripheral insulin resistance in response to an insulin clamp. Tonino concluded that a

13.4% increase in insulin action could modify insulin resistance. Furthermore, this reversal of insulin resistance represented a 33% increase in glucose tolerance, usually associated with healthy adults between the ages of 30 and 70 years.

In a similar experiment, Kahn et al. (1990) studied the effects of a sedentary life on the development of insulin resistance in 13 healthy, older men aged 61-82 years. Researchers hypothesized that aerobic exercise may help delay or prevent insulin resistance, which could deter the development of type 2 diabetes. Researchers used tests for insulin sensitivity, carbohydrate tolerance, and beta cell function to assess the development of insulin resistance. To reduce the acute effects of exercise, testing occurred 60 hours after the final exercise session. Participants followed strict dietary guidelines (i..e., 50 % carbohydrates, 30% fat, and 20% protein) for 2 weeks before testing to stabilize weight and minimize effects on insulin sensitivity. The exercise program included running or biking 5 days per week for 6 months. Final intensity and duration of exercises were performed at 80-85% of heart rate reserve for 45 minutes per day.

Body weight decreased due to an 11% decrease in fat mass, and lean muscle mass remained unchanged. No changes occurred in basal plasma glucose levels, but participants had lower fasting levels of insulin, suggesting an increase in insulin sensitivity. No changes in glucose tolerance occurred, but the insulin response to the oral glucose tolerance test (OGTT) decreased after training ($p < .05$). Furthermore, researchers determined that insulin sensitivity remained inversely related to insulin secretion, and this helps to explain why sedentary individuals produce more insulin to overcome insulin resistance. Additionally, Kahn et al. (1990) determined that increased insulin sensitivity resulted from regular aerobic exercise, and exercise minimized insulin production and decreased insulin resistance. The previous factors may be associated with a decreased incidence of type 2 diabetes.

Insulin Sensitivity

The following studies represent research on the effects of insulin sensitivity and the incidence of type 2 diabetes. Heath et al. (1983) found that the glucose levels of young, trained individuals exhibited a minimal response to a 100 g oral glucose load. After 10 days of inactivity, the glucose tolerance of the same individuals deteriorated. Participants who exercised on the 11th day restored glucose tolerance to training levels. Blood glucose rose 10-25% during inactivity versus the trained state, while insulin levels rose 55-120% during the same period. In the trained state, participants exhibited a smaller insulin response to a glucose load which resulted from increased insulin sensitivity.

Heath et al. (1983) determined that acute exercise responses affect glucose metabolism, but exercise responses become minor when inactive for 10 days. Even though researchers observed young, trained individuals, similar results have been hypothesized for older, sedentary adults.

Seals, Hagberg, Hurley, Ehsani, and Holloszy (1984) tested 24 healthy men and women (with an average age of 63 years) and assessed glucose tolerance and insulin sensitivity. Participants engaged in a 12-month endurance program that used low and high intensity exercises. Fourteen participants exercised and 10 participants served as nonexercising controls. None of the participants had regularly exercised for the previous 5 years. Participants walked at low intensities (i.e., 60% of heart rate maximum), averaging 4.6 miles per week for 6 months. During the next 6 months, the exercise group trained three times per week at 80-90% of heart rate maximum while walking, jogging, or bicycling.

Seals et al. (1984) performed an OGTT 14 hours after the last exercise session, but found no differences in glucose tolerance between the exercise and control groups. However, body composition changes occurred after high intensity training ($p < .05$). Although glucose tolerance was not altered, insulin responses to the OGTT decreased 8% following low intensity training and 23% after high intensity training.

Mayer-Davis et al. (1998) studied the effects of moderate versus intense exercise among individuals with a wide range of glucose tolerances. A total of 1,467 men and women participated, with an age range from 40-69 years. The study population consisted of 38% nonHispanic whites, 34% Hispanics, and 28% African-Americans. The participants used a Likert-type scale to validate the frequency of vigorous exercise. In addition, trained interviewers administered a one year recall of physical activity. Groups of activities (i.e., home, work, or leisure time) were used to estimate energy expenditure. Researchers measured BMI and waist-to-hip ratio on all participants and used a modified food frequency intake to assess food consumption patterns of the participants.

The researchers found that 7% of the participants exercised moderately, while 2% exercised vigorously. Both vigorous and nonvigorous activity resulted in increased insulin sensitivity. A weak correlation coefficient existed between energy expenditure and insulin sensitivity ($r = .14$, $p < .001$).

Smutok et al. (1994) compared the effectiveness of strength and aerobic training programs with middle-aged men with IGT, type 2 diabetes or hyperinsulinemia. Researchers studied 26 asymptomatic, untrained, nonsmoking men with an average age of 54.9 years. Participants volunteered for 20 weeks of either strength training ($N = 8$), aerobic training ($N = 8$), or control group ($N = 10$). In addition, each group had three participants with IGT.

All participants were interviewed by a dietitian and received instructions for recording food intake 4 days before an OGTT. Participants maintained their regular diet throughout the study. Before and after training and following an overnight fast, participants underwent an OGTT while researchers assessed plasma glucose and plasma insulin levels.

The strength training program consisted of two sets of resistance exercises that focused on large muscle groups of the back, legs, and arms. The ability of participants to complete 15 repetitions determined the beginning resistance. At the sixth session, a one repetition maximum (RM) was completed. Participants completed a 12-15 RM workload, three times per week for 20 weeks with a 90 second rest interval between exercises.

The aerobic training group initially exercised at 50-60% of heart rate reserve on a treadmill and following the second week, intensity increased to 60-70% of heart rate reserve. For the final 12 weeks, exercise increased to 80-85% of heart rate reserve for 30 minutes. After 20 weeks, researchers repeated all pretest measurements and conducted an OGTT within 24 hours of the last exercise session.

The strength group showed a 12% reduction in total glucose area under the OGTT curve, while the aerobic group showed a 16% reduction. All men with IGT in the strength and aerobic groups normalized their OGTTs following the training sessions. Fasting plasma insulin levels decreased in the strength group ($p < .05$) but not in the aerobic group.

The researchers concluded that strength training and aerobic training are comparable in improving insulin sensitivity and glucose tolerance in men with abnormal glucose regulation. Furthermore, Smutok et al. (1994) concluded that strength and aerobic training may offer protection from type 2 diabetes.

In a similar study, Eriksson et al. (1998) examined the differences in insulin sensitivity and lipid profiles between individuals engaged in circuit weight training programs. Participants for the study included 22 males and females with IGT. All participants kept a food and exercise diary throughout the study, but participants did not change their diet.

Seven males and seven females (average age of 60 years) participated in the aerobic endurance program. Only the aerobic group was randomly separated into a control and an exercise group. Aerobic exercisers participated in a 6 month supervised, moderate exercise program (i.e., 60% of heart rate maximum) for 1 hour per week. In addition, participants completed endurance activities at home for 1-1.5 hours per week.

The control group received information about the beneficial effects of exercise, but did not receive any formal training.

Eight males with an average age of 40 years comprised the circuit weight training group. Participants trained three times per week for 10 weeks using a moderate intensity and moderate volume supervised program. The exercise program consisted of eight exercises, 8-12 repetitions per set, and three sets per session at 50-60% of maximum power. Researchers adapted the intensities at weeks 2 and 5.

The endurance training group increased their high density lipoprotein (HDL) levels, but did not improve insulin sensitivity. The circuit weight training group had a 23% increase ($p < .05$) in total body glucose disposal, increased HDL levels, but no significant weight changes (i.e., BMI or percent body fat). Researchers concluded that the changes in insulin sensitivity occurred independent of aerobic power levels. Therefore, researchers advocated the incorporation of moderate weight training in addition to endurance activities to reduce the progression of IGT to type 2 diabetes.

Cardiorespiratory Fitness Level and Risk for Diabetes

Hollenbeck, Haskell, Rosenthal, and Reaven (1984) studied 20 older males with an average age of 67 years and divided the men into exercise and nonexercise groups. All participants had normal fasting blood glucose levels (i.e., < 110 mg/dl) and BMIs (i.e., < 30 kg/m^2). Insulin-stimulated glucose uptake was determined by using the insulin clamp technique to measure insulin-stimulated glucose disposal rates (MCR).

Researchers noted that BMIs did not differ significantly between groups, but the exercising subjects had an increased MCR compared to the nonexercisers ($p < .01$). The

MCR presented an accurate estimate of total glucose disposal rates, and researchers found a moderately high correlation ($r = .74$, $p < .001$) between aerobic power and MCR. Even when differences in BMI and percent body fat were accounted for, the moderately high correlation remained ($r = .70$).

Lynch et al. (1996) studied the relationship of exercise intensity, duration, and cardiorespiratory fitness to the incidence of type 2 diabetes. Initially, researchers used a 12-month leisure-time history to assess physical activity. The participants estimated exercise intensity during activity on a scale from 0-3 (0 = no breathing problems and 3 = breathlessness). For each activity, specific metabolic units (MET) corresponded to the reported intensity levels. One MET represents the amount of oxygen required per minute during resting conditions (Fox, Bowers, & Foss, 1993).

Lynch et al. (1996) determined that exercise completed at MET levels > 5.5 and for greater than 40 minutes per week reduced the incidence of type 2 diabetes. Regardless of duration, participants continued to show protective effects at higher intensities of exercise, but limited protection existed if intensity decreased below 5.5 METs. Exercise duration had a low correlation with cardiorespiratory fitness ($r = .32$). Men with the highest levels of cardiorespiratory fitness decreased their risk of diabetes by 80%, compared with men in the lowest fitness quartile. Researchers suggested that individuals at higher risk for type 2 diabetes might achieve protective benefits from exercise intensities less than 5.5 METs. Whereas participants who exercised at lower intensities achieved protective effects due to decreases in BMIs, individuals who exercised at higher intensities achieved protection from type 2 diabetes due to the metabolic effects.

Wei et al.(1999) examined the association between impaired fasting glucose, cardiorespiratory fitness, and type 2 diabetes. Participants included 8,633 men aged 30-79 years at baseline. Researchers used criteria from the American Diabetes Association to diagnose impaired fasting glucose (> 110 but < 125 mg/dl) and type 2 diabetes (> 126 mg/dl). Furthermore, all participants attained 85% of their age-predicted maximal heart rate. Therefore, researchers concluded that the exercise test reflected maximal performance. Total time spent on the treadmill determined fitness levels. According to established age ranges, researchers classified treadmill times between age groups. Low-fitness related to the lowest 20% of times, while moderate-fitness consisted of the next 40% of times, and high-fitness comprised the top 40% of times.

During the follow-up period, 593 men developed impaired fasting glucose and 149 developed diabetes. Men in the low-fitness group had almost a two-fold risk for impaired fasting glucose when compared to the high fitness group. This trend remained apparent even when researchers adjusted for age, parental diabetes, smoking, and alcohol use. A dose-response gradient occurred across all three fitness levels ($\underline{p} < .001$). Men in the low-fitness group had a 3.7-fold greater risk for diabetes than men in the high-fitness group. In addition, older participants and individuals with higher BMIs had a direct impact on impaired fasting glucose.

Wei et al. (1999) concluded that a high cardiorespiratory fitness level at baseline resulted in a strong, inverse relationship with the development of impaired fasting glucose and diabetes. This inverse relationship existed after researchers adjusted for age, parental history of diabetes, alcohol consumption, and cigarette smoking.

Intervention Studies (Diet and Exercise)

Before baseline testing, Bogardus et al. (1984) conducted an OGTT on 18 untrained, obese, glucose intolerant, males and females. During baseline testing, all participants ate a weight maintenance diet. Following baseline testing, researchers randomly divided participants into two study groups. The diet only group (D) had 8 participants and the diet and training group (DPT) had 10 participants. The majority of participants were females with an average age of 44 years. One-half of each study group had diagnosed type 2 diabetes, while the remaining participants exhibited varying degrees of glucose intolerance.

During the 12 week study, the DPT group exercised three times per week for 1 hour and received instructions to exercise at home on the remaining days. The training program consisted of stretching, light weight training and aerobic exercises at 75% of maximum heart rate for 20-30 minutes. Both groups ate a hypocaloric diet comprised of 450 kcal/m^2 of body surface (i.e., 25% protein, 15% fat, and 60% carbohydrate). Both groups met with a dietician or nurse to assure compliance and assess glucose and insulin levels. Two weeks before re-entry into the metabolic ward, both groups reverted to the weight maintaining diet comprised of the aforementioned proportions. Metabolic tests were conducted the sixth day after the last exercise session.

Researchers found similar decreases in body weight, fat-free mass, and fat mass. Metabolic tests showed that glucose production within the body decreased while sensitivity to insulin increased in both groups. Researchers concluded that with the degree of weight loss in this study, the liver was the main site of increased insulin sensitivity.

Furthermore, researchers did not find significant differences in peripheral glucose disposal between groups, but researchers found that the DPT group exhibited greater improvement in carbohydrate storage (i.e., glycogen synthesis).

Erikson and Lindegarde (1991) conducted a 5 year prospective study to determine if lifestyle intervention could prevent the progression of IGT to type 2 diabetes. During a previously completed screening, researchers administered an OGTT, and the follow-up consisted of 5,149 men aged 54.3 $\pm$ 1.4 years. Researchers identified individuals with type 2 diabetes and IGT, and established four treatment groups.

Group 1 consisted of 41 newly diagnosed individuals with type 2 diabetes (i.e., no symptoms) who were invited to the "borderline diabetes clinic." Group 2 consisted of 181 individuals with IGT who were enrolled in a prevention program. Group 3 consisted of 79 individuals with IGT who did not participate in the prevention program. Group 4 consisted of 114 randomly selected individuals with a normal OGTT.

Upon entry to the borderline clinic, researchers offered individuals a choice to participate in a long-term intervention with consecutive testing (i.e., 6, 12, 18, 24, 36, 48, and 60 months after enrollment). Baseline testing consisted of an OGTT, and ergometry. Researchers gave participants a choice to follow the protocol on their own or in a group setting. Approximately 44% of participants in group 1 and 38% of participants in group 2 received 6 months of supervised training, followed by 6 months of diet treatment or vice versa. After 12 months, participants followed the previous guidelines with partners or on their own.

After 12 months of treatment, 53.8 % of the participants in group 1 no longer met the criteria for type 2 diabetes. In group 2, 75.8% of participants improved glucose tolerance, with 52.2% falling below the diagnostic level for IGT and 10.6% developing type 2 diabetes. In group 3, glucose tolerance had deteriorated in 67.1% of individuals while diabetes occurred in 28.6% of participants. The compliance rate of the program was exceptional (i.e., $< 10\%$ drop-out rate). Furthermore, researchers suggested that weight loss and physical activity may improve glucose tolerance, although correlation coefficients remained weak ($r = .19$, $p < .02$) and ($r = .22$, $p < .02$), respectively.

Yamanouchi et al. (1995) studied 24 obese individuals (average age of 41 years) with type 2 diabetes. All participants maintained good control of their diabetes with diet before entering the study. None of the participants regularly participated in any exercise before the study. Researchers assigned subjects to one of two groups and matched participants by age, sex, and BMI.

The diet group (D) consisted of 10 participants (i.e., 8 males and 2 females) who managed their diabetes by diet. The diet and exercise (DE) group consisted of 14 participants (i.e., 11 males and 3 females) who managed diabetes by walking and diet. Participants entered the hospital for a supervised 6 to 8 week stay and followed a prescribed diet (i.e., 54-58% carbohydrate, 17-20% protein, 25-26% fat and total calories of 1,000-1,600/day). Participants in the DE group received instructions to walk a minimum of 10,000 steps/day. Researchers instructed individuals in the D group to walk the same distances before entry into the hospital. During the hospital stay, the D group walked an average of two miles per day while the DE group averaged over eight miles per day.

Both groups lost significant weight during the test period, but the DE group lost 7.8 ± 0.8 kg compared to 4.2 ± 0.5 kg for the D group ($p < .01$). Researchers noted blood glucose values decreased in both groups following training ($p < .05$). Additionally, basal insulin levels remained significantly lower in the DE group ($p < .05$). Following training, researchers assessed insulin sensitivity and noted that sensitivity increased significantly in the DE group ($p < .001$). Changes in the post-training insulin sensitivity correlated to average steps per day ($r = .7257$, $p < .005$) in the DE group. Changes in body weight after training in the DE group correlated to changes in insulin sensitivity ($r = .5410$, $p < .05$). Researchers concluded that low intensity exercise (i.e., walking) can improve insulin sensitivity and reduce body weight in obese, men and women with type 2 diabetes.

Pan et al. (1997) investigated whether diet, exercise, or diet and exercise might decrease the incidence of type 2 diabetes in 531 Chinese individuals with IGT. Individuals had their BMI evaluated and based upon their results, entered a specific clinical intervention. The combination of work and leisure-time physical activity determined energy expenditure. Participants spent time walking, stair climbing, dancing, swimming, and gardening. Researchers compared the incidence of type 2 diabetes between an intervention and a control group. The incidence of diabetes decreased 47% in the exercise group and 38% in the diet and exercise group. Differences between interventions did not exist, but the progression of IGT to type 2 diabetes was delayed.

Wing, Venditti, Jakcic, Polley, and Lang (1998) investigated the efficacy of a 2 year lifestyle intervention program in overweight individuals with a family history of diabetes. The average age of participants was 45.7 ± 4.4 years and a BMI was 35.9 ± 4.3 at baseline. Females comprised 79% of the study group. Researchers established four treatment groups and randomly assigned participants (N = 154) to one of the four groups (i.e., control, diet, diet and exercise, or exercise).

The control group studied a self-help manual that encouraged individuals to lose weight on their own. The diet group met in groups of 20 individuals for weekly meetings for the first 6 months and then biweekly meetings for 6 months. During the second year, supplemental courses helped individuals stay focused on weight loss. Behavioral intervention techniques focused on modifying food intake and food choices. Participants maintained a diet (i.e., 800-1,000 kcals/day with 20% of calories from fat) for weeks 1 through 8. By week 16, researchers set caloric goals at 1,200-1,500 kcal/day. Participants self-monitored eating habits for 6 months, and dietitians reviewed the records and gave appropriate advice regarding weight loss procedures.

The exercise group met at the same frequency as the diet group, but received instructions from an exercise physiologist and behavioral therapist. In addition to lecture material, therapists conducted weekly 50-60 minute walks with each individual from weeks 1 to 10. Researchers encouraged participants to increase physical activity expenditure to 1,500 kcal/week by walking 3 miles/day for 5 days. Researchers increased activity levels by 250 kcal/week based on participants' self-reported activity levels. By week 24, 75% of participants had achieved the 1500 kcal/week goal. The diet and exercise group received similar information as the diet only and exercise only groups, but the content of information remained less focused on either aspect.

Researchers assessed body weight, height, BMI, and waist and hip circumference at baseline, 6 months, 1 year, and 2 years. An OGTT was completed at baseline and at year 2. Participants used the Paffenbarger Physical Activity Questionnaire to report self-measured exercise levels. Researchers assessed dietary intake by the Block Food Frequency measure and participants kept 3 day food diaries which dietitians reviewed.

The three treatment groups varied in their short-term effectiveness, but long-term changes were nonexistent after 2 years. The diet and diet and exercise groups had greater initial weight loss after 6 months compared to the exercise group. Changes in weight loss disappeared after 1 year, and other physiologic measures reverted to baseline levels after 2 years. A 4.5 kg weight loss during the intervention decreased the incidence of diabetes by 30% relative to no weight loss. Additionally, participants with IGT at baseline decreased the risk of further glucose deterioration when modest weight loss was achieved.

Meta-Analysis

Edelstein et al. (1997) conducted an analysis of six prospective studies which determined risk factors for the progression of IGT to type 2 diabetes. The six studies were: Baltimore Longitudinal Study of Aging, Rancho Bernardo Study, San Antonio Heart Study, Naura Study, San Luis Valley Diabetes Study and Pima Indian Study. Participants ranged in age from 37-68 years with multiple ethnicities (i.e., Causasian, Hispanic, Mexican-American, Indian, and Micronesian). Females comprised the majority of participants, but study populations were mixed.

Researchers used an OGTT to confirm IGT and used World Health Organization criteria to diagnose IGT (fasting plasma glucose < 140 mg/dl and a 2-hour postchallenge glucose between 140-199 mg/dl). Researchers diagnosed type 2 diabetes by the WHO criteria (fasting plasma glucose > 140 mg/dl or 2-hour postchallenge glucose $\geq$ 200 mg/dl).

At baseline (i.e., initial diagnosis of IGT), researchers determined potential predictors of type 2 diabetes. Researchers measured age (years), BMI, fasting glucose, and 2-hour postglucose challenge. Researchers computed the incidence density rate for those individuals who progressed from IGT to type 2 diabetes. The density rate was defined as the number of new diabetes cases per 1,000 person-years of follow-up.

Including all studies, 2,389 individuals with IGT were followed for 16,775 person-years. Individuals who progressed from IGT to type 2 diabetes ranged from 23% in the San Luis Valley Diabetes Study to 62% in the Pima Indian Study. Researchers found that higher baseline fasting blood sugars and 2-hour postglucose challenge remained the best indicators for identifying individuals who progressed from IGT to type 2 diabetes. Additionally, measurements of obesity (i.e., BMI, WHR, and waist circumference) were associated with a high rate for progression from IGT to type 2 diabetes.

Although family history for diabetes is regarded as a risk factor, the previous analysis did not find an increased risk for type 2 diabetes. Also, gender did not have an association with the progression of IGT to type 2 diabetes. Additionally, researchers found inconsistent results in associating age with an increased risk for conversion from IGT to type 2 diabetes.

Obesity and Weight Loss

Ford, Williamson, and Liu (1997) studied a cohort of 14,407 individuals for a 20 year period during the National Health and Nutrition Examination Survey. Researchers studied weight changes between baseline examination (1971-1975) and the first follow-up (1982-1984). From 1984 through 1992, researchers noted the incidence of type 2 diabetes. Questionnaires, institutional records, and death certificates were used to determine which participants became diabetic from 1982 through 1992.

Researchers weighed all participants during baseline (1971-1975) and again at the first follow-up (1982-1984). Researchers used scales to measure participants' weight during baseline, but participants' weight was measured at home during the follow-up. After excluding participants for various reasons, the final population of the study included 8,545 individuals with 487 cases of diabetes.

At baseline, researchers noted that factors such as age, race, educational background, blood pressure, and overweight increased the risk for type 2 diabetes. The incidence of diabetes increased as BMI increased. For each 2.7-3.6 kg increase in weight, the risk for developing diabetes increased 12.1%. Researchers determined that weight-related changes did not have a significant interaction with age, race, or sex of an individual. Researchers concluded that a weight gain over a 10 year period significantly increased the risk for type 2 diabetes.

Everson et al. (1998) examined 2,272 middle-aged men to assess the risk of weight gain and the development of insulin resistance syndrome. Insulin resistance syndrome was defined as a combination of hyperinsulinemia, hypertension, and dyslipidemia.

Researchers measured baseline weight, but participants' self-reported their own weight at age 20.

Everson et al. (1998) determined that 7.4% of the participants met the standards for insulin resistance syndrome; 55% of the men exhibited one or two of the metabolic components of insulin resistance, whereas 37.6% developed none of the conditions. The prevalence of obesity (BMI > 28) was greater in men with the syndrome than men without the syndrome. Men with insulin resistance syndrome gained more weight during middle age. For each 5% increase in weight (i.e., different than age 20 weight), there was a 20% increased risk of having the syndrome by middle age. This finding remained even when researchers adjusted for physical activity, smoking, and parental history of diabetes. Weight gains during adulthood (> 10% of body weight at age 20) increased the risk for developing insulin resistance syndrome compared to men whose weight remained stable. Researchers concluded that early intervention remains vital in preventing excessive weight gain which may lead to heart disease, type 2 diabetes, or both.

Colman et al. (1995) conducted a prospective study involving obese, sedentary, middle-aged men with normal glucose or IGT. Researchers investigated whether weight loss could improve insulin sensitivity, improve glucose tolerance, or both. Researchers randomized 73 men to a 1 year intervention (i.e., 3 months isocaloric diet followed by a 9 month hypocaloric diet) and 26 men to a control group (i.e., 3 months isocaloric diet followed by 9 months weight maintenance). Final data were reported on 35 men who lost at least 5 kg of weight and 15 controls.

Dietitians educated participants on the different diets and keeping 7-day food records. The control group attended weekly diet counseling, while the intervention group attended weekly behavioral modification sessions. For the first 3 months, participants did not alter physical activity patterns or weight. Dietitians monitored weights every week to assure compliance. Anticipated weight loss in the intervention group was estimated at 10% of initial body weight.

The weight loss program resulted in a 19% reduction in body fat and a 3% reduction in fat-free mass. In the weight loss group, the prevalence of IGT decreased from 57% to 40%, while the control group showed an increase from 40% to 67%. Researchers used an OGTT to show that glucose tolerance improved following weight loss (i.e., decreased area under glucose curve). Although fasting glucose levels did not change significantly, fasting insulin levels decreased by 20% in the intervention group. The participants reduced BMI, body fat, and waist circumference, resulting in increased insulin sensitivity. Researchers concluded that 45% of the men with IGT at baseline had normalized glucose tolerance following the intervention. Furthermore, researchers acknowledged that exercise and diet combined have a synergistic effect in improving glucose tolerance.

Adherence Issues

When beginning an exercise or nutritional program, the adherence of the individual to the prescribed program is important. The final choice of whether to follow prescribed guidelines is up to the particular individual. Unless there is some type of commitment from individuals to improve their lifestyle, the program will probably fail. Some individuals prefer to change their lifestyle by themselves, while others prefer group settings (e.g., Weight Watchers, aerobic classes, or exercise with a friend).

Brownwell (1998) noted that the biologic effects of diet and exercise have a positive effect. However, Brownwell stated that the psychological impact of exercise may improve self-esteem, body image and mood, thereby improving nutritional adherence. Brownwell acknowledged that exercise intensity and duration may be secondary in relation to the way individuals feel about making "positive changes" in their lives.

Exercise and nutritional interventions are not quick solutions; therefore, a long-term, gradual weight loss is preferred. This method usually prevents physiological weight re-gain, but further strategies are needed to prevent psychological relapses. Coping strategies, which deal with everyday stressors, focus on ways to maintain weight loss and prevent relapses.

Weight loss needs to be an achievable goal according to Brownwell. Moderate weight loss (5-10 % of initial body weight) needs to be reinforced as a beneficial treatment. Unrealistic weight loss goals tend to set up behavior patterns in which negative feelings become associated with the unmet goals. As people continue to fail, they set more unrealistic goals for themselves and a cycle develops.

Quick weight loss schemes usually involve losing massive amounts of weight (i.e., water and lean body mass) in a short period. Quick weight loss rarely keeps the weight off and puts the body under major stress. Exercise coupled with caloric reduction produces greater and longer lasting weight loss for most people. More specific guidelines will be given in the lifestyle manual on how to adhere to an exercise and nutritional intervention program.

Summary

Type 2 diabetes is a widespread problem in the United States. Health agencies such as the American Diabetes Association and the Centers for Disease Control consider type 2 diabetes near epidemic levels. Epidemiological, prospective, and longitudinal studies have been completed, indicating that type 2 diabetes may be preventable, if diagnosed at an early stage of development.

Similar to many chronic diseases, type 2 diabetes develops over years and results from genetic and environmental factors. Lifestyle factors such as nutrition and exercise play an important role in the progression of type 2 diabetes. Obesity and inactivity increase the risk for type 2 diabetes, and within the United States obesity and inactivity continue to increase. Programs which decrease obesity and inactivity should decrease the incidence of type 2 diabetes. Without intervention, increases in type 2 diabetes remain likely. The proposed manual will focus on individuals who are "at risk" for type 2 diabetes, and ways to minimize the progression of type 2 diabetes.

Physical exercise (i.e., aerobic and weight training) can alter risk factors (i.e., IGT, obesity, dyslipidemia, and hypertension) associated with type 2 diabetes. Aerobic and weight training exercises help to increase insulin sensitivity and aid in weight loss. Although the precise exercise intensity for preventing type 2 diabetes remains controversial, a moderately intense aerobic program (i.e., 60-70% of heart rate maximum) seems prudent for individuals at risk for type 2 diabetes. A weight training program would aid in retaining lean body mass and also increase caloric expenditure. For individuals at risk for type 2 diabetes, a modified circuit weight training program appears feasible.

However, exercise alone will not promote enough weight loss without a concurrent reduction in calorie intake. Moderate caloric restriction remains vital in decreasing the incidence of type 2 diabetes. Weight reductions may also improve insulin sensitivity and enhance participation in exercise by minimizing the stigma associated with obesity. Weight reduction plus an exercise program will produce the greatest amount of long-term weight loss. Specific weight reductions depend on the individual, but modest reductions (i.e., 5-10% of initial body weight) should improve the metabolic profiles of "at risk" individuals.

CHAPTER III

Methodology

This chapter contains the purpose of the project, an explanation of the design, and a review of the evaluation process. Lastly, a brief review will summarize the contents of the chapter.

Prevention Manual

The purpose of this creative project included, 1) a review of current literature describing the use of nutrition and exercise in the prevention of type 2 diabetes, 2) synthesis of the reviewed literature, 3) development of a manual for prevention of type 2 diabetes, 4) development of the feedback questionnaire for the manual, 5) quantitative and qualitative analyses of the feedback from returned evaluation forms, and 6) use of the feedback to revise the manual.

The proposed manual was developed for review by health professionals and "at risk" men and women (See Appendix A). Health professionals in the Santa Clara Valley involved with diabetes education were contacted and these health professionals acted as distributors for the manual. Manuals were distributed to health professionals and individuals "at risk". Individuals "at risk" are defined as men and women who are sedentary, overweight/obese, or have factors related to insulin resistance (i.e., dyslipidemia, hypertension, and IGT). The greater the number of previous mentioned factors, the greater the risk for type 2 diabetes. The final audience will be middle-aged (40-60 years) men and women "at risk."

The manual will be divided into five sections. A brief introduction will explain what type 2 diabetes is and who is at increased risk. Furthermore, the components of a lifestyle intervention will be reviewed, and the purpose of this manual will be explained.

Dietary guidelines will follow American Diabetes Association Guidelines which are developed in conjunction with the American Dietetic Association. In accordance with the guidelines, an overview of the American Dietetic Association's Food Guide Pyramid will be reviewed with suggestions for caloric reduction and weight loss.

Next, a section will be devoted to the promotion of an active lifestyle using a combination of aerobic and circuit weight training. Guidelines from the American College of Sports Medicine will provide the basis for suggestions on exercise and "at risk" groups. The following section will discuss the issues of adherence to exercise and nutritional programs and methods to accomplish desired goals. A final section will discuss the role of lifestyle intervention in promoting a healthier life and preventing disease.

Evaluation

This manual will be mailed to 20 health professionals as well as 20 "at risk" males and females aged 40-60 years. An evaluation form will be sent to prospective evaluators to fill out and return (See Appendices C and D). The selection of "at risk" individuals will allow for feedback from potential end users.

The evaluation will consist of a Likert-type scale which evaluators will use to determine the efficacy of the manual. A 5-point Likert-type scale will define the evaluator's agreement with 10 questions relating to the presentation and content of information within the manual. A "1" response will indicate the least amount of agreement and a "5" will indicate the most agreement. In addition, space will be provided after each question for respondents to provide additional comments.

The returned evaluations will be quantitatively and qualitatively assessed. The mean and standard deviation for each question on the evaluation will be calculated. Independent t-tests will be used to compare the responses of the two groups of evaluators on each question. Also, the comments provided by each evaluator will be qualitatively evaluated and summarized for each group. A comparison between the feedback from the two groups of evaluators will be completed, and necessary revisions will be made to the manual (See Appendix B).

Summary

Chapter III details the procedures that were necessary to develop the prevention manual. An evaluation form was sent to health professionals and "at risk" individuals. A Likert-type scale was used to obtain quantitative feedback. Comments from both groups was qualitatively discussed. The feedback from both groups was analyzed and used to revise the manual, where necessary.

Chapter IV

Results

Chapter IV presents the results of 32 evaluation forms sent to prospective evaluators: diabetic health care professionals and "at risk" middle-aged men and women. A discussion section will interpret the results and conclusions, and make recommendations for revisions to the manual. Lastly, a chapter summary will review the major points of Chapter IV.

The purpose of this creative project included 1) a review of current literature describing the use of nutrition and exercise in the prevention of type 2 diabetes, 2) synthesis of the reviewed literature, 3) development of a manual for prevention of type 2 diabetes, 4) inclusion of the feedback questionnaire for the manual, 5) quantitative and qualitative analyses of the feedback from returned evaluation forms, and 6) use of the feedback to revise the manual.

Two evaluator groups (health professionals and "at risk" individuals) received 20 evaluation forms each to fill out and return. Evaluators returned 32 forms which totaled a response rate of 80%. Health professionals consisted of diabetic educators, registered dietitians, public health workers, and exercise physiologists. Professionals had either direct experience with diabetes, nutrition, or exercise. "At risk" men and women met the criteria previously established in chapter III (i.e.,overweight or obese and a sedentary lifestyle).

The evaluations included quantitative and qualitative (comments) data. Quantitative analysis consisted of the mean and standard deviation for each question. In addition, a t-test assessed differences between the two groups. Evaluators had the opportunity to comment on each question of the evaluation and these comments were qualitatively assessed.

Level of Significance

A probability level of $p \leq .05$ was established as a significant level of difference between groups.

Reliability of Instrument

The Likert-scale generally employs a 5 to 7 point scale which allows evaluators more choices in responding to questions. The more intervals (5 point or 7 point) used in an evaluation, the more reliable the instrument is considered (Thomas & Nelson, 1996).

Quantitative Results

Overall, evaluators rated the manual favorably, with 90% of the questions scored 4 or higher (a score of 5 equaled strong agreement). Evaluators from the "at risk" group rated every question higher than the health professional group. Although nutrition and exercise remained the foundations of the manual, significant differences ($p \leq 0.05$) between groups resulted when evaluators answered questions 6 and 7 (exercise). However, no significant differences occurred between groups when evaluators answered questions 3 and 4 (nutrition).

Both groups rated question 10 (citing the usefulness of the study) with the highest rating of all questions (4.69 ± 0.69; $M \pm SD$). In contrast, health professionals rated question 2 (purpose of the manual) the lowest (3.97 ± 0.75), while "at risk" individuals rated question 3 (nutritional recommendations) the lowest (4.14 ± 0.28). All quantitative results are presented on Tables I, II-A, and II-B (pages 44-47).

Qualitative Results

Of the 10 questions on the evaluation form, evaluators had an opportunity to comment on every question. Of the 32 returns, 18 health professionals and 14 "at risk" evaluators completed the evaluation form. The total number of opportunities to comment equaled 320 for both groups. Overall, both groups commented on 141 of 320 possible opportunities which equaled a 44% answer rate. The "at risk" individuals commented on approximately 36% of all opportunities, while the health professional group remarked on approximately 51%.

Question 1, "The language and writing style are easily understood," received the most comments (61%) from the health professionals, while questions 8 and 10 received the fewest (28%) comments. In the "at risk" group, question 4, "The dietary recommendations are feasible for middle-aged men and women," received the most comments (43%), while question 8 received the fewest (14%) possible comments (refer to Table III).

Questions 1, 2, 3, 4, 6, 7, and 8 represent significant differences between groups or deal with the basic nutrition and exercise concepts in the manual and will be used to revise the manual contents (Refer to Table I). Due to lower response rate and higher agreement between groups, questions 5 , 9, and 10 will not be used to revise the manual.

Table I: Overall Quantitative Results

Question	Overall M+SD	Prof M+SEM	At risk M+SEM	t-value	P
1) The language and writing style are easily understood.	4.28 ± .73	3.94 ± .17	4.71 ± .12	-3.44	.002
2) The introduction provides enough information to clarify the purpose of the manual.	3.97 ± .75	3.69 ± .17	4.36 ± .17	-2.93	.007
3) The nutritional recommendations are straightforward and easy to comprehend.	4.06 ± .80	4.00 ± .14	4.14 ± .28	-.49	.630
4) The dietary recommendations are feasible for middle-aged men and women.	4.03 ± .69	3.89 ± .11	4.21 ± .24	-1.24	.232
5) The manual properly identifies who is "at risk."	4.38 ± .71	4.22 ± .17	4.57 ± .17	-1.41	.170
6) The exercise recommendations are feasible for middle-aged men and women.	4.16 ± .63	3.94 ± .15	4.43 ± .14	-2.31	.028
7) The exercise recommendations are straightforward and easy to comprehend.	4.19 ± .74	3.94 ± .17	4.50 ± .17	-2.25	.032
8) As an individual "at risk" for type 2 diabetes, I believe there is a need for information on preventing type 2 diabetes.	4.22 ± .71	3.89 ± .14	4.64 ± .17	-3.50	.001
9) The manual represents a practical approach to preventing type 2 diabetes.	4.31 ± .69	4.17 ± .17	4.50 ± .17	-1.37	.181
10) I would use the information in this manual to educate myself about the prevention of type 2 diabetes.	4.69 ± .69	4.67 ± .18	4.71 ± .16	-.19	.85

Notes: Possible range of scores from 1 to 5 with a score of 1 equal to strongly disagree and 5 equal to strongly agree.

Questions 8, 9, and 10 on this evaluation refer to questions 10, 8 and 9 respectively, on the health professional evaluation form.

Table II A: "At Risk" Scoring Results

Questions	SD	D	N	A	SA
1) The language and writing style are easily understood.	0	0	0	4	10
2) The introduction provides enough information to clarify the purpose of the manual.	0	0	1	7	6
3) The nutritional recommendations are straightforward and easy to comprehend.	0	2	0	6	6
4) The dietary recommendations are feasible for middle-aged men and women.	0	1	1	6	6
5) The manual properly identifies who is "at risk."	0	0	1	4	9
6) The exercise recommendations are feasible for middle-aged men and women.	0	0	0	8	6
7) The exercise recommendations are straightforward and easy to comprehend.	0	0	1	5	8
8) As an individual "at risk" for type 2 diabetes, I believe there is a need for information on preventing type 2 diabetes.	0	0	1	2	11
9) The manual represents a practical approach to preventing type 2 diabetes.	0	0	1	3	10
10) I would use the information in this manual to educate myself about the prevention of type 2 diabetes.	0	0	1	5	8

Notes: SD = Strongly Disagree
D = Disagree
N = Neutral
A = Agree
SA = Strongly Agree

Questions 8, 9, and 10 on this evaluation form refer to questions 10, 8, and 9, respectively, on the health professional evaluation form

Table II B: Health Professional Scoring Results

Questions	**SD**	**D**	**N**	**A**	**SA**
1) The language and writing style are easily understood.	0	0	6	7	5
2) The introduction provides enough information to clarify the purpose of the manual.	0	1	6	10	1
3) The nutritional recommendations are straightforward and easy to comprehend.	0	0	3	12	3
4) The dietary recommendations are feasible for middle-aged men and women.	0	0	3	14	1
5) The manual properly identifies who is "at risk."	0	0	3	8	7
6) The exercise recommendations are feasible for middle-aged men and women.	0	0	4	11	3
7) The exercise recommendations are straightforward and easy to comprehend.	0	1	2	12	3
8) The manual represents a feasible and realistic approach to preventing type 2 diabetes.	0	0	4	12	2
9) Professionally, I would use this information to educate individuals "at risk" for type 2 diabetes.	0	0	3	9	6
10) As a health professional, I feel that there is a need for more information about preventing type 2 diabetes.	0	1	1	3	13

Notes: SD = Strongly Disagree
D = Disagree
N = Neutral
A = Agree
SA = Strongly Agree

Questions 10, 8, and 9 on this evaluation form refer to questions 8, 9, and 10 respectively, on the "at risk" evaluation form.

Table III: Qualitative Response Rates from Both Groups

Questions	**Comments Health Prof**	**Comments At Risk**
1) The language and writing style are easily understood.	11/18 = 61%	4/14 = 29%
2) The introduction provides enough information to clarify the purpose of the manual.	8/18 = 44%	4/14 = 29%
3) The nutritional recommendations are straightforward and easy to comprehend.	9/18 = 50%	5/14 = 36%
4) The dietary recommendations are feasible for middle-aged men and women.	6/18 = 33%	6/14 = 43%
5) The manual properly identifies who is "at risk."	7/18 = 39%	4/14 = 29%
6) The exercise recommendations are feasible for middle-aged men and women.	6/18 = 33%	3/14 = 21%
7) The exercise recommendations are straightforward and easy to comprehend.	10/18 = 56%	4/14 = 29%
8) As an individual "at risk" for type 2 diabetes, I believe there is a need for information on preventing type 2 diabetes.	5/18 = 28%	3/14 = 21%
9) The manual represents a practical approach to preventing type 2 diabetes.	8/18 = 44%	5/14 = 36%
10) I would use the information in this manual to educate myself about the prevention of type 2 diabetes.	5/18 = 28%	2/14 = 14%

Note: Questions 8, 9, and 10 on this evaluation form refer to questions 10, 8, and 9, respectively, on the health professional evaluation form.

Discussion

Currently, 8% of the United States population over the age of 45 years has type 2 diabetes, while another 20% has undiagnosed type 2 or IGT (Harris et al., 1992). Consequently, health care expenditures for diabetes total over $100 billion (Clarke, 1997). Underlying the medical aspects of diabetes, an information void between the scientific community and the general public exists. As a result, much needed information remains inaccessible or incomprehensible to the "lay" person. Therefore, a manual on prevention of type 2 diabetes seems necessary to fill that void and make "at risk" people aware that practical, preventive approaches are available.

From the review of literature, exercise and nutrition emerged as important but controversial methods to prevent type 2 diabetes (Burchfiel et al., 1995; Ford et al., 1997; Helmrich et al., 1991; Manson et al., 1992; Pan et al., 1997; Wei et al., 1999; Wing et al., 1998). Eighty-five percent of the information contained in the manual specifically dealt with exercise and nutrition as ways to minimize the risk of type 2 diabetes. Questions 3 and 4 on the evaluation form asked for an assessment of the nutritional objectives.

Question 3 : "The nutritional recommendations are straightforward and easy to comprehend."

Question 4 : "The dietary recommendations are feasible for middle-aged men and women."

In an effort to avoid the controversy over specific dietary recommendations, "a reduction in *total caloric intake* to facilitate a moderate weight loss" was emphasized. Nevertheless, two individuals "at risk" misunderstood the goals of the manual and remained more concerned with the percentages of fat, carbohydrates, and protein. Another individual suggested the American Heart Association guidelines as a dietary recommendation. In contrast, the American Diabetes Association reiterates that no one diet can meet the needs for all "at risk" individuals; therefore, a registered dietitian should work with individuals to tailor a specific diet to meet daily needs.

Problems with dietary recommendations remain widespread because health agencies as well as the scientific community constantly change dietary recommendations for the public. Furthermore, there is no agreement among health agencies when presenting information to the public. Consequently, individuals become more confused about what steps to take. Therefore, the revised edition of the manual will advocate more strongly working with a registered dietitian to achieve individual dietary goals.

Not surprisingly, since most of the health care professionals have a nutrition background, they made four times as many comments on questions 3 and 4. On the one hand, health professionals showed a new approach to diabetes prevention and treatment by embracing new ideas such as carbohydrate counting and fewer snacks per day. On the other hand, traditional ideas such as three meals and three snacks per day and a high carbohydrate diet are losing favor. One health professional asked, "What are the nutrition recommendations from the American Dietetic Association and American Diabetes Association?" Based on the comments from both groups, some aspects of nutritional advice will need to be re-evaluated in the revised manual. Emphasis on newer dietary recommendations such as carbohydrate counting, fewer snacks, and smaller meals will be recommended.

The following two questions on exercise will be discussed, since exercise combined with caloric restriction appears to improve the profile of an "at risk" individual. In the literature review, researchers prescribed aerobic exercise as the main form of exercise to enhance and maintain weight loss (Eriksson et al., 1998; Pan et al., 1997; Wing et al., 1998). In contrast, the manual suggests aerobic exercise combined with a circuit weight training program to enhance long-term weight loss and improve the metabolic profile of "at risk" individuals.

Questions 6 and 7 on the evaluation form asked for an assessment of the exercise objectives in the manual.

Question 6 : "The exercise recommendations are feasible for middle-aged men and women."

Question 7 : "The exercise recommendations are straightforward and easy to comprehend."

Two health professionals commented on the location where exercise occurs, "For many people, I don't believe the gym is an option," and "People need exercises they can do at home." Although many research studies have been conducted in controlled settings, the applicability of these findings in the "real world" remains unproven. Factors such as access to exercise equipment, daily stressors, and climate may affect nutritional and exercise recommendations. Nevertheless, the revised manual will emphasize that any exercise is better than no exercise, regardless of where exercise is done. Although the gym may not appear to be the first choice for many people, gyms, recreation centers, and community centers provide access to weight machines at low costs. Although weight machines remain essential to the circuit weight training program, one to two days per week is considered sufficient to promote benefits. Although circuit weight training remains important to the exercise program, finding access to machines may be difficult. If access is not feasible, hand-held free weights may produce similar benefits as reported by previous research (Smutok et al., 1994). In addition, free weights provide individuals with the opportunity to exercise at home, although weights will have to be purchased.

Three health professionals commented, "Individuals should get checked out by a physician before beginning an exercise program." Health professionals, as well as the American College of Sports Medicine, advocate a physical examination before starting an exercise program, and the manual will strongly emphasize medical clearance before beginning exercise. Physiological changes such as hypertension, neuropathy, and retinopathy may occur 4 to 7 years before the diagnosis of type 2 diabetes is made (Harris et al., 1992). So, medical clearance becomes imperative in "at risk" populations to prevent any exercise-induced problems. Further incentive to motivate people to exercise is the health status of "at risk" individuals and its relationship to heart disease. People "at risk" for type 2 diabetes remain at elevated risks for heart-related problems as reported by Harris (1989).

Five health professionals commented, "I don't understand what circuit weight training is," and "People may need instructions from a health professional to understand these recommendations." One purpose of the manual was to make general recommendations about exercise and to promote awareness about how these concepts may help prevent type 2 diabetes. For specific exercise prescriptions and further clarification, an exercise physiologist or trainer should be consulted. Furthermore, phone numbers of agencies (American College of Sports Medicine, International Diabetes Athletics Association, and the American Diabetes Association) may help locate trainers and will be provided in the revised manual.

The lack of comments from the "at risk" group could lead one to conclude that "at risk" individuals understood the exercise recommendations. However, since individuals "at risk" for type 2 diabetes are traditionally overweight and less active, the lower percent of comments (29%) from "at risk" individuals may be more representative of a lack of understanding in the group. Furthermore, it seems likely that "at risk" individuals remained confused, given that numerous health professionals had similar questions about circuit weight training. Or, it remains possible that health professionals may be limited by their exercise background. Nevertheless, health professionals probably are more aware of the exercise benefits compared with the "lay" person.

Question 8 on the evaluation form asked for an assessment of the need for the manual, "As an individual "at risk" for type 2 diabetes, I believe there is a need for information on preventing type 2 diabetes." This same question was asked to the health professional evaluators but targeted to them.

Bogardus et al., (1984); Eriksson and Lindegarde, (1991); Eriksson et al., (1998); Pan et al., (1997); and Wing et al., (1998) have used diet, exercise, or both to reduce the risk or minimize type 2 diabetes. However, the context of these research studies remain difficult for the "lay" person to understand. Question 8 received low comment rates from both groups with only 21% of the "at risk" group and 28% of health professionals responding. Consequently, question 8 may reflect a general lack of concern among people "at risk." Or, people may not understand what being "at risk" means, while others may deny being "at risk", or individuals may feel apathetic.

Harris (1989) stated that individuals with IGT were at increased risk for heart-related diseases. Therefore, the low response rate to question 8 demands attention, and every effort will be made to strongly point out the dangers associated with type 2 diabetes. One "at risk" individual commented, "I learned new information from just reading this," while a health professional commented, "The manual may be pertinent for highly educated people but not for those in greatest need for the information."

Questions 1 and 2 asked evaluators to assess the structure and purpose of the study.

Question 1 : "The language and the writing style are easily understood."

Question 2 : "The introduction provides enough information to clarify the purpose of the manual."

Health professionals commented extensively on the use of wording and language, while the "at risk" group seemed more at ease with the language level. This discrepancy might be explained since the majority of "at risk" evaluators were highly educated. Although the language level of the manual targeted a more literate audience, the manual still remained more understandable than the reviewed studies, as indicated by the high agreement, especially in the "at risk" group. On the other hand, since health professionals work with a wide variety of socioeconomic groups where individuals may be less educated, a lower reading level would be justified.

A total of 61% of the professionals responded with a comment for question 1 compared to 7% of the "at risk" individuals. Health professionals commented, "If not intended for health professionals, the language is too scholarly." Another health professional commented, "Not written at eighth grade level," while another professional commented, "Good for a highly literate population." It seems apparent that given the overwhelming responses by health professionals, they thought the language level was too advanced. In addition, health professionals suggested lowering reading levels for a broad-based appeal. Although it remains unlikely that one manual will suit the needs of every "at risk" person, the revised manual will take into account the need for less scientific language. Another possible solution would be to develop several manuals specific to target groups, such as individuals who speak English as a second language or less educated individuals.

Question 2 asked evaluators to clarify the introduction and purpose of the manual. Health professionals commented more than "at risk" individuals, but one health professional and one "at risk" evaluator commented, "The introduction was not clearly defined." Another health professional commented, "The concepts in the manual's introduction were too complex for 'at risk' individuals." Although no specific "introduction" was defined in the manual, pages 1 and 2 attempted to define the problem and lay a foundation for using lifestyle interventions to prevent type 2 diabetes in susceptible individuals. In the revision, a specific section labeled "introduction" will be made, and concepts will be expanded upon to further clarify the purpose of the manual.

Questions 5, 9, and 10 resulted in no significant differences between groups and relatively low comment response rates. Therefore, no extensive review of the comments will be made.

Recommendations

Future revisions to the manual would include more specific nutritional information in association with the Food Guide Pyramid. For example, what constitutes a serving and how many servings are required per day. In addition, nutritional recommendations would be made based upon gender, age, and activity levels of individuals. Additionally, access to the National Strength and Conditioning Association website would further provide additional information about locating trainers or exercise physiologists.

Weaknesses of Study

Type 2 diabetes remains a very difficult concept to convey and understand. For the sake of brevity, the manual was intended to be a concise information guide which did not burden individuals with excessive information. Unfortunately, this meant that some subjects did not receive due attention. For example, concepts such as motivation and adherence did not receive adequate emphasis, as well as some nutritional aspects.

Furthermore, the evaluation form used in this project suffered from several flaws. "At risk" evaluators were accepted as meeting the established criteria for individuals "at risk" for type 2 diabetes without proper clarification of health status. In addition, the sample size of the project was fairly small (40 total evaluations sent) and did not represent a wide spectrum of individuals "at risk." Most of the "at risk" individuals were college educated and, therefore, may have a greater understanding of concepts presented.

Finally, changes made to the manual were deemed necessary from the evaluation feedback. Unfortunately, no follow-up evaluations were distributed to interpret revisions, thereby leaving the revised manual without any further evaluation.

Summary

Chapter IV presented the results of the evaluation which have been qualitatively assessed and the panel of evaluators rated the manual favorably. Qualitative analysis of comments were made for questions 1, 2, 3, 4, 6, 7, and 8 in the discussion. Conclusions and recommendations were also made within the discussion. The feedback from the evaluation forms will be used to revise the manual and produce a more useful tool to help "at risk" individuals understand how they might prevent type 2 diabetes.

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Appendix A

Prevention Manual for Type 2 Diabetes

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What is Type II Diabetes?

Our bodies produce the hormone insulin to help move glucose (a sugar used for energy) into the cells of our body. If glucose cannot enter the cells efficiently, it builds up in the bloodstream. Excess blood glucose for extended periods of time can damage vital organs of the body. In response to the elevated glucose levels, our bodies produce more insulin to lower blood sugar levels. Over time (often as long as 9-12 years), the body may inefficiently use insulin or completely stop producing insulin. The result may be type II diabetes. An intermediate condition called impaired glucose tolerance (IGT) further increases the risk for developing type II diabetes.[1]

Normal Blood Sugar Range:
70 – 110 mg/dl (fasting)

Impaired glucose tolerance range:
Greater than 110 but less than 140 mg/dl (fasting)

Who is "at risk"?

Certain ethnic groups such as African-Americans, Mexican-Americans, American Indians, Japanese-Americans and Pacific Islanders have been identified as high risk groups for type II diabetes.

Your health care provider has identified you as "at risk" for type II diabetes. This means you may be:

- ✓ middle-aged
- ✓ sedentary
- ✓ overweight or obese

In addition, you may have impaired glucose tolerance or you may have a family history of type II diabetes.

33% of all Americans are obese, which means that they have a body mass index (BMI) > 30. A BMI > 25 is considered overweight.[2]

Why is early detection so important?

After the age of 40, testing for type II diabetes should occur every 2-3 years. If other risk factors are present, more frequent testing should occur.

We are probably not aware of the gradual glucose buildup in the beginning stages of type II diabetes or IGT. Type II diabetes develops over time, and early symptoms are often overlooked. Damage to the eyes, heart and kidney often occurs before detection.[3] Early detection of IGT means that changes in diet and exercise can generally minimize damage to vital organs and prevent type II diabetes.

Symptoms of abnormal glucose levels:

- ✓ Fatigue
- ✓ Excessive thirst /frequent urination
- ✓ Blurry vision
- ✓ Weight loss

What is lifestyle intervention?

Knowing you are at risk means you may be able to take steps to:

- ✓ prevent type II diabetes
- ✓ decrease damage to the body associated with type II diabetes

Key lifestyle habits to prevent type II diabetes:

- ✓ *Improve diet:* (1) facilitate weight loss if needed; (2) increase insulin sensitivity
- ✓ *Increase physical activity:* (1) facilitate weight loss or maintenance of weight; (2) increase insulin sensitivity; (3) maintain/build lean body mass

Diet alone results in loss of water, fat mass and lean body mass (muscle).

Diet plus exercise results in loss of body fat while minimizing loss of muscle mass.

60-90 % of people diagnosed with type II diabetes are overweight/obese.[4]

What are the dietary components of a healthy lifestyle?

All of us have specific dietary wants, needs and preferences. Talking with a registered dietitian to tailor an optimal nutritional program is important. The goal of this program should be a reduction in total caloric intake, which should facilitate ***moderate*** weight loss (5-10 lbs).

A nutrition and exercise program should:

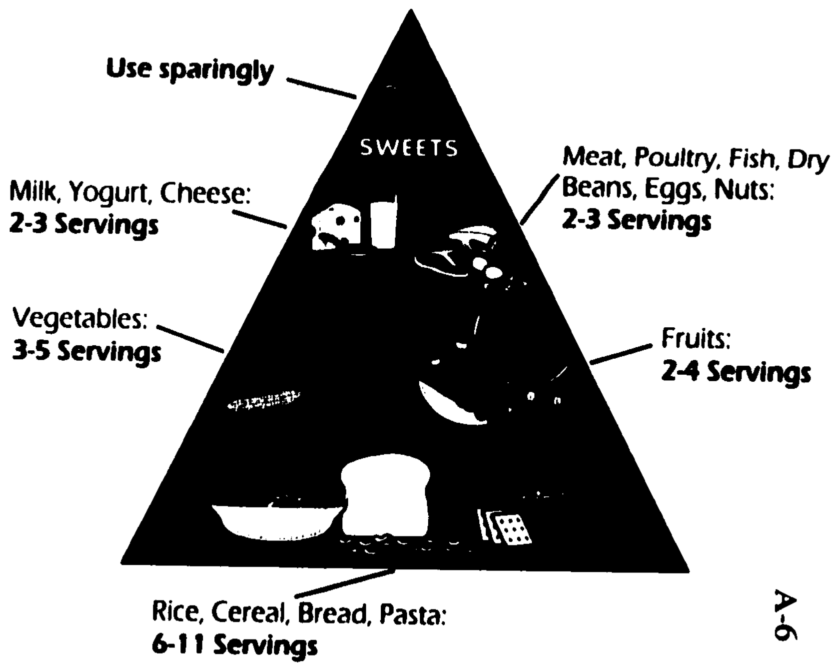
- ✓ decrease blood pressure
- ✓ lower blood sugar
- ✓ increase insulin sensitivity
- ✓ decrease the risk for type II diabetes

The goals are:

- ✓ slow weight loss (0.5-1.0 lb per week)
- ✓ expend more calories than we consume (often referred to as negative caloric balance
- ✓ maintain long-term weight loss

Any excess calories, regardless of the source (fat, carbohydrate or protein) will eventually result in increased fat storage.

The United States Department of Agriculture has developed a visual aid (Food Guide Pyramid) to help individuals make healthy food choices. The Food Guide Pyramid[5] will not satisfy everyone's nutritional needs. An assessment by a dietitian knowledgeable about diabetes can identify individual needs.



Dietary caloric reduction

Sample Week (should be accomplished every week until desired weight loss is achieved):

Mon	Tues	Wed	Thurs	Fri	Sat	Sun
-300 cal/ day	-300 cal/ day	-300 cal/ day	-300 cal/ day	-300 cal/ day	-300 cal/ day	-300 cal/ day

- ✓ Small caloric reductions at each meal for a total daily reduction of 300 calories
- ✓ Smaller, more frequent meals (three meals and three snacks)
- ✓ Focus on decreasing saturated fat intake
- ✓ Counting carbohydrates may aid certain "at risk" individuals.

The simplest way to decrease total caloric intake is to reduce the amount of dietary fat, especially saturated fats.
See Appendix A for suggestions.

How is body fat measured?

– The measurement of overweight and obesity in relation to type II diabetes

There appears to be a relationship between body mass index (BMI) and the incidence of type II diabetes. The higher the BMI, the greater the risk for type II diabetes. In addition to a high BMI, an inactive lifestyle further increases the risk for type II diabetes. BMI is a ratio between body weight and height.

See Appendix D for a BMI chart and directions on how to calculate your BMI.

How does exercise improve the profile of an "at risk individual"?

What are the benefits of exercise in preventing type II diabetes:

- ✓ Decreased insulin production
- ✓ Increased insulin sensitivity
- ✓ Helps in weight reduction/regain cycle
- ✓ Helps retain lean body mass (muscle)
- ✓ Improves cholesterol levels

Goal: Weight loss while retaining lean body mass (muscle tissue).

General benefits of exercise:

- ✓ Increased energy
- ✓ Decreased appetite
- ✓ Weight control/loss
- ✓ Increased sense of well being
- ✓ Lower blood pressure

The importance of aerobic exercise in the prevention of type II diabetes

Aerobic activities elevate heart rate within a recommended range for an extended period of time. Benefits include:

- ✓ Improved circulation
- ✓ Increased insulin sensitivity
- ✓ Decreased insulin production
- ✓ Helps facilitate weight loss
- ✓ Lowers blood sugar

Recommendations:

- ✓ Seek guidance from an exercise physiologist/ trainer
- ✓ Choose a moderate exercise intensity
- ✓ Begin exercising for 15 minutes on 3-4 days per week
- ✓ Begin exercise program slowly
- ✓ Choose an activity that you enjoy

Recommended heart rate ranges and formula

220 – age = maximum heart rate

Exercise should be completed at moderate intensities (50 – 60%) of maximum heart rate.

For obese/sedentary individuals, the American College of Sports Medicine recommends beginning exercise between 50% - 60% of maximum heart rate.[6] See Appendix B for activity suggestions.

Example: A 50 year old, sedentary female wants to begin a low intensity (50-60 %) aerobic exercise program. She would calculate her exercise heart rate range by:

220-50 = 170 beats per min (maximum heart rate)
170 X .50 = 85 beats per min (low end range)
170 X .60 = 102 beats per min (high end range)

Initially, she would want to exercise at a heart rate between 85 and 102 beats per minute for 15-20 minutes. Ultimately, the goal is to accumulate 30 minutes of aerobic activity per day.

Example of moderate aerobic exercise program

Sample week (should be accomplished every week until weight loss goals are achieved).

Mon	Tues	Wed	Thurs	Fri	Sat	Sun
30 min. walk	Circuit weight	30 min. swim	Circuit weight	30 min. bike	rest	light activity

Gradual increases in *duration* (time spent) should occur first, after week 2 (from 15 to 20 minutes/day) until 30 minutes per day is achieved.

After 1 month, changes in *frequency* should occur (from 2 to 3 days/wk to 3 to 5 days/wk).

Intensity should be adjusted, only when an individual is comfortable with the existing intensity.

Circuit weight training and the prevention of type II diabetes

Circuit weight training combines weights with an aerobic component. Individuals use lighter weights and shorter rest periods between exercises. This setup benefits "at risk" individuals because lighter weights minimize injuries while building lean body mass.[7]

The benefits of a circuit weight training program include:

- ✓ Improved insulin sensitivity
- ✓ Increased lean body mass
- ✓ Decreased fat mass
- ✓ Improved cholesterol levels
- ✓ Decreased blood sugar

For suggestions about specific circuit weight Training exercises, see Appendix C. Having access to weight facilities will effect the circuit weight program.

Increased muscle mass expends more calories than any other tissue.

Sample diet and exercise training program

	↓ calories (diet)	↓ calories (exercise)	Total caloric reduction
Monday	-300	-300 (aerobic)	- 600
Tuesday	-300	-300 (weights)	- 600
Wednesday	-300	Light activity -100	- 400
Thursday	-300	-300 (weights)	- 600
Friday	-300	-300 (aerobic)	- 600
Saturday	-300	Rest	- 300
Sunday	-300	Light activity -100	- 400
Weekly total	- 2100 cal	- 1400 cal	- 3500 cal

One pound of fat is equivalent to 3500 calories. By following the sample, one pound of fat may be lost per week. The circuit weight training should help to retain muscle mass and increase insulin sensitivity.

Staying with the program

Motivation for initiating changes:

- ✓ Decrease risk for cardiovascular problems
- ✓ Improve blood pressure
- ✓ Improve cholesterol
- ✓ Maintain adequate vision
- ✓ Maintain kidney function

Strategies for implementing changes in exercise:

- ✓ Find an exercise partner
- ✓ Find an activity that you enjoy (walking, swimming, jogging or biking)
- ✓ Begin exercise program slowly
- ✓ Make gradual changes to program duration's, frequencies and intensities
- ✓ Incorporate exercise into everyday life (taking stairs, walk to lunch, park farther from work etc.)
- ✓ Maintain positive attitude about changes (exercising is good for me)
- ✓ Complete aerobic exercises throughout the day (3 times/day for 10 minutes each session) for a total of 30 minutes per day.

A healthier lifestyle will result from a lifestyle intervention, regardless if type II diabetes is prevented or not.

Strategies for changing diet:

- ✓ Concentrate on one aspect at a time (decreasing saturated fat)
- ✓ Involve a partner or friend in healthier eating habits
- ✓ Go to a group therapy (weight watchers or type II diabetes support group, etc.)
- ✓ Talk to a registered dietitian about your goals.

Outcomes of a lifestyle Intervention

Healthier lifestyle due to:

- ✓ Increased physical activity
- ✓ Better mental functioning/outlook
- ✓ Increased self-esteem
- ✓ Weight loss (fat)
- ✓ Decreased saturated fat will improve cholesterol levels while decreasing risk for heart-related problems associated with type II diabetes.

The prevention of type II diabetes is dependent on:

- ✓ Genetic make-up of individual
- ✓ Compliance with dietary and exercise suggestions

Even if type II diabetes does occur, the lifestyle changes should minimize the impact of complications as well as the severity of diabetes itself.

Endnotes

1. Harris, M. I., et al., 1992. Onset of NIDDM Occurs at least 4 – 7 years before clinical diagnosis. Diabetes Care, vol 15, 817 – 818.
2. Bray, G. A., 1992. Pathophysiology of obesity. American Journal of Clinical Nutrition, vol 55, 488 – 489s.
3. Diabetes facts and figures, 1997, http://www.Diabetes.org/ada/c20f.html
4. Harris, M. I., 1987. Prevalence of diabetes and impaired glucose tolerance and plasma glucose levels in the U. S. population aged 20 – 74 years. Diabetes, vol 36, 523 – 534.
5. Food Guide Pyramid adapted from United States Department of Agriculture/United States Department of Health and Human Services.
6. ACSM's Guidelines for Exercise Testing and Prescription, 1995, 218 – 219.
7. Erikkson, J., 1998. Aerobic endurance exercise or circuit-type resistance training for individuals with impaired glucose tolerance? Hormones in Metabolic Research, 30, 37 – 41.

Appendix A: Methods to Decrease Saturated Fat Intake

- ✓ Choose low-fat or non-fat dairy products (milk, cheese, yogurt and ice cream)
- ✓ Trim excess fat from meats
- ✓ Remove chicken skin before cooking
- ✓ Avoid frying foods, try broiling foods instead
- ✓ Avoid trans fatty acids (margarines, partially hydrogenated food products)
- ✓ Use olive oil or canola oil
- ✓ Increase your consumption of healthy fats (almonds, hazelnuts and other nuts/seeds, avocados) in place of saturated fats
- ✓ Talk to a registered dietitian to develop a specific program for you.

Appendix B: Aerobic Activity Choices

- ✓ Walking
- ✓ Jogging (moderate pace)
- ✓ Biking
- ✓ Swimming
- ✓ Stair climbing
- ✓ Yard-work
- ✓ Hiking
- ✓ Circuit weight training

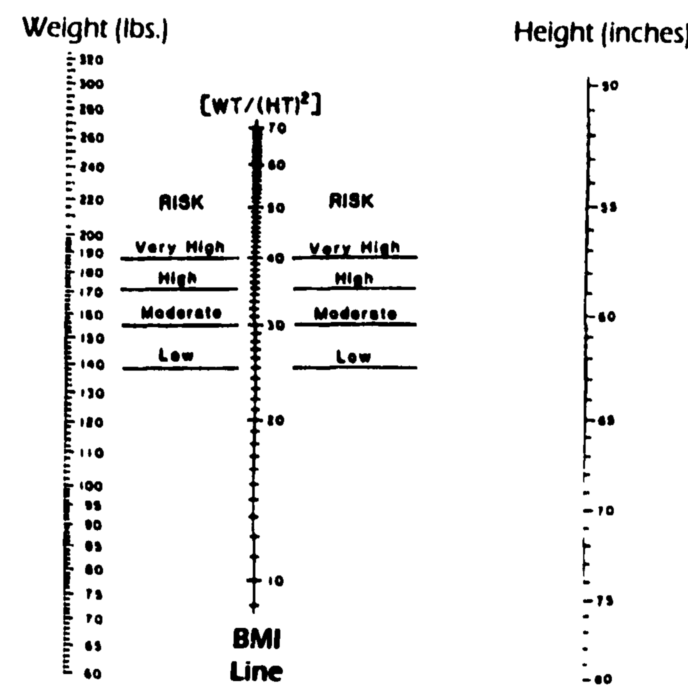
Appendix C: Circuit Weight Training Exercises

- ✓ Exercises should focus on upper and lower body
- ✓ Large muscle groups should be worked: chest, back, legs and arms
- ✓ Work with an exercise specialist who is familiar with circuit weight training
- ✓ Train by using lighter weights, more exercises and shorter rest intervals
- ✓ Maintain proper rest between workout sessions (Mon and Thurs, or Tues and Friday)
- ✓ Proper stretching is vital to prevent injuries, especially when beginning a weight training program
- ✓ **Access to weight machines will limit the ability of individuals to participate in circuit weight training. Use of free weights may be used as an alternative.**

Appendix D
BMI Chart and Directions

First, determine your weight and height. Secondly, use a ruler and draw a line connecting weight to height. The point where it crosses the BMI line is your body mass index.

Body Mass Index



Appendix B

Prevention Manual for Type 2 Diabetes

By Miguel Camacho
San Jose State University

Acknowledgements

I wish to thank the following people for their help in producing this manual:

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Furthermore, Michelle Bush lent her computer knowledge to completing the design and layout of this manual, for which I am grateful.

Introduction

Type 2 diabetes and a condition referred to as impaired glucose tolerance (IGT) are becoming public health problems in the United States. IGT refers to blood sugar levels that are not normal, but not high enough to be considered diabetes. The precise cause of type 2 diabetes remains unknown. But, we do know that factors such as moderate weight gain and lack of exercise contribute to the problem. By improving our lifestyle, we reduce our risk of developing type 2 diabetes. There are other contributing factors in the development of type 2 diabetes such as: aging, ethnicity, and genetics. Unfortunately, there is little that can be done about these factors. Consequently, lifestyle changes become that much more important.

Over 16 million Americans have diabetes, with 90-95% of people having type 2 diabetes. About 50% of these individuals are not aware that they have diabetes.[1]

Purpose of the Manual

This manual was developed for middle-aged men and women aged 40-60 years who are considered "at risk" for type 2 diabetes. Being "at risk" means that certain lifestyle factors such as being overweight (high body mass index) or being inactive increase your risk for developing type 2 diabetes. This manual will present general concepts for individuals to make changes in eating and exercise habits. This manual does not intend to provide all the answers to prevent type 2 diabetes. Rather, this manual intends to present easily understood information, which can be used by individuals to lower the risk of developing type 2 diabetes.

Impaired glucose tolerance is present in approximately 20 million Americans. About 40-45% of individuals 65 years-of-age and older have either type 2 diabetes or impaired glucose tolerance.[2]

What is Type 2 Diabetes?

Our bodies produce the hormone insulin to help move glucose (a sugar used for energy) into the cells of our body. If glucose cannot enter the cells efficiently, it builds up in the bloodstream. Excess blood glucose for extended periods of time can damage vital organs of the body. In response to the elevated glucose levels, our bodies produce more insulin to lower blood sugar levels. Over time (often as long as 9-12 years), the body may inefficiently use insulin or completely stop producing insulin. The result may be type 2 diabetes. An intermediate condition called impaired glucose tolerance further increases the risk for developing type 2 diabetes.

Normal Blood Sugar Range:
70 – 110 mg/dl (fasting).

Impaired glucose tolerance range:
Greater than 110 but less than 126 mg/dl (fasting).

Type 2 Diabetes Range:
Greater than 126 mg/dl.

Who is "at risk"?

Certain ethnic groups such as African-Americans, Mexican-Americans, American Indians, Japanese-Americans and Pacific Islanders have been identified as high risk groups for type 2 diabetes.

Your health care provider has identified you as "at risk" for type 2 diabetes. This means you may be:

- ✓ Middle-aged
- ✓ Sedentary
- ✓ Overweight or obese

In addition, you may have impaired glucose tolerance or you may have a family history of type 2 diabetes.

A sedentary lifestyle and excess weight are factors which can be controlled and ultimately lower Your risk for type 2 diabetes.

Why is early detection so important?

After the age of 40, testing for type 2 diabetes should occur every 2-3 years. If other risk factors are present, more frequent testing should occur.

We are probably not aware of the gradual glucose buildup in the beginning stages of type 2 diabetes. Type 2 diabetes develops over time, and early symptoms are often overlooked. Damage to the eyes, heart and kidney often occurs before detection.[3] Early detection of abnormal blood sugar means that changes in diet and exercise may minimize damage to vital organs and prevent type 2 diabetes.

Symptoms of abnormal glucose levels:

- ✓ **Fatigue**
- ✓ **Excessive thirst /frequent urination**
- ✓ **Blurry vision**
- ✓ **Hunger**

What is lifestyle intervention?

Knowing you are "at risk" means you may be able to take steps to:

- ✓ Prevent type 2 diabetes.
- ✓ Decrease damage to the body associated with type 2 diabetes.

Key lifestyle habits to prevent type 2 diabetes:

- ✓ *Improve diet:* (1) help with weight loss if needed; (2) maintain long-term weight loss.
- ✓ *Increase physical activity:* (1) lose weight loss or maintain weight; (2) improve the effectiveness of insulin; (3) prevent loss of muscle mass during weight loss, build lean body mass (muscle).

Diet alone results in loss of water, fat mass and lean body mass (muscle).

Diet plus exercise results in loss of body fat while minimizing loss of muscle mass.

What are the dietary components of a healthy lifestyle?

Everyone has specific dietary wants, needs and preferences. Talking with a registered dietitian to tailor an optimal nutritional program is important. The goal of this program should be a reduction in total caloric intake, which should encourage *moderate* weight loss (5-10 % of initial body weight).[4]

A nutrition and exercise program may:

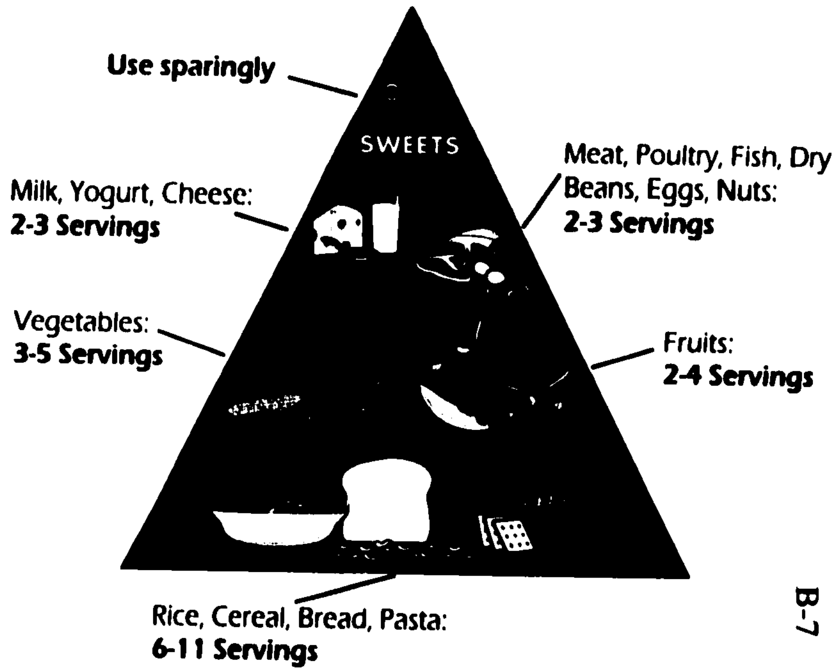
- ✓ Decrease blood pressure.
- ✓ Lower blood sugar.
- ✓ Help the body use insulin more efficiently.
- ✓ Decrease the risk for type 2 diabetes.

The goals are:

- ✓ Slow weight loss (0.5-1.0 lb per week).
- ✓ Expend more calories than consumed.
- ✓ Maintain long-term weight.
- ✓ Improve cholesterol profile.
- ✓ Decrease risk for heart-related diseases.

Any excess calories, regardless of the source (fat, carbohydrate or protein) will eventually result in increased fat storage.

The United States Department of Agriculture and the American Dietetic Association have developed the Food Guide Pyramid to help individuals make healthier food choices. However, *the Food Guide Pyramid will not satisfy everyone's nutritional needs.*[5] An assessment by a dietitian knowledgeable about diabetes should be used to identify individual needs.



Dietary caloric reduction

Sample Week (should be accomplished every week until desired weight loss is achieved):

Mon	Tues	Wed	Thurs	Fri	Sat	Sun
-300 cal/day	-300 cal/day	-300 cal/day	-300 cal/day	-300 cal/day	-300 cal/day	-300 cal/day

- ✓ Make small caloric reductions at each meal for a total daily reduction of 300 calories .
- ✓ Eat smaller, more frequent meals (three meals and one snack).
- ✓ Focus on decreasing saturated fat intake.
- ✓ Counting carbohydrates can help keep blood sugar in check.
- ✓ Limit intake of cakes, candies and sweets.
- ✓ Choose high fiber foods (beans, fruits and green leafy vegetables).

The simplest way to decrease total calories is to reduce the amount of dietary fat, especially saturated fats. See Appendix A for suggestions.

How is body fat measured?

The measurement of overweight and obesity in relation to type 2 diabetes

There appears to be a connection between body mass index (BMI) and the incidence of type 2 diabetes. The higher the BMI, the greater the risk for type 2 diabetes. In addition to a high BMI, an inactive lifestyle further increases the risk for type 2 diabetes. BMI is a ratio between body weight and height. See Appendix D for a BMI chart and directions on how to calculate your BMI.

33% of all Americans are obese, which means that they have a body mass index (BMI) > 30.

Over 50% of adults are considered overweight[6] (BMI > 25).

60-90% of people diagnosed with type 2 diabetes are overweight/obese.[7]

How does exercise improve the profile of an "at risk individual"?

What are the benefits of exercise in preventing type 2 diabetes:

- ✓ Decreases insulin production.
- ✓ More efficient use of insulin.
- ✓ Helps in weight reduction/regain cycle.
- ✓ Helps retain lean body mass (muscle).
- ✓ Improves cholesterol levels.
- ✓ Decreases risk for heart-related problems.

Goal: Weight loss while retaining lean body mass (muscle tissue).

General benefits of exercise:

- ✓ Increased energy.
- ✓ Decreased appetite.
- ✓ Weight control/loss.
- ✓ Increased sense of well being.
- ✓ Lower blood pressure.

For individuals "at risk", medical clearance should be obtained before beginning an exercise program.

The importance of aerobic exercise in the prevention of type 2 diabetes

Aerobic activities are activities that elevate heart rate within a recommended range for an extended period of time. Benefits include:

- ✓ Improved circulation.
- ✓ More efficient use of insulin.
- ✓ Decreased insulin production.
- ✓ Helps with weight loss.
- ✓ Lowers blood sugar.

Recommendations:

- ✓ Seek guidance from an exercise physiologist/trainer.
- ✓ Choose a moderate exercise intensity.
- ✓ Begin exercising for 15 minutes on 3-4 days per week.
- ✓ Begin exercise program slowly.
- ✓ Choose an activity that you enjoy.
- ✓ Incorporate exercise into daily routine.

Recommended heart rate ranges and formula

220 – age = maximum heart rate (HR max)

Exercise should be completed at moderate intensities (50 – 60%) of maximum heart rate

For obese/sedentary individuals, the American College of Sports Medicine recommends beginning exercise between 50% - 60% maximum heart rate.[8] See Appendix B for activity suggestions.

Example: A 50 year old, sedentary female wants to begin a low intensity (50-60 %) aerobic exercise program. She would calculate her exercise heart rate range by:

220-50 = 170 beats per min is her HR max

170 X .50 = 85 beats per min (low end range)

170 X .60 = 102 beats per min (high end range)

Initially, she would want to exercise at a heart rate between 85 -102 beats per minute for 15-20 minutes. Ultimately, the goal is to accumulate 30 minutes of aerobic activity per day.

Example of moderate aerobic exercise program

Sample week (should be accomplished every week until weight loss goals are achieved).

Mon	Tues	Wed	Thurs	Fri	Sat	Sun
30 min. walk	Circuit weight training	30 min. swim	Circuit weight training	30 min. bike	rest	light activity

Gradual increases in *duration* (time spent) should occur first, after week 2 (from 15 to 20 minutes/day) until 30 min per day is achieved.

After 1 month, changes in *frequency* should occur (from 2 to 3 days/wk to 3 to 5 days/wk).

***Intensity* (refers to heart rate in response to exercise) should be adjusted only when an individual is comfortable with the existing intensity.**

Circuit weight training and the prevention of type 2 diabetes?

Circuit weight training uses lighter weights and shorter rest periods between exercises. This setup benefits "at risk" individuals because lighter weights minimize injuries while building or retaining lean body mass.[9]

The benefits of a circuit weight training program include:

- ✓ More efficient use of insulin.
- ✓ Increased or prevent loss of lean body mass.
- ✓ Decreased fat mass.
- ✓ Improved cholesterol levels.
- ✓ Decreased blood sugar.

For suggestions about specific circuit weight training exercises, see Appendix C. *Having access to weight facilities will effect the circuit weight program.*

Increased muscle mass expends more calories than any other tissue.

Sample diet and exercise training program

	↓ calories (diet)	↑ calories (exercise)	Total caloric reduction
Monday	-300	-300 (aerobic)	- 600
Tuesday	-300	-300 (weights)	- 600
Wednesday	-300	-300 (aerobic)	- 600
Thursday	-300	-300 (weights)	- 600
Friday	-300	-300 (aerobic)	- 600
Saturday	-300	Rest	- 300
Sunday	-300	Light activity	- 300
Weekly total	- 2100 cal	- 1500 cal	- 3600 cal

One pound of fat is equivalent to 3500 calories. By following the sample, one pound of fat may be lost per week. The circuit weight training should help to retain muscle mass and use insulin more efficiently.

Staying with the program

Motivation for initiating changes:

Prevent type 2 diabetes complications

- ✓ Decrease risk for cardiovascular problems.
- ✓ Improve blood pressure.
- ✓ Improve cholesterol.
- ✓ Maintain or improve quality of life.
- ✓ Minimize risk for diabetic-related complications.

Strategies for implementing changes in exercise:

- ✓ Find an exercise partner.
- ✓ Find an activity that you enjoy (walking,
- ✓ swimming, jogging or biking).
- ✓ Begin exercise program slowly.
- ✓ Make gradual changes to program duration's, frequencies and intensities.
- ✓ Incorporate exercise into everyday life (taking stairs, walk to lunch, park farther from work etc).
- ✓ Maintain positive attitude about changes.
- ✓ Complete aerobic exercises throughout the day (3 times/day for 10 minutes each session) for a total of 30 minutes per day.
- ✓ Get adequate rest between exercise sessions.

Strategies for changing diet:

- ✓ Concentrate on one aspect at a time (decreasing portion sizes).
- ✓ Involve a partner or friend in healthier eating habits.
- ✓ Talk to a registered dietitian about your goals.
- ✓ Maintain exercise routine.
- ✓ Get positive reinforcement from a friend or partner.

A healthier lifestyle will result from a lifestyle intervention, regardless if type 2 diabetes is prevented or not.

Outcomes of a lifestyle intervention

Healthier lifestyle due to:

- ✓ Increased physical activity.
- ✓ Better mental functioning/outlook.
- ✓ Increased self-esteem.
- ✓ Weight loss (fat).
- ✓ Decreased saturated fat will improve.

cholesterol levels while decreasing risk for heart-related problems associated with type 2 diabetes.

The prevention of type 2 diabetes is dependent upon:

- ✓ Genetic make-up of individual.
- ✓ Compliance with dietary and exercise suggestions.

Even if type 2 diabetes does occur, the lifestyle changes should minimize the impact of complications as well as the severity of diabetes itself.

Endnotes

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5. Food Guide Pyramid adapted from the United States Department of Agriculture/United States Department of Health and Human Services.
6. Bray, "Pathophysiology", p 490s.
7. Harris, 1987. "Prevalence", p 525.
8. ACSM's Guidelines for Exercise Testing and Prescription, 1995, 218-219.
9. Erikkson, J., 1998. Aerobic endurance exercise or circuit-type resistance training for individuals with impaired glucose tolerance? Hormones in Metabolic Research, vol 30, 37-41.

Appendix A: Methods to Decrease Fat Intake

- ✓ Choose low-fat or non-fat dairy products (milk, cheese, yogurt and ice cream).
- ✓ Trim excess fat from meats.
- ✓ Remove chicken skin before cooking.
- ✓ Avoid frying foods, try broiling foods instead.
- ✓ Avoid trans fatty acids (margarines, partially hydrogenated food products).
- ✓ Use olive oil or canola oil to cook with.
- ✓ Use healthy fats (almonds, hazelnuts and other nuts/seeds) in place of saturated fats.
- ✓ Talk to a registered dietitian to develop a specific program for you.

Appendix B: Aerobic Activity Choices

- ✓ Walking
- ✓ Jogging
- ✓ Biking
- ✓ Swimming
- ✓ Stair climbing
- ✓ Yard-work
- ✓ Hiking
- ✓ Circuit weight training
- ✓ Housework

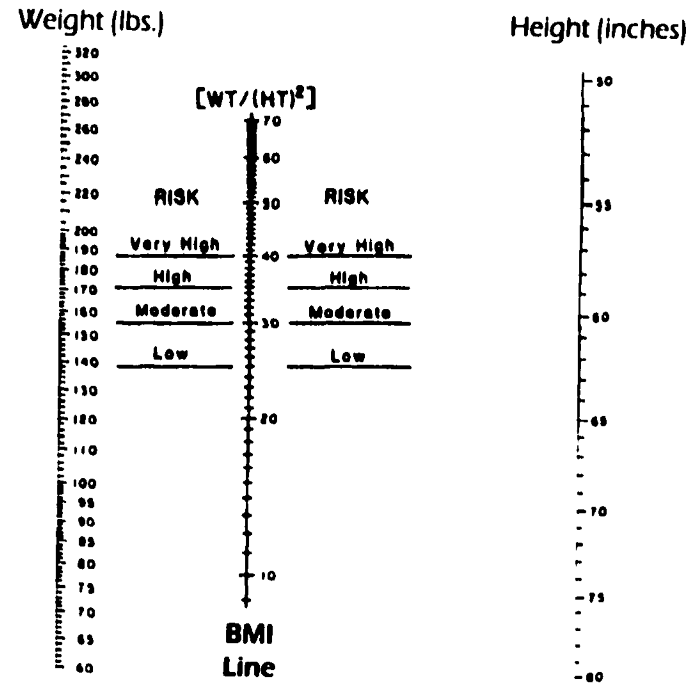
Appendix C: Circuit Weight Training Exercises

- ✓ Exercises should focus on upper and lower body.
- ✓ Large muscle groups should be worked: chest, back, legs and arms.
- ✓ Work with an exercise specialist who is familiar with circuit weight training.
- ✓ Train by using lighter weights, more exercises and shorter rest periods.
- ✓ Maintain adequate rest between workout sessions (Monday and Thursday, or Tuesday and Friday).
- ✓ Proper stretching is vital to prevent injuries, especially when beginning a weight training program.
- ✓ Access to weight machines will limit the ability of individuals to participate in circuit weight training. Free weights may be used as an alternative, if needed.

Appendix D: BMI Chart and Directions

Determine your weight and height. Use a ruler and draw a line connecting weight to height. The point where it crosses the BMI line is your body mass index.

Body Mass Index



Helpful Phone Numbers/Web Sites

For information on nutrition, exercise and prevention of type 2 diabetes, call or contact the American Diabetes Association:
www.diabetes.org
1-800-342-2383

For information on contacting an exercise physiologist or trainer, call the American College of Sports Medicine:
1-800-486-5643

For nutrition help and contacting a registered dietitian, call or contact the American Dietetic Association:
www.eatright.org
1-800-877-1600

To learn more about exercise and diabetes, contact the International Diabetes Athletic Association:
www.getnet.com/~idaa
1-800-898-4322

Appendix C

Health Professional Evaluation

Instructions for health professional evaluators: A Likert-type scale will assess the efficacy of the proposed lifestyle intervention manual. A evenly weighted scale with 1 equaling "strongly disagree" and 5 equaling "strongly agree" will be used. Following each question, circle the appropriate number which conveys your agreement or disagreement with the question. Additional space is provided for further comments.

1--Strongly Disagree

2--Disagree

3--Neutral

4--Agree

5--Strongly Agree

1. The language and writing style are easily understood.

   1 2 3 4 5

   Comments:

2. The introduction provides enough information to clarify the objectives of the manual.

   1 2 3 4 5

   Comments:

3. The nutritional recommendations are straightforward and easy to comprehend.

   1 2 3 4 5

   Comments:

4. The dietary recommendations are feasible for middle-aged men and women.

1 2 3 4 5

Comments:

5. The manual properly identifies who is an “at risk” individual.

1 2 3 4 5

Comments:

6. The exercise recommendations are feasible for middle-aged men and women.

1 2 3 4 5

Comments:

7. The exercise recommendations are straightforward and easy to comprehend.

1 2 3 4 5

Comments:

8. The manual represents a feasible and realistic approach to preventing type 2 diabetes.

1 2 3 4 5

Comments:

9. Professionally, I would use this information to educate individuals "at risk for type 2 diabetes.

1 2 3 4 5

Comments:

10. As a health professional, I feel that there is a need for more information about preventing type 2 diabetes..

1 2 3 4 5

Comments:

Appendix D

"At Risk" Evaluation

Instructions for "at risk" evaluators: A Likert-type scale will assess the efficacy of the proposed lifestyle intervention manual. A evenly weighted scale with 1 equaling "strongly disagree" and 5 equaling "strongly agree" will be used. Following each question, circle the appropriate number which conveys your agreement or disagreement with the question. Additional space is provided for further comments.

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Comments:

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1 2 3 4 5

Comments:

7. The exercise recommendations are straightforward and easy to comprehend.

1 2 3 4 5

Comments:

8. As an individual "at risk" for type 2 diabetes, I believe there is a need for information on preventing type 2 diabetes.

1 2 3 4 5

Comments:

9. This manual represents a practical approach to preventing type 2 diabetes.

1 2 3 4 5

Comments:

10. I would use the information in this manual to educate myself about the prevention of type 2 diabetes.

1 2 3 4 5

Comments: