MUSCLE STRENGTHENING ACTIVITIES AND ITS ASSOCIATION WITH SELF-RATED HEALTH AMONG DIABETIC PERSONS IN NORTH CAROLINA: AN EXAMINATION OF 2013 BRFSS DATA

by

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ABSTRACT

GREGORY T. SCAROLA. Muscle strengthening activities and its association with self-rated health among diabetic persons in North Carolina: an examination of 2013 BRFSS data. (Under the direction of Dr. CRYSTAL N. PIPER)

OBJECTIVE: To examine the relationship between meeting muscle strengthening activity (MSAs) guidelines among individuals with diabetes and meeting the guidelines association on self-rated health among adults in North Carolina. METHODS: Self-rated health (Would you say your general health is: favorable (excellent, very good, good), or non-favorable (fair or poor)) was assessed among 1325 individuals in North Carolina who reported having diabetes mellitus by the Behavioral Risk Factor Surveillance System (BRFSS). Univariate analysis was used to determine study population demographics. Bivariate and multivariate analyses were used to assess the association between self-rated health and the covariates. RESULTS: 16% of sample population met muscle strengthening recommendation. Variables found to be a significant predictor of self-rated health were income (OR=4.17, p=0.0002) and education (OR=2.86, p=0.0016). Individuals who met the muscle strengthening recommendation were slightly more likely, how not statistically significant, to report favorable general health (OR=1.03, p=0.8885). DISCUSSION: Meeting muscle strengthening activity recommendations has very little, if any, association with improved self-rated health in individuals with diabetes mellitus. Income and education were statistically significant predictors of self-rated; which follows the literature. Future studies are needed to determine if there is an association between meeting muscle strengthening activities recommendations and self-rated health among adults with type 2 diabetes in North Carolina.

DEDICATION

I would like to dedicate this thesis to my nephew, Noah Theodore, in hopes that he learns with hard work and a little perseverance anything is possible.

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CHAPTER 1: INTRODUCTION

Diabetes is a chronic disease in which the blood glucose levels are increased beyond normal levels. Consumed food is turned into glucose, which in turn is withdrawn from the blood stream to be used as energy by the body's cells. To aid in the glucose being withdrawn is the hormone insulin, which is produced by the pancreas. In diabetics however, insulin is either not produced, type 1 diabetes, or insulin is not used as efficiently as it could be, type 2 diabetes. When insulin is not produced or not used efficiently glucose builds up in the blood stream and creates high blood glucose levels. Over time high blood glucose levels can lead to health complications such as heart disease, kidney failure, blindness, lower extremity amputation and stroke. Diabetes, type 1 or type 2, can be managed through a healthy diet and adequate amounts of physical activity (Centers for Disease Control and Prevention, 2015).

In 2012, in the United States, diabetes affected 29.1 million people or 9.3% of the population; this is an increase of 4% from 2010 (American Diabetes Association, 2014). Of people aged 20 years or older, 15.9% of the American Indian/Alaskan Natives have been diagnosed with diabetes. Non-Hispanic Blacks, Hispanics, Asian Americans and Non-Hispanic Whites have 13.2, 12.8, 9.0 and 7.6 percent of the populations diagnosed with diabetes respectively (Centers for Disease Control and Prevention, 2014). Diabetes is the 7th leading cause of death in the United States and in 2010 caused 69,000 deaths and was listed as the underlying cause of death in an additional 234,000 deaths (ADA,

2014). In 2012, diabetes cost an estimated $245 billion in the United States between direct medical costs and indirect costs of disability and missed work (CDC, 2014).

In North Carolina, 10.9% percent of the population or 788,000 adults had been diagnosed with diabetes as of 2011. As of 2011, diabetes was the 7th leading cause of death in North Carolina. In North Carolina, diabetes is more prevalent in African-Americans, 13.8%, compared to Non-Hispanic White, 10.4%. Diabetes affects older adults at a higher rate than younger adults; in 2011, 1 in 5 adults over 55 years had been diagnosed with diabetes and adults aged 65 years and older had the highest rate of diabetes at 23.2% (North Carolina Department of Health and Human Services, 2013). Adults in North Carolina, with less than a high school diploma had a rate of diabetes at 17.8% compared to adults with a high school diploma at 11.9% and adults with a college degree at 6.0% (NCDHHS, 2013).

Strength training or resistance training or muscle-strengthening activity are all names for a type of physical activity that increases skeletal muscle strength, power, endurance and mass (CDC, 2015). According to the CDC, adults require muscle strengthening activities 2 or more days per week and should target large muscle groups, such as the legs, chest, back, arms and shoulders (CDC, 2015). In 2013, only 27% of adults in North Carolina met the guidelines for muscle-strengthening activity, compared to nearly 30% nationwide that meet the muscle-strengthening recommendations (CDC, 2014). Non-Hispanic White adults are more likely to meet the muscle strengthening guidelines, 23%, than non-Hispanic black adults, 18%, and Hispanic adults, 16% (CDC, 2014). Benefits of muscle strengthening activities include reducing the signs and symptoms of arthritis, diabetes, osteoporosis, obesity, back pain and depression (CDC,

2011). However, few studies have examined muscle strengthening activities in a diabetic population and its association on self-rated quality of life. A study assessing these variables is vital as the rate of diabetes has been consistently escalating over the past years and is considered as one of the major burdens on the health care system. The main objective of this study is to examine the relationship between muscle strengthening activities among individuals with diabetes and its relationship to self-rated quality of life among adults in North Carolina.

CHAPTER 2: LITERATURE REVIEW

This literature explores the research surrounding diabetes, muscle strengthening activities (MSAs), and self-rated health. The first section discusses diabetes and its impact on individuals in the United States. The next section discusses risk factors related to developing type 2 diabetes. The following section discusses muscle strengthening activities, in persons with diabetes. The final section discusses self-rated health in persons with diabetes.

Diabetes in the United States

Diabetes is a chronic disease in which the body either does not produce insulin, type 1, or does not use insulin properly, type 2 (The American Diabetes Association, 2014). In the case of type 2 diabetes, the body does not properly use insulin. Insulin resistance increases and insulin sensitivity decreases, resulting in the pancreas working harder to keep up with the amount of insulin needed by the body; eventually the pancreas is no longer able to keep up with the insulin demands of the body and blood glucose levels rise beyond normal levels (The American Diabetes Association, 2014). Prolonged elevated blood glucose levels have a negative impact on health, specifically on the eyes, kidneys, nerves and heart. As of 2014, one in three people in the United States will develop type 2 diabetes in their lifetime and 29.1 million people currently have the disease (CDC, 2014). Adults with diabetes have a 50% increased risk of death as compared to adults without diabetes (CDC, 2014). While there is no cure for type 1 diabetes, both type 1 and type 2 diabetes can be managed through lifestyle changes, such

as eating healthier and meeting the guidelines for muscle strengthening (2 or more days per week of muscle strengthening activity) (CDC, 2015). As a result of exercise being a modifiable risk factor of diabetes the current study will examine the benefits of muscle strengthening as it relates to diabetes.

Diabetes Risk Factors

Type 1 diabetes is a generally a congenital disease, that is genetics is the primary risk factor. Type 2 diabetes, however, has many risk factors including genetics. Risk factors for type 2 diabetes include income and education, obesity and sedentary lifestyle, age, race, and family history (Mayo Clinic, 2014). The CDC notes the risks factors for type 2 diabetes to be older age, obesity, family history of diabetes, and prior history of gestational diabetes, impaired glucose tolerance, physical inactivity, and race (CDC, 2015). Persons that are Black, Hispanic, American Indian and Asian American/Pacific Islander have a higher risk of developing type 2 diabetes (CDC, 2015).

Muscle Strengthening Activities (MSAs)

Muscle strengthening Activities are any exercise that is designed to strengthen the physical muscle of the body; usually by targeting large muscle groups (back, chest, core, shoulders, arms and legs). According to the CDC, muscle strengthening physical activity should be performed at least 2 times per week and should target large muscle groups (CDC, 2015). Other activities that are considered muscle-strengthening activities are using resistance bands, body weight exercises (push-ups, sit-ups), heavy gardening and yoga (CDC, 2015).

MSAs in Diabetic Populations

The intervention length of the studies used in the literature of the current study ranged from 7 weeks to 416 weeks, with a median intervention length of 16 weeks. In a study conducted by Sigal et al. in 2007, 251 adults aged 39-70 with type II diabetes were placed into an intervention group that resistance trained 3 times per week for 22 weeks or into a control group. The results showed that the change in hemoglobin $A1_c$ from the control group to the resistance training group was a decrease of 0.38 percentage point (from 0.72 to 0. 22) (Sigal et al, 2007). In a study conducted by Taylor, Fletcher, Mathis & Cade in 2014, 21 people with type II diabetes were assigned to moderate or high intensity resistance training group. The moderate intensity group trained at 75% of their 8-repitition maximum and the high intensity group trained at 100% of their 8-repition maximum. The moderate intensity group showed the greatest mean decrease, 15.8%, in glucose levels from immediately before exercise to 1 hour after exercise and the high intensity group showed the greatest mean decrease, 21.5%, in the glucose levels measured immediately before exercise and immediately after exercise. The previous results show that both moderate and high intensity exercise are effective means of reducing glucose levels (Taylor, Fletcher, Mathis & Cade, 2014). Egger et al. conducted a study in 2012 which examined whether resistance training was as effective as endurance training with respect to glycemic control in 32 patients with type II diabetes. The results showed that resistance training is just as effective as endurance training at glycemic control in patients with type II diabetes (Egger et al. 2012).

Bacchi et al. found, in a study of 40 type II diabetic patients aged 40 to 70 years, that resistance training increases insulin sensitivity and improves metabolic features.

Resistance training was comprised of exercises that work major muscle groups and began at 30-50% of the patient's one repetition max and progressed over the 4 months to 70-80% of the patient's one repetition max (Bacchi et al. 2012). In a study conducted by Cauza et al (2005), 22 participants with type II diabetes completed a muscle strengthening activities intervention of 6 sets per muscle group per week for 4 months. The results showed that the resistance training group had significant improvements in blood glucose and insulin resistance (Cauza et al. 2005). In a 16-week progressive resistance training intervention, 62 Latino adults with type II diabetes and a mean age of 66 years were randomly assigned to either a progressive resistance training group or a control group. The results of the study showed that resistance training was feasible and effective at improving glycemic control (Castaneda et al. 2002). A study conducted in 2002 by Dunstan et al. examined the effects of a 26 week high-intensity progressive resistance training in sedentary, overweight men and women aged 60 to 80 years with type II diabetes. The results of this study showed that high-intensity progressive resistance training may be effective at improving glycemic control in older adults with type II diabetes (Dunstan et al. 2002). In a study by Jorge et al. 48 patients with type II diabetes were randomly assigned to 3 different exercise groups to train 3 times per week for 60 minutes per session for 12 weeks and one control group for comparison. The results showed that the resistance training group decreased their fasting plasma glucose and their postprandial plasma glucose. Resistance training also showed a 65% increase in Insulin Receptor Substrate-1 (IRS-1), which functions with other molecules to help the insulin reaction within the body (Jorge et al. 2011). Other factors known to influence the

prevalence of diabetes are aerobic exercise (CDC, 2015; Jorge et al, 2011; Bacchi et al, 2012) and maintaining a healthy diet (CDC, 2015).

Self-Rated Health Status

Self-rated quality of life is a general question about the participant's health that assesses whether the participant has excellent, very good, good, fair or poor health. For the purpose of the current study self-rated quality of life and self-rated health status will be used interchangeably. In a study conducted in 1998 by Klein, Klein and Moss, the factors that are related to diabetes were found to contribute to improved self-related health. Some of the factors that are related to diabetes may be modifiable and therefore if improved may lead to an upgraded rating of self-reported health (Klein, Klein & Moss, 1998). A study conducted in 2008 by Unden et al. noted that women with diabetes self-reported a worse quality of life than their male counterparts. The previous finding highlights the need for identifying methods to improve self-related health status and quality of life among people with diabetes and particularly women with diabetes (Unden, 2008). Self-rated health is an important variable as it has been shown to be a significant predictor of mortality in persons with older onset of diabetes; persons with younger onset of diabetes did not show a significant prediction of mortality (Dasbach, Klein, Klein & Moss, 1994). In a study conducted by Molarius and Janson, chronic diseases were assessed to determine their impact on self-rated health; the findings show that while chronic diseases do impact self-rated health it was the common symptoms like weakness and musculoskeletal pains constituted more to the overall self-rating of health than the burden of chronic disease (Molarius & Janson, 2002). A study of Texas residents showed that a lower body mass index was associated with excellent, very good and good self-

ratings of health (Phillips, Hammock & Blanton, 2005). In a study by Wennberg et al. (2012), the authors found that low self-rated health was associated with an increased risk of mortality in persons with diabetes when compared to persons without diabetes that self-rated their health as favorable.

Self-Rated Health and Race

According to Borrell and Dallo (2007), Hispanic Whites were two times more likely to rate their health as fair or poor when compared with non-Hispanic Whites. Hispanic Blacks were more likely to self-rate their health as fair or poor when compared with non-Hispanic Whites. No differences existed between Hispanic Blacks and non-Hispanic Blacks with regards to self-rated health (Borrell & Dallo, 2007). According to Chandola and Jenkinson (2000), a single item self-rated health question is valid to measure health status in varying ethnic groups.

Self-Rated Health and Sex

According to Borrell and Dallo, females are more likely to self-rate their health as fair or poor when compared with males, regardless of their race or ethnicity (2007). In a study by Jonsson, Nystrom, Sterky, and Wall in 2001, sex was found to be more associated with self-rated health eight years after diabetes diagnosis than after one year of diagnosis.

Self-rated Health and Education

In a study by Zhang et al (2010), found that neighborhoods with a higher number of college graduates reported better self-rated general health when compared to other neighborhoods. Being highly educated was found to reduce the odds of self-reporting poorer health (Heng, 2009).

Self-rated Health and Income

According to a study by Heng (2009), having a higher income reduces the odds of self-reporting poorer health.

Self-rated Health and Insurance

In a study conducted by Nielsen and Garasky (2008), the results showed that adults with individual insurance coverage as well as adults with family insurance coverage were more likely to report favorable health. The results showed that adults who were members of a family in which a single family member was uninsured were 37% more likely to report fair or poor health (Nielsen & Garasky, 2008).

Summary:

Evidence has shown that diabetes prevalence is trending upward in the United States as a whole and also in North Carolina. Studies have shown that diabetes is a multifaceted problem that results from many predisposing and enabling risk factors. However, few studies have examined the relationship between meeting muscle strengthening activity guidelines and self-rated health in persons with diabetes.

The current study assesses general health status, meeting muscle strengthening activity guidelines, age, race, sex, education, income, insurance, last routine checkup and diabetes status in the state of North Carolina. The current study examines the relationship between meeting strength training guidelines and self-rate health in persons with diabetes in North Carolina using the 2013 Behavioral Risk Factor Surveillance System (BRFSS).

CHAPTER 3: HYPOTHESIS

The current study examines the relationship between meeting the resistance training guidelines (2 or more days per week of muscle strengthening activity) and self-rated health status among people with diabetes mellitus. The current study uses secondary data from the Behavioral Risk Factor Surveillance System (BRFSS) which is collected by the Centers for Disease Control and Prevention (CDC). The following hypothesis will be tested:

Hypothesis 1: Adults with diabetes that do not meet the muscle strengthening activities guidelines will have less favorable self-rated health status compared to adults in North Carolina with diabetes that meet the muscle strengthening activities guidelines.

CHAPTER 4: THEORETICAL FRAMEWORK

Disparities exist in the ability of certain populations to access physical activity and specifically muscle strengthening physical activity. Prevalence of diabetes was highest, in 2013, among persons who were aged 65 years and older, a minority (non-Hispanic Black, mixed race and Hispanics), those with a low socio-economic status (SES) and those with a lower education level (Centers for Disease Control and Prevention, 2013). The Aday and Andersen Behavioral Model will be used for this study. The Aday and Andersen Behavioral Model (Figure 1) provides an understanding of access to healthcare (Aday & Andersen, 1974). The Aday and Andersen Behavior Model was used to examine predictors and determinants of access to healthcare by examining predisposing, enabling, and need factors. The Aday and Anderson Behavioral Model shows that an individual's access to healthcare is based on the three core components of predisposing factors, enabling factors and need (see Figure 1). The predisposing factors will be race, gender and self-rated health. The enabling factors will be income, education, and insurance. The need factor is the conditions for which health care services are sought which is diabetes. All these components determine an individual's likelihood to engage in muscle strengthening activities.

CHAPTER 5: METHODS

Study Design and Population

The current study was a cross-sectional study using secondary data from the 2013 Behavioral Risk Factor Surveillance System (BRFSS). The Behavioral Risk Factor Surveillance System (BRFSS) is the United States' largest health information telephone survey that assesses individual health behaviors. Data was collected for the BRFSS through telephone surveys. Data collected through the BRFSS was from all 50 states as well as the District of Columbia. The BRFSS used a random digit dialing method to contact potential survey respondents aged 18 years and older. The objective of BRFSS was to collect data on individual preventive health behaviors and risky health behaviors. Annually the BRFSS completes greater than 400,000 surveys making it the largest health survey system on the planet (CDC, 2015).

The BRFSS questionnaire contains 3 components: 1) the core (questions used by all jurisdictions participating in the BRFSS); 2) optional questions (questions that each jurisdiction may decide to use or not use on their questionnaire); 3) state-added questions (questions developed by each state for use within their own state) (Condon, Holtzman, Leutzinger, Nelson, Waller, 1998). Adults without a telephone are excluded from the BRFSS survey (Condon, Holtzman, Leutzinger, Nelson, Waller, 1998). Interviewers are trained by the CDC initially then further training is provided by each individual state. Interviews are conducted during each of the 12 calendar months in order to meet the

monthly and annual goals of 125-405 and approximately 125,000 respectively (Condon, Holtzman, Leutzinger, Nelson, Waller, 1998).

North Carolina began participating in the BRFSS survey in 1987. Health behavior information is collected about diseases such as cardiovascular disease, cancer, diabetes and injuries (North Carolina State Center for Health Statistics, 2013). In 2013, North Carolina had 6,667 landline participants in the BRFSS survey and 1,951 cell phone participants; 8,860 BRFSS participants total in North Carolina (Centers for Disease Control and Prevention, 2014). In North Carolina, the 2013 BRFSS landline survey had a response rate of 40.6%, a cellular phone response rate of 36.6% and a combined response rate 39.6% (Centers for Disease Control and Prevention, 2014). With 1325 participants reported having diabetes in North Carolina and a total of 8860 participants in North Carolina, the 1325 participants is 14.9% percent of the responding population, which is representative of the percent of persons with diabetes in North Carolina as a whole. BRFSS uses weighted data through raking methods to ensure data samples are representative of the population of North Carolina (CDC, 2013).

Measurement of Variables

Participants for this study were aged 18 years and older. Diabetic participants were identified based on the question have you "Ever been told you have diabetes" is question 7.12 of the 2013 BRFSS questionnaire and was a self-reported question. The participants responded with "yes"; "yes, but female told only during pregnancy"; "no"; "no, pre-diabetes or borderline"; "don't know/not sure"; "refused"; or "not asked or missing." Therefore, the question "Ever been told you have diabetes" was used to

determine if the respondent has diabetes (North Carolina State Center for Health Statistics, 2013).

The main outcome variable for this study was self-rated health status which was assessed using the following BRFSS question: "Would you say that in general your health is:" These responses were dichotomized as either "favorable" or "non-favorable". Favorable health included respondents who rated their health status as excellent, very good, and good, and non-favorable health included respondents who rated their health status as fair and poor; variables were dichotomized in this fashion based on methods used by previous research from (Greiner, Snowdown and Greiner, 1999, Mcgee, Liao, Cao & Cooper, 1999, (Dowd & Zajacova, 2007), and (Shi and Starfield, 2000). Self-rated health status was assessed through subjective means based on the participant's perception and expectations of their health (Smith et al., 2010). In addition, participants who responded with "don't know", "not sure" or refused to answer for any of the following questions were re-coded as missing and excluded from the data analysis.

The following variables were also examined to determine the relationship among individuals with diabetes.

Met Muscle Strengthening Activity (MSAs) guidelines was assessed by the BRFSS question:

- Muscle Strengthening Recommendations

    1) Met muscle strengthening or 2) Did not meet muscle strengthening

Meeting the muscle strengthening recommendations was assessed by asking participants "what type of physical activity or exercise did you spend the most time doing during the past month?" followed up by "how many times per week or per month did you

take part in this activity during the past month?" and followed up by "and when you took part in this activity, for how many minutes or hours did you usually keep at it?" Respondents were then asked to respond to the question "what other type of physical activity gave you the next most exercise during the past month?" with the number of times and minutes assessed in follow-up like the previous questions. The interviewer then coded the responses by number of minutes reported as having met or having not met muscle strengthening recommendations. Of note, duties that were performed as part of the respondents "regular job" were not included as part of the physical activity modes, times, or minutes for this survey (North Carolina State Center for Health Statistics, 2013). The independent variables in this study were: Age, Race, Sex, Education, Income, Insurance and Time since last checkup.

Age was assessed by the BRFSS question:

- What is your age?

    1) *Open ended or 2) don't know/not sure or 3) refused*

Race was assessed by the BRFSS question:

- Which one of the following would you say is your race?

    1) *White or 2) Black or 3) Other*

Sex was assessed by the BRFSS question:

- Indicate sex of respondent

    1) *Male or 2) Female*

Highest grade completed in school was assessed by the BRFSS question:

- What is the highest grade or year of school you completed?

1) *Never attended school or only kindergarten or 2) Grades 1 through 8 (Elementary) or 3) Grades 9 through 11 (Some high school) or 4) Grade 12 or GED (High school graduate) or 5) College 1 year to 3 years (Some college or technical school) or 6) College 4 years or more (College graduate) or 7) Refused*

Income level was assessed by BRFSS question:

- Is your annual household income from all sources:
  1) *Less than $10,000 or 2) Less than $15,000 ($10,000 to less than $15,000) or 3) Less than $20,000 ($15,000 to less than $20,000) or 4) Less than $25,000 ($20,000 to less than $25,000) or 5) Less than $35,000 ($25,000 to less than $35,000) or 6) Less than $50,000 ($35,000 to less than $50,000)*
  or 7) Less than $75,000 ($50,000 to less than $75,000) or 8) $75,000 or more or 9) don't know/not sure or 10) Refused

Insurance status was assessed by BRFSS question:

- Do you have any kind of health care coverage, including health insurance, prepaid plans such as HMOs, government plans such as Medicare, or Indian Health Service?
  1) *Yes or 2) No or 3) Don't know/Not sure or 4) Refused*

How long since last routine checkup with a doctor was assessed by BRFSS question:

- About how long has it been since you last visited a doctor for a routine checkup? [A routine checkup is a general physical exam, not an exam for a specific injury, illness, or condition.]
  1) *Within past year (anytime less than 12 months ago) or 2) Within past 2 years (1 year but less than 2 years ago) or 3) Within past 5 years (2 years but less than 5 years ago) or 4) 5 or more years ago or 5) Don't know/Not sure or 6) never or 7) refused*

Determination of whether the respondent has diabetes was assessed by the BRFSS question:

- (Ever told) you have diabetes?
  1) *Yes or 2) Yes, but female told only during pregnancy or 3) No or 4) No, pre-diabetes or borderline diabetes or 5) Don't know/not sure or 6) Refused*

Any questions that were responded to as "don't know" or "refused" or unanswered were excluded from the analysis.

Resources for the current study were found by searching Google Scholar with the key words "diabetes strength aerobic" and "diabetes resistance aerobic." Resources were also found by searching PubMed using the keywords "muscle strengthening diabetes" and "resistance training diabetes." Only articles written in English were included. To be considered for inclusion articles must have study participants that were age 18 years or older.

Excluded articles used study participants age 17 years or younger. Articles written in a language other than English were excluded from consideration. Articles written

before the year 1990 were excluded from consideration. Articles that were required to be purchased were excluded from the thesis.

Data Analysis

As a result of the complex design utilized in the BRFSS dataset, SAS software version 9.4 was used to calculate the adjusted and unadjusted odds ratios and 95% confidence intervals (CIs). A single dichotomous outcome, favorable versus non-favorable self-rated health, was the primary outcome objective. Univariate analysis was used to summarize the data variables. Bivariate analysis was completed using logistic regression in muscle strengthening activities utilization accounted for differences in self-rated health among adults in North Carolina with diabetes by using unadjusted odds ratio (OR) and 95% Confidence Intervals (CI). Data was processed using SAS University Edition Software. To account for the complex sampling design (raking weighting methodology) of the BRFSS 2013 data; stratum weight, final weight and a primary sampling unit was incorporated into the analysis process using the sample design statements _STSTR (sample design stratification variable), _PSU (primary sampling unit) and _LLCPWT (final trimmed weight) which were provided by BRFSS. For this PROC SURVEYFREQ (univariate analysis) and PROC SURVEY LOGISTIC (bivariate and multivariate analysis) codes were used. For all analyses, statistical significance was set at $P<.05$. The estimates produced in this study were weighted to represent the United States population and to adjust for potential survey response bias.

The multivariate model was grounded in empirical and conceptual considerations. The theoretical framework, figure 1, was replicated to decide which variables to consider

in the model by comprising predisposing, enabling, and need variables. For all analysis statistical significance was set at $p<0.05$.

Parametric testing by means of univariate/bivariate/multivariate analysis was executed to examine self-rated health in diabetic adults in North Carolina. The Chi Square test statistic was in the bivariate and multivariate analyses to test for independence between age, race, education, income, meeting MSAs guidelines, and favorable health status.

Analysis

Descriptive statistics of the study sample were acquired using univariate analysis. Percentages and frequencies were calculated to describe the demographics of the study population (Table 1). Unadjusted odds ratios (OR) and 95% confidence intervals (CI) were used to compare favorable health status with the independent variable using logistic regression analysis (Table 2). The bivariate analysis provided the first signal of the associations and differences between the variables. Adjusted odds ratios (OR) and 95% confidence intervals (CI) were used to compare meeting muscle strengthening activities (MSAs) guidelines with the independent variable using logistic regression analysis (Table 3). Multivariate logistic regression was used to test for the association between favorable health status (dependent outcome variable) and the independent variables.

Power/Sample Size

This study included 8,860 adults that live in the state of North Carolina; 1325 that answered “yes” to the question “Have you ever been told you have diabetes”. Women who answered “yes” to gestational diabetes were excluded from the sample. The outcome variable in this study was favorable self-rated health. The primary exposure

variable in this study was met MSAs guidelines. Alpha was set at 0.05 with the power at 80%. There was approximately a 3:1 unexposed to exposed ratio for meeting muscle strengthening activities recommendations that results in a smallest detectable Odds Ratio (OR) of 0.76.

Ethical Issues/Human Subject Projection

This study used data from the 2013 BRFSS dataset. Proper IRB exemption was obtained from UNC Charlotte prior to beginning the study. No direct contact was made with the study participants.

CHAPTER 6: RESULTS

Univariate Analysis

The 2013 BRFSS had an original weighted sample size of 491,771 individuals. Of the total responding population for North Carolina (8,860), 15% reported having diabetes (1,325 respondents) based on the BRFSS question (Have you ever been told you have diabetes?). Table 1 recapitulates the study sample population demographics. Those responding to the questionnaire were primarily female 52%, while males represented 48%. Of the respondents, 40% reported being aged 65 years and older, 1% 18 to 24 years, 3% 25 to 34 years, 10% 35 to 44 years, 19% 45 to 54 years, and 27% 55 to 64 years. Sixty-five percent of the respondents were white, 28% reported being Black, and 7% reported belonging to "Other" racial groups. Sixteen percent of respondents reported meeting the muscle strengthening activity recommendation and 84% reported not meeting the MSAs recommendation. Fifty-three percent reported having favorable health and 47% reported having unfavorable health. Of the respondents, 88% reported having healthcare coverage and 12% reported not having healthcare coverage. Respondents reported 61% having a high school diploma, 15% reported having graduated from college and 24% reported having less than a high school diploma. Those responding reported 24% having an annual income of $50,000 per year or greater, 27% reported an annual income of $15,000-$24,999, 21% reported having an annual income of less than $15,000, 14% reported an annual income between $25,000-$34,999, and 14% reported an annual income of $35,000-$49,999. Of the respondents, 90% reported having had a checkup in

the previous year, 6% reported having a check over 1 year but less than 2 years, 4% reported having a checkup 2 or more years ago and <1% reported never having a checkup.

Bivariate Analysis

Table 2 recapitulates the results from the bivariate analysis using logistic regression. In the bivariate analysis (Table 2.), health care coverage, income and education were found to be statistically significant. Diabetic participants who had health care coverage were more likely to have favorable general health than those without health care coverage (OR = 1.85; CI: 1.121,3.041). Individuals who reported an income of $50,000 or more (OR=5.58; CI: 3.365,9.247) were more likely to have favorable general health than those with and income of $15,000 - $24,999 This was followed by those with an income of $35,000 - $49,999 (OR=2.55; CI: 1.452,4.464) and $25,000 - $34,999 (OR=2.09; CI: 1.196,3.645). College graduates (OR = 5.73; CI: 3.535,9.278) were more likely to report favorable general health than high school graduates (OR=3.09; CI: 2.094,4.573) and those with less than high school diploma

Diabetic participants who met the MSAs recommendation were slightly more likely to report favorable general health when compared to those who did not meet the MSAs recommendation; however, this finding was not at a statistically significant level (OR=1.33, CI: 0.876,2.030).

Multivariate Analysis

Table 3 recapitulates the multivariate analysis. In multivariate analysis (Table 3.) only income and education were found to be statistically significant. Individuals with an income of $50,000 or more were more likely to report favorable general health than the

rest (OR = 4.17; CI: 2.277,7.641). College graduates were more likely to report favorable general health than high school graduates and those with less than high school graduates (OR = 2.86; CI: 1.514,5.404).

Individuals who met the MSAs recommendations were slightly more likely to report favorable health (OR=1.03, CI: 0.651,1.642) when compared with individuals who did not meet the MSAs recommendations.

Hypothesis Testing

Bivariate and Multivariate analyses of meeting muscle strengthening activities (MSAs) and the covariates age, race, sex, income, education, insurance, and time since last routine checkup were conducted to test the study hypothesis.

Hypothesis 1: Adults with diabetes that do not meet the muscle strengthening activities guidelines will have less favorable self-rated health status compared to adults in North Carolina with diabetes that meet the muscle strengthening activities guidelines.

Results of the Aday and Andersen Model

The Aday and Andersen model used for the current study provides an understanding predictors and determinants of care. Specifically, the self-rated health of persons in North Carolina with diabetes was examined. The current model includes predisposing factors, need factors, and enabling factors. The predisposing factors are personal characteristics (i.e. race and sex). The enabling factors in the study included: income, education, insurance, met MSAs guidelines. The need factor for the study was being diagnosed with diabetes. The presentation of the Aday and Andersen model was helpful in providing an understanding to the self-rated health of persons with diabetes in North Carolina; however further research is necessitated to fully understand how the

predisposing factors, need factors, and enabling factors of the Aday and Andersen model contribute to the self-rated health of persons with diabetes, not only in North Carolina but in the United States as a whole.

CHAPTER 7: DISCUSSION

The finding that individuals with diabetes who met the muscle strengthening recommendation were slightly more likely, however not statistically significant, to report favorable health does not support hypothesis 1 that "Adults with diabetes that do not meet the muscle strengthening activities guidelines will have less favorable self-rated health status compared to adults in North Carolina with diabetes that meet the muscle strengthening activities guidelines." Limited research exists on MSAs and its association with self-rated health.

Summary of Findings

Non-Hispanic Whites were less likely to self-rate their health as favorable when compared to Blacks and "other" racial groups; a finding that is not consistent across the literature (Borrell & Dallo, 2007). Persons with greater annual incomes self-reported their health as favorable at a greater percentage as those persons with a lesser income; this finding is also consistent across the literature (Heng, 2009). Likewise, those persons with a higher education level were more likely to self-rate their health as favorable; a finding consistent with the literature (Zhang et al, 2010).

As age increases the percent of respondents who reported favorable health increases with the exception of the 45 to 54 years aged group; very little literature exists on age and self-rated health making this result difficult to compare. Those respondents who reported having healthcare coverage have a higher percentage of favorable self-rated health when compared with those respondents who did not have healthcare coverage. The

healthcare coverage result follows the literature (Nielsen & Garasky, 2008). Time since last checkup showed having a checkup within the past year was meaningful but not significant with regards to favorable health.

Study Limitations and Strengths

Selection bias is a likely limitation due to the BRFSS data collection method using landline phones and mobile phones; this method excludes persons without the use of a phone. Secondly, the BRFSS data collection method uses self-reporting which exposes this dataset to possible recall bias from the participants not recalling correctly information from the past. A third type of limitation is volunteer bias; this bias occurs because the people who participate in a study may be different from the people who choose not to participate in a study. Males and females essentially self-reported their health as favorable at the same rate; this finding contradicts the literature where Borrell and Dallo (2007) found that females are more likely to self-rate their health less favorably than males.

A strength of this study would be the use of the Behavioral Risk Factor Surveillance System (BRFSS); as BRFSS is representative of a large sample of North Carolina adults as well as the reliability and accuracy that is associated with the BRFSS dataset. The use of SAS for complex weighted sampling provided increased accuracy, as well as improved the validity of the study results. The current study is one of a few studies that considered meeting the MSAs guidelines and its association with self-rated health in persons with diabetes.

Ethical Issues

The current study is using secondary data from the 2013 BRFSS data source. BRFSS is a publicly available data source that uses and IRB approval process. Exemption from IRB approval through UNC Charlotte was obtained before the study commenced. This study did not involve direct contact with any participants.

Significance

Diabetes is the 7th leading cause of death in North Carolina as well as the United States as a whole (North Carolina Department of Health and Human Services, 2013). The population of the United States is over 300 million, the pre-diabetic and diabetic population is over 100 million people; roughly one/third of the population is managing pre-diabetes or diabetes (American Diabetes Association, 2015). With the growing projection for persons expected to develop diabetes in North Carolina, 1.2 million new cases by 2030, and the United States as a whole, the current study could lead to the development of improved physical activity recommendations that could aid in the prevention of diabetes.

The cost of diabetes in the United States in 2012 was $245 billion (American Diabetes Association, 2014). The annual cost of diabetes in the United States is likely to increase with the growing population of people with diabetes. Better prevention methods are needed to reduce the number of people developing type 2 diabetes. The current study could add to the physical activity recommendations which in turn could help improve the numbers of people with diabetes thereby reducing the costs associated with diabetes in the United States.

Future Studies

The current study necessitates further studies into the association between meeting MSAs and self-rated health in diabetic populations. The 2013 BRFSS is a secondary data source and as such future studies should incorporate primary data collection to ensure the MSAs guidelines are met as well as attaining a more accurate self-rated health variable. The primary data collection will afford the opportunity of a more comprehensive questionnaire relating to meeting MSAs guidelines as well as self-health rating. The current study has relevance to diabetes educators and diabetes program planners, who can make more informed recommendations to diabetics with regards to improving self-rated health.

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APPENDIX A: TABLES

TABLE 1: Demographic characteristics of individuals with diabetes in North Carolina (n=1325)

Table 1. Demographic Characteristics of Individuals with Diabetes in North Carolina (n = 1325)

Characteristics	**Frequency (n)**	**%**
Race		
White	809	64.70
Black	353	27.83
Other	153	7.47
Total	1315	100.00
Met MSA Recommendations		
Yes	196	16.06
No	1048	83.94
Total	1244	100.00
Age (years)		
18 to 24	3	0.34
25 to 34	19	3.18
35 to 44	72	9.91
45 to 54	183	18.88
55 to 64	360	27.30
65 to older	688	40.38
Total	1325	100.00
Health Care Coverage		
Yes	1200	87.95
No	119	12.05
Total	1319	100.00
Income		
$15,000 - $24,999	288	26.86
$25,000 - $34,999	139	14.02
$35,000 - $49,999	140	14.13
$50,000 or more	213	24.33
Less than $15,000	261	20.67
Total	1041	100.00
Time Since Last Check Up		
Within Past Year	1189	89.73
1 Year but Less than 2 Years	59	5.52
2 Years or More	54	4.46
Never	6	0.29
Total	1308	100.00
Gender		
Female	792	51.60
Male	533	48.40
Total	1325	100.00
Education		
College Graduate	256	14.55
High School Graduate	786	61.03
Less than High School Graduate	281	24.42
Total	1323	100.00
General Health		
Favorable	696	52.80
Unfavorable	625	47.20
Total	1321	100.00

TABLE 2: Unadjusted associations between study demographics and self-rated health, 2013 BRFSS, (n=1325)

Table 2 Unadjusted Associations between Study Demographics and Self-rated Health, 2013 BRFSS, (n=1325)			
	Odds Ratio	**95% Confidence Interval**	**P Value**
Race			
White	1.23	0.869-1.725	0.50
Black	1.00	1.00 -1.00	
Other	1.10	0.598-2.006	
Met MSA Recommendations			
Yes	1.33	0.876-2.030	0.18
No	1.00	1.00-1.00	
Age (years)			
18 to 24	1.00	1.00 -1.00	
25 to 34	0.25	0.016 - 3.832	0.89
35 to 44	0.23	0.017 - 3.005	
45 to 54	0.23	0.018 - 2.930	
55 to 64	0.21	0.016 - 2.617	
met MSA Recommendations	0.22	0.017 - 2.744	
Health Care Coverage			
Yes	1.85	1.121-3.041	0.02
No	1.00	1.00 - 1.00	
Income			
Less than $15,000	1.23	0.760 - 1.989	<.0001
$15,000 - $24,999	1.00	1.00-1.00	
$25,000 - $34,999	2.09	1.196 - 3.645	
$35,000 - $49,999	2.55	1.452-4.464	
$50,000 or More	5.58	3.365-9.247	
Time Since Last Check Up			
Within past year	1.07	0.527-2.159	0.37
1 year but less than 2 years ago	1.00	1.00-1.00	
2 years or more	0.58	0.211-1.569	
Never	0.49	0.062-3.873	
Gender			
Male	1.15	0.850-1.552	0.37
Female	1.00	1.00 - 1.00	
Education			
College Graduate	5.73	3.535 - 9.278	<.0001
High School Graduate	3.09	2.094-4.573	
Less than High School Diploma	1.00	1.00 - 1.00	

TABLE 3: Adjusted results of self-rated health and race, met muscle strengthening activities recommendations, age, healthcare coverage, income, time since last check up, gender and education; 2013 BRFSS, (n=1325)

Table 3 Adjusted Results of Self-rated Health and Race, Met Muscle Strengthening Activities Recommendations, Age, Healthcare Coverage, Income, Time Since Last Check Up, Gender and Education; 2013 BRFSS, (n=1325)			
	Odds Ratio	**95% Confidence Interval**	**P Value**
Race			
White	0.85	0.532-1.349	0.1798
Black	1.00	1.00 - 1.00	
Other	1.62	0.748-3.497	
Met MSA Recommendations			
Yes	1.03	0.651-1.642	0.8885
No	1.00	1.00-1.00	
Age			
18 to 24	1.00	1.00-1.00	
25 to 34	0.84	0.044-15.923	0.9448
35 to 44	0.99	0.058-16.914	
45 to 54	0.74	0.046-11.894	
55 to 64	0.92	0.057-14.709	
65 & older	0.97	0.061-15.374	
Health Care Coverage			
Yes	1.25	0.659-2.373	0.4943
No	1.00	1.00-1.00	
Income			
Less than $15,000	1.29	0.776-2.136	0.0002
$15,000 - $24,999	1.00	1.00-1.00	
$25,000 - $34,999	1.76	0.989-3.144	
$35,000 - $49,999	2.07	1.134-3.775	
$50,000 or More	4.17	2.277 - 7.641	
Time Since Last Check Up			
Within past year	0.86	0.426-1.730	0.4445
1 year but less than 2 years ago	1.00	1.00-1.00	
2 years or more	0.45	0.152-1.309	
Never	0.45	0.023-8.674	
Gender			
Male	1.01	0.691-1.461	0.9796
Female	1.00	1.00 - 1.00	
Education			
College Graduate	2.86	1.514-5.404	0.0016
High School Graduate	2.22	1.376-3.585	
Less than High School Diploma	1.00	1.00-1.00	

APPENDIX B: FIGURES

FIGURE 1. Aday and Andersen Model