EXPLORING FACTORS THAT INFLUENCE DIABETES EDUCATOR'S PHYSICAL ACTIVITY COUNSELING DURING DIABETES SELF-MANAGEMENT EDUCATION AND SUPPORT

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EXPLORING FACTORS THAT INFLUENCE DIABETES EDUCATOR'S PHYSICAL ACTIVITY COUNSELING DURING DIABETES SELF-MANAGEMENT EDUCATION AND SUPPORT

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Physical activity (PA) is considered a cornerstone to diabetes management and care. Diabetes educators (DE) come from a variety of health disciplines and are responsible for delivering physical activity counseling to patients during Diabetes Self-Management Education and Support (DSME/S). PURPOSE: The purpose of this study was to identify factors that may influence physical activity counseling during the delivery of DSME/S. METHODS: Pennsylvania DEs were recruited from the State Diabetes Conference and surveyed regarding their: time dedicated to PA counseling; importance placed on PA as a treatment; knowledge of the current PA Guidelines for American Adults (PAGAA); level of confidence with PA counseling; barriers associated with PA counseling. RESULTS: 119 DEs participated in the survey (95.8% female; 94.1% Caucasian; 60.5% nurses; 73.9% Certified Diabetes Educators (CDE)). Mean age was 51.9 ±10.7 years with a mean of 13 ±8.62 years delivering DSME/S. Of the 4 content areas examined during DSME/S (healthy eating, taking medications, monitoring blood glucose and being active), DEs spent the least amount of time addressing PA during DSME/S (14.5 ±12.1 minutes). DEs ranked PA as the 3rd most important treatment modality behind healthy eating and taking medications but above monitoring blood glucose. Nearly ¾ (74%) of DEs reported the correct PAGAA for moderate intensity aerobic activity. However, only 40.2% of DEs reported knowledge of vigorous intensity aerobic activity with 51% acknowledging resistance training guidelines. Approximately half (54.7%) of DEs reported “very confident” counseling on PA during DSME/S. When examining barriers with PA counseling during DSME/S, DEs ranked “inability to engage patients on PA” as the most challenging personal barrier while “time allotted for DSME/S visits was reported as the greatest challenge to counsel on PA within as a practice barrier. CONCLUSION: DEs have an obligation to discuss PA as a treatment strategy during DSME/S. These data lend credence to the improvement of effective PA counseling within DSME/S delivery.

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PREFACE

I have been so fortunate to be surrounded by such prestigious professionals in their respected fields of physical activity and diabetes throughout this endeavor.

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1.0 BACKGROUND AND RATIONALE

The burden of diabetes has risen exponentially in the United States (U.S.). The most recent reports suggest that diabetes affects approximately 29 million people living in the U.S. with approximately 1.5 million newly diagnosed cases each year [1, 2]. The prevalence of diabetes may double by the year 2050, thereby estimating that 1 in 3 Americans will have developed this disease [3, 4]. Diabetes increases the risk of cardiovascular disease mortality by 3 fold and is the leading contributor of new cases of blindness, stroke, non-traumatic amputations, and kidney disease [5-7]. Rates of depression, anxiety and disability are significantly higher in diabetes patients compared to those who do not have diabetes [8-11]. Additionally, nearly 1/3 of all physician office visits and 40% of hospital outpatient visits have diabetes listed as the primary reason for the encounter [12].

Recent analysis revealed that diagnosed cases of diabetes cost the U.S. nearly $245 billion, with $176 billion attributed to direct health care expenditures [12]. The indirect costs consisting of premature mortality, lost productivity due to work related absenteeism, reduced productivity at work or home and unemployment from chronic disability, cost roughly $69 billion [12]. Approximately 1 in 5 health care dollars in the U.S. is spent caring for someone with diagnosed diabetes, while nearly 1 in 10 health care dollars is attributed directly to diabetes [13].

1.1 PHYSICAL ACTIVITY AS A TREATMENT STRATEGY

Physical activity has long been considered a cornerstone to diabetes management. Through the earlier part of the 20^{th} century, Dr. Elliot Joslin, a prominent physician of diabetes care, recommended that his patients take up exercise to improve glycemic control and to avoid early death and complications [14]. Since this time, compelling evidence of the numerous health benefits of physical activity for those seeking to prevent or manage diabetes continues to increase [15-17]. Such benefits include improved insulin action, lower blood glucose levels, reduced risk factors for cardiovascular diseases, sustained bodyweight and enhanced functional mobility [18-23].

A single bout of exercise has been shown to improve insulin action and glucose clearance within skeletal muscle [24]. While these effects vary and have been shown to diminish as quickly as a few hours to a few days post session, habitual bouts of physical activity provide sustained effects [25, 26]. However, the level of improvement is impacted by such factors as diabetes control, the volume of exercise administered, and fitness status [20, 27-29]. For example, Jakicic et al. reported that 4 year improvements in cardiorespiratory fitness was inversely associated with hemoglobin A1c (HbA1c) levels in overweight and obese individuals with type 2 diabetes, even after adjusting for diabetes medication use, baseline HbA1c, weight change, and baseline fitness levels [30].

Alternatively, resistance training is a valid mode of exercise to improve insulin action and glycemic levels [19, 31-33]. This suggests that additional physiological mechanisms initiated through muscular contraction also improve insulin sensitivity [34, 35]. Consequently, recent reports propose that the combination of aerobic and resistance training may be more effective for blood glucose management compared to either type alone [27]. For example, while Sigal et al.

determined that aerobic exercise or resistance training alone improved glycemic control in adults with type 2 diabetes, improvement was even more pronounced when patients participated in a combination of aerobic and resistance training [36].

The therapeutic benefits of physical activity may also alter pharmacotherapy treatment by reducing the amount of insulin or hyperglycemic medications needed by patients [37-40]. Campbell et al. determined that patients with type 1 diabetes may need to reduce prandial insulin before and after an exercise bout by 25% and 50%, respectively, to avoid post exercise hypoglycemia [38]. The ability to reduce the volume of insulin per day can further benefit the patient by attenuating the unfavorable weight gain accompanied with insulin regimens [41, 42]. According to findings from the Look AHEAD Research Group, overweight adults with type 2 diabetes who lost weight through a lifestyle program that included physical activity, took less medication for hyperglycemia, hypertension and hyperlipidemia compared to a usual care group [43]. Physical activity has also been shown to be associated with reduced medication costs related to diabetes management [43]. These cost savings may benefit all patients, particularly those with multiple pharmaceutical therapies and restricted prescription coverage.

1.2 PHYSICAL ACTIVITY GUIDELINES

The *1996 Surgeon General's Report on Physical Activity and Health* was a landmark publication that highlighted the importance of physical activity for a variety of health-related outcomes [44]. Following this document, the *2008 Physical Activity Guidelines for Americans* made specific recommendations on the health benefits of regular physical activity for Americans [44, 45].The key recommendation of this report is for adults (age 18 years and older) to engage in a minimum of 150 minutes of moderate intensity aerobic activity, or a minimum of 75 minutes of vigorous intensity aerobic activity, or an equivalent combination of moderate and vigorous intensity aerobic activity, per week for substantial health benefits. Included is also a recommendation of at least 2 days of moderate or high intensity muscle strengthening activities (i.e. resistance training) involving all major muscle groups, each week [45]. Regardless of diabetes status (type 1, type 2, gestational), all adults with diabetes are encouraged to adopt regular exercise in accordance with these Physical Activity Guidelines for American Adults (PAGAA) [45].

Despite these recommendations and documented health improvements, only 39% of adults with diabetes are considered to be regularly active, as defined by engaging in moderate or vigorous activity $\geq$ 30 minutes, 3 times per week [46]. Not only are those with diabetes more sedentary than the general population, they report greater relapse from physical activity [46]. People with diabetes aged 60 years or older are 2–3 times more likely to report an inability to walk one-quarter of a mile, climb stairs, or do housework compared to people without diabetes in the same age group [46]. A potential contributor to these alarming statistics may be that diabetes patients report that they receive less support, education, and encouragement for physical activity compared with any other aspect of diabetes management [47]. This raises the question of whether current diabetes care specialists possess the knowledge, abilities or the interest to effectively deliver physical activity assessment and education to the diabetes population.

1.3 DIABETES SELF-MANAGEMENT EDUCATION AND SUPPORT

Diabetes Educators (DE) are health practitioners from a variety of disciplines whom traditionally deliver Diabetes Self-Management Education and Support (DSME/S). DSME/S is the formal process through which persons with, or at risk for diabetes, interact and collaborate with the DE to develop and use the knowledge and skills required to reach their self-defined diabetes goals. The American Association of Diabetes Educators (AADE) states, regardless of professional discipline, the DE must be prepared to provide clients with the knowledge and skills to effectively manage all aspects of their diabetes plan [48]. Therefore, DEs must possess a body of knowledge that spans across professional disciplines to provide comprehensive DSME/S.

In 1997, the AADE established a framework of seven self-care behaviors [49]. These seven self-care behaviors, known as the AADE 7, consist of 1) Monitoring 2) Healthy Eating 3) Being Active 4) Reducing Risk 5) Healthy Coping 6) Taking Medication and 7) Problem Solving [49]. Thus, DEs are responsible for the inclusion of a physical activity component for diabetes management. It is illustrated within the "Being Active" self-care behavior that the DE identifies the environmental and physical barriers of patients with diabetes and is further responsible for prescribing an individualized exercise plan of action [49]. Added encouragement to engage the diabetes patient to be physically active is provided in the 2012 AADE Position Statement on Physical Activity and Diabetes [50]. This stance illustrates that the DE should use the most current exercise guidelines (i.e. PAGAA) to tailor the exercise prescription and counsel diabetes patients on safe and effective goals to enhance the patient's clinical and behavioral health outcomes. Despite this, the "Being Active" self-care behavior rooted within the DSME/S framework is routinely under emphasized [47].

A potential barrier to effective education regarding physical activity and diabetes is that historically, DEs have evolved from a nursing or dietetic (nutrition) background. Previous literature has suggested that outpatient nurses, who are certified as a diabetes educator (CDE), do not include exercise teaching in their education programs [51]. Reasons for this were due to a lack of knowledge designing an appropriate fitness plan with multisystem diseases, a lack of resources, and a stereotype of a client's ability and motivation to exercise [51]. A study evaluating health visitors and practice nurses on the promotion of physical activity revealed that only 9% of the nurses correctly described the current recommendations for physical activity [52]. Robbins et al. found that 58% of nurse practitioners routinely advise patients about physical activity [53]. Similar studies have also been conducted on dietitians. For instance, McKenna et al. evaluated the views and promotion of physical activity with registered dietitians (RD) [54] and found that greater than 90% agreed that physical activity promotion was important and should be included in their role. However, only 52% of RDs would ask their patients about physical activity during the initial visit. This percentage fell to 44% during follow up visits [54]. The most common allocation of time promoting physical activity within this sample was 5 minutes. Although, it should be noted that with the exception of the study by Ruby et al. [51], these studies did not specifically include DEs.

1.4 SIGNIFICANCE

Over the years, the DSME/S curricula has evolved from a standard, didactic encounter into an empowerment based model where DEs now spend a great amount of time ascertaining behavioral goals and helping patients to create informed decisions about their diabetes management [55]. According to Funnell et al., empowerment is focused on helping the patient get the resources they need and the outcomes they want [55]. Effective self-management of diabetes requires the expertise of the educator and the expertise of patients to work on their goals, priorities and resources [55]. Given this, it is necessary for the DE to understand the benefits of physical activity and how to provide effective physical activity education to their patients. DEs must assist patients in developing individualized plans that fit their current diabetes control, physical abilities and other lifestyle factors. Due to the complexities of identifying individualized exercise prescriptions in those with diabetes related complications, many DEs may find it difficult to deliver appropriate physical activity counseling to patients. In addition, diabetes patients who participate in physical activity may exhibit major variations in glucose levels that hinder glycemic control. This requires the DE to further address these potential barriers and safety precautions, while reinforcing the benefits of regular physical activity to promote patient adherence [56, 57]. Hence, DEs cannot expect to assist the patient in working toward improved physical activity behavior if the DE is not knowledgeable about physical activity.

Clinical exercise physiologists may be considered an ideal professional to work within a diabetes care team to assess, educate and prescribe appropriate exercise regimens for diabetes patients. However, many care teams do not include a clinical exercise physiologist [58]. Further, only a small percentage of practitioners refer their patients to such specialists [51]. Clinical exercise physiologists do not have a large presence within the diabetes management setting. The 2013 National Certification Board for Diabetes Educators (NCBDE) statistics show that only 45 of the 17, 876 professionals who have the CDE credential are exercise physiologists [59]. This suggests that physical activity education and counseling primarily remains in the hands of DEs with professional disciplines lacking formal exercise training [58]. These issues may be reflective of the current trends in exercise participation in patients with diabetes, which suggests that effective promotion of exercise has been less than ideal [46]. For this reason, it is important to identify factors that may influence physical activity counseling during the delivery of DSME/S. Therefore, this study will explore the following aims.

1.5 SPECIFIC AIMS

The specific aims of this study are to assess Diabetes Educators responses regarding physical activity counseling during their delivery of Diabetes Self-Management Education and Support. The aims will be identified by:

1) The time dedicated to physical activity counseling
2) The importance that they place on physical activity as a treatment strategy compared to other treatment strategies (health eating, monitoring blood glucose and taking diabetes medications)
3) Their knowledge regarding the current, 2008 Physical Activity Guidelines for American Adults
4) Their level of confidence counseling on physical activity
5) The specific barriers that they may encounter regarding physical activity counseling

In addition, the following exploratory aims will be examined to determine the influences of the responses for specific aims 1-5.

6) The discipline in which they are trained
7) Their level of educational training (undergraduate, graduate, post-graduate, etc.)

8) Their clinical practice setting (hospital, primary care, private practice, etc.)

9) Certification as a diabetes educator (CDE)

10) Their personal exercise behaviors

2.0 REVIEW OF THE LITERATURE

2.1 THE BURDEN OF DIABETES

Current estimates reveal that approximately 9.3% of the U.S. population has diabetes with about 1.5 million newly diagnosed cases each year [2, 60]. According to reports from the Centers for Disease Control and Prevention, approximately 5,200 people are diagnosed with diabetes every day [61]. If these trends continue, 1 in 3 Americans will develop this disease by 2050 [3]. Diabetes has taken an exceptional toll on the U.S. through its acute and chronic complications, disability and premature death [62]. For instance, diabetes contributes to over 230,000 deaths annually and is the leading cause of kidney failure, new cases of blindness, and non-traumatic lower limb amputations [63, 64]. The cost of diagnosed diabetes in the U.S. is nearly $245 billion, where $176 billion is attributed to direct health care expenditures and roughly $69 billion is recognized as indirect costs such as absenteeism from work, disease related disability and lost productivity due to early mortality [12]. Approximately 1 in 5 health care dollars in the U.S. is spent caring for someone with diagnosed diabetes, while roughly 1 in 10 health care dollars is directly attributed to diabetes [13].

2.2 CLASSIFICATION OF DIABETES

The etiology of diabetes is commonly classified into 3 categories: type 1 diabetes, type 2 diabetes and gestational diabetes. Unconventional health conditions may also contribute to diabetes such as rare genetic conditions, surgery, infection, pancreatic disease and certain chronic medication use [64, 65]. However, these account for only 1-5% of the diagnosed cases of diabetes.

Type 1 Diabetes

Type 1 diabetes (T1D) comprises approximately 5-10% of all diagnosed cases. It is manifested by the destruction of the insulin producing pancreatic beta cells causing insulin deficiency and overt hyperglycemia [66]. Recent data suggests that T1D is increasing globally at a rate of about 3% per year [67]. While 70% of all T1D cases are diagnosed before 30 years of age, it can present at any age. The root cause of T1D is yet to be elucidated; however, its development is thought to be a result of autoimmune, genetic and environmental factors [68].

Type 2 Diabetes

The most prevalent form of diabetes is type 2 diabetes (T2D) accounting for roughly 90-95% of all cases [65]. T2D is illustrated by a progressive and multifactorial pathophysiology [69]. Initially, insulin resistance is the feature characteristic of T2D leading to inhibited muscle glucose uptake and an overproduction of hepatic glucose leading to hyperglycemia [69, 70]. Further progression can be marked by absolute insulin deficiency [69]. The major risks for T2D include non-modifiable factors such as age, race and family history, as well as modifiable factors such as obesity and physical inactivity [17]. Considering the role of the latter, T2D typically presents with greater health issues (hypertension, hyperlipidemia, sleep apnea, etc.) at the time of diagnosis and in its earlier stages compared to T1D. Consequently, T2D is regarded as one the greatest chronic disease threats of industrialized countries [71].

Gestational Diabetes

Gestational diabetes (GDM) is the most prevalent metabolic disorder during pregnancy effecting approximately 14% of the pregnant population [65]. GDM occurs through glucose intolerance at the onset or first recognition of pregnancy and increases the risk of developing T2D by 40-60% later in life [65, 72, 73]. GDM can be harmful to both mother and fetus with its correlation of preeclampsia, increased birth weight, greater risk of infant death and elevated risk of infant hypoglycemia following delivery [74]. The increased prevalence of obesity and diabetes in females of child bearing years living in the Unites States is enhancing the rates of GDM [75].

2.3 TREATMENT GOALS OF DIABETES

The overarching goal of diabetes treatment is to improve glucose control to prevent the effects of severe variations in glucose levels, as well as to reduce risk factors to prevent the long term complications of microvascular and macrovascular conditions [66]. This approach is guided by evidence based outcomes showing that aggressive control to maintain lower glycemic levels reduces the risk of long term diabetes complications [76-80]. The Diabetes Control and Complications Trial (DCCT) enrolled 1,441 individuals with T1D with the objective to determine whether intensified diabetes therapy could prevent or delay vascular complications compared to conventional therapy [81]. The DCCT unequivocally showed that improving glycemic control reduces the risk for eye, kidney and nerve diseases by 76%, 50% and 60%, respectively [82, 83]. Similarly, the United Kingdom Prospective Diabetes Study (UKPDS) observed the benefits of glycemic control in people with T2D and determined that for every percentage point decrease in HbA1c, the risk for microvascular complications reduced by 37% [80]. Currently, the American Diabetes Association (ADA) recommends using HbA1c as a reliable measure of average glycemic control [84]. It is advocated that glycemic targets be individualized based on clinical judgment [84, 85]; however, for most non-pregnant adults, a reasonable treatment goal reflects an HbA1c of <7% due to the strong predictive values for diabetes complications with greater HbA1c levels [80, 84].

Despite the importance of achieving blood glucose control, only half of individuals with diabetes are currently reaching the clinical treatment goals [86]. Optimal diabetes care is effectively achieved through an eventual triad of variables that include pharmacotherapy, nutrition and physical activity. Nonetheless, according to the 2012 joint positions statement of the ADA and the European Association for the Study of Diabetes (EASD), newly diagnosed diabetes patients with an HbA1c near target (HbA1c <7.5%) may be given the opportunity to engage in lifestyle modification, such as healthy eating and physical activity, for a period of 3-6 months before beginning pharmacotherapy [85]. This approach clearly appreciates the impact that lifestyle change can have on diabetes control. Unfortunately, physical activity is often overlooked as an important component of lifestyle modification intervention when treating diabetes [47, 51].

2.4 PHYSICAL INACTIVITY: AN INDEPENDENT RISK FACTOR FOR DEVELOPING DIABETES

In recent decades, the prevalence of non-exercise (i.e. housework, shopping, vocational movements) and sedentary (i.e. sitting, laying down) behaviors have risen exponentially [87, 88]. A report from the United States National Health and Nutrition Examination Survey (NHANES) revealed that the vast majority of daily non-sleeping time was spent in either sedentary behaviors (58%) or light-intensity activities (39%), with only 3% of time spent exercising [89]. With the increasing ability to quantify energy expenditure, these behaviors are progressively deemed as independent risk factors for the development of T2D [88, 90-92].

Observational studies measuring sedentary indicators have routinely found an increased risk for the development of T2D [93, 94]. Hu et al. demonstrated that independent of body weight and physical activity levels, prolonged television viewing was directly related to diabetes risk [94]. Healy et al. determined that sedentary time, measured by accelerometry, was significantly associated with 2 hour plasma glucose levels (β= 0.29, 95% CI: 0.11 to -0.48, p=.002) with participants from the Australian Diabetes, Obesity and Lifestyle Study [92, 95]. Disturbingly, Healy also demonstrated that even with those who met the current public health guidelines for physical activity, sedentary television time remained significantly correlated with metabolic risk [96]. However, as acute bouts of sedentary breaks have been shown to be effective in improving glycemia, this study also revealed that less sedentary time, coupled with greater levels of low intensity activity throughout the day, was negatively associated with 2 hour plasma glucose levels (β= -0.25, 95% CI: -0.45 to -0.06, adjusted r^2=.14, p=.012) [95]. A greater effect was shown with increases in moderate to vigorous activity (β= -1.07, 95% CI: -1.77 to - 0.37, adjusted r^2=.15, p=.003) [95].

Participating in regular physical activity can reduce the risk of developing T2D [97-100]. For example, Hu et al. reported that the relative risk of T2D reduced progressively with increases in leisure time, occupational, and commuting time in physical activity among Finnish men and women [97]. In fact, participating in all 3 forms of physical activity reduced the risk of developing T2D by 62%. The Nurse's Health Study examined the association of physical activity and T2D in 87,253 women living in the United States [101]. After 8 years of observation, results revealed that engaging in at least 1 day per week of vigorous physical activity reduced the risk of T2D by 33% compared to those that did not engage in any vigorous activity [101]. Subsequent analysis determined an inverse association between increasing duration and intensity of activity with diabetes risk [99]. Similar reductions in diabetes risk were found in men in the Physicians Health Study [98]. Moreover, Helmrich et al. found a 6% decrease in the age-adjusted risk for the development of diabetes for each 500-kcal (calorie) increase in weekly leisure time physical activity energy expenditure [102]. Overall, it appears that the scientific evidence suggests that regular physical activity may reduce T2D risk by 30-50% [100, 101, 103, 104].

Results of observational studies have been confirmed by randomized clinical trials that include physical activity as an intervention strategy on diabetes prevention and management [17, 105, 106]. For example, the Diabetes Prevention Program (DPP) revealed that losing roughly 7% of total body weight and achieving as little as 150 minutes of weekly activity, reduced the risk of developing T2D by 58% and as high as 71% in adults 60 years and older [17]. Ten year results of the DPP indicated that, although weight regain toward baseline occurred, the diabetes incidence rates remained stable in the healthy lifestyle group [107]. Similar prevention efforts with long term follow up were found across multiple populations [105, 106, 108, 109]. The Finnish Diabetes Prevention Study, another large scale randomized trial, examined the effects of an intensive lifestyle modification in overweight men and women with impaired glucose tolerance [105]. After approximately 3 years, a relative risk reduction of 58% was found in the intervention group compared to the control group. Moreover, risk reduction was also linked to the magnitude of lifestyle changes achieved. People who lost $\geq$5% of their bodyweight had a 74% risk reduction while those who exceeded the recommended amount of physical activity (4 hours per week), had an 80% risk reduction [110].

While the combination of healthy eating and physical activity has been shown to be most effective in T2D risk reduction, there is convincing evidence that prescribing exercise alone can be effective in curbing the development of T2D [35, 106, 111, 112]. For example, The DaQing IGT (impaired glucose tolerance) and Diabetes Study compared the effects of diet alone, exercise alone, and a combination of diet and exercise with T2D incidence. Six year results exposed a greater risk reduction in the exercise only group compared to the diet and combination groups (46% vs. 42% and 31%, respectively) [106]. Moreover, the DPP determined that those who achieved the physical activity goal after 1 year displayed a 44% relative risk reduction in T2D despite not meeting the weight loss goal [113].

There is also evidence from acute and short-term studies to support the importance of physical activity as an effective treatment for glucose regulation. A study examining a 24 hour bout of sitting revealed that insulin action was reduced by 39% in a sample of non-obese, fit adults compared to their 24 hour, active counterparts ($p<.001$) [114]. Conversely, even short periods (2 minutes) of light-to-moderate intensity activity performed every 20 minutes has been shown to decrease plasma glucose by 24.1% to 29.6% ($p<.0001$) and insulin by 23% ($p<.001$) over a 5 hour period compared to uninterrupted sitting time in overweight and obese adults [115]. Mikus et al. used continuous glucose monitoring to observe the effect of 3 days of reduced physical activity ($\leq$5,000 steps per day) on post prandial glucose levels in previously active (as defined by $\geq$10,000 steps per day) healthy adults [91]. Changes in post prandial glucose excursions significantly increased between 30-50% at 30, 60 and 90 minute intervals post meal ($p<.05$). Moreover, fasting plasma insulin levels were significantly altered following the 3 days of reduced activity (23.3$\pm$3.2 to 34.2$\pm$3.7 pmol/L, $p<.05$) [91].

2.5 POTENTIAL PHYSIOLOGICAL PATHWAYS IN WHICH PHYSICAL ACTIVITY INFLUENCES DIABETES CONTROL

Over the past half century, compelling scientific evidence has consistently demonstrated the importance of physical activity as a therapeutic modality to manage diabetes [20, 116]. Even before the introduction of pharmacological interventions for hyperglycemia, physical activity was used as a treatment to control diabetes [14]. Physical activity improves whole body insulin sensitivity in both individuals with normal insulin action and in those with insulin resistant conditions like obesity and diabetes [117-120]. The following sections provide evidence on the potential pathways by which physical activity may influence diabetes control, which includes both glucose and insulin.

2.6 PHYSICAL ACTIVITY MODE AND DIABETES MANAGEMENT

Aerobic Exercise

Aerobic exercise is defined as continuous, dynamic physical activity that uses large muscle groups and requires aerobic metabolic pathways to sustain the activity [121]. Aerobic physical activity has been the most tested and recommended mode of physical activity for the management of diabetes and diabetes related conditions [73]. The effect of physical activity on the T1D population typically fails to demonstrate glycemic improvements [57]. However, the requirements for lower insulin doses resulting from exercise participation are indicative of improved insulin sensitivity. Reasons for the lack of glycemic improvements are likely due to the difficulty of balancing exogenous insulin administration with the nutrition and physical activity regimens [14]. For instance, Rasmussen et al. evaluated postprandial glucose responses following 30 minutes of moderate intensity cycling versus no exercise after a 50 gram carbohydrate meal with constant insulin infusion. In this T1D cohort, blood glucose responses following the meal with subsequent exercise, were lowered by $34 \pm 12\%$ ($p<.01$) compared to after the meal without exercise [122]. This study, and others, indicate that exercise by itself, has hypoglycemic effects in those with T1D [38, 39]. Furthermore, regular physical activity with T1D has shown great improvements in blood pressure, lipid levels and reductions in diabetes related complications [123-125].

Where those with T1D (or insulin dependent T2D) show some difficulty with glycemic control with exercise, people with T2D demonstrate more consistent glycemic improvements. In a meta-analysis by Boule et al., a subgroup analysis revealed significant differences in glycemic control, measured by HbA1c levels, between aerobic exercise groups and non-exercise controls with T2D (−0.67%, 95% CI: −1.04% to −0.30%; $p<.001$) [20]. Umpierre et al. further determined that a structured physical activity duration of $\geq$150 minutes per week was associated with even greater benefits in glycemia (-0.89% reduction in HbA1c) [126]. Because those with diabetes often exhibit a low cardiorespiratory fitness level, walking is often the initial mode of choice when starting an aerobic exercise program [127]. Therefore, Praet et al. compared a brisk walking intervention with a structured, medical fitness program in middle aged to older adults with T2D [128]. One year results confirmed improvements in glycemic control, measured by HbA1c, for both groups (95% CI: -0.42% and -0.43%, p=.99, respectively).

Low intensity aerobic activity has reported modest glycemic benefits in a number of cohorts [24], whereas high intensity physical activity has been shown to produce greater improvements in glucose levels [129]. For instance, Di Peitro et al. explored the 9 month effects of light intensity (50% VO2peak), moderate intensity (65% VO2peak) and high intensity (85% VO2peak) on insulin sensitivity in adult females with T2D [129]. When normalizing for circulating insulin levels, glucose uptake followed a dose response trend with relative exercise intensity marking only significant improvements in the high intensity group (25%, p<.05). However, other studies regarding the T2D population have found that when matched for overall energy expenditure, equal benefits can be realized with varying intensities [128, 130]. Conversely, 8 months of supervised moderate intensity aerobic activity induced a greater improvement in insulin sensitivity in T2D subjects compared to vigorous intensity in the STRRIDE Study [131]. These findings may be of importance because they highlight the potential benefits of both low and moderate intensity physical activity on glycemic control while indicating that vigorous intensity physical activity, which may not be well tolerated in patients with T1D or T2D [132], may not be essential for improving glycemic control.

Although HbA1c is a valid measure of overall glycemic control and risk for diabetes related complications, it may fail to capture the magnitude, frequency and duration of significant glucose excursions. Indeed, postprandial hyperglycemia and glycemic variability poses risk for the development of cardiovascular complications, independent of basal blood glucose concentrations [133, 134]. A single bout of moderate intensity aerobic activity in both insulin treated and non-insulin treated men with T2D showed that average blood glucose concentrations were significantly lower over the 24 hour period following a single bout of exercise compared to the inactive control group ($p<.001$) [135]. The single bout of exercise reduced the time spent in hyperglycemia (blood glucose >180mg/dl) by as much as 31% over the subsequent 24 hours ($p<.001$). Results of this study were in agreement with Mikus et al. who found that aerobic exercise significantly reduced glycemic excursions in adults with T2D followed for 7 days [136]. In this study, overweight and obese sedentary adults with T2D performed 60 minutes of walking and cycling at 60-75% of heart rate reserve for 7 consecutive days. Continuous glucose monitoring revealed that the daily maximum blood glucose levels were reduced significantly (13.6 ± 1.2 mmol/L vs. 10.9 ± 0.08 mmol/L, $p<.01$) as well as the difference between the minimum and maximum daily blood glucose levels at baseline and after 7 days (10.0 ± 1.1 mmol/L vs. 6.9 ± 0.7 mmol/L, $p<.01$, respectively). Post prandial glucose and peak post prandial glucose levels were also significantly reduced ($p<.05$).

It has also been speculated that aerobic physical activity may attenuate beta cell destruction [137]. The STRRIDE Study was a randomized controlled trial testing the effects of different durations and intensities of exercise on numerous cardiometabolic risk factors [138]. Slentz et al. evaluated the Disposition Index (DI), an accepted measure of beta cell function, with exercise intensity in this cohort of sedentary, overweight adults [137]. Results revealed that DI was significantly improved with all exercise training intensities. However, moderate intensity activity yielded greater improvements in DI (742±1680, p=.002) compared to both low and high amounts of vigorous activity (255±1023, p=.063 and 255±688, p=.004; respectively) [137]. Malin and colleagues reported that expending >2,000 kcal/week increases pancreatic β-cell function in a linear dose-response manner in men and women with impaired insulin secretion (DI (1st phase): r = .54, p < 0.001; DI (2nd phase): r = .56, p = 0.0005) [139].

Accumulated Bouts of Aerobic Physical Activity

Barriers to adopting physical activity such as a lack of time or decreased aerobic capacity to participate in 30 minutes or more of physical activity are often cited. Jakicic et al. found that multiple bouts of aerobic physical activity, for 10 minutes, helped to not only initiate the adoption of regular exercise, but also improved cardiorespiratory fitness similar to those randomized to the longer, continuous bout of physical activity [140]. While many studies have confirmed equivalent improvements in cardiorespiratory fitness in single versus intermittent bouts of physical activity, research observing the effects of short bouts accumulated over the day, compared to a single continuous bout in adults with diabetes or diabetes related improvements, are both scarce and less conclusive [141]. Miyashita and colleagues tested the effects of 3 minute bouts of treadmill running performed 10 times compared to a single 30 minute bout on next day plasma glucose levels. Fasting plasma glucose was lower after the accumulated exercise compared to the control group but not in the continuous group [142]. In contrast, Baynard et al. observed participants under 3 conditions: a single 30 minute bout, 10 minute bouts performed 3 times, or no exercise bout in overweight T2D and normal weight healthy controls [143]. Each bout of activity was performed at 60-65% of VO2max. Next day measures of glucose and insulin levels revealed no differences in either of the 3 conditions. The disparities with these studies may support the evidence that during an acute bout of exercise, the intensity, or a longer duration of exercise, is perhaps a stronger predictor of metabolic outcomes [143, 144].

There is also evidence on the chronic effect of short bouts of exercise on insulin levels and glycemic control. Kohno et al. reported significant reductions in plasma insulin levels following a 3 minute warm up, a 6-minute cycling exercise performed at 75% VO2max, and a 3-minute cool down, performed four times daily for 3 weeks in hypertensive patients [145]. Eriksen et al. observed 50-70 year old men with T2D who participated in two different exercise regimens: 1 bout of 30 minutes and 3 bouts of 10 minutes of moderate intensity aerobic exercise [146]. After 4-5 weeks of aerobic training, fasting glucose significantly decreased by 1mmol/L (p=.01) in the 3x10 group but not in the 1x30 group. Also, 2 hour oral glucose tolerance decreased by 7.5% in the 3x10 group (p=.04) with no significant improvements in the 1x30 group. However, the authors concluded that such differences between the groups may be explained by small sample sizes and a difference in BMI between the groups at baseline.

Resistance Training Exercise

Resistance training has also been shown to improve insulin action and glycemic levels [19, 31-33]. Although the evidence regarding resistance training on diabetes control is less prominent than aerobic training, properly designed resistance training programs have shown improvements in insulin action [32, 147, 148]. For instance, Miller et al. determined that a whole body resistance training program, performed 3 times per week for 16 weeks, showed a greater than 20% increase in glucose disposal during the hyperglycemic-euglycemic clamp procedure and observed significantly lower fasting and OGTT insulin levels post training [147]. Holten and colleagues studied the effects of a 6 week resistance-training program in patients with T2D [118]. This study utilized a unique, one-legged training design, with the second leg used as a control. The training model consisted of 3 exercises, 3 days per week, taking no more than 30 minutes per session. Muscle biopsy data revealed that GLUT 4 (glucose transport proteins) density in resistance-trained muscle increased by 40% following the study [118]. In accordance with these findings, Boule et al. determined that resistance training can improve HbA1c values similar to aerobic regimens (−0.64%, 95% CI: −1.29% to 0.01%; p =.05) [20]. However, the resistance training studies involved in this analysis were limited and involved only circuit training programs. For instance, Honkola et al. prescribed a 5 month circuit performed 2 times per week involving 8-10 stations. Each exercise was performed at approximately 65-70% of the subject's 1 repetition maximum (1-RM) [149]. Dunstan et al. prescribed 8 weeks of circuit weight training, 3 days per week using an intensity level of 50-55% of subject's 1-RM. The aerobic activity that was compared to these resistance training regimens were moderate intensity in nature and consisted mostly with walking. The duration ranged from 30-90 minutes per week over a 3-6 day period [20].

Combination of Aerobic and Resistance Training Exercise

Recent analysis has supported the inclusion of both aerobic and resistance training exercise to obtain various health benefits [36, 150-152]. In fact, current reports suggest that the combination of aerobic and resistance training may be more effective for blood glucose management compared to either type alone [27]. Sigal et al. determined that both aerobic exercise or resistance exercise alone improved glycemic control, measured by HbA1c, in adults with T2D compared to an inactive control group (-0.51%, 95% CI: -.87% to -.14%, p=.007 and -

0.38%, 95% CI: -.72% to -.22%, p=.03, respectively). However, HbA1c improvement was even more pronounced when patients participated in a combination of aerobic and resistance training. For instance, an additional -0.46% (95% CI: -.83 to -.09, p=.014) and -0.59% (95% CI: -.95 to -.23, p=.001) reduction in HbA1c was determined in the combined group compared to the aerobic and resistance training alone, respectively [36]. Nonetheless, this study revealed that a greater amount of activity was undertaken in the combined group and may have contributed to the enhanced improvements in that group.

Church et al. attempted to match energy expenditure in participants with T2D by tailoring the volume of physical activity in the aerobic, resistance training and combined groups. This study found that only the combined exercise group significantly improved HbA1c levels by -0.34% (95% CI: -.64 to -.03, p=0.03) [152]. Yardley et al. further explored the impact of glycemic levels with combined training by determining whether the order of aerobic and resistance training imposed different glycemic effects when undertaken together [151]. Results revealed that performing resistance training first can result in an attenuation of blood glucose decline, less exercised induced hypoglycemia, and a reduced need for carbohydrate supplementation during exercise compared to performing aerobic training first. These findings can help arm the patient with specific exercise strategies to help avoid exercise induced hypoglycemia or having to ingest extra calories to prevent exercise induced hyperglycemia through single session combination training [151].

2.7 THE ROLE OF CARDIORESPIRATORY FITNESS

Cardiorespiratory fitness (CRF) is a common outcome measure of aerobic exercise status and has been associated with improvements in all-cause mortality and cardiovascular disease risk in individuals with and without diabetes [153-157]. A recent meta-analysis determined a significant inverse relationship between CRF and HbA1c levels across the studies ($r=0.72$, $p=.04$) [127]. Investigators from the DARE (Diabetes Aerobic and Resistance Exercise) Trial revealed that improvements in CRF were significantly associated with a reduction in HbA1c ($p=.04$) following a 6 month aerobic exercise regimen in sedentary adults with T2D [158]. Jakicic et al. reported that 4 year improvements in CRF was inversely associated with HbA1c levels in overweight, obese individuals with T2D, even after adjusting for diabetes medication use, baseline HbA1c, weight change, and baseline fitness levels ($p<.01$) [30]. Similarly, the Italian Diabetes and Exercise Study (IDES) showed a linear association between improvements in CRF and HbA1c levels, independent of body weight changes, in a diabetes cohort randomized to an aerobic exercise intervention ($p<.01$) [156]. To achieve the most significant improvements in CRF, vigorous intensity bouts of aerobic activity are relatively determined to be the most effective. However, increases in total duration may also enhance CRF [127].

2.8 PHYSICAL ACTIVITY AND THE ABC'S OF DIABETES CARE

Cardiovascular disease (CVD) is the major cause of morbidity and mortality in people with diabetes [84]. Hence, it is recognized that the control of cardiovascular risk factors among people with diabetes is pivotal for the prevention and management of cardiovascular complications [76, 78, 159-161]. The elements of a comprehensive care plan for individuals with diabetes involves regular management of the "ABCs" of diabetes care which includes HbA1c (A), blood pressure (B) and cholesterol (C) levels [84]. According to the ADA's 2014 Standards of Care in Diabetes, recommended treatment goals include: HbA1c <7%, blood pressure <140 mmHg systolic/ <80 mmHg diastolic, and low density lipoprotein cholesterol (LDLc) <100 mg/dl [84]. While these are recommended for most people with diabetes, more or less stringent goals may be warranted based on one's duration of diabetes, life expectancy and comorbid conditions. For example, it is suggested that those with overt CVD may benefit with further reductions in LDLc levels less than 70 mg/dl. Of interest, physical activity has been shown to improve many of these cardiovascular disease risk factors in individuals with both T1D and T2D [27, 121].

A. Hemoglobin A1c (HbA1c)

The glycemic goal for a patient with diabetes is to safely and effectively achieve near normal blood glucose levels [84]. The HbA1c is a measure of average glycemic control over a duration of 2-3 months and correlates with overall treatment efficacy [162]. Each 1% decrease in HbA1c levels translates to an approximate 40% decrease in the frequency of microvascular complications [80]. Physical activity and structured exercise have been shown to be effective for reducing HbA1c.

The RAED2 (Resistance Versus Aerobic Exercise in Type 2 Diabetes) Study compared four months of moderate aerobic training (3 days per week for 60 minutes) to resistance training (9 exercises with 3 sets of 10 repetitions targeting the whole body, 3 days per week) [163]. Results showed similar improvements with a -0.40% (95% CI; -.61 to -.18) reduction in HbA1c in the aerobic training condition compared to a reduction in HbA1c of -0.35% (95% CI; -.59 to -.10) in the resistance training condition (p= .759). Another study examining a combined aerobic and resistance training regimen showed a significant group x time interaction for HbA1c in post-menopausal women with T2D compared to the control group (p<.001) [164]. Subjects performed 75 minutes, 2 days per week of treadmill walking at a moderate to vigorous intensity with 6 resistance training exercises at 3 sets of 12 repetitions on 2 non consecutive days per week. Following the 4 month intervention, HbA1c levels did not change from baseline in the control group (baseline: 7.3%±0.8, 4 months: 7.3%±0.7) while there was a marked decline in HbA1c from baseline in the exercise group (baseline: 7.9%±1.5, 4 months: 6.7%±0.9) [164]. These findings are supported by a meta-analysis which revealed that physical activity alone has the ability to elicit a mean reduction in HbA1c of -0.67% with aerobic intervention and a similar -0.64% reduction with resistance training [20].

When examining the literature, there does appear to be an inverse dose response relationship between physical activity and reduction in HbA1c. Umpierre et al. assessed the relationship between physical activity and reduced HbA1c from a meta-analysis evaluating the volume of weekly physical activity [126, 165]. This data showed that the duration of weekly, structured physical activity of ≥150 minutes per week was associated with a -0.89% absolute reduction in HbA1c compared to a -0.36% reduction with <150 minutes per week in those with T2D. [126, 165]. Greater improvements in HbA1c levels have been documented with higher doses of activity, particularly in those with greater levels of baseline HbA1c values [126, 127, 165].

B. Blood Pressure

High blood pressure, or hypertension, is regarded as both a cardiovascular condition and a major risk factor for stroke, coronary heart disease, renal disease and retinopathy [44]. More than 60% of individuals with T2D are burdened by hypertension [64]. The effects of regular physical activity on reductions in blood pressure (BP) in both those with and without diabetes are well documented [27, 166, 167]. Moderate aerobic physical activity consisting of approximately 120 minutes per week, has been shown to reduce systolic BP between -3 to -11 mmHg and diastolic BP between -3 to -8 mmHg [168, 169]. Zois et al. observed four months of combined aerobic (75 minutes, 2 days per week) and resistance training (3 sets of 12 repetitions, 2 days per week) and found significantly reduced resting systolic BP values in postmenopausal women (baseline: 143 ± 9 mmHg, 4 months: 132 ± 8 mmHg, $p<.01$) [164].

The reductions in blood pressure are greater among hypertensive individuals compared to their normotensive counterparts [169]. Nonetheless, a modest 2 mmHg reduction in systolic BP correlates with a 4-6% reduction in mortality risk due to stroke and coronary heart disease [170]. Therefore, physical activity may play a pivotal role in cardiovascular risk reduction in diabetes patients.

C. Blood Lipids

Adverse blood lipid profiles consist of high levels of LDL cholesterol (LDLc), low levels of high density lipoprotein cholesterol (HDLc) and high levels of triglycerides (TG). It is well documented that these abnormalities are linked to insulin resistance and diabetes [171]. The recognized benefits of regular physical activity on lipids are strongest when considering improvements in HDLc and TG [172-174]. For instance, performing 30-60 minutes of moderate aerobic activity on 3-5 occasions per week results in approximately a 4% mean increase in HDLc and roughly a 12% decrease in TG [173].

The evidence to date concerning improvements in LDLc has been inconsistent [175-178]. For example, the HERITAGE Family Study examined the effects of a twenty week, moderate intensity aerobic exercise regimen, performed 3 days per week for a duration of 30-50 minutes per session. This protocol determined increases in HDLc by 3.6% with no changes in LDLc levels [175]. In contrast, a meta- analysis performed by Kelley et al. determined that only LDLc is significantly affected by physical activity in adults with T2D yielding roughly a 5% reduction [179].

Beneficial changes in lipid measures have been most prominent when baseline measures were more severe [180]. Moreover, the type of exercise regimens performed may contribute to such mixed results. For instance, Cauza et al. compared the effects of a 4 month strength training and aerobic training program on metabolic control [167]. Analysis revealed that strength training, performed 3 times per week progressing from 1 set of 10-15 repetitions per muscle group to 6 sets of 10-15 repetitions per muscle group, significantly reduced total cholesterol (-23 mg/dl, $p<.01$), LDLc (-14 mg/dl, $p<.01$) and increased HDLc (5 mg/dl, $p<.01$) while the endurance trained group (3 days per week of moderate intensity cycling progressing from 15-90 minutes in duration) resulted in no significant changes in either parameter. Other reports have indicated a dose response relationship regarding the effects of physical activity on lipids and may account for additional variations in the literature [181].

These reductions in the “ABCs” of diabetes care show that physical activity has the therapeutic potential to benefit the cardiovascular risk factors of patients with diabetes. However, physical activity may also enhance cost savings, particularly in those using multiple pharmaceutical therapies and with restricted prescription coverage [43, 182]. For example, the Look AHEAD Research Group reported that overweight adults with T2D who adopted a physically active lifestyle and lost weight took less medication for hyperglycemia, hypertension and hyperlipidemia compared to the usual care group. This correlated with a lower monthly medication cost in participants in the intervention condition vs. the usual care group meeting the optimal care goals (HbA1c $<7\%$; BP $<130/80$ mmHg; LDLc <100 mg/dl) of diabetes (median costs \$177 vs. \$128, respectively, $p<.001$) [43].

2.9 PHYSICAL ACTIVITY AND QUALITY OF LIFE WITH DIABETES

Quality of life is a construct that consists of the physical, emotional and social aspects of well-being and has been gaining much attention in physical activity investigations [183-187]. Adults with diabetes report having lower quality of life compared to their non-diabetic counterparts [188]. A national sample of U.S. adults revealed that both men and women with diabetes had a 2-3 fold increased odds of having the inability to perform mobility related tasks such as walking ¼ of a mile [OR=2.12; 95% CI (1.53-2.93) in women and OR=1.86; 95% CI (1.24-2.59) in men], climbing stairs [OR=1.66; 95% CI (1.26-2.19) in women and OR=1.63; 95% CI (1.13-2.36) in men] and performing housework duties [OR=1.94; 95% CI (1.42-2.66) in women and OR=1.70; 95% CI (1.12-2.59) in men], compared to their non-diabetes counterparts [189]. Moreover, depression affects approximately 1 in 4 people with diabetes [84]. Depression can have a negative impact on a person's ability to adhere to a diabetes care regimen that can result in greater risks for microvascular and macrovascular complications [84].

Physical Activity and Physical Functioning

Impaired physical functioning is associated with less independence through reduced mobility, lower muscle quality and an increased risk of falls and fractures [190-194]. Indeed, these elements can be positively impacted through regular physical activity in those with diabetes [190, 195, 196]. The HART-D (Health Benefits of Aerobic and Resistance Training in Individuals with Type 2 Diabetes) Trial found that adults with T2D, who participated in approximately 150 minutes per week of either moderate intensity aerobic exercise, resistance training, or a combination of the two for 9 months, significantly improved their scores on the SF-36 quality of life physical health component scores compared to the control group (resistance training: p=.005, aerobic training: p=.001, combined training: p=.015) [183]. However, Reid and colleagues demonstrated that 3 days per week of resistance training, but not aerobic training, in adults with T2D imposed clinically significant improvements in physical functioning compared to a control group [186]. These mixed results may support a dose response relationship between physical activity and quality of life measures. The physical activity regimen by Reid was performed for a shorter duration (~ 5 months) compared to 9 months with the HART-D trial. Another study, the Italian Diabetes Exercise Study (IDES), revealed that volume of exercise was correlated with increased improvements in physical quality of life [197]. For instance, when comparing quintiles corresponding to a volume of PA (<12, 12–17.5, 17.6–22.2, 22.3–28.4, >28.4 MET-hrs/week), a significant improvement in the physical health component was present only for a total amount of exercise over 17.5 MET hrs/ week following the exercise intervention [197]. Moreover, four year results from the Look AHEAD Research Group revealed a significant, 48% reduction in mobility related disability for the intervention group compared to the support group and determined that these reductions were mediated by improved fitness and weight loss ($p<.001$) [18].

Physical Activity and Psychosocial Improvements

There is an abundance of evidence regarding the effects of physical activity on psychological well-being [185, 198, 199]. The DREW (Dose Response to Exercise in Post-Menopausal Women) Study, a randomized clinical trial comparing the effects of reaching 50%, 100% and 150% of the current public health guidelines for physical activity, demonstrated that exercise dose was an independent predictor for mental health improvements (t_1=2.03; p=.04) [184]. Another study assessing resistance training in depressed older adults revealed a 59% reduction in the Hamilton Rating Scale of Depression scores after 10 weeks of resistance training consisting of 3 sets of 8 repetitions, 3 days per week using major all muscle groups, compared to only a 20% reduction in controls (p=.008) [200].

However, large scale studies documenting the positive effects of physical activity on the psychological aspects of health related quality of life in patients with diabetes appear conflicting [183, 197, 201, 202]. For instance, the DARE Study found that the control group displayed greater improvements in mental health quality of life compared to the exercise intervention group [201]. Similarly, the HART-D Study determined that no significant differences were found between the control group and any of the exercise regimens (aerobic, resistance or combination) [183]. However, HART-D did reveal that the combination of resistance training and aerobic training was associated with greater improvements in overall mental health scores compared to the aerobic training group (p=.004). In contrast to DARE and HART-D, the IDES Trial not only determined that supervised aerobic and resistance training improved mental quality of life measures, it further revealed that a dose response relationship exists between the improvements in mental health scores and the volume of physical activity [197, 203].

Smaller studies have also demonstrated improvements in well-being with the diabetes population. A sample of hemodialysis patients who underwent 90 minutes of aerobic exercise, 3 days per week for 12 weeks, significantly improved their depression scores compared to baseline measures [204]. Also, a sample of elderly, T2D subjects significantly improved scores of total psychological well-being (p=.023), anxiety (p=.007), positive well-being (p=.01) and energy (p=.03) compared to baseline measures, using the 22- item Well- Being Questionnaire [205, 206]. This evidence shows that physical activity does appear to induce psychological improvements in the diabetes population as well, however most convincingly in a dose dependent manner [201, 204].

2.10 THE ROLE OF PHYSICAL ACTIVITY ON BODY WEIGHT AND COMPOSITION

Weight loss is recommended for all overweight or obese individuals who have, or are at risk, for diabetes [84]. While the National Heart Lung and Blood Institute (NHLBI) recommends a minimum weight loss of 10% body weight, it has been established that clinically meaningful improvements in chronic disease risk factors may occur with a modest 2-3% reduction in body weight [207, 208]. The most effective strategies to obtain weight loss involves the combination of a caloric deficit through healthy eating and an increase in caloric expenditure through physical activity [209]. Calorie restriction and expenditure must be sustained to prevent weight regain. Accordingly, aerobic physical activity levels beyond the current public health guidelines (i.e.

200-300 minutes of moderate intensity aerobic activity per week) may be necessary for most individuals to induce greater weight loss or prevent weight regain [208, 209].

When considering physical activity as a sole intervention for weight loss, modest reductions in body weight have typically been documented (<3%) [207]. Wing et al. revealed that exercise alone only displayed around a 2% weight loss at 6 months compared to 9.1% in diet only and 10.4% in diet plus exercise interventions [210]. However, interventions comparing the effects of aerobic exercise versus caloric deficit that involve the same degree of negative energy balance can produce equal reductions in body weight [22, 211].

A number of studies have contributed to the body composition literature by determining the effects of exercise on changes in regional obesity even in the absence of weight loss [211-213]. Ross et al. assigned overweight men to one of three study groups to determine the independent effect of diet induced weight loss, exercise induced weight loss, or exercise without weight loss with reductions with abdominal obesity [22]. After the three month intervention period, the exercise without weight loss group had significantly reduced total abdominal fat ($p<.001$) and visceral adipose tissue (VAT) compared to the control group ($p=.001$). Similar results have also been shown in overweight, premenopausal women [211]. Another study assessing the reductions in abdominal adiposity and exercise, without weight loss, compared men across 3 categories: lean (control), obese; and obese with T2D [213]. Following 13 weeks of aerobic exercise, all groups significantly reduced total fat ($p<.01$), abdominal SAT ($p<.05$), and more importantly, abdominal VAT ($p<.01$). These studies revealed that exercise, even without weight loss, is a useful method for reducing abdominal fat. These results are clinically important considering that the excess accumulation of adipose tissue, particularly in the abdomen, is strongly associated with insulin resistance and glucose intolerance, overt diabetes, hypertension and hyperlidemia [214-216].

2.11 PHYSICAL ACTIVITY GUIDELINES FOR AMERICAN ADULTS

In 1995, The Centers for Disease Control and the American College of Sports Medicine collaborated to outline the physiological, epidemiological, and clinical evidence relating to the impact of physical activity on public health [217]. Subsequently, the first ever *Physical Activity and Health: A Report of the Surgeon General* in 1996 was issued revealing that all U.S. adults should accumulate 30 minutes or more of moderate intensity aerobic physical activity on most, preferably all days of the week to obtain health benefits [44]. To solidify the impact that physical activity has on health, the *National Physical Activity Guidelines for Americans* was released by the Federal government in 2008 [45]. According to this updated report, all American adults should progress to a minimum of 150 minutes of moderate intensity aerobic activity, or a minimum of 75 minutes of vigorous intensity aerobic activity, or an equivalent combination of moderate and vigorous intensity aerobic activity, per week for substantial health benefits. Aerobic activity should be performed in episodes of at least 10 minutes and spread throughout the week. Furthermore, due to the increasing evidence of resistance training as a beneficial mode of activity for health, a recommendation of at least 2 days of muscle strengthening activities (i.e. resistance training) per week is advised in addition to the aerobic activity guidelines. The guidelines further recognize that Americans can obtain greater benefits of disease prevention and management, as well as body weight maintenance through larger amounts of activity. However, while there is currently no maximum guideline for physical activity, Americans should acknowledge that too high of an activity volume may induce musculoskeletal injuries due to overuse or physical and emotional burnout [218, 219]. Whereas a minimum level of physical activity has been considered to sustain risk reduction for a number of conditions, health benefits appear to occur through modest increases in activity throughout the progression toward the recommended amounts of activity [45]. Thus, it is indicated that even minor increases in physical activity can lead to significant health benefits, particularly among the least active [220]. Regardless of diabetes status (i.e. T1D, T2D), all adults with diabetes are encouraged to adopt regular exercise in accordance with the Physical Activity Guidelines for Americans when possible [45, 84].

2.12 DIABETES SELF-MANAGEMENT EDUCATION AND SUPPORT (DSME/S)

DSME/S Background

DSME/S is the formal process through which persons with or at risk for diabetes interact and collaborate with the diabetes educator (DE) to develop and use the knowledge and skills required to reach their self-defined diabetes goals [221]. Traditionally, diabetes education involved didactic approaches where the patient acted as a passive recipient of information and care. However, DSME/S has evolved into a more collaborative process between the patient and educator that begins with knowledge of the condition and subsequently, assessing appropriate behavior changes to engage the patient in self-directed management goals. This exchange is meant to accomplish not only glycemic management, but also enhanced quality of life and healthcare cost savings [222].

DSME/S is not designed to be a single event but rather an ongoing process of facilitating the knowledge and skills necessary to empower the patient to adopt self-care behaviors. Continual behavior change and clinical status outcomes should be measured at regular intervals pre and post intervention [14, 222]. To help guide the DE toward effective behavioral counseling for patients with diabetes, the AADE established a framework of seven self-care behaviors [49]. These seven self-care behaviors, known as the AADE 7, consist of 1) Monitoring 2) Healthy Eating 3) Being Active 4) Reducing Risk 5) Healthy Coping 6) Taking Medication and 7) Problem Solving [49]. It is illustrated within the "Being Active" self-care behavior that the DE identifies environmental and physical barriers of adopting a physical activity regimen and is responsible for prescribing an exercise plan of action [49]. According to the 2012 AADE Position Statement on Physical Activity and Diabetes, to enhance patient outcomes, the DE should use the current exercise guidelines as a foundation to tailor the exercise prescription and counsel diabetes patients on safe and effective goals [50].

DSME/S Delivery

According to the AADE, DEs are health practitioners who focus on helping those with or at risk for diabetes achieve appropriate clinical outcomes through education and behavior change strategies [48, 222]. While DEs come from a variety of health professions, more than 70% of diabetes educators remain under two disciplines- nursing and dietetics [14]. Still, the AADE states that regardless of one's professional discipline, the DE must be prepared to provide clients with the knowledge and skills to effectively manage their diabetes [48]. Certainly, knowledge is a pre-requisite for action. Just as diabetes patients must have sufficient knowledge to effectively self-manage their disease, clinicians must have sufficient knowledge to teach and empower patients about how to best manage their disease. Therefore, DEs must possess a body of knowledge that spans across disciplines (i.e. nutrition, physical activity, pharmacotherapy management) to provide comprehensive diabetes education.

2.13 PHYSICAL ACTIVITY COUNSELING IN DIABETES EDUCATION

While there is extensive evidence regarding the effects of physical activity intervention in large scale clinical and community trials, there is a paucity of literature on effective physical activity counseling initiatives during DSME/S. However, studies examining physical activity counseling in the practice setting have proven to be an effective alternative to supervised, structured programs [47, 223-225]. For example, Kirk and colleagues randomly assigned T2D patients to either a 30 minute tailored discussion encouraging patients to adopt the current physical activity guidelines by examining the benefits, barriers, suitable activities and goal setting compared to the distribution of a standard “Exercise and Diabetes” leaflet only [47]. Follow up was given at 1 and 3 months of care. Those who acquired the tailored intervention reported a median increase of 128 minutes [95% CI (85-182.5)] of moderate activity compared to no increases in activity for the control group [47]. Also, a significant improvement between the exercise and control groups were recorded in HbA1c levels (-.31 versus .37, respectively) at 6 month follow up (p=.02).

Another study compared two randomized groups of patients with T2D who attended an outpatient diabetes center [226]. All patients received education according to the center’s usual care criteria consisting of a clinical examination with diet and exercise counseling. However, the intervention group obtained an additional 30 minute session of structured advice regarding physical activity adoption. This intervention group also received a brief (~15 minutes) follow up phone call every 3 months to determine their physical activity participation and addressed barriers to exercise as necessary. After 2 years, the intervention group demonstrated a significantly greater level of energy expenditure compared to baseline (27.1 MET-hrs/week vs. 0.8 MET-hrs/week, $p<.001$, respectively). This change marked a 7-fold greater increase in energy expenditure compared to the usual care group. Seventy percent of the intervention group obtained energy expenditures in accordance to the physical activity guidelines compared to only 18% in the usual care group. As a result, HbA1c levels were significantly lower at 2 years in the intervention group compared to the usual care group ($7.0\pm0.1\%$ and $7.6\pm0.1\%$, $p<.001$, respectively) [226].

2.14 BARRIERS TO PHYSICAL ACTIVITY COUNSELING IN DSME/S

It has been reported that diabetes patients receive less support, education, and encouragement for physical activity compared with any other aspect of diabetes management [47]. This is troubling considering that Forbes et al. determined that over 90% of patients would prefer to be counseled on physical activity [51, 227]. Thus, it is important to better understand factors that contribute to the lack of physical activity counseling.

A common reason for the lack of physical activity counseling in the primary care and other clinical settings often includes “lack of time”, which may be due to competing demands or confidence in counseling on physical activity [228, 229]. This barrier has also been reported in DSME/S encounters [51, 54]. However, Bull and colleagues have shown that a brief (2-3 minutes) intervention implemented within primary care was effective at increasing both exercise frequency and duration over a 6 month period [223]. It has also been reported that a written prescription for exercise (like that of a medication script) combined with verbal advice by a general practitioner, was related to greater motivation and compliance to physical activity compared to providing verbal advice alone [230]. Other studies have found that with adequate training, provider counseling can be feasible in the primary care and other clinical settings [223-225]. Such findings of effective, brief encounters contrast the commonly reported barrier of “lack of time” to discuss physical activity [223, 231, 232]. These findings suggest that advising patients with diabetes on the adoption and maintenance of physical activity is feasible and can be effective in the traditional clinical setting [225, 226, 233].

A lack of knowledge, skills or experience required to promote and prescribe physical activity has also been indicated as a barrier to physical activity counseling [51, 234]. McKenna et al. revealed that only 52% of RDs would inquire about physical activity with their patients during an initial visit, while only 44% of those RDs would inquire about physical activity during a follow up visit [54]. Douglas et al. evaluated health visitors and practice nurses on the promotion of physical activity and found that only 9% of nurses correctly described the current recommendations of physical activity [52, 235]. Additionally, 30% of the nurse Certified Diabetes Educators (CDEs) sample stated that the elderly population is too frail with too many complications to engage them in physical activity [51] This suggests that nurse CDEs may not appreciate or understand exercise approaches for the elderly.

Jansink et al. examined barriers toward physical activity counseling using a sample of nurses who provide diabetes care [234]. Barriers reported included a self-perceived lack of counseling skills, the inability to create a structured action plan, and a lack of motivation to counsel patients when patients did not appear interested to change behaviors. Of interest, many nurses reported that nutrition counseling is not their responsibility but rather the responsibility of the dietitian and would only engage in nutrition advice if forced to [234]. However, this study did not survey whether the nurses felt physical activity counseling was their duty.

2.15 SUMMARY OF THE LITERATURE

The role of physical activity on improving diabetes related outcomes is well documented [27, 30, 168]. The scientific evidence confirms that the reductions in HbA1c from regular physical activity are similar to any single anti-hyperglycemic pharmacological agent for the treatment of diabetes and like pharmacotherapy, appears to result in a dose dependent manner [20, 126, 236]. Nonetheless, the lack of a physical activity prescription continues to plague the diabetes patient during clinical evaluation and diabetes management counseling and as a consequence, likely reflects the deplorable physical activity participation rates within the diabetes population [46, 47, 51, 54].

DEs come from a variety of professional backgrounds and reside within various practice settings. Depending on the DEs professional background, the DE may be limited in the ability to effectively counsel patients on specific diabetes treatment behaviors. Indeed, the lack of documented physical activity in those with diabetes may be reflective of the DEs ability to provide physical activity counseling.

Therefore, determining the factors that influence physical activity counseling within DSME/S is paramount to determine whether physical activity can be effectively discussed as a treatment tool for diabetes patients. The results of this study may provide valuable insight regarding the DEs barriers to physical activity counseling. This in turn may guide DEs toward seeking solutions to improve physical activity counseling within DSME/S. This data may also express the need to promote referral strategies in order to empower the patient to seek more appropriate settings for physical activity counseling.

3.0 METHODS

3.1 STUDY DESIGN

This study utilized a cross sectional, descriptive design to evaluate factors that may influence the ability of DE to counsel patients on physical activity during DSME/S. These factors were assessed through the distribution of a paper survey in the attempt to answer important diabetes management questions related to physical activity listed in the specific aims.

3.2 TARGETED SAMPLE POPULATION

DEs within the state of Pennsylvania (PA), whom are associated with the professional network of the AADE, were the targeted population for this study. The AADE is the premier professional organization for DEs in the United States with approximately 13,000 members. Members are subscribed to local networking groups with the opportunity to connect with other DEs throughout a specific geographical region. For example, the PA State network affords DEs within the state to interact through professional meetings, online chat and email to discuss state specific diabetes practices and policies, local events, research based and case study findings within the diabetes profession. Currently, there are 620 AADE members within the PA Network (PAN). Each year, PAN members have the opportunity to attend the PA State Diabetes

Conference to network and participate in educational lectures on various diabetes education practices and policies.

3.3 ELIGIBILITY CRITERIA

To be deemed eligible for this study, DEs had to be currently practicing as a DE, and providing DSME/S to adult patients (aged 18 years and older) with diabetes. Exclusion criteria applied to anyone not practicing as a DE or those DEs who are limited to working only with pediatric diabetes patients. This inclusion and exclusion criteria was captured through self-reported procedures.

3.4 RECRUITMENT

Recruiting efforts entailed the distribution of a paper survey that was created by the Principal Investigator (PI). The PI obtained permission from the AADE's, PA State Coordinating Body to collect the survey data at the 2014 Pennsylvania State Diabetes Conference. The PI was offered a table, in a separate area of the meeting venue, to recruit DEs to voluntarily participate in completing the survey. Each DE who participated was given a unique identifier to ensure that all responses remained confidential. All forms were approved by the appropriate member of the PA State Coordinating Body of the AADE, as well as the Institutional Review Board at the University of Pittsburgh.

DEs who volunteered to take part in the study were given a raffle ticket. At the close of the PA State Diabetes Conference, the winner of the randomly drawn ticket received a $160 gift card that covered the reimbursement for the conference registration. Also, they the resource book, Physical Activity and Diabetes: A Clinicians Guide to Prescribing Physical Activity, signed by author, Dr. Sheri Colberg, PhD.

3.5 SURVEY

A survey was developed by the PI in an attempt to determine specific factors that may influence the DEs ability to counsel on physical activity during DSME/S (Appendix C). Portions of this survey have been adapted from previous studies [51, 237]; however, no validated questionnaire currently existed that specifically pertained to the aims of this study. Therefore, the PI worked with the co-investigators of the study (Dissertation Committee Members), who have professional expertise with validating questionnaires to enhance the face validity of the survey questions. The PI further collaborated with 4 certified DEs within the Pittsburgh, PA region during the developmental process. DEs were chosen because they represent the study population, and these individuals provided feedback on the flow of questions and the wording of questions on the survey that was developed. Based on this input, questions were modified where appropriate. Also, questions that were not considered to add utility to the advancement of DSME/S based on the study aims were not included in the survey, whereas questions thought to provide insight were added.

The survey consists of 26 questions divided into 4 distinct parts: the inclusion/ exclusion section and 3 sections within the body of the survey. First, 2 exclusion questions were provided to quickly exclude any DE who did not meet the eligibility criteria. This was designed to minimize any unnecessary time participating in the survey. Following the inclusion/ exclusion section of the survey, those eligible were encouraged to proceed to Section 1. Section 1 includes 10 questions related to demographic information and professional services that may dictate subject responses listed under the primary aims. The subsequent section of the survey (Section 2) provides 15 questions intending to capture information relevant to addressing the primary aims of the study. This includes questions regarding the DEs time dedicated to counseling on physical activity; the level of importance that DEs place on physical activity as a treatment tool compared to 3 other treatment methods (healthy eating, monitoring blood glucose and taking diabetes medications) within the AADE's 7 Self Care Behaviors (AADE 7); the DE's knowledge regarding the 2008 Physical Activity Guidelines for American Adults; and DE's level of confidence toward counseling on physical activity. This section of the survey also displays questions seeking to determine barriers related to physical activity counseling regarding patient characteristics, as well as barriers and possible solutions expressed within the educator's practice setting. Section 3 includes 1 question (with 2 parts) focused on identifying the personal physical activity behaviors of DEs.

3.6 ANTICIPATED RESPONSE RATE

There are approximately 620 members of the AADE PA Network. The Annual PA State Diabetes Conference has been increasing in attendance over the past few years with more than 200 members attending in 2013. The response rates specific to health care professionals determined an overall survey response rate to be 53% [238]. Considering that the survey was being distributed to a professionally recognized network with an attendance rate of approximately 200 members with an incentive to participate, the PI anticipated that this survey would be completed by a minimum of 100 eligible volunteers.

3.7 DATA COLLECTION AND MANAGEMENT

Data was collected by the PI throughout the survey administration process. All data was collected in a de-identified manner so that the responses were not linked to individual DEs. Surveys were subsequently converted into the Statistical Package for the Social Sciences (SPSS) (version 20, IBM Corp., Armonk, NY). Survey data was managed by the PI in a password protected computer and stored on a secure disk in a locked filing area at the University of Pittsburgh Diabetes Institute. Data was only accessible to the investigators in this study.

3.8 STATISTICAL ANALYSIS

Data was analyzed using Statistical Package for the Social Sciences (SPSS) (version 20, IBM Corp., Armonk, NY). Descriptive data were used to report the demographics and background information of the DE sample and examine the sample of DEs. Means and standard deviations were calculated for age as a continuous variable, the number of years performing DSME/S counseling, time spent counseling on physical activity within DSME/S visits and the average minutes per week of the DEs who participate in regular physical activity. Frequencies and percentages were calculated for gender, ethnicity, race, reported practice setting, educational discipline, level of education obtained, possession of the CDE credential and those who reported engaging in regular physical activity. Medians and mean ranks were used to describe the ranking of time spent addressing the 4 content areas of DSME/S and all Likert- scale responses.

Because the assumptions of normality were not met with this sample, non-parametric statistics were used. The Kruskal Wallis H test was used to determine group associations between each specific aim on Exploratory aims 1-3: educational discipline, level of education obtained and practice setting, to allow for the examination of whether there was a significant difference on the DE's time spent addressing physical activity, the level of importance placed on physical activity as a diabetes treatment strategy, the DE's knowledge of the PAGA for adults, the DE's level of confidence regarding physical activity counseling and the personal and practice barriers encountered during DSME/S visits. If significant differences were identified, pairwise comparisons using Dunn's (1964) procedure with a Bonferroni correction for multiple comparisons were used. Adjusted p-values are presented. Values are mean ranks unless otherwise stated.

The Mann Whitney U test was used to determine group associations between each specific aim with Exploratory Aims 4 and 5: the possession of the CDE credential and the personal physical activity behaviors of the DEs, to determine whether there was a significant difference on the DE's time spent addressing physical activity, the level of importance placed on physical activity as a diabetes treatment strategy, the DE's knowledge of the PAGA for adults, the DE;s level of confidence regarding physical activity counseling and the personal and practice barriers encountered during DSME/S visits.

The Chi-squared test of association was used to determine group differences among the DEs who correctly identified the PAGA guidelines for adults and those who did not (specific aim

3) on each Exploratory aim (1-5). If a significant association was identified, the strength of the association was observed using Cramer's V statistic, which ranges from 0 to +1. Post hoc analyses for the chi- squared test of association was determined by exploring the standardized residuals between the observed and expected frequencies of each category. The size of the standardized residual was compared to the standardized residuals to the critical values that correspond to an alpha of .05; a p value $<.05$ (+1.96 and -1.96). If the standardized residuals were found to fall outside of this region, a statistically significant difference was reported.

4.0 RESULTS

The purpose of this descriptive study was to examine factors that influence DE's physical activity counseling delivered within DSME/S. Self-reported data were collected to capture DEs responses to the: 1) time dedicated to physical activity counseling; 2) importance placed on physical activity as a treatment strategy for diabetes; 3) level of knowledge regarding the current Physical Activity Guidelines for American Adults; 4) level of confidence toward physical activity counseling; and 5) DEs personal and practice barriers that may influence their physical activity counseling. Exploratory analyses were also conducted to determine the influence of the following factors on the primary outcome variables: 1) type of educational discipline of the DE; 2) level of education of the DE; 3) type of practice setting the DE resides; 4) possession of the CDE credential; and 5) personal physical activity behaviors of the DEs.

4.1 SUBJECT CHARACTERISTICS

A paper survey was distributed to Pennsylvania DEs who attended the 2014, AADE, *3rd Annual PA State Diabetes Conference*. The number of DEs attending the conference in 2014 was 170. One hundred thirty five DEs indicated a willingness to complete the survey, yielding a response rate of 79.4% of all attendees. However, of the 135 surveys distributed, 125 surveys were collected and of these, 119 respondents were deemed eligible to complete the survey. Table

1 provides a summary of the surveys distributed and the percentage rates obtained through this process.

Table 1: Response Rates from Diabetes Educators Attending the 2014 PA State Diabetes Conference

	Total Conference Attendees	**Total Surveys Distributed**	**Total Surveys Collected**	**Total Eligible Surveys Completed**
N	170	135	125	119
% of Total Conference Attendees	100%	79.4%	73.5%	70.0%

Demographic characteristics of the 119 survey respondents are provided in Table 2. The subjects were primarily female (95.8%, n=114); Caucasian (94.1%, n=112); and with a mean age of 51.9±10.7 years. The majority had an educational discipline in Nursing (60.5%, n=72) followed by Nutrition (28.6%, n=34); Pharmacy (5.9%, n=7); Health Education (2.5%, n=3); Doctor (1.7%, n=2); and Exercise Physiologist (.8%, n=1). Approximately 75% (n=88) reported that they possess the CDE credential. Nearly 80% (n=93) of respondents reported personal engagement in regular physical activity. For those who reported regular engagement in physical activity, mean physical activity minutes were 178.8 ±125.9 per week.

Table 2: Demographic characteristics of the Diabetes Educators who responded to the survey at the 2014 Pennsylvania State Diabetes Conference

Variables	Categories	Mean ± St. Dev. or % (N)	Total (N)
Age	(Years)	51.9 ±10.7	119
Gender	(% Female)	95.8% (114)	119
Race	Caucasian Black or African American Native Hawaiian or Pacific Islander Asian Other	94.1% (112) 3.4% (4) .8% (1) .8% (1) .8% (1)	119
Ethnicity	Hispanic (% Yes)	2.5% (3)	119
Educational Discipline	Nursing Nutrition Pharmacy Health Education Doctor Other (Exercise Physiologist)	60.5% (72) 28.6% (34) 5.9% (7) 2.5% (3) 1.7% (2) .8% (1)	119
Level of Education	Associate's Degree Bachelor's Degree Master's Degree Doctoral Degree Other Degree	11.8% (14) 50.4% (60) 23.5% (28) 5.0% (6) 9.2% (11)	119
CDE	(% Yes)	73.9 (88)	119
Regular Personal Engagement in Physical Activity over the past 6 Months	(% Yes)	80.2% (93)	116
Minutes per Week of Individuals Reporting Regular Personal Engagement in Physical Activity over the past 6 Months	(Minutes per Week)	178.8 ± 125.9	93

DSME/S characteristics are provided in Table 3. The majority of subjects primarily perform individual DSME/S counseling (78.4%, n=87 of 111) with the majority also providing DSME/S counseling in an outpatient setting (77.2%, n=88 of 114). Regarding practice setting, 51.7% (n=60) report working in an outpatient hospital, with the remainder of the subjects working in an inpatient hospital setting (19%, n=22), primary care (11.2%, n=13), home health

(1.7%, n=2) or the pharmacy (.9%, n=1). An additional 15.5% (n=18) reported “other” settings which involved endocrinology clinics (3), corporate settings (1), wellness centers (4), insurance provider (1), pharmaceutical company (1) or “no clarification” (8) was stated. The average years performing DSME/S within this sample of DEs was 13 ±8.63 (n=115).

Table 3: Delivery of Diabetes Self-Management and Support

Variables	Categories	Mean ± Standard Deviation or % (N)	Sample (N) with valid data
DSME/S Format:	Group Individual	21.6% (24) 78.4% (87)	111
DSME/S Setting:	Inpatient Outpatient	22.8% (26) 77.2% (88)	114
Practice Setting:	Outpatient Hospital Primary Care Inpatient Hospital Pharmacy Home Health Other	51.7% (60) 11.2% (13) 19.0% (22) .9% (1) 1.7% (2) 15.5% (18)	116
Performing DSME/S:	(Years)	13 ±8.62	115

4.2 TIME SPENT COUNSELING ON PHYSICAL ACTIVITY: SPECIFIC AIM 1

During DSME/S, DEs are expected to discuss self-management treatment strategies under 4 content areas (healthy eating, being physically active, blood glucose monitoring, and taking medications). Of these 4 content areas, DEs reported that physical activity is addressed least frequently as compared to (17.7% of DSME/S time, 14.5±12.1 minutes) healthy eating (36.5% of DSME/S time); blood glucose monitoring (23.4% of DSME/S time); and taking medications (28.8% of DSME/S time) (Figure 1). It should be noted that some of the subjects did not correctly add their percent of time to equal 100%. Therefore, the total percent of time in Figure 1 is >100%.

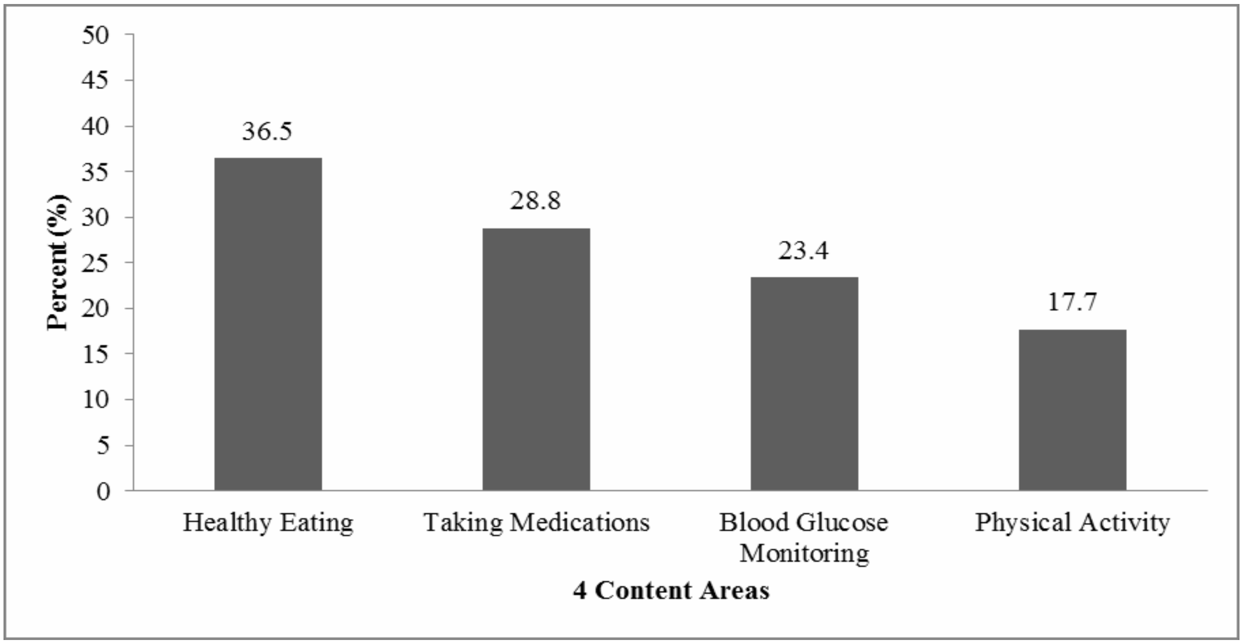


Figure 1: Percent of Time Diabetes Educators Report Spending on Addressing the 4 Content areas of DSME/S

Exploratory analyses were conducted to examine whether the amount of time spent counseling on physical activity was influenced by educational discipline, level of education, practice setting, possession of the CDE, or the personal physical activity behaviors of the DE (Table 4). There were no significant differences with time spent counseling on physical activity across the levels of educational discipline (p=.926); the education level (p= .184); or practice setting (p= .092). Moreover, there were no significant differences on time spent counseling on physical activity and possession of the CDE (p= .387); or personal physical activity behaviors of the DEs (p= .259).

Table 4: Comparisons of Time the Diabetes Educators Spent Counseling on Physical Activity among the Categories of Educational Discipline, Education Level, Practice Setting, Possession of the CDE Credential, and Personal Physical Activity Behaviors of Diabetes Educators

Variables	Categories	Total (N)	Mean Rank	P value
Educational Discipline	Nurse Education Nutrition Education Other Education Total	69 33 13 115	58.68 56.14 59.12	.926*
Education Level	Associate's Degree Bachelor's Degree Master's Degree Other Degree Level Total	13 59 28 15 115	73.73 52.77 59.52 62.10	.184*
Practice Setting	Outpatient Hospital Primary Care Inpatient Hospital Other Setting Total	59 13 20 23 115	60.77 72.69 45.48 53.48	.092*
CDE	Yes No Total	86 29 115	56.47 62.53	.387**
Regular Personal Engagement in Physical Activity over the past 6 Months	Yes No Total	89 23 112	58.22 49.83	.259**
*indicates χ^2 based on Kruskal Wallis H test **indicates Z based on Mann Whitney U test				

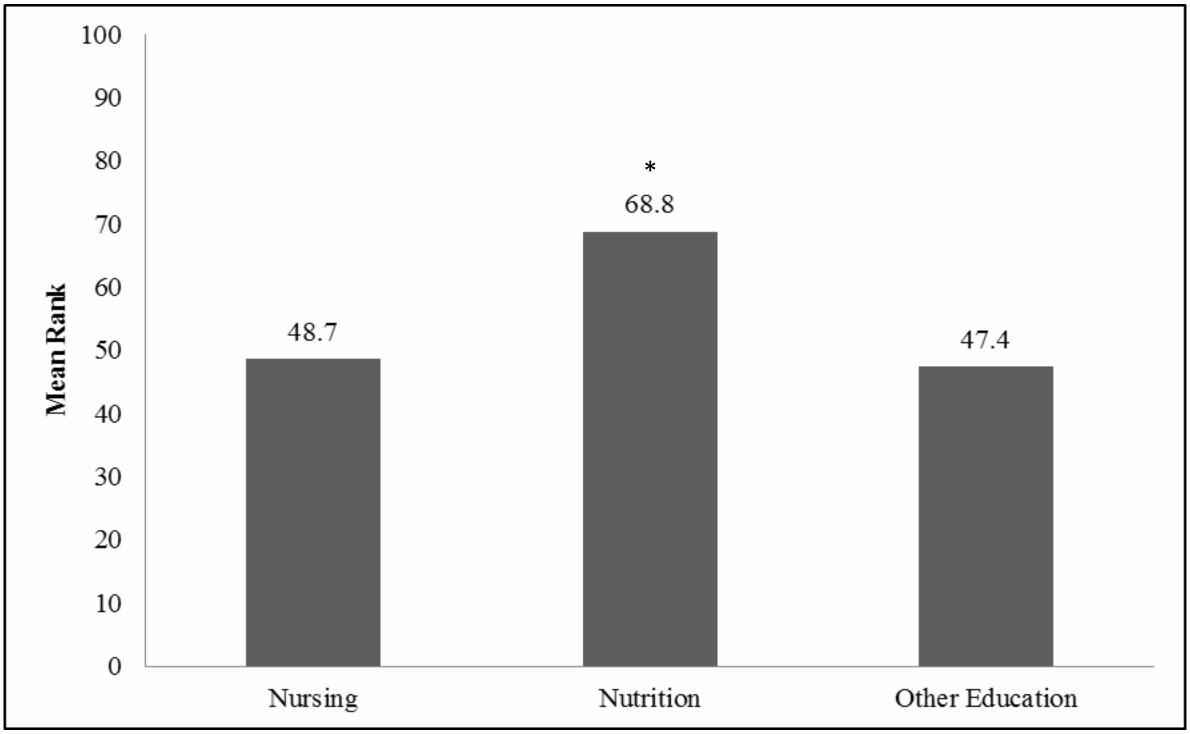
4.3 THE IMPORTANCE PLACED ON PHYSICAL ACTIVITY AS A TREATMENT STRATEGY COMPARED TO OTHER TREATMENT STRATEGIES IN DSME/S: SPECIFIC AIM 2

DEs ranked healthy eating (38.9%) and taking medications (28%) as the two most important treatments ahead of physical activity (19.6%) (Table 5). When responses were collapsed to form a "more important" category (response 3 or 4) or a "less important" category (response 1 or 2), subjects continued to rank healthy eating (61.1%) as important compared to physical activity (50.9%).

Table 5: Level of Importance the Diabetes Educators Placed on the 4 Content Areas of Diabetes Self-Management Education and Support (N=107).

	Percent (N) of Respondents in each Likert Category			
Variables	**1 (Least Important)**	**2**	**3**	**4 (Most Important)**
Healthy Eating	20.4% (22)	18.55 (20)	22.2% (24)	38.9% (42)
Physical Activity	21.5% (23)	27.1% (29)	31.8% (34)	19.6% (21)
Blood Glucose Monitoring	26.2% (28)	35.5% (38)	24.3% (26)	14% (15)
Taking Medications	31.8% (34)	18.7% (20)	21.5% (23)	28% (30)

Exploratory analyses revealed that educational discipline significantly influenced the level of importance placed on physical activity as a treatment strategy (p=.008) (Table 6). Post-hoc comparisons revealed that DEs with a nutrition discipline ranked physical activity significantly higher (mean rank= 68.81) compared to those with a nursing discipline (mean rank= 48.68) (p=.007), with no additional significant comparisons observed (Figure 2). No significant differences were found with the importance placed on physical activity as a treatment strategy across the categories of education level (p=.753) or the categories of practice setting (p=.794). Also, there were no significant relationships with the importance placed on physical activity as a treatment strategy and possession of the CDE (p=.387) or the personal physical activity behavior of the DEs (p=.733) (Table 6).



*significant difference between nutrition and nurse education using a Bonferroni adjusted p value < .0167

Figure 2: The Level of Importance Placed on Physical Activity by Diabetes Educators based on Educational Discipline

Table 6: Comparisons of the Importance the Diabetes Educators Placed on Physical Activity as a Treatment Strategy among the Categories of Educational Discipline, Education Level, Practice Setting, Possession of the CDE Credential, and Personal Physical Activity Behaviors of Diabetes Educators

Variables	Categories	Total (N)	Mean Rank	P value
Educational Discipline	Nurse Education Nutrition Education Other Education Total	67 29 11 107	48.68 68.81 47.36	.008*
Education Level	Associate's Degree Bachelor's Degree Master's Degree Other Degree Level Total	13 54 24 16 107	48.35 53.65 59.02 52.25	.753*
Practice Setting	Outpatient Hospital Primary Care Inpatient Hospital Other Setting Total	54 13 21 19 107	55.88 48.23 50.81 56.13	.794*
CDE	Yes No Total	86 29 115	56.47 62.53	.387**
Regular Personal Engagement in Physical Activity over the past 6 Months	Yes No Total	84 21 105	53.49 51.05	.733**

*indicates χ^2 based on Kruskal Wallis H test **indicates Z based on Mann Whitney U test

4.4 KNOWLEDGE OF THE CURRENT PHYSICAL ACTIVITY GUIDELINES FOR AMERICAN ADULTS: SPECIFIC AIM 3

Moderate Intensity Aerobic Physical Activity Guidelines

Approximately 74% (n=88) of DEs reported a value of at least 150 minutes (range, 150-300) of moderate intensity, aerobic physical activity (MPA) per week to be consistent with the amount recommended in the PAGAA. For the 26% (n=31) who reported a value of less than 150 minutes per week to be consistent with the MPA recommended in the PAGAA, the mean amount of MPA reported was 75.6±39.7 minutes per week.

Table 7 shows the exploratory analyses for Aim 3. A significant difference was determined with MPA guideline knowledge (at least 150 minutes per week) across the categories of both educational discipline (p=.011), and level of education obtained (p=.001). Post hoc analysis revealed that those within the "other" educational discipline category were significantly less likely to report a value of at least 150 minutes of MPA per week compared to the nurse education and nutrition education categories (p<.05).

When examining the categories of education level, post hoc analysis revealed that those in the "other" degree level, were significantly less likely to report a value of at least 150 minutes of MPA per week compared to those within the associate's, bachelor's and master's education levels (p<.05). Subjects who possessed the CDE were significantly more likely to report a value of at least 150 minutes of MPA per week compared to those who do not have the CDE (p=.001). Differences were not observed for knowledge of MPA guidelines between the categories of practice setting (p=0.328) or the categories of personal physical activity behaviors of the DEs (p=0.791).

Table 7: Diabetes Educator's Knowledge of the Current Physical Activity Guidelines for American Adults for Moderate Intensity Aerobic Physical Activity among the Categories of Education Discipline, Education Level, Practice Setting, Possession of the CDE Credential, and Personal Physical Activity Behaviors of Diabetes Educators

Variables	Categories	Reporting at least 150 minutes per week as the public health recommendation for physical activity		χ^2	P value
		N	%		
Educational Discipline (N=119)	Nurse Education (N=72) Nutrition Education (N=34) Other Education (N=13) Total (N=119)	49 26 4	68.1% [A] 76.5% 30.8% [A]	9.03	.011
Education Level (N=119)	Associate's Degree (N=14) Bachelor's Degree (N= 60) Master's Degree (N=28) Other Degree Level (N=17) Total (N=119)	7 47 20 5	50% [B] 78.3% [C] 71.4% [D] 29.4%[B, C, D]	16.256	.001
Practice Setting (N=119)	Outpatient Hospital (N=60) Primary Care (N=13) Inpatient Hospital (N=22) Other Setting (N=24) Total (N=119)	43 9 11 16	71.7% 69.2% 50% 66.7%	3.445	.328
CDE (N=119)	Yes (N=88) No (N=31) Total (N=119)	66 13	75% 41.9%	11.231	.001
Regular Engagement in Physical Activity over the past 6 Months (N=116)	Yes (N=78) No (N=38) Total (N=116)	62 31	79.5% 81.6%	.070	.791
Chi square test of association Values with the same superscript indicate that the post-hoc analysis shows a significant difference at p<0.05.					

Vigorous Intensity Aerobic Physical Activity Guidelines

The PAGAA also includes recommendations of obtaining at least 75 minutes per week of vigorous intensity aerobic physical activity (VPA) as an alternative to the 150 minutes of MPA. Less than half of the subjects (40.2%, n=45 of 112) reported knowledge of this VPA guideline. Of those who were aware of a VPA guideline, 51% (n=23) reported a duration of at least 75 minutes (range, 75-300) per week while 49% (n=22) reported values less than 75 minutes per week (45.2±20.01 minutes).

Exploratory analyses showed no difference in knowledge of the VPA guideline across the categories of educational discipline (p=.208); level of education (p= .131); possession of the CDE (p=.436) or the personal physical activity behaviors of the DEs (p=.064) (Table 8). A significant difference for knowledge of the VPA guideline across the categories of practice setting was observed, (p=.036); however, post hoc analyses revealed no statistically significant differences on knowledge of the VPA guideline among the practice settings categories.

Table 8: Diabetes Educator's Knowledge of Vigorous Aerobic Physical Activity Guidelines among the Categories of Educational Discipline, Education Level, Practice Setting, Possession of the CDE credential, and Personal Physical Activity Behaviors of Diabetes Educators

Variables	Categories	Total reporting knowing of VPA Guidelines	Percent reporting knowing of VPA Guidelines	χ^2	P-value
Educational Discipline	Nurse Education (N=67) Nutrition Education (N=33) Other Education (N=12) Total (N=112)	25 17 3	37.3% 51.5% 25%	3.14	.208
Education Level	Associate's Degree (N=13) Bachelor's Degree (N=59) Master's Degree (N=26) Other Degree level (N=14) Total (N=112)	3 29 10 3	23.1% 49.2% 38.5% 21.4%	5.638	.131
Practice Setting	Outpatient Hospital (N=58) Primary Care (N=12) Inpatient Hospital (N=20) Other Setting (N=22) Total (N=112)	23 2 13 7	39.7% 16.7% 65% 31.8%	8.533	.036
CDE	Yes (N=84) No (N=28) Total (N=112)	32 13	31.8% 46.4%	.607	.436
Regular Personal Engagement in Physical Activity over the past 6 Months	Yes (N=88) No (N=22) Total (N=110)	39 5	44.3% 22.7%	3.419	.064

Chi square test of association
VPA= Vigorous Intensity Physical Activity

Resistance Training Guidelines

The PAGAA further documents that all American adults should incorporate resistance training (RT) exercises at least 2 times per week for additional health benefits. Close to 64% (n=72 of 113) of subjects reported that there is an established frequency of weekly RT within the current PAGAA. Of those, 98.6% (n=71) reported a frequency of at least 2 days (range, 2-5) per week while only 1.4% (n =1) responded with a value of 1 day per week.

Exploratory analyses reported a significant difference with knowledge of the RT guideline across the categories of educational discipline (p=.047) (Table 9). Post hoc analysis determined no statistically significant differences on the responses across the categories. No significant relationships were identified with knowledge of the established RT guideline among education level (p=.232); practice setting (p=.719); possession of the CDE (p=.267); or personal physical activity behaviors of the DEs (p=.652) (Table 9).

Table 9: Diabetes Educator's Knowledge of Resistance Training Guidelines within the Physical Activity Guidelines for American Adults among the Categories of Educational Discipline, Education Level, Practice Setting, Possession of the CDE credential, and Personal Physical Activity Behaviors of Diabetes Educators

Variables	Categories	Total reporting knowing of RT Guidelines	Percent reporting knowing of RT Guidelines	χ^2	P value
Educational Discipline	Nurse Education (N=68) Nutrition Education (N=33) Other Education (N=12) Total (N=113)	41 26 5	60.3% 78.8% 41.7%	6.11	.047
Education Level	Associate's Degree (N=13) Bachelor's Degree (N=58) Master's Degree (N=27) Other Degree Level (N=15) Total (N=113)	8 36 21 7	61.5% 62.1% 77.8% 46.7%	4.29	.232
Practice Setting	Outpatient Hospital (N=58) Primary Care (N=12) Inpatient Hospital (N=21) Other Setting (N=22) Total (N=113)	39 7 14 12	67.2% 58.3% 66.7% 54.5%	1.342	.719
CDE	Yes (N=84) No (N=29) Total (N=113)	56 16	66.7% 55.2%	1.267	.267
Regular Personal Engagement in Physical Activity over the past 6 Months	Yes (N=88) No (N=23) Total (N=111)	58 14	65.9% 60.9%	.203	.652
Chi square test for association RT= Resistance Training					

4.5 LEVEL OF CONFIDENCE TOWARD PHYSICAL ACTIVITY COUNSELING DURING DSME/S: SPECIFIC AIM 4

Subjects were evaluated on their level of confidence with delivering the 4 content areas of DSME/S (healthy eating, physical activity, blood glucose monitoring and taking medications).

The primary content area of interest involved the DE's confidence in physical activity counseling. Overall, 54.7% (n= 64 of 117) reported that they are "very confident" counseling on physical activity compared to 41% (n=48) reporting "somewhat confident" and 4.3% (n=5) reporting "not confident at all".

Exploratory analyses are reported in Table 10. There were no significant differences in the DEs level of confidence in delivering physical activity counseling as a treatment strategy across the categories of educational discipline (p=.537); education level (p=.218); or possession of the CDE (p=.135). Practice setting was significantly associated with the subject's level of confidence on physical activity counseling as a treatment strategy (p=.029). Post-hoc analysis revealed that outpatient DEs have a significantly greater level of confidence when counseling on physical activity compared to those working in an inpatient hospital (mean ranks= 65.73 versus 43.70, respectively) (p=.018). There was also a significant difference found with the level of confidence on physical activity counseling as a treatment strategy with personal exercise behaviors of the DEs (p=.002). Subjects who reported engaging in regular physical activity over the past 6 months perceived themselves as more confident counseling on physical activity compared to those who reported not engaging in regular physical activity over the past 6 months.

Table 10: Diabetes Educator's Confidence toward Counseling on Physical Activity as a Treatment Strategy among the Categories of Educational Discipline, Education Level, Practice Setting, Possession of the CDE Credential, and Personal Physical Activity Behaviors of Diabetes Educators

Variables	Categories	Not Confident at all		Somewhat Confident		Very Confident		P value
		N	%	N	%	N	%	
Educational Discipline	Nurse Education (n=72) Nutrition Education (n=32) Other Education (n=13) Total (n=117)	4 1 0	5.6% 3.1% 0%	28 12 8	38.9% 37.5% 61.5%	40 19 5	55.6% 59.4% 38.5%	.537*
Education Level	Associates Degree (n=14) Bachelor's Degree (n=58) Master's Degree (n=28) Other Degree Level (n=17) Total (n=117)	1 1 3 0	7.1% 1.7% 10.7% 0%	6 20 12 10	42.9% 34.5% 42.9% 58.8%	7 37 13 7	50% 63.8% 46.4% 41.2%	.218*
Practice Setting	Inpatient Hospital (n=58) Primary Care (n=13) Outpatient Hospital (n=22) Other Setting (n=24) Total (n=117)	1 0 3 1	1.7% [A] 0% 13.6% [A] 4.2%	19 7 12 10	32.8% [B] 53.8% 54.5% [B] 41.6%	38 6 7 13	65.5% [C] 46.2% 31.8% [C] 54.2%	.029*
CDE	Yes (n=87) No (n=30) Total (n=117)	3 2	3.4% 6.7%	33 15	37.9% 50%	51 13	58.6% 43.3%	.135**
Regular Personal Engagement in Physical Activity over the past 6 Months	Yes (n=91) No (n=23) Total (n=114)	3 1	3.3% 4.3%	30 16	33% 69.6%	58 6	63.7% 26.1%	.002**

*p value based on Kruskal Wallis H test; ** p value based on Mann Whitney U test
Values with the same superscript indicate that the post-hoc analysis shows a significant difference at $p<0.05$.

Additional analyses were conducted to determine the level of confidence with physical activity goal setting and creating individualized exercise programs for aerobic training and resistance training. However, these were not part of the primary aims and are therefore illustrated in Appendix D (Tables 15-17).

4.6 BARRIERS WITH PHYSICAL ACTIVITY COUNSELING DURING DSME/S: SPECIFIC AIM 5

4.6.1 Diabetes Educator's Personal Barriers during DSME/S

DEs ranked specific barriers regarding their ability to counsel patients on physical activity (Table 11). The two most challenging personal barriers reported included "assuring safe physical activity plans for patients with co-morbidities" and the "inability to engage patients in physical activity" (i.e. due to motivation or lack of interest). The least challenging personal barrier reported was "limited knowledge of physical activity's effects on diabetes control".

Table 11: Diabetes Educator's Ranking of Perceived Personal Barriers toward Physical Activity Counseling (n=107)

		Ranking % (N)			
Barriers	**Median**	**1**	**2**	**3**	**4**
		(Least Challenging)			**(Most Challenging)**
Assuring safe physical activity plans for patients with co-morbidities (HTN, CVD, etc.)	3	17.8% (19)	16.8% (18)	31.8% (34)	33.6% (36)
Inability to engage patients in physical activity (i.e. motivation, interest, etc.)	3	12.1% (13)	23.4% (25)	27.1% (29)	37.4% (40)
Limited knowledge of physical activity's effects on diabetes control	1	50.5% (54)	24.3% (26)	17.8% (19)	7.5% (8)
Limited knowledge of proper physical activity counseling	2	20.6% (22)	35.5% (38)	22.4% (24)	21.5% (23)

Exploratory analyses were conducted to examine whether the personal barriers were influenced by educational discipline, level of education, practice setting, possession of the CDE, or the personal physical activity behaviors of the DEs. Complete results are provided in

Appendix D, Tables 18-21. Results of only the statistically significant, or those with a trend toward statistical significance, with personal barriers across the exploratory aims are shown in Table 12.

Barrier 1: Assuring Safe Physical Activity Plans for Patients with Co-morbidities

When DEs were asked about their challenges with assuring safe physical activity plans for patients with co-morbidities, a significant association was found across the categories of educational discipline (p=.039) (Table 12). However, post hoc analysis revealed no significant differences across the categories of educational discipline. No significant differences were found between the rankings on "assuring safe physical activity plans for patients with co-morbidities" across the categories of level of education (p=.338); practice setting (p=.569); possession of the CDE (p=.144) or the personal physical activity behaviors of DEs (p=.719) (Appendix D, Table 18).

Barrier 2: Inability to Engage Patients in Physical Activity

When DEs were asked about their challenges with their inability to engage patients in physical activity, no significant differences were found across the categories of educational al discipline (p=.055); level of education (p=.950); practice setting (p=.520); possession of the CDE (p=.747) or the personal physical activity behaviors of DEs (p=.151) (Appendix D, Table 19).

Barrier 3: Limited Knowledge of Physical Activity's Effects on Diabetes

When DEs were asked about their challenges with having a limited knowledge of physical activity's effects on diabetes control, no significant differences were found across the categories of educational discipline (p=.062); education level (p=.105); practice setting (p=.274); or personal physical activity behaviors of the DEs (p=.154) (Appendix D, Table 20). However, possession of the CDE resulted in a significant difference with having the CDE and “limited knowledge of physical activity’s effects on diabetes control” (p=.021). DEs without the CDE were more likely to rank “limited knowledge of physical activity’s effects on diabetes control” as a greater challenge (rank 3 or 4) compared to those with the CDE (Table 12).

Barrier 4: Limited Knowledge of Proper Physical Activity Counseling

When DEs were asked about their challenges with having a limited knowledge of proper physical activity counseling, no significant differences were found across the categories of educational discipline (p=.432); level of education (p=.910); practice setting (p=.711); possession of the CDE (p=.907); or personal physical activity behaviors of the DEs (p=.409) (Appendix D, Table 21).

Table 12: Diabetes Educator's Ranking of Perceived Personal Barriers among the categories of Educational Discipline and Possession of the CDE Credential

Barriers	Categories	Ranking								P value
		1 Least Challenging		2		3		4 Most Challenging		
		N	%	N	%	N	%	N	%	
Assuring Safe Physical Activity Plans for Patients with Co-morbidities (HTN, CVD, etc.)	Nurse Education (N=64)	14	21.9%	11	17.2%	19	29.7%	20	31.2%	.039*
	Nutrition Education (N=33)	2	6.1%	5	15.2%	11	33.3%	15	45.5%	
	Other Education (N=10)	3	30%	2	20%	4	40%	1	10%	
	Total (N=107)									
Inability to Engage my Patient in Physical Activity	Nurse Education (N=64)	8	12.5%	20	31.2%	17	26.6%	19	29.7%	.055*
	Nutrition Education (N=33)	5	15.2%	4	12.1%	9	27.3%	15	45.5%	
	Other Education (N=10)	0	0%	1	10%	3	30%	6	60%	
	Total (N=107)									
Limited Knowledge on Physical Activity and how it affects Diabetes Control	Nurse Education (N=64)	28	43.8%	16	25%	13	20.3%	7	10.9%	.062*
	Nutrition Education (N=33)	22	66.7%	6	18.2%	5	15.2%	0	0%	
	Other Education (N=10)	4	40%	4	40%	1	10%	1	10%	
	Total (N=107)									
	Certified Diabetes Educator(N=81)	45	55.6%	20	24.7%	12	14.8%	4	4.9%	.021**
	Not a Certified Diabetes Educator (N=26)	9	34.6%	6	23.1%	7	26.9%	4	15.4%	
	Total (N=107)									

*p-value based on Kruskal-Wallis H test, **p-value based on Mann-Whitney U test

4.6.2 Diabetes Educator's Practice Barriers during DSME/S

The greatest practice barrier documented was "time allotted for DSME/S visits" with the second most reported barrier involving "limited physician support and/ or guidance for physical activity counseling". The remainder of challenges appear to be equally ranked between the "least challenging" and "most challenging" responses (median= 3) (Table 13). When responses were collapsed to form a "more challenging" category (response 4, 5 or 6) or a "less challenging" category (response 1, 2 or 3), similar results remained with "time allotted for DSME/S visits" as the greatest barrier (61%) followed by "limited physician support and/ or guidance for physical activity counseling" (57%).

Table 13: Diabetes Educator's Ranking of Perceived Practice Barriers toward Physical Activity Counseling (N=100)

Barriers	Median	Ranking % (N) 1	2	3	4	5	6
		Least Challenging					**Most Challenging**
Time allotted for DSME/ S visits	5	18% (18)	12% (12)	9% (9)	9% (9)	17% (17)	35% (35)
Limited availability for individual visits	3	18% (18)	17% (17)	18% (18)	13% (13)	26% (26)	8% (8)
Lack of physical activity resources (i.e. handouts)	3	19% (19)	20% (20)	17% (17)	27% (27)	7% (7)	10% (10)
No reimbursement for physical activity counseling	3	16% (16)	15% (15)	25% (25)	17% (17)	12% (12)	15% (15)
Not sure which exercise professionals to refer to	3	13% (13)	24% (24)	16% (16)	14% (14)	20% (20)	13% (13)
Limited physician support and/ or guidance for physical activity counseling	4	16% (16)	12% (12)	15% (15)	20% (20)	18% (18)	19% (19)

Exploratory analyses were conducted to examine whether each practice barrier was influenced by educational discipline, level of education obtained, practice setting, possession of the CDE, and the personal exercise behaviors of the DEs. Complete results are provided in Appendix D, Tables 22-27. Results of only the statistically significant, or those with a trend toward statistical significance, between these practice barriers and the exploratory aims are provided in Table 14.

Barrier 1: Time available for DSME/S

When DEs were asked about their challenges with time available for DSME/S, no significant differences were found across the categories of educational discipline (p=.274); level of education (p= .424); possession of the CDE (p=.109); or personal physical activity behaviors of the DEs (p=.933) (Appendix D, Table 22). However, practice setting significantly influenced the DEs ranking of “time allotted for DSME/S visits” (p=.022) (Table 14). Post hoc analysis revealed that “time allotted for DSME/S visits” was a significantly greater barrier for DEs working in the inpatient hospital setting (mean rank= 65) compared to those working in primary care (mean rank= 34.04) (p=.014).

Barrier 2: Limited Availability for Individual DSME/S

When DEs were asked about their challenges with a limited availability for individual DSME/S, no significant differences were found across the categories of educational discipline (p=.767); education level (p=.412); practice setting (p=.546); or personal physical activity behaviors of the DEs (p= .858) (Appendix D, Table 23). However, there was a significant difference between DEs with and without the CDE on their ranking of “limited availability for individual visits” (p= .035) (Table 14).

Barrier 3: Lack of Physical Activity Resources

When DEs were asked about their challenges with having a lack of physical activity resources, no significant differences were found across the categories of educational discipline (p=.694); education level (p=.194); practice setting (p=.908); possession of the CDE (p= .428); or personal physical activity behaviors of the DEs (p= .770) (Appendix D, Table 24).

Barrier 4: No Reimbursement for Physical Activity Counseling

When DEs were asked about their challenges with having no reimbursement for physical activity counseling, no significant differences were found across the categories of educational discipline (p=.153); education level (p=.493); practice setting (p=.306); or personal physical activity behaviors of the DEs (p= .862) (Appendix D, Table 25). However, there was a significant difference between DEs with and without the CDE on their ranking of “no reimbursement for physical activity counseling” (p= .022) (Table 14).

Barrier 5: Not sure which Exercise Professional to Refer the Patient to for Counseling

When DEs were asked about their challenges with being unsure which exercise professional to refer patients to for counseling, no significant differences were found across the categories of educational discipline (p= .941); level of education (p= .676); possession of the CDE (p= .170); or personal physical activity behaviors of the DEs (p= .699) (Appendix D, Table 26). A significant difference was found on DEs ranking of “not sure which exercise professionals to refer to” across the categories of practice setting (p=.038) (Table 14). Post hoc analysis showed a significantly greater barrier reported for “not sure which exercise professionals to refer to” in DEs who work in primary care (mean rank= 66.54) compared to DEs working in the inpatient hospital setting (mean rank= 38.92) (p=.043).

Barrier 6: Limited Physician Support and/ or Guidance for Physical Activity Counseling

When DEs were asked about their challenges with limited physician support and/ or guidance for physical activity counseling, no significant differences were found across the categories of educational discipline (p= .771); level of education (p= .289); practice setting (p=

.998); possession of the CDE (p= .577); or personal physical activity behaviors of the DEs (p= .738) (Appendix D, Table 27).

Table 14: Diabetes Educator's Ranking of Perceived Practice Barriers among the Categories of Practice Setting and Possession of the CDE Credential

Barriers	Categories	Ranking												P value
		1 Least Challenging		2		3		4		5		6 Most Challenging		
		N	%	N	%	N	%	N	%	N	%	N	%	
Time allotted for Diabetes Self-Management Education and Support (DSME/S) Visits	Outpatient Hospital (N=51)	8	15.7%	8	15.7%	5	9.8%	3	5.9%	10	19.6%	17	33.3%	.022*^{A}
	Primary Care (N=13)	5	38.5%	2	15.4%	1	7.7%	0	0%	4	30.8%	1	7.7%	
	Inpatient Hospital (N=19)	2	10.5%	0	0%	0	0%	3	15.8%	3	15.8%	11	57.9%	
	Other Setting (N=17)	3	17.6%	2	11.8%	3	17.6%	3	17.6%	0	0%	6	35.3%	
	Total (N=100)													
Not Sure Which Exercise Professional to Refer to	Outpatient Hospital (N=51)	7	13.7%	13	25.5%	8	15.7%	8	15.7%	10	19.6%	5	9.8%	.038*^{A}
	Primary Care (N=13)	2	15.4%	0	0%	0	0%	3	23.1%	5	38.5%	3	23.1%	
	Inpatient Hospital (N=19)	3	15.8%	6	31.6%	6	31.6%	2	10.5%	1	5.3%	1	5.3%	
	Other Setting (N=17)	1	5.9%	5	29.4%	2	11.8%	1	5.9%	4	23.5%	4	23.5%	
	Total (N=100)													
Limited Availability for Individual Visits	Certified Diabetes Educator(N=75)	16	21.3%	15	20%	1	18.7%	8	10.7%	15	20%	7	9.3%	.035**
	Not a Certified Diabetes Educator (N=25)	2	8%	2	8%	4	16%	5	20%	11	44%	1	4%	
	Total (N=100)													
No Reimburse-ment for Physical Activity Counseling	Certified Diabetes Educator(N=75)	11	14.7%	9	12%	18	24%	12	16%	10	13.3%	15	20%	.022**
	Not a Certified Diabetes Educator (N=25)	5	20%	6	24%	7	28%	5	20%	2	8%	0	0%	
	Total (N=100)													

*p-value based on Kruskal-Wallis H test, **p-value based on Mann-Whitney U test
Post hoc: ^{A} indicates significant difference between inpatient setting and primary care setting

4.7 ADDITIONAL ANALYSES

DEs reported “assuring safe physical activity plans for patients with co-morbidities” as the second “most challenging” personal barrier. It may be of interest whether limited physician support/ guidance might play a role in the DE’s challenges of assuring safe activity plans for patients with co-morbidities. Additional analysis was conducted to recognize whether this barrier is a related to “limited physician support/ guidance for physical activity counseling” (the 2nd “most challenging” practice barrier reported). Each category was collapsed to represent “not a challenge” or “challenge” for each barrier. A chi squared test for association found no significant differences between these groups (p=.479).

There was one exercise physiologist (EP) within this sample. The investigators hypothesize that the DE with an exercise physiology discipline would report the most positive responses regarding physical activity counseling compared to the other educational disciplines across the specific aims. While the data are strictly anecdotal, Table 28 in the appendix (Appendix D) reports the responses of the EP compared to the responses of the other disciplines. The exercise physiologist was 40 years of age, female and Caucasian. The EP does not have the CDE, has been working for 3 years as a DE in the outpatient hospital setting through an individual format.

The EP, DE reported 50% of DSME/S time counseling on physical activity. While this amount was documented as the greatest percentage of time spent, this was not the greatest amount of minutes reported counseling on physical activity during DSME/S (60 minutes was the greatest amount of minutes reported). The EP ranked physical activity as the 3rd most important treatment strategy during DSME/S, behind taking medications and healthy eating, respectively. The correct recommendations for both moderate and vigorous aerobic physical activity per week and at least 2 days per week of resistance training were reported. Moreover, the level of confidence counseling on physical activity during DSME/S described by the EP was ranked as "very confident". No data were recorded for the personal barriers or practice barriers.

4.8 SUMMARY

This study evaluated various factors that may influence the diabetes educator's (DE) counseling on physical activity during DSME/S. In summary, this study showed that:

1) Among the 4 content areas of DSME/S (healthy eating, physical activity, blood glucose monitoring and taking medications), DEs spend the least amount of time addressing physical activity (less than 18% of DSME/S time).
2) DEs ranked physical activity as the 3rd most important treatment strategy, behind healthy eating and taking medications.
3) Approximately 1/3 of DEs did not know that the current recommendations for moderate intensity aerobic activity is at least 150 minutes per week.
4) Less than half of DEs knew there were vigorous intensity aerobic activity recommendations. Of those, 29% indicated a response of at least 75 minutes per week.
5) Almost 2/3 of DEs knew there were resistance training recommendations. Of those, 1/3 indicated a response of at least 2 days per week.
6) Approximately half of DEs reported that they were not "very confident" delivering physical activity counseling.
7) The greatest personal barriers of DEs are "assuring safe physical activity plans for their diabetes patients with co-morbidities" and the "inability to engage their patients in physical

activity”. The least reported personal barrier is “limited knowledge of physical activity’s effects on diabetes control”.

8) The most often identified barriers reported by DEs in their practice setting is “time allotted for DSME/S visits” and “limited physician support and guidance for physical activity counseling”.

5.0 DISCUSSION

5.1 INTRODUCTION

Physical activity has long been considered a cornerstone to diabetes management. Nonetheless, only 39% of adults with diabetes are considered to be regularly active in the United States [46]. The relatively low participation in physical activity in the United States may negatively impact chronic conditions, such as diabetes [91, 94, 115].

The healthcare sector is the nation's largest industry and can promote physical activity to a mass audience whose primary reason for visiting is to seek health advice. Studies have indicated that although physical activity counseling can be effective in the clinical realm [223, 224, 239], many providers report barriers within their respected settings [228, 234, 240]. DEs are health practitioners from an array of disciplines whom traditionally deliver DSME/S to patients in a variety of health settings. The AADE recommends that DEs should use the current exercise guidelines to tailor exercise prescriptions and counsel diabetes patients on safe and effective goals to enhance their clinical and behavioral health outcomes. Still, diabetes patients report that they receive less support, education, and encouragement for physical activity compared with any other aspect of diabetes management [47].

5.2 RESPONSE RATE

Recruiting healthcare professionals is often a challenge in research with cited barriers such as time constraints, lack of incentives and a lack of perceived value of the survey [241, 242]. Based on a recent meta- analysis, the survey response rates of health care professionals is 53% [238]. Web based and postal mail surveys have become increasingly popular as a means to reach large populations, however, they often suffer from low response rates and high variability (15-94%) [243-246]. Ingel et al. provided an electronic based survey method in attempt to maximize response rates targeting outpatient nurses. While this study reached over 2,000 professionals through the PA State Board of Nursing list serve, it only obtained a 4.7% completion rate over many weeks of effort [241]. Conversely, Zewe et al. surveyed acute care nurses from an academic medical center using a simple paper and pencil method yielding a 74% usable survey response rate [247]. Again, data collection involved many strategies and multiple attempts. In consideration of these findings, this study utilized a paper and pencil survey design with a personal interaction recruitment method to try to capture the maximum amount of participants in a single time period at a profession conference for DEs in the state of Pennsylvania. Because this conference draws DEs from each region of the state, this recruitment method was chosen with the attempt to capture a representative sample of all Pennsylvania DEs and obtained a response rate of 70% (119 of the 170 attendees). This represents approximately 19% (119 of 620) of DEs within the state of Pennsylvania.

5.3 THE DIABETES EDUCATOR'S TIME DEDICATED TO PHYSICAL ACTIVITY

There are multiple content areas that DEs may need to discuss to help their patients manage diabetes [49, 66]. DEs reported their percentage of time spent on 4 content areas of DSME/S (healthy eating, physical activity, blood glucose monitoring and taking medications). Results showed that DEs dedicate the least amount of DSME/S time counseling on physical activity (14.5$\pm$12.1 minutes (17.7% of DSME time)) compared to the other content endorsed during DSME/S.

To the investigator's knowledge, this is the first study to quantify the allocation of time that DEs spend counseling on physical activity. However, previous studies assessing the time dedicated to physical activity have shown lower amounts of physical activity counseling time with various healthcare professionals [54, 241, 248]. McKenna et al. evaluated physical activity promotion in 397 registered dietitians [54]. In those who reported engaging in physical activity promotion, the average amount of time spent was 8.96$\pm$19.8 minutes [54]. Ingel recently surveyed outpatient nurse's time spent counseling on physical activity. Results determined that those who counsel their patients on physical activity spend an average of 6.36$\pm$8.9 minutes per patient [241]. The amount of time spent counseling on physical activity is even less when examining physicians [248, 249]. Pollak et al. evaluated office based physicians with direct patient care using the National Ambulatory Medical Care Survey. Results showed that office based physicians spend an estimated time of 2.89 minutes (SE=.92) for preventive visits (total average duration of visit = 22.4$\pm$11.8 minutes) and 1.43 minutes (SE=.48) for chronic visits (total average duration of visit = 18.9$\pm$9.2 minutes) [249]. However, direct comparison between DSME/S visits and these other clinical visits may be difficult due to the varying overall duration that may differ by type of visit.

5.4 TO ASSESS THE IMPORTANCE THAT DIABETES EDUCATORS PLACE ON PHYSICAL ACTIVITY AS A TREATMENT STRATEGY FOR DSME/S

DEs ranked physical activity as the third "most important" treatment strategy (19.6%) behind healthy eating (38.9%) and taking medications (28%). Blood glucose monitoring was ranked the least "most important" treatment strategy for diabetes management (14%). The literature is largely absent regarding DE's views on the perceived importance of using physical activity as a therapeutic modality. A study by Shultz et al. revealed that less than half (48%) of sampled DEs stated that physical activity is not a high priority [250]. Robbins et al. surveyed nurse practitioners on their barriers with physical activity counseling and showed that a major barrier was failure to give priority to physical activity [53]. These studies did not specifically compare the importance of physical activity to other counseling areas. Tompkins et al. sampled 398 nurse practitioners residing in a variety of clinical settings and showed that 84% ranked physical activity counseling as important as prescribing medications [251]. Ingel et al. examined the priority of physical activity counseling among outpatient nurses compared to other health counseling topics [241]. Results showed that compared to 10 health counseling topics commonly addressed by outpatient practice nurses, physical activity was ranked 3rd in priority next to smoking cessation and medical compliance. In contrast, a similar survey by Zewe et al. found that more than half of acute care nurses ranked physical activity counseling as the lowest priority compared to 9 other patient care activities [247]. These differences may have been influenced by the variability in practice settings; however, the current study did not find any significant differences between inpatient and outpatient settings for physical activity counseling. Finally, it should be recognized that "least important" is not a mirror image of "most important". Therefore, these results regarding this aim, should be interpreted with caution.

This study determined that DEs with a nutrition background ranked physical activity significantly higher compared to DEs with a nursing background (p=.007). This difference may have been influenced by the DE's view on whether they are responsible for physical activity counseling. For instance, a greater proportion of nutrition professionals felt that they were responsible for counseling on physical activity during a DSME/S visit compared to the nurse professionals (73.5% versus 63.5%, respectively).

5.5 TO ASSESS THE DIABETES EDUCATOR'S KNOWLEDGE REGARDING THE CURRENT PHYSICAL ACTIVITY GUIDELINES FOR AMERICAN ADULTS

These results support the literature regarding the healthcare professional's limited knowledge of the dose of physical activity recommended for public health [51, 234, 241, 247]. For instance, Ingel et al. determined that only 60% of non-inpatient nurses reported at least 150 minutes of moderate intensity aerobic activity (MPA) per week [241].

A major factor that influenced the DE's knowledge of physical activity guidelines was educational discipline. Those with a nutrition degree reported a greater knowledge of both MPA and resistance training (RT) recommendations compared to both a nursing background and those falling within the "other" educational discipline category. In this sample, a greater proportion of DEs with a degree in nutrition reported engaging in regular physical activity compared to nurse DEs (88% versus 77%, respectively).

Another factor that influenced this sample of DE's responses was having the Certified Diabetes Educator (CDE) credential. Those with the CDE reported a significantly greater knowledge of the recommended minutes of MPA per week compared to those without the CDE (p=.001). A previous study comparing registered dietitians with and without the CDE credential found that those with the CDE scored significantly higher on physical activity knowledge scores, using the Exercise Teaching Questionnaire, compared to the registered dietitians without the CDE [252]. Because the CDE exam requires a general knowledge of physical activity and diabetes, these outcomes may be due to a greater exposure to physical activity content during the CDE certification preparation.

5.6 TO ASSESS THE DIABETES EDUCATOR'S LEVEL OF CONFIDENCE TOWARD PHYSICAL ACTIVITY COUNSELING DURING DSME/S

Diabetes education has evolved from a didactic approach utilizing handouts and lecture slides to a more individualized interaction between both patient and provider [48, 49]. Currently, the role of the DE is to help empower patients to take action by applying the knowledge and skills necessary for the patient to self-manage their diabetes.

Frequently cited reasons for not delivering health related care is a perceived lack of confidence to provide counseling [240, 253, 254]. In this current study, approximately 55% of DE reported that they were very confident with delivering physical activity counseling to their diabetes patients. These results are slightly lower than the confidence levels of outpatient nurses documented by Ingel et al., where 68% of nurses "agreed" or "strongly agreed" that they were confident counseling on physical activity [241]. However, both of these findings are markedly greater than the confidence levels of acute care nurses. For instance, Zewe queried 194 acute care nurses on their confidence to provide physical activity counseling with their patients [247]. Only 14.1% reported that they were very confident with physical activity counseling. With this study, practice setting appeared to influence levels of confidence with physical activity counseling. Outpatient DEs had a significantly greater level of confidence toward physical activity counseling compared to inpatient DEs ($p=.018$). The results indicate that the type of setting in which the healthcare professional resides may play a role in confidence with physical activity counseling.

It has been documented that those who personally participate in physical activity are more likely to counsel their patients on exercise [255]. This study found a significant difference in the level of confidence for physical activity counseling between those who regularly engage in personal physical activity and those who reported not engaging in personal physical activity ($p=.002$). Both knowledge of physical activity and the understanding of how to participate in a regular exercise regimen may correlate with confidence for physical activity counseling.

5.7 TO ASSESS BARRIERS THAT DIABETES EDUCATORS ENCOUNTER REGARDING PHYSICAL ACTIVITY COUNSELING DURING DSME/S

Personal Barriers

Many barriers continue to affect the clinician’s ability to counsel on physical activity [51, 250, 253]. Results of this study show that the most documented personal barriers included the “inability to engage patients in physical activity” (i.e. due to motivation or lack of interest). This barrier has been acknowledged elsewhere [234]. For example, a qualitative study by Jansink et al. showed that primary care nurses feel that a major barrier involves the patient’s attitude toward physical activity adoption, where low levels of patient motivation are inversely related to nurses physical activity counseling [234].

The “limited knowledge on physical activity’s effects on diabetes control” and “limited knowledge of proper physical activity counseling” were perceived as the lowest barriers. This is in contrast to the literature recording low levels of confidence on physical activity counseling in clinicians [234, 248]. This is also interesting considering that the data show that only about 1/3 of the sample was “very confident” with physical activity goal setting and roughly 20% and 10% were very confident counseling on individual aerobic and resistance training regimens, respectively.

Practice Barriers

The most frequently cited practice barriers for DE’s regarding physical activity counseling was “time allotted for DSME/S visits”. This is commonly reported among clinicians [52, 235, 248, 249]. The current study found that DEs who work in the inpatient setting perceived time to be a greater barrier compared to all other settings, particularly compared to the primary care setting (p=.014). On the other hand, those who work in primary care were significantly more likely to report “not sure which exercise professional to refer to” compared to those working in the inpatient setting (p=.038). This may be due to the fact that hospital settings usually have more health education or clinical exercise physiology staff available for referral compared to the primary care practices.

5.8 LIMITATIONS

The following limitations should be considered when interpreting the findings from this study.

Generalizability and Sample Size

1) Data were obtained by only those who attended the 2014, Pennsylvania Diabetes Conference. Those who attend the conference may be more inclined to seek professional knowledge and stay current with best practice procedures. Furthermore, the 26.5% of the survey non-responders may not represent the same demographics as those who completed the survey. Therefore, this convenience sample may be subject to selection bias and may not be representative of all DEs in the state of Pennsylvania. Future studies should implement different recruiting methods to improve heterogeneity. Consideration should also be given to recruiting a national sample of DEs to increase overall generalizability. However, the percentages across educational disciplines of this sample favors a national representation of DEs. For instance, this sample reflected 60.5% nurses’ 28.6% nutritionists, 5.9% pharmacists and 2.6% “other health professionals (<1% exercise physiologists). This is in accordance with the national statistics among AADE members (53% nurses; 29% nutritionists; 9% pharmacists and 3% “other health professionals (< 1% exercise physiologists)). The comparison across gender was 95.8% for this sample versus 91% in among the AADE. These similarities help with the generalizability of the study.
2) The sample size obtained from this study increases the likelihood of the data to be subjected to type II error and hindered the ability to report extensive and definitive

analysis regarding moderating factors and heterogeneity. This study also explored various factors that may have influenced the subject's responses. These subcategory analyses forced a greater reduction in sample size, thereby enhancing the possibility of reporting type II error when observing each aim. Hence, these results should be interpreted with caution.

Data Collection and Instrumentation

1) The survey instrument used was created by the investigators of the study. Although the survey was piloted with a small sample of DEs prior to initiation, it is not a validated questionnaire. Therefore, a future recommendation should be to test the reliability and the validity of the survey instrument on additional subjects. Moreover, like all subjective measures of data collection, this survey was based on self-report which subject the data to response bias. Future considerations should involve direct observation methods to assess the DE's practice behaviors and delivery of DSME/S.
2) The survey queried on formal training in exercise physiology or exercise science. However, the survey did not query on any other training related to physical activity or physical activity counseling that the DE may have received. Thus, it is possible that individuals receiving more continuing education in physical activity may have responded differently to the survey, but this was not able to be ascertained. Therefore, future surveys should include questions on formal and other forms of physical activity education or training that was received by DEs.
3) The survey queried about time spent counseling on physical activity as a treatment strategy compared to 3 other content areas within DSME/S. Perhaps the DEs spend

additional time delivering other important information that was not captured with this instrument. Therefore, results may be misleading and subject to information bias.

4) The survey did not query on the number of sessions, the length of sessions, or whether the content delivered is weighted according the session order. Therefore, it could not be indicated if the responses regarding the delivery of physical activity and the other treatments were ranked according to the session delivered or the amount of time available.

5) The survey queried the level of importance placed on physical activity as a treatment strategy compared to 3 other content areas within DSME/S. Perhaps the DEs believe there is other important information that needs to be addressed during DSME/S that was not captured with this instrument. Therefore, those results may be misleading and subject to information bias.

6) The survey instrument queried subjects on personal engagement in regular physical activity over the past 6 months. However, it failed to identify whether the reported amounts were a product of light, moderate or vigorous intensity and whether the reported minutes included either aerobic or resistance training or both. Therefore, this study was unable to identify whether those who report regular physical activity were also obtaining the current Physical Activity Guidelines for American Adults.

7) This study targeted DEs. Perhaps the patient perspective would have provided additional insight which may influence the interpretations of this analysis. Future studies should query the patient population to determine what they would like to know regarding physical activity adoption to help guide the specific learning needs of both the educators,

for effective delivery of physical activity content, as well as to cover the learning needs of the patients.

5.9 CONCLUSION

Healthcare professionals have been increasingly called upon to initiate physical activity counseling with their patients [256]. Recent reports indicate that only 10% of primary care visits include some type of physical activity counseling [257]. DEs are in a unique position to provide routine follow-up with patients and counsel on lifestyle management behaviors, like physical activity.

This study was conducted to examine specific factors that may influence the DE's ability to counsel patients on physical activity. These findings support the need to improve DE's knowledge of physical activity and their confidence in counseling on physical activity. Reimbursement through a clinical exercise physiologist referral system could help to ease the challenges of the DEs reported barriers with physical activity counseling. However, there is currently not a reimbursable payer system specifically for physical activity counseling with exercise physiologists. Thus, strategies should be consider by leading professional organizations, such as the AADE, to enhance the knowledge, confidence and counseling strategies of DEs regarding physical activity. This may result in improved health outcomes for patients with diabetes.

APPENDIX A

ATTENTION ALL DIABETES EDUCATORS!

VOLUNTEER IN THIS STUDY FOR

A CHANCE TO GAIN BACK YOUR REGISTRATION FEE

Plus: a signed copy of *Exercise and Diabetes: A Clinician's Guide to Prescribing Physical Activity*, by Dr. Sheri Colberg, PhD

THIS WILL ONLY TAKE ABOUT
5 MINUTES OF YOUR TIME!

This study is being conducted by Robert Powell, diabetes educator and PhD Candidate at the University of Pittsburgh, Department of Health and Physical Activity. This survey collection is to partially fulfill his doctoral degree requirements. He can be reached at 412-864-0168.

APPENDIX B

Introductory Script

The purpose of this research study is to explore factors associated with counseling your diabetes patients on physical activity during Diabetes Self-Management Education and Support (DSME/S).

This survey will take approximately 5 minutes to complete. Your participation is voluntary and you may withdraw at any time. If you are willing to participate, the survey will ask you questions about your background (i.e. race, education, years as a diabetes educator, etc.) as well as questions regarding your abilities and barriers with providing physical activity counseling to your diabetes patients.

There are no foreseeable risks to you nor is there any direct benefit. As an appreciation of your time and volunteering, each volunteer will be given a raffle ticket which will be used in a random drawing for the possibility of obtaining a gift card of $160 and a copy of the American Diabetes Association's physical activity reference book, *Exercise and Diabetes: A Clinician's guide to Prescribing Physical Activity*, signed by author Dr. Sheri Colberg, PhD.

This is an entirely anonymous survey so your responses will not be identifiable to you in any way. Also, all results will be stored in a locked filing cabinet and a password protected computer accessible only to the investigators of this study.

This study is being conducted by Robert Powell, PhD Candidate at the University of Pittsburgh, Department of Health and Physical Activity. This survey collection is to partially fulfill his doctoral degree requirements. He can be reached at 412-864-0168.

APPENDIX C

This Survey is designed to explore factors associated with counseling your diabetes patients on physical activity during Diabetes Self-Management Education and Support (DSME/S)

Unique Identifier:

__ __ __ __

Please circle your responses to the following:

A) Do you provide Diabetes Self-Management Education and Support (DSME/S)?

a. Yes

b. No (Not eligible- stop survey)

B) Does the diabetes population that you serve involve patients aged 18 years and older?

a. Yes

b. No (Not eligible- stop survey)

Section 1: Please describe yourself:

1) Age (in years):_________

2) Gender:
    a. Male
    b. Female

3) Ethnicity: Do you consider yourself to be Hispanic or Latino, that is, of Mexican, Puerto Rican, Cuban, or Latin American descent?
    a. Yes
    b. No
    c. Unknown

4) Race:
   a. White
   b. Black or African American
   c. American Indian
   d. Alaska Native
   e. Native Hawaiian or Pacific Islander
   f. Asian
   g. Other
   h. Unknown

5) Indicate your academic training by placing an “X” in the appropriate boxes below.

	Academic Degree Earned				
	Associates Degree	Bachelor’s Degree	Master’s Degree	Doctorate Degree	Other
Nursing					
Nutrition/Dietetics					
Exercise Physiology					
Pharmacy					
Health Education					
Medical Doctor (MD, DO, etc.)					
Other: _________					

6) Do you currently hold the Certified Diabetes Educator (CDE) credential?
   a. Yes
   b. No
7) How many years have you provided Diabetes Self-Management Education and Support (DSME/S)?________(years)

8) In which of these formats do you deliver most of your DSME/S sessions?
   a. Group
   b. One on one (individual)

9) In which setting do you spend the majority of time providing diabetes education?
   a. Inpatient
   b. Outpatient

10) Where is your MAIN practice setting?

a. Hospital-based outpatient clinic
b. Primary Care Practice(s)
c. Inpatient Hospital
d. Pharmacy
e. Home Health Services
f. Other_______________

Section 2: Please answer the following regarding your DSME/S sessions

11) Regarding YOUR DSME/S sessions, please indicate **the percent (%) of time** YOU typically spend addressing 4 of the common content areas:

Content Areas	**PERCENT (%) of TIME During an AVERAGE Session**
Healthy Eating	
Physical Activity	
Monitoring	
Medications	

12) Based on YOUR OPINION, when educating a patient, how would YOU RANK the level of importance of your addressing each of the following content areas: (Use each number only once)

Content Areas	**LEVEL of IMPORTANCE** **1=least important** **4= most important**
Healthy Eating	
Physical Activity	
Monitoring	
Medications	

13) Based on YOUR experience, how do you think YOUR PATIENTS rank the following content areas as a priority in their diabetes management? (Use each number only once)

Content Areas	**LEVEL of PATIENT PRIORITY** 1=lowest priority 4= highest priority
Healthy Eating	
Physical Activity	
Monitoring	
Medications	

14) Please indicate YOUR level of confidence delivering each of the following content areas.

Content Areas	**Not Confident at all**	**Somewhat Confident**	**Very Confident**
Healthy Eating			
Physical Activity			
Monitoring			
Medications			

15) On average, how many minutes do you spend on physical activity counseling during DSME/S sessions?_______(minutes)

16) Do you think that all patients with diabetes can benefit from engaging in some form of physical activity?
   a. Yes
   b. No
   c. Not sure

17) Do you think that it is the responsibility of the diabetes educator to counsel patients on INDIVIDUALIZED physical activity levels or plans?
   a. Yes (skip to question 19)
   b. No

18) If No, whom do you think should be primarily responsible for counseling patients on an INDIVIDUALIZED physical activity plan?

a. Doctor

b. Personal Trainer

c. Clinical Exercise Physiologist

d. Other healthcare provider (please specify) ________________

e. Not sure

19) According to the Physical Activity Guidelines for American Adults, the goal for adults with diabetes is to progress to, and achieve a minimum of_________minutes per week of **moderate intensity aerobic activity** (i.e. brisk walking).

20) Are there specific recommendations for **vigorous intensity aerobic activity** (i.e. running) within the Physical Activity Guidelines for American Adults?

a. No (skip to Question 21)

b. Yes

If "yes", the recommended amount of vigorous intensity physical activity is at least ________minutes per week

21) Within the Physical Activity Guidelines for American Adults, are there specific recommendations for **resistance training**?

a. No (skip to Question 22)

b. Yes

If "yes", the recommended amount of resistance training is at least ______days per week

22) Please indicate YOUR CONFIDENCE to perform each of the following by placing an "X" in the appropriate boxes below.

I AM CONFIDENT COUNSELING ON PHYSICAL ACTIVITY with patients who have diabetes……………..	**Not Confident at all**	**Somewhat Confident**	**Very Confident**
who use oral anti- hyperglycemic medications			
who use insulin			
who use insulin pump therapy			
when discussing goal setting			
with diabetes related complications (i.e. retinopathy, neuropathy, nephropathy)			
with comorbidities (i.e. obesity, arthritis, hypertension, hyperlipidemia)			
to create an INDIVIDUALIZED plan using aerobic activity			
to create an INDIVIDUALIZED plan using resistance training			

23) From your perspective, RANK (from least to most) the following issues that can challenge your ability to effectively counsel your patients on physical activity: (Use each number only once)

Challenges for ME with my PATIENTS	**<u>Ranking</u>** **1=least challenging** **4=most challenging**
assuring safe activity plan for patient's comorbidities	
inability to engage my patient in physical activity	
limited knowledge on physical activity and how it affects diabetes control	
limited knowledge in proper physical activity counseling	

24) RANK (from least to most) the following factors within your WORK SETTING that create challenges to your ability to effectively counsel your patients on physical activity. (Use each number only once)

Challenges with MY work setting	**<u>Ranking</u>** **1=least challenging** **6= most challenging**
Time allotted for DSME/S visits	
Limited availability for individual visits	
Lack of physical activity resources (i.e. handouts)	
No reimbursement for physical activity counseling	
Not sure which exercise professionals to refer to	
Limited physician support and/or guidance for physical activity counseling	

25) RANK (from least to most) the following resources that if made available, would help you to more effectively counsel your patients on physical activity? (Use each number once)

Resources to help ME engage in physical activity counseling	**<u>Ranking</u>** **1=least beneficial resource** **8= most beneficial resource**
Continuing Education opportunities on Physical Activity counseling	
More time with patients during visits	
More opportunities for individual visits for patient counseling	
More opportunities for group visits to engage patients in activity counseling	
Greater access to exercise professionals **within** my clinical/ diabetes care team	
Referral opportunities to exercise professionals **outside** of my clinical team	
Greater Physician support/guidance for physical activity counseling	
Reimbursement for physical activity counseling	

Section 3: Please describe your personal exercise behaviors:

26) Over the past 6 months have you regularly engaged in physical activity?

a. Yes

b. No

If "Yes", on average, how many minutes per week of physical activity do you engaged in?________________(minutes per week)

Thank you for your time!!!

APPENDIX D

Table 15: Diabetes Educator's Confidence toward Counseling on Physical Activity Goal Setting among the Categories of Educational Discipline, Education Level, Practice Setting, Possession of the CDE credential, and Personal Physical Activity Behaviors

Variables	Categories	Not Confident at all		Somewhat Confident		Very Confident		P value
		N	%	N	%	N	%	
Confidence to Discuss Physical Activity Goal Setting	Nurse Education (N=72)	4	5.5%	25	34.7%	43	59.7%	.227*
	Nutrition Education (N=33)	0	0%	8	24.2%	25	75.8%	
	Other Education (N=10)	0	0%	4	40%	6	60%	
	Total (N=115)							
	Associates Degree (N=14)	0	0%	6	42.9%	8	57.1%	.511*
	Bachelor's Degree (N=58)	1	1.7%	16	27.6%	41	70.7%	
	Master's Degree (N=28)	2	7.1%	10	35.7%	16	57.1%	
	Other Degree Level (N=15)	1	6.7%	5	33.3%	9	60%	
	Total (N=115)							
	Outpatient Hospital (N=58)	2	3.4%	10	17.2%	46	79.3%	<.001*
	Primary Care (N=13)	0	0%	6	46.2%	7	53.8%	
	Inpatient Hospital (N=21)	2	9.5%	14	66.7%	5	23.8%	
	Other Setting (N=23)	0	0%	7	30.4%	16	69.6%	
	Total (N=115)							
	Certified Diabetes Educator(N=88)	1	1.1%	25	28.4%	62	70.5%	.007**
	Not a Certified Diabetes Educator (N=27)	3	11.1%	12	44.4%	12	44.4%	
	Total (N=115)							
	Engaged in Regular Physical Activity over the past 6 Months (N=90)	3	3.3%	29	32.2%	58	64.4%	.916**
	Did Not Engage in Regular Physical Activity over the past 6 Months (N=22)	1	4.5%	7	31.8%	14	63.6%	
	Total (N=112)							

*p-value based on Kruskal-Wallis H test, **p-value based on Mann-Whitney U test

Table 16: Diabetes Educator's Confidence to develop an Aerobic Exercise Plan among the Categories of Educational Discipline, Education Level, Practice Setting, Possession of the CDE credential, and Personal Physical Activity Behaviors

Variables	Categories	Not Confident at all		Somewhat Confident		Very Confident		P value
		N	%	N	%	N	%	
Confidence to Develop an Aerobic Exercise Plan	Nurse Education (N=71) Nutrition Education (N=34) Other Education (N=10) Total (N=115)	28 5 4	39.4% 14.7% 40%	31 20 2	43.7% 58.8% 20%	12 9 4	16.9% 26.5% 40%	.065*
	Associates Degree (N=14) Bachelor's Degree (N=59) Master's Degree (N=28) Other Degree Level (N=14) Total (N=115)	3 18 9 7	21.4% 30.5% 32.1% 50%	9 26 12 6	64.3% 44.1% 42.9% 42.9%	2 15 7 1	14.3% 25.4% 25% 7.1%	.368*
	Outpatient Hospital (N=59) Primary Care (N=13) Inpatient Hospital (N=20) Other Setting (N=23) Total (N=115)	17 2 8 10	28.8% 15.4% 40% 43.5%	30 6 10 7	50.8% 46.2% 50% 30.4%	12 5 2 6	20.3% 22% 10% 26.1%	.221*
	Certified Diabetes Educator(N=88) Not a Certified Diabetes Educator (N=27) Total (N=115)	25 12	28.4% 44.4%	42 11	47.7% 40.7%	21 4	23.9% 14.8%	.114**
	Engaged in Regular Physical Activity over the past 6 Months (N=90) Did Not Engage in Regular Physical Activity over the past 6 Months (N=22) Total (N=112)	25 10	27.8% 45.5%	43 10	47.8% 45.5%	22 2	24.4% 9.1%	.055**
*p-value based on Kruskal-Wallis H test, **p-value based on Mann-Whitney U test								

Table 17: Diabetes Educator's Confidence to develop an Resistance Training Plan among the Categories of Educational Discipline, Education Level, Practice Setting, Possession of the CDE credential, and Personal Physical Activity Behaviors

Variables	Categories	Not Confident at all		Somewhat Confident		Very Confident		P value
		N	%	N	%	N	%	
Confidence to Develop a Resistance Exercise Plan	Nurse Education (N=71)	37	52.1%	30	42.3%	4	6.1%	.065*
	Nutrition Education (N=34)	10	29.4%	19	55.9%	5	14.7%	
	Other Education (N=10)	5	50%	3	30%	2	20%	
	Total (N=115)							
	Associates Degree (N=14)	5	35.7%	8	57.1%	1	7.1%	.648*
	Bachelor's Degree (N=59)	27	45.8%	24	40.7%	8	13.6%	
	Master's Degree (N=28)	12	42.9%	14	50%	2	7.1%	
	Other Degree Level (N=14)	8	57.1%	6	42.9%	0	0%	
	Total (N=115)							
	Outpatient Hospital (N=59)	25	42.4%	27	45.8%	7	11.8%	.234*
	Primary Care (N=13)	9	69.2%	4	30.8%	0	0%	
	Inpatient Hospital (N=20)	9	45%	10	50%	1	5%	
	Other Setting (N=23)	9	39.1%	11	47.8%	3	13%	
	Total (N=115)							
	Certified Diabetes Educator(N=88)	39	44.3%	42	47.7%	7	8%	.980**
	Not a Certified Diabetes Educator (N=27)	13	48.2%	10	37%	4	14.8%	
	Total (N=115)							
	Engaged in Regular Physical Activity over the past 6 Months (N=90)	35	38.9%	45	50%	10	11.1%	.008**
	Did Not Engage in Regular Physical Activity over the past 6 Months (N=22)	15	68.2%	7	31.8%	0	0%	
	Total (N=112)							

*p-value based on Kruskal-Wallis H test, **p-value based on Mann-Whitney U test

Table 18: Diabetes Educator's Ranking of Perceived Personal Barriers among the Categories of Educational Discipline, Education Level, Practice Setting, Possession of the CDE credential, and Personal Physical Activity Behaviors

Barriers	Categories	Ranking								P value
		1 Least Challenging		2		3		4 Most Challenging		
		N	%	N	%	N	%	N	%	
Assuring Safe Physical Activity Plans for Patients with Co-morbidities (HTN, CVD, etc.)	Nurse Education (N=64)	14	21.9%	11	17.2%	19	29.7%	20	31.2%	.039*
	Nutrition Education (N=33)	2	6.1%	5	15.2%	11	33.3%	15	45.5%	
	Other Education (N=10)	3	30%	2	20%	4	40%	1	10%	
	Total (N=107)									
	Associates Degree (N=13)	5	38.5%	3	23.1%	1	7.7%	4	30.8%	.338*
	Bachelor's Degree (N=56)	8	14.3%	9	16.1%	22	39.3%	17	30.4%	
	Master's Degree (N=25)	3	12%	4	16%	7	28%	11	44%	
	Other Degree Level (N=13)	3	23.1%	2	15.4%	4	30.8%	4	30.8%	
	Total (N=107)									
	Outpatient Hospital (N=56)	8	14.3%	8	14.3%	20	35.7%	20	35.7%	.569*
	Primary Care (N=13)	3	23.1%	1	7.7%	6	46.2%	3	23.1%	
	Inpatient Hospital (N=20)	5	25%	3	15%	3	15%	9	45%	
	Other Setting (N=18)	3	16.7%	6	33.3%	5	27.8%	4	22.2%	
	Total (N=107)									
	Certified Diabetes Educator(N=81)	11	13.6%	13	16%	29	35.8%	28	34.6%	.144**
	Not a Certified Diabetes Educator (N=26)	8	30.8%	5	19.2%	5	19.2%	8	30.8%	
	Total (N=107)									
	Engaged in Regular Physical Activity over the past 6 Months (N=83)	14	16.9%	12	14.5%	31	37.3%	26	31.3%	.719**
	Did Not Engage in Regular Physical Activity over the past 6 Months (N=23)	5	21.7%	6	26.1%	3	13%	9	39.1%	
	Total (N=106)									

*p-value based on Kruskal-Wallis H test, **p-value based on Mann-Whitney U test

Table 19: Diabetes Educator's Ranking of Perceived Personal Barriers among the Categories of Educational Discipline, Education Level, Practice Setting, Possession of the CDE credential, and Personal Physical Activity Behaviors

Barriers	Categories	Ranking								P value
		1 Least Challenging		2		3		4 Most Challenging		
		N	%	N	%	N	%	N	%	
Inability to Engage my Patient in Physical Activity	Nurse Education (N=64)	8	12.5%	20	31.2%	17	26.6%	19	29.7%	.055*
	Nutrition Education (N=33)	5	15.2%	4	12.1%	9	27.3%	15	45.5%	
	Other Education (N=10)	0	0%	1	10%	3	30%	6	60%	
	Total (N=107)									
	Associates Degree (N=13)	0	0%	3	23.1%	7	53.8%	3	23.1%	.950*
	Bachelor's Degree (N=56)	7	12.5%	16	28.6%	12	21.4%	21	37.5%	
	Master's Degree (N=25)	4	16%	4	16%	6	24%	11	44%	
	Other Degree Level (N=13)	2	15.4%	2	15.4%	4	30.8%	5	38.5%	
	Total (N=107)									
	Outpatient Hospital (N=56)	7	12.5%	16	28.6%	13	23.2%	20	35.7%	.520*
	Primary Care (N=13)	2	15.4%	2	15.4%	3	23.1%	6	46.2%	
	Inpatient Hospital (N=20)	4	20%	3	15%	7	35%	6	30%	
	Other Setting (N=18)	0	0%	4	22.2%	6	33.3%	8	44.4%	
	Total (N=107)									
	Certified Diabetes Educator(N=81)	10	12.3%	18	22.2%	22	27.2%	31	38.3%	.747**
	Not a Certified Diabetes Educator (N=26)	3	11.5%	7	26.9%	7	26.9%	9	34.6%	
	Total (N=107)									
	Engaged in Regular Physical Activity over the past 6 Months (N=83)	8	9.6%	20	24.1%	21	25.3%	34	41%	.151**
	Did Not Engage in Regular Physical Activity over the past 6 Months (N=23)	5	21.7%	5	21.7%	7	30.4%	6	26.1%	
	Total (N=106)									

*p-value based on Kruskal-Wallis H test, **p-value based on Mann-Whitney U test

Table 20: Diabetes Educator's Ranking of Perceived Personal Barriers among the Categories of Educational Discipline, Education Level, Practice Setting, Possession of the CDE credential, and Personal Physical Activity Behaviors

Barriers	Categories	Ranking								P value
		1 Least Challenging		2		3		4 Most Challenging		
		N	%	N	%	N	%	N	%	
Limited Knowledge on Physical Activity and how it affects Diabetes Control	Nurse Education (N=64)	28	43.8%	16	25%	13	20.3%	7	10.9%	.062*
	Nutrition Education (N=33)	22	66.7%	6	18.2%	5	15.2%	0	0%	
	Other Education (N=10)	4	40%	4	40%	1	10%	1	10%	
	Total (N=107)									
	Associates Degree (N=13)	3	23.1%	5	38.5%	2	15.4%	3	23.1%	.105*
	Bachelor's Degree (N=56)	29	51.8%	12	21.4%	13	23.2%	2	3.6%	
	Master's Degree (N=25)	16	64%	5	20%	3	12%	1	4%	
	Other Degree Level (N=13)	6	46.2%	4	30.8%	1	7.7%	2	15.4%	
	Total (N=107)									
	Outpatient Hospital (N=56)	32	57.1%	10	17.9%	12	21.4%	2	3.6%	.274*
	Primary Care (N=13)	5	38.5%	5	38.5%	2	15.4%	1	7.7%	
	Inpatient Hospital (N=20)	7	35%	6	30%	3	15%	4	20%	
	Other Setting (N=18)	10	55.6%	5	27.8%	2	11.1%	1	5.6%	
	Total (N=107)									
	Certified Diabetes Educator(N=81)	45	55.6%	20	24.7%	12	14.8%	4	4.9%	.021**
	Not a Certified Diabetes Educator (N=26)	9	34.6%	6	23.1%	7	26.9%	4	15.4%	
	Total (N=107)									
	Engaged in Regular Physical Activity over the past 6 Months (N=83)	45	54.2%	19	22.9%	14	16.9%	5	6%	.154**
	Did Not Engage in Regular Physical Activity over the past 6 Months (N=23)	9	39.1%	6	26.1%	5	21.7%	3	13%	
	Total (N=106)									

*p-value based on Kruskal-Wallis H test, **p-value based on Mann-Whitney U test

Table 21: Diabetes Educator's Ranking of Perceived Personal Barriers among the Categories of Educational Discipline, Education Level, Practice Setting, Possession of the CDE credential, and Personal Physical Activity Behaviors

Barriers	Categories	Ranking								P value
		1 Least Challenging		2		3		4 Most Challenging		
		N	%	N	%	N	%	N	%	
Limited Knowledge in Proper Physical Activity Counseling	Nurse Education (N=64)	15	23.4%	16	25%	15	23.4%	18	28.1%	.432*
	Nutrition Education (N=33)	4	12.1%	19	57.6%	7	21.2%	3	9.1%	
	Other Education (N=10)	3	30%	3	30%	2	20%	2	20%	
	Total (N=107)									
	Associates Degree (N=13)	5	38.5%	2	15.4%	3	23.1%	3	23.1%	.910*
	Bachelor's Degree (N=56)	12	21.4%	19	33.9%	9	16.1%	16	28.6%	
	Master's Degree (N=25)	3	12%	12	48%	8	32%	2	8%	
	Other Degree Level (N=13)	2	15.4%	5	38.5%	4	30.8%	2	15.4%	
	Total (N=107)									
	Outpatient Hospital (N=56)	9	16.1%	22	39.3%	11	19.6%	14	25%	.711*
	Primary Care (N=13)	3	23.1%	5	38.5%	2	15.4%	3	23.1%	
	Inpatient Hospital (N=20)	5	25%	7	35%	7	35%	1	5%	
	Other Setting (N=18)	5	27.8	4	22.2%	4	22.2%	5	27.8%	
	Total (N=107)									
	Certified Diabetes Educator(N=81)	16	19.8%	30	37%	17	21%	18	22.2%	.907**
	Not a Certified Diabetes Educator (N=26)	6	23.1%	8	30.8%	7	26.9%	5	19.2%	
	Total (N=107)									
	Engaged in Regular Physical Activity over the past 6 Months (N=83)	17	20.5%	32	38.6%	16	19.3%	18	21.7%	.409**
	Did Not Engage in Regular Physical Activity over the past 6 Months (N=23)	4	17.4%	6	26.1%	8	34.8%	5	21.7%	
	Total (N=106)									

*p-value based on Kruskal-Wallis H test, **p-value based on Mann-Whitney U test

Table 22: Diabetes Educator's Ranking of Perceived Practice Barriers among the Categories of Educational Discipline, Education Level, Practice Setting, Possession of the CDE credential, and Personal Physical Activity Behaviors

Barriers	Categories	Ranking												P value
		1 Least Challenging		2		3		4		5		6 Most Challenging		
		N	%	N	%	N	%	N	%	N	%	N	%	
Time allotted for Diabetes Self-Management Education and Support (DSME/S) Visits	Nurse Education (N=60)	12	20%	5	8.3%	4	6.7%	6	10%	8	13.3%	25	41.7%	.274*
	Nutrition Education (N=31)	5	16.1%	6	19.4%	4	12.9%	3	9.7%	7	22.6%	6	19.4%	
	Other Education (N=9)	1	11.1%	1	11.1%	1	11.1%	0	0%	2	22.2%	4	44.4%	
	Total (N=100)													
	Associates Degree (N=12)	2	16.7%	1	8.3%	1	8.3%	2	16.7%	1	8.3%	5	41.7%	.424*
	Bachelor's Degree (N=53)	9	17%	8	15.1%	6	11.3%	5	9.4%	8	15.1%	17	32.1%	
	Master's Degree (N=23)	6	26.1%	3	13%	0	0%	2	8.7%	5	21.7%	7	30.4%	
	Other Degree Level (N=12)	1	8.3%	0	0%	2	16.7	0	0%	3	25%	6	50%	
	Total (N=100)													
	Outpatient Hospital (N=51)	8	15.7%	8	15.7%	5	9.8%	3	5.9%	10	19.6%	17	33.3%	.022*
	Primary Care (N=13)	5	38.5%	2	15.4%	1	7.7%	0	0%	4	30.8%	1	7.7%	
	Inpatient Hospital (N=19)	2	10.5%	0	0%	0	0%	3	15.8%	3	15.8%	11	57.9%	
	Other Setting (N=17)	3	17.6%	2	11.8%	3	17.6%	3	17.6%	0	0%	6	35.3%	
	Total (N=100)													
	Certified Diabetes Educator(N=75)	15	20%	9	12%	9	12%	6	8%	13	17.3%	23	30.7%	109**
	Not a Certified Diabetes Educator (N=25)	3	12%	3	12%	0	0%	3	12%	4	16%	12	48%	
	Total (N=100)													
	Engaged in Regular Physical Activity over the past 6 Months (N=78)	14	17.9%	10	12.8%	6	7.7%	7	9%	14	17.9%	27	34.6%	.933**
	Did Not Engage in Regular Physical Activity over the past 6 Months (N=21)	4	19%	2	9.5%	3	14.3%	1	4.8%	3	14.3%	8	38.1%	
	Total (N=99)													

*p-value based on Kruskal-Wallis H test, **p-value based on Mann-Whitney U test

Table 23: Diabetes Educator's Ranking of Perceived Practice Barriers among the Categories of Educational Discipline, Education Level, Practice Setting, Possession of the CDE credential, and Personal Physical Activity Behaviors

Barriers	Categories	Ranking												P value
		1 Least Challenging		2		3		4		5		6 Most Challenging		
		N	%	N	%	N	%	N	%	N	%	N	%	
Limited Availability for Individual Visits	Nurse Education (N=60)	9	15%	10	16.7%	14	23.3%	5	8.3%	17	28.3%	5	8.3%	.767*
	Nutrition Education (N=31)	7	22.6%	5	16.1%	4	12.9%	7	22.6%	6	19.4%	2	6.5%	
	Other Education (N=9)	2	22.2%	2	22.2%	0	0%	1	11.1%	3	33.3%	1	11.1%	
	Total (N=100)													
	Associates Degree (N=12)	2	16.7%	1	8.3%	1	8.3%	1	8.3%	4	33.3%	3	25%	.412*
	Bachelor's Degree (N=53)	8	15.1%	11	20.8%	13	24.5%	4	7.5%	14	26.4%	3	5.7%	
	Master's Degree (N=23)	5	21.7%	3	13%	2	8.7%	7	30.4%	4	17.4%	2	8.7%	
	Other Degree Level (N=12)	3	25%	2	16.7%	2	16.7%	1	8.3%	4	33.3%	0	0%	
	Total (N=100)													
	Outpatient Hospital (N=51)	11	21.6%	7	13.7%	8	15.7%	7	13.7%	12	23.5%	6	11.8%	.546*
	Primary Care (N=13)	1	7.7%	4	30.8%	5	38.5%	2	15.4%	0	0%	1	7.7%	
	Inpatient Hospital (N=19)	2	10.5%	2	10.5%	3	15.8%	4	21.1%	8	42.1%	0	0%	
	Other Setting (N=17)	4	23.5%	4	23.5%	2	11.8%	0	0%	6	35.3%	1	5.9%	
	Total (N=100)													
	Certified Diabetes Educator (N=75)	16	21.3%	15	20%	14	18.7%	8	10.7%	15	20%	7	9.3%	.035**
	Not a Certified Diabetes Educator (N=25)	2	8%	2	8%	4	16%	5	20%	11	44%	1	4%	
	Total (N=100)													
	Engaged in Regular Physical Activity over the past 6 Months (N=78)	12	15.4%	15	19.2%	15	19.2%	11	14.1%	19	24.4%	6	7.7%	.858**
	Did Not Engage in Regular Physical Activity over the past 6 Months (N=21)	6	28.6%	2	9.5%	3	14.3%	2	9.5%	6	28.6%	2	9.5%	
	Total (N=99)													

*p-value based on Kruskal-Wallis H test, **p-value based on Mann-Whitney U test

Table 24:Diabetes Educator's Ranking of Perceived Practice Barriers among the Categories of Educational Discipline, Education Level, Practice Setting, Possession of the CDE credential, and Personal Physical Activity Behaviors

Barriers	Categories	Ranking												P value
		1 Least Challenging		2		3		4		5		6 Most Challenging		
		N	%	N	%	N	%	N	%	N	%	N	%	
Lack of Physical Activity Resources	Nurse Education (N=60)	10	16.7%	12	20%	9	15%	18	30%	6	10%	5	8.3%	.694*
	Nutrition Education (N=31)	6	19.4%	7	22.6%	7	22.6%	6	19.4%	1	3.2%	4	12.9%	
	Other Education (N=9)	3	33.3%	1	11.1%	1	11.1%	3	33.3%	0	0%	1	11.1%	
	Total (N=100)													
	Associates Degree (N=12)	0	0%	2	16.7%	2	16.7%	4	33.3%	2	16.7%	2	16.7%	.194*
	Bachelor's Degree (N=53)	15	28.3%	9	17%	5	9.4%	17	32.1%	3	5.7%	4	7.5%	
	Master's Degree (N=23)	4	17.4%	4	17.4%	8	34.8%	2	8.7%	1	4.3%	4	17.4%	
	Other Degree Level (N=12)	0	0%	5	41.7%	2	16.7%	4	33.3%	1	8.3%	0	0%	
	Total (N=100)													
	Outpatient Hospital (N=51)	10	19.6%	11	21.6%	5	9.8%	17	33.3%	3	5.9%	5	9.8%	.908*
	Primary Care (N=13)	3	23.1%	1	7.7%	3	23.1%	4	30.8%	1	7.7%	1	7.7%	
	Inpatient Hospital (N=19)	2	10.5%	7	36.8%	5	26.3%	2	10.5%	1	5.3%	2	10.5%	
	Other Setting (N=17)	4	23.5%	1	5.9%	4	23.5%	4	23.5%	2	11.8%	2	11.8%	
	Total (N=100)													
	Certified Diabetes Educator(N=75)	14	18.7%	14	18.7%	12	16%	21	28%	6	8%	8	10.7%	.428**
	Not a Certified Diabetes Educator (N=25)	5	20%	6	24%	5	20%	6	24%	1	4%	2	8%	
	Total (N=100)													
	Engaged in Regular Physical Activity over the past 6 Months (N=78)	16	20.5%	15	19.2%	13	16.7%	22	28.2%	5	6.4%	7	9%	.770**
	Did Not Engage in Regular Physical Activity over the past 6 Months (N=21)	3	14.3%	5	23.8%	4	19%	5	23.8%	2	9.5%	2	9.5%	
	Total (N=99)													

*p-value based on Kruskal-Wallis H test, **p-value based on Mann-Whitney U test

Table 25: Diabetes Educator's Ranking of Perceived Practice Barriers among the Categories of Educational Discipline, Education Level, Practice Setting, Possession of the CDE credential, and Personal Physical Activity Behaviors

Barriers	Categories	Ranking												P value
		1 Least Challenging		2		3		4		5		6 Most Challenging		
		N	%	N	%	N	%	N	%	N	%	N	%	
No Reimbursement for Physical Activity Counseling	Nurse Education (N=60)	11	18.3%	7	11.7%	19	31.7%	10	16.7%	6	10%	7	11.7%	.153*
	Nutrition Education(N=31)	3	9.7%	6	19.4%	3	9.7%	7	22.6%	5	16.1%	7	22.6%	
	Other Education (N=9)	2	22.2%	2	22.2%	3	33.3%	0	0%	1	11.1%	1	11.1%	
	Total (N=100)													
	Associates Degree (N=12)	2	16.7%	2	16.7%	6	50%	1	8.3%	1	8.3%	0	0%	.493*
	Bachelor's Degree (N=53)	6	11.3%	8	15.1%	16	30.2%	9	17%	6	11.3%	8	15.1%	
	Master's Degree (N=23)	4	17.4%	4	17.4%	2	8.7%	5	21.7%	3	13%	5	21.7%	
	Other Degree Level (N=12)	4	33.3%	1	8.3%	1	8.3%	2	16.7%	2	16.7%	2	16.7%	
	Total (N=100)													
	Outpatient Hospital (N=51)	7	13.7%	7	13.7%	14	27.5%	8	15.7%	6	11.8%	9	17.6%	.306*
	Primary Care (N=13)	1	7.7%	2	15.4%	3	23.1%	2	15.4%	1	7.7%	4	30.8%	
	Inpatient Hospital (N=19)	6	31.6%	3	15.8%	3	15.8%	3	15.8%	3	15.8%	1	5.3%	
	Other Setting (N=17)	2	11.8%	3	17.6%	5	29.4%	4	23.5%	2	11.8%	1	5.9%	
	Total (N=100)													
	Certified Diabetes Educator(N=75)	11	14.7%	9	12%	18	24%	12	16%	10	13.3%	15	20%	.022**
	Not a Certified Diabetes Educator (N=25)	5	20%	6	24%	7	28%	5	20%	2	8%	0	0%	
	Total (N=100)													
	Engaged in Regular Physical Activity over the past 6 Months (N=78)	14	17.9%	10	12.8%	19	24.4%	13	16.7%	9	11.5%	13	16.7%	.862**
	Did Not Engage in Regular Physical Activity over the past 6 Months (N=21)	2	9.5%	5	23.8%	5	23.8%	4	19%	3	14.3%	2	9.5%	
	Total (N=99)													

*p-value based on Kruskal-Wallis H test, **p-value based on Mann-Whitney U test

Table 26: Diabetes Educator's Ranking of Perceived Practice Barriers among the Categories of Educational Discipline, Education Level, Practice Setting, Possession of the CDE credential, and Personal Physical Activity Behaviors

Barriers	Categories	Ranking												P value
		1 Least Challenging		2		3		4		5		6 Most Challenging		
		N	%	N	%	N	%	N	%	N	%	N	%	
Not Sure Which Exercise Professionals to Refer to	Nurse Education (N=60)	7	11.7%	17	28.3%	7	11.7%	10	16.7%	12	20%	7	11.7%	.941*
	Nutrition Education (N=31)	6	19.4%	4	12.9%	6	19.4%	3	9.7%	7	22.6%	5	16.1%	
	Other Education (N=9)	0	0%	3	33.3%	3	33.3%	1	11.1%	1	11.1%	1	11.1%	
	Total (N=100)													
	Associates Degree (N=12)	2	16.7%	3	25%	2	16.7%	3	25%	1	8.3%	1	8.3%	.676*
	Bachelor's Degree (N=53)	8	15.1%	11	20.8%	5	9.4%	7	13.2%	14	26.4%	8	15.1%	
	Master's Degree (N=23)	2	8.7%	7	30.4%	6	26.1%	2	8.7%	5	21.7%	1	4.3%	
	Other Degree Level (N=12)	1	8.3%	3	25%	3	25%	2	16.7%	0	0%	3	25%	
	Total (N=100)													
	Outpatient Hospital (N=51)	7	13.7%	13	25.5%	8	15.7%	8	15.7%	10	19.6%	5	9.8%	.038*
	Primary Care (N=13)	2	15.4%	0	0%	0	0%	3	23.1%	5	38.5%	3	23.1%	
	Inpatient Hospital (N=19)	3	15.8%	6	31.6%	6	31.6%	2	10.5%	1	5.3%	1	5.3%	
	Other Setting (N=17)	1	5.9%	5	29.4%	2	11.8%	1	5.9%	4	23.5%	4	23.5%	
	Total (N=100)													
	Certified Diabetes Educator(N=75)	8	10.7%	17	22.7%	11	14.7%	12	16%	18	24%	9	12%	.170**
	Not a Certified Diabetes Educator (N=25)	5	20%	7	28%	5	20%	2	8%	2	8%	4	16%	
	Total (N=100)													
	Engaged in Regular Physical Activity over the past 6 Months (N=78)	10	12.8%	19	24.4%	13	16.7%	11	14.1%	15	19.2%	10	12.8%	.699**
	Did Not Engage in Regular Physical Activity over the past 6 Months (N=21)	3	14.3%	4	19%	3	14.3%	3	14.3%	5	23.8%	3	14.3%	
	Total (N=99)													

*p-value based on Kruskal-Wallis H test, **p-value based on Mann-Whitney U test

Table 27: Diabetes Educator's Ranking of Perceived Practice Barriers among the Categories of Educational Discipline, Education Level, Practice Setting, Possession of the CDE credential, and Personal Physical Activity Behaviors

Barriers	Categories	Ranking												P value
		1 Least Challenging		2		3		4		5		6 Most Challenging		
		N	%	N	%	N	%	N	%	N	%	N	%	
Limited Physician Support and/ or Guidance for Physical Activity Counseling	Nurse Education (N=60)	11	18.3%	9	15%	7	11.7%	11	18.3%	11	18.3%	11	18.3%	.771*
	Nutrition Education (N=31)	4	12.9%	3	9.7%	7	22.6%	5	16.1%	5	16.1%	7	22.6%	
	Other Education (N=9)	1	11.1%	0	0%	1	11.1%	4	44.4%	2	22.2%	1	11.1%	
	Total (N=100)													
	Associates Degree (N=12)	4	33.3%	3	25%	0	0%	1	8.3%	3	25%	1	8.3%	.289*
	Bachelor's Degree (N=53)	7	13.2%	6	11.3%	8	15.1%	11	20.8%	8	15.1%	13	24.5%	
	Master's Degree (N=23)	2	8.7%	2	8.7%	5	21.7%	5	21.7%	5	21.7%	4	17.4%	
	Other Degree Level (N=12)	3	25%	1	8.3%	2	16.7%	3	25%	2	16.7%	1	8.3%	
	Total (N=100)													
	Outpatient Hospital (N=51)	8	15.7%	5	9.8%	11	21.6%	8	15.7%	10	19.6%	9	17.6%	.998*
	Primary Care (N=13)	1	7.7%	4	30.8%	1	7.7%	2	15.4%	2	15.4%	3	23.1%	
	Inpatient Hospital (N=19)	4	21.1%	1	5.3%	2	10.5%	5	26.3%	3	15.8%	4	21.1%	
	Other Setting (N=17)	3	17.6%	2	11.8%	1	5.9%	5	29.4%	3	17.6%	3	17.6%	
	Total (N=100)													
	Certified Diabetes Educator(N=75)	11	14.7%	11	14.7%	11	14.7%	16	21.3%	13	17.3%	13	17.3%	.577**
	Not a Certified Diabetes Educator (N=25)	5	20%	1	4%	4	16%	4	16%	5	20%	6	24%	
	Total (N=100)													
	Engaged in Regular Physical Activity over the past 6 Months (N=78)	12	15.4%	9	11.5%	12	15.4%	14	17.9%	16	20.5%	15	19.2%	.738**
	Did Not Engage in Regular Physical Activity over the past 6 Months (N=21)	3	14.3%	3	14.3%	3	14.3%	6	28.6%	2	9.5%	4	19%	
	Total (N=99)													

*p-value based on Kruskal-Wallis H test, **p-value based on Mann-Whitney U test

Table 28: Responses of the Exercise Physiologist, Diabetes Educator (n=1)

Category	Variable	Response of the Exercise Physiologist	Responses of the Other Educational Disciplines
Time spent Counseling on Physical Activity	% of time Minutes	50 30	17.4 [E] 14.39 $\pm$ 12.02 [A]
Level of Importance Placed on Physical Activity as a Treatment	Mean Rank	3rd	3RD [D]
Knowledge of Physical Activity Guidelines	Minutes per week of moderate aerobic Minutes per week vigorous aerobic Days per week of resistance training	150 75 2	(30-420) [C] (4-300) [C] (1-5) [C]
Confidence Counseling on Physical Activity	Mean Rank	"Very Confident"	54.3% (63) [B]
Minutes per Week Reporting Regular Personal Engagement in Physical Activity over the past 6 Months	(Minutes per Week)	120	179.4 $\pm$ 126.5 [A]
Mean $\pm$ S.D. [A] %(N) [B] (Range) [C] Mean Rank [D] Percent [E]			

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