

The Effects of a Walking Exercise Program on Glucose Control in Type 2 Diabetes Mellitus

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Abstract

Individuals with type 2 diabetes are often unaware that physical activity can improve glucose utilization and thereby decrease blood sugar. The author investigated a 16 week walking intervention on Type 2 diabetics and the impact this exercise has on HbA1c levels, weight loss and exercise levels. Two men and seven women (n = 9) participated in the program. Results indicated significance increase in physical activity levels (t = 11.08 p = .001) and increased weight loss (t = 12.5 p = .001) but no significance difference for HbA1c (t = 1.4 p=1.08). Implications include the benefits of walking on other health outcomes and the need for long term commitments to exercise because some outcomes such as HbA1c may take longer to show improvement.

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Introduction

A Disease Burden

Type 2 diabetes mellitus (T2DM) is a chronic disease that has become an epidemic in the United States with levels continuing to rise. Statistics from the American Diabetes Association (ADA) (Centers for Disease Control and Prevention, {CDC}, 2011a), revealed an estimated 25.8 million adults (8.3% of the population) and children have diabetes, 7 million are undiagnosed, 79 million have prediabetes, and 1.9 million people aged 20 years or older were newly diagnosed with diabetes in 2010.

Economic Impact

The cost attributable to the diagnosis of diabetes in 2007 was \$174 billion dollars (116 billion in direct and 154 billion in indirect medical costs). Further sobering statistics reveal estimated costs for undiagnosed diabetes and pre-diabetes to be \$18 billion and \$25 billion, respectively, with an additional cost for gestational diabetes of \$623 million during 2007 in the United States (“Diabetes Statistics”, 2011)

T2DM is a metabolic disorder involving the pancreas which results in an inadequate insulin production, inability of insulin action, or a combination of these two outcomes. Type 2 DM is often undiagnosed until chronic elevations of plasma glucose levels reveal the insidious effects of hyperglycemia on susceptible organs leading to neuropathy, nephropathy, retinopathy and cardiovascular disease (Hayes & Kriska, 2008; Irvine & Taylor, 2009). In T2DM muscle cells do not respond to insulin properly (insulin resistance) and there is an inappropriate compensatory insulin production which further exacerbates end organ target damage (ADA, 2012; Colberg et al., 2010). Exercise or physical activity has been known to improve diabetes

and is a low cost treatment option for T2DM. Unfortunately, patients often lack an understanding of how participation in physical activity may improve the glucose utilization. Walking is an exercise that offers one of the best means of reducing blood sugar in sedentary people or those at risk of developing the disease (Baker, Mutrie & Lowry, 2008; Irvine & Taylor, 2009).

In T2DM insulin resistance is improved during exercise when contracting muscles take up blood glucose (BG) and intake of glucose is further enhanced as exercise intensifies or is prolonged (Colberg et al., 2010). Long term measurement of glucose control with hemoglobin A1C (HbA1c) provides information on how well glucose is being utilized. The HbA1C is an accurate measure of blood sugar across a three month period and one of the most accurate measures of diabetes management and insulin regulation (Balatbat, 2010). Despite the importance of HbA1c levels, individuals are often unaware of their target levels of HbA1c (Nesbeth, Orskov, & Rosenthal, 2009).

Problem identification

The U.S. Department of Health and Human Services (USDHHS, 2008a) recommends 2.5 hours or 150 minutes of moderate intensity activity weekly. These guidelines were written in response to persistent disappointing levels of inactivity among Americans which falls short of Healthy People 2020 goals to reduce the proportion of adults who engage in no leisure-time physical activity, and increase the proportion of adults who meet Federal physical activity guidelines for aerobic physical activity and for muscle-strengthening activity, among others, that address physical activity at the population and individual level (USDHHS, 2008b).

Sedentary lifestyles contribute to weight gain and increase the risk for T2DM among adults and children. Despite the problems associated with inadequate activity levels and the

benefits of exercise, fewer than half of American adults attain the recommended amount of physical activity (USDHHS, 2008a). In one longitudinal qualitative study, participants placed less value on regular physical activity, lost interest and motivation to exercise and walk with time, and lacked the understanding of physical activity being fundamental to diabetes management (Peel, Douglas, Parry and Lawton, 2010). These researchers recognized the importance of physical activity in T2DM but theorize that here is a lack of knowledge in how to implement advice and sustain activities.

When physical activity is continued on a regular basis and integrated with other lifestyle changes, T2DM can be prevented or delayed (Diabetes Prevention Program {DPP}, 2011; Peterson, 2007). Despite the health benefits of physical activity, individuals with diabetes were found to exercise less often than people who did not have diabetes (39% versus 59%, respectively) (Allen, Jacelon and Chipkin, 2009) This increases health care costs and creates significant health and psychosocial problems across the population (CDC, 2011b).

Consequences of the problem

Individuals with T2DM often exhibit poor glucose control which can lead to the chronic complications of nerve damage, preventable blindness, kidney failure and cardiovascular disease (heart disease, strokes and non traumatic limb amputations) and ultimately leads to death (Waryasz and McDermott, 2010). Diabetes was the seventh leading cause of death in the year 2007 (CDC, 2011a). Allen, Jacelon & Chipkin, (2009) found that the mortality that is directly related to diabetes could be reduced through an increase in physical fitness and structured exercise programs or by integrating physical activity in daily routines despite an individual's race or income.

Practice gaps

In a study on activity levels among diabetics it was found that less than 3% of participants had physical activity assessments reported or received advice in regards to physical activity (Marshall, Smith, Bauman, & Kaur, 2005). Researchers in this study mention that assessment of physical activity levels may require extended office visit times and consequently are not assessed as part of the individuals' routine history (Marshall et al., 2005). Peterson (2007) also mentioned time restrictions, daunting tasks, including the provider's perceived limited knowledge about counseling, uninterested patients, and competing office priorities as barriers.

Because an assessment of exercise patterns and education about the benefits of exercise are not part of the normal primary care visit, patients may not feel that physical activity is important to their health. Furthermore, patients with T2DM may not understand the significant role of exercise or physical activity in controlling their blood sugar levels nor understand the improved outcomes regular exercise can provide.

Evidence based solutions

The American Heart Association (AHA, 2011) lists modifiable risk factors such as obesity, being overweight and physical inactivity as barriers to preventing diabetes from developing. Lifestyle changes, which included physical activity, were associated with disease improvement in patients with T2DM in the historical 2002 Diabetes Prevention Program study (DPP, 2008). Walking, is a form of exercise that can be undertaken by most people, is inexpensive, and may be done using 10-minute intervals several times a day or at longer walking episodes several times a week, and can also be reasonably recommended for most people with T2DM (Colberg, et al., 2010).

Walking is considered a mild to moderately intensive physical activity that may have an effect on serum glucose levels. Negri et al., (2010) evaluated 59 subjects randomized into a control group and an intervention group. The intervention group was organized into walking groups that exercised three days a week gradually increasing the intensity and time to 45 minutes at each session. Participants were followed at two months and four months where baseline measures and walking activity were obtained and compared. The results indicated improved HbA1c levels over control groups. Clearly, a walking exercise program would benefit people with T2DM and should be individualized as proclaimed by Johnson, Boulé, Bell and Bell (2008), to eventually increase the frequency and intensity of the activity due to walking activity's ability to lessen plasma glucose levels.

Literature Review

A review of relevant literature found limited studies that evaluated the effect of walking on T2DM. However, there were many studies that included increased exercise activity to determine the effect of physical activity on plasma glucose levels in diabetes.

The Effect of Exercise

In a randomized control clinical trial using three groups, researchers found that intensive lifestyle interventions reduced diabetes prevalence by 58%, with a startling 71% reduction in adults 60 years and older over a three year period (DPP, 2008). In this landmark study, eligible participants were randomized to an intensive lifestyle intervention described as $\geq 7\%$ of weight loss and maintenance of weight loss; 1200-1800 k/cal consumption per day with $\leq 25\%$ of those being fat calories; and ≥ 150 minutes of physical activity per week. Another experimental group received metformin, and the other was a placebo group. Results indicated that intensive lifestyle intervention was efficacious in all age groups, including those over 60 years old. In addition,

lifestyle changes were more successful than the metformin arm. It was further mentioned in Healthy People 2020 (USDHHS, 2008b) that lifestyle interventions consistently revealed benefits despite differences in age, BMI, gender, and cultural background and had a significant impact in older age individuals, and effective in racial and ethnic groups.

Similar evidence was demonstrated by Irvine & Taylor (2009) in a large systematic review of nine randomized trials involving 372 participants with T2DM revealed that these patients improved hgbA1c through resistance exercise. Individuals who completed at least an eight week trial of progressive resistance exercise improved 55% toward meeting the target hgbA1c goal of 7.0 % (Irvine & Taylor, 2009).

To further compare exercise versus inactivity in the diabetic population, a study of Black women by Krishnan, Rosenburg, and Palmer (2008) evaluated sedentary activity, such as a considerable amount of time watching TV daily (five hours), with no physical activity, and found an association with the development of T2DM compared to black women who had a brisk walking activity and watched less than one hour of television per day. The need to promote the health benefits of exercise in preventing diabetes is clear, and a walking exercise program may be the key to reduce disease burden.

Assessment and prescription of physical activity

O'Dwyer & Coote (2010) discussed the importance of assessing current levels of participation in physical activity to determine whether recommendations are necessary for an individual or certain at risk populations to improve a condition or prevent a disease such as diabetes from developing. The principal purpose of assessing physical activity is to determine the impact of suggested or prescribed activities as part of the therapeutic regime and whether individuals fulfill them and improve health outcomes or to evaluate the level of success and make new proposals.

The office visit setting is an ideal encounter for this assessment, but in order for this to be practical, an assessment tool would need to ask useful questions and be quickly and easily administered in current time-pressured office visits (Marshall et al., 2005). A brief activity questionnaire can produce important information regarding exercise levels in office patients and whether current levels are sufficient. Attitudes and beliefs about exercise can be discussed along with identification of barriers to tailor an individual approach.

Proposed Solution

Oberg (2007) advocates a discussion of the health benefits of specific activities prior to starting a physical activity program and an explanation of the immediate health benefits of any exercise. Walking, a common aerobic exercise, for example, was found to improve glucose utilization and insulin sensitivity within 30 minutes of exercise and was further improved as intensity increased. People need specific, individualized instructions similar to medication prescriptions detailing the dose, amount, frequency and intensity of an activity to be successful at physical activity.

Promoting physical activity as part of a healthy lifestyle can be done by encouraging patients to be more active in daily routines and choosing options that increase movements while performing daily chores or tasks. Others clinicians may prefer the individualized approach of a structured program to ensure an increase in activity levels. Waryasz & McDermott, (2010) found that instructions for exercise are often vague and not specific and that for most people a prescription for exercise is more effective. Using a prescription allows the patient to know exactly what exercise intensity, duration, and activity are prescribed based on the individual need.

Patient education about exercise has been shown to help individuals with T2DM improve physical activity. Using a convenience sample of patients who participated in an intervention

where instructions and a pedometer was used to log the steps accomplished daily, Vincent (2009), recorded increased physical activity over time from 4175 steps to 7238 daily steps and was a statistically significant increase ($t = -2.51, p = .03$). Other outcomes of interest in the study were improved plasma glucose (hgb1c levels) and weight loss. The use of a pedometer may be a suitable tool in facilitating a walking exercise program in T2DM by setting individualized goals, increasing daily steps to be more physically active and helping to control blood sugars.

Marshall et al., (2005) advocated incorporating an assessment of physical activity levels (including walking as a moderately intense activity) as part of the individual's routine history that may enable identification of who needs physical activity counseling by their practitioners. Marshall et al., (2005) further investigated the reliability and validity of a brief physical activity assessment tool to be used in the primary care setting and found that although the information did not yield comprehensive information about exercise activity for the participants, the tool did identify individuals who were insufficiently active in meeting physical activity guidelines and was quickly administered during the office visit. Providers are in a position to offer advice, counsel, educate, and prescribe physical activity when a brief activity questionnaire is easily and quickly administered.

Engaging patients in the office setting, who are identified as inactive, overweight and have T2DM presents an opportunity to improve health, lessen the economic, and societal burden of this disease for those individuals. A prescription for a walking exercise program in patients with T2DM would make exercise expectations clear for the participants and increase compliance. A follow up appointment also provides the opportunity to dialogue and encourage patients for continued motivation and evaluate the effectiveness of the walking activity to promote self care efficacy.

Methods

Project Description and Procedure

This project evaluated a walking exercise program to improve physical activity levels among outpatients with T2DM in a primary care office setting. The objective of this program was to increase walking activity on a weekly basis setting a goal of 15 minutes of walking three days a week and increasing this amount to an ultimate goal of 30 minutes daily, five days a week. The intention was to increase the duration, intensity or frequency of walking over a 12-16 week time frame. The program was approved by the Christine E Lynn College of Nursing at Florida Atlantic University. The primary care practice from which patients were recruited approved the project and allowed the project director to place flyers and ask patients to participate. Participants were excluded if they were insulin dependent due to the potential physiological response to increased physical activity while using exogenous insulin, the ability to read, speak and write in English and be free of disabilities or medical conditions limiting their ability to walk. Other exclusion criteria include unwillingness or difficulties in meeting program requirements, lack of transportation and telephone service as patients would require follow up appointments and blood work, appointment reminders and telephone service for occasional phone calls to provide encouragement and reminders to exercise.

Participants

A convenience sample of 20 participants both men and women, who were over 18 years of age from a primary care office were invited to participate. Ten declined to participate due to failure to meet program commitment requirements and the presence of other co morbidities limiting full participation. Ten outpatients, between 47 to 70 years who had an existing diagnosis of T2DM were recruited. One individual, who agreed to participate, was lost to follow up after the first visit due to failure to have the baseline lab work done by week six. There were two

males and seven females age 47 to 70 years old who had an existing diagnosis of T2DM. Six classified themselves as White, non Hispanic, three as African American or Black. Two had less than high school education, five had completed high school and two had some college. All the participants were able to speak, read and write in English. The participants were undergoing different treatment strategies for T2DM with diet, exercise and or metformin, or lifestyle changes as part of their care. The final sample size was $N = 9$

Project

A participant introduction to the 16 week walking exercise program was completed by the nurse practitioner and program objectives were explained to potential participants during a routine appointment. Questions regarding program expectations, safety and uncertainty were addressed for the participants and they were further reassured that there would be no additional costs associated with participation other than that expected for routine diabetic follow up care and lab work. Patients who agreed to participate gave informed consent and then were asked to fill out a self-reported demographic information questionnaire and asked to answer a brief physical activity questionnaire. The information was placed in a participant's file along with a copy of the most recent lab work obtained from the medical records prior to recruitment. Participants were given adequate privacy during the interview process and confidentiality was preserved by maintaining records in a separate file cabinet accessible only by the nurse practitioner for study purposes.

The participants were provided with an activity, weight and self monitoring blood glucose log and given directions in how to complete them. Contact information was exchanged with the participants and the nurse practitioner to facilitate communication for the following 16 weeks should any questions or issues arise. An arrangement to review logs and compliance was scheduled as an office visit (at no cost) or as a follow up contact by phone or email between the

nurse practitioner and the participants at four to six weeks and throughout the program to review progress and logs, and explain the effects of physical activity on the information provided. It was also an opportunity for encouragement to stay active, address any obstacles that impeded walking activities and resolve the challenges encounters. Individuals were praised for independently designing strategies to maintain walking activity in their lives which reinforced self-care efficacy.

Participants were scheduled to have lab work which included a HbA1c, fasting blood sugar and a lipid panel done by week 12 to 16 of the program allowing them enough time to work in the follow up visit into their busy schedules because many of the participants had many other obligations that prevented them to follow up at a precise time. The flexibility of follow up contributed to participation and completion of the program intervention and adequate time to review the results of the outcomes by 16 weeks.

Measures

Demographic information including; age, gender, race, ethnicity, marital status, education, and length of time with T2DM was recorded. In addition, a brief physical activity questionnaire (Marshall et al., 2005) was completed by the participants measuring the level of physical activity at the start of the program using two questions that assess how much time is spent performing vigorous physical activity and moderate physical activity. This questionnaire was used as a pretest to gauge baseline activity and walking levels and as a post test for comparison at 16 weeks. Vigorous activity was described as activity that makes you sweat, puff or pant (e.g. jogging, digging, aerobics or fast bicycling). Moderate physical activity was described as walking activity that increases your heart rate or makes you breathe harder than normal (e.g. mowing the lawn, carrying light loads, bicycling at a regular pace, or playing tennis). The intensity, duration, and amount of time physical activity was performed a week will

be given a score for either level and then tallied as score. A score greater than four was considered sufficiently active and participants were encouraged to keep it up and to add walking activity. Those who scored zero to three were insufficiently active and encouraged to start walking setting a small goal of 15 minutes and increasing the time spent walking.

A daily record of exercise activity and weekly weights were logged on a self monitoring blood glucose log by the participants. Other measures included standardized HbA1c as a measure of long term serum glucose control (Balatbat, 2005) and weight (using a balance scale) obtained prior to recruitment as a baseline measure and by 16 weeks.

Results

Physical activity levels were insufficient at baseline for seven of the nine participants. At four to six weeks all the participants had increased their walking activity to meet the short term goal of walking three days a week and by 16 weeks were walking four days a week for 30 minutes. The participants also had baseline weights and HbA1c levels and had a repeat measure obtained at 16 weeks. A paired *t*-tests was used to compare participants physical activity levels, weights and HbA1c for significance. The findings indicated that there was a significance increase in physical activity levels ($t = 11.08$, $p = .001$) and a significant decrease in weight ($t = 12.5$, $p = .001$) between weeks one and 16 of the program. No significance difference in HbA1c ($t = 1.4$, $p = 1.08$) levels between week one and 16 were noted.

Discussion

Physical activity and weight showed a significant difference between pre and post measurements. Increases in physical activity and decreases in weight can be attributed to the education and encouragement participants received from their primary care provider.

Although the primary outcome of HbA1c did not indicate significance between pre and post test measures, patients with T2DM gained a better understanding of the effects of exercise on other health outcomes. Implications for nursing and health care from this project are that making an effort to assess a patient with T2DM's physical activity level and prescribing a reasonable exercise program that increases in duration and intensity over time can assist patients to undertake a physical activity program and lose weight. Primary care providers should be encouraged to discuss physical activity with patients and help them to understand the role of physical activity in the treatment of T2DM.

Limitations of this program evaluation include the small number of participants and lack of Hispanic representation due to language barriers. The findings may also have been influenced by a close association with the participants who were motivated by the nurse practitioner to exercise but may also indicate that part of a successful walking exercise program may require social support to maintain the motivation to walk.

Conclusion

The benefits of physical activity are well recognized in the literature in preventing and managing T2DM but is used broadly and may be vague as to what constitutes being active. Patients need clarification of what is meant by exercise and a prescription for walking simplifies what is expected. Walking is considered a moderately intense physical activity and is one of the best forms of exercise available to all, and has limited risks associated with it. Many of the benefits reach beyond the expectations of improving serum glucose in the T2DM population and needs to be promoted in individuals who are inactive.

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