January 2013

The Relationship Between Socioeconomic Status and Body Mass Index on Vitamin D Levels in African American Women with and without Diabetes Living in Areas with Abundant Sunshine

Shani Vann Davis
University of South Florida, sdavis@health.usf.edu

The Relationship Between Socioeconomic Status and Body Mass Index on Vitamin D Levels in African American Women with and without Diabetes Living in Areas with Abundant Sunshine

by

Shani V. Davis

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
Department of Health Sciences
College of Nursing
University of South Florida

Major Professor: Maureen Groer, Ph.D., RN, FAAN
Co-Major Professor: Frances Rankin-Sahebzamani, Ph.D., ARNP-C
Kevin B. Sneed, Pharm D.
Kevin Kip, Ph.D.

Approved: July 2, 2013

Keywords: Hypovitaminosis D, obesity, poverty, chronic disease, race

DEDICATION

The entirety of this work from consideration, to completion is dedicated to the inspiration, the memory, and my love for Mrs. Rutha M. Rayford, RN.

My character, strength, courage, dreams, will, persistence, and aptitude, I owe to your example. Not a day goes by that you are not missed in my life. Thank you for continuing to speak to my spirit and for pressing me forward. I miss you, Granny.

ACKNOWLEDGMENTS

Luke 12:48 can be translated as "To whom much is given, of him (or her,) much shall be required; and of whom much is entrusted, more will also be demanded."

To God, I am so thankful for this opportunity to explore the vastness of your favor on my life; and for the courage to accept the challenges, and espouse the discipline necessary to complete this journey. You blessed with a gift to guide and empower persons toward better personal, family, and community health. Thus, this blessing isn't mine to keep.

To my dissertation chair, Dr. Maureen Groer, and committee members, Dr. Frances Rankin-Sahebzamani, Dr. Kevin Sneed, and Dr. Kevin Kip, thank you for the time, direction, assist, and insight that you contributed to my success in this program. Thank you Dr. Jason Beckstead for making statistics interesting and understandable. To my classmates preceding me in graduation, still in the program, or those deciding against continuing the program, I am thankful for your roles in getting me to this point. I extend double thanks my classmates from Jordan, Thailand, and Eretria for the perspectives they added to my enrichment. To the memory of Rod Hale, and to the USF School of Graduate Studies, thanks for making this journey possible via the USF Graduate Student Success Fellowship. I am forever obligated to tout the tenacity of your efforts in recruiting and preparing Bull ambassadors to take on the world. Finally, words can't convey my gratitude for the patience, flexibility, understanding, and sacrifice of my husband, Julius, and my children, Daryn and Wilson. A great deal of this endeavor has been for you three; and for the rest of our days together I will make you proud for allowing me time to do this. To Mama…you know, and I love you for who I am.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

OBJECTIVE: To examine the relationships between socioeconomic status (SES), body mass index (BMI), and vitamin D levels in African American (AA) women living in areas with abundant sunshine; and to explore if diabetes moderates these relationships.

SIGNIFICANCE: More AA's live in poverty, and experience obesity, diabetes, and chronic disease compared to other groups. Eighty percent of AA women are overweight or obese, and rates of type 2 diabetes is highest in this group. Minority race, obesity, and diabetes increase risks for low vitamin D, and are associated with p

DESIGN AND METHOD: A cross-sectional descriptive research design was used to examine the specified relationships. Data from 611 non-pregnant AA women ≥ age 20 from the National Health and Nutrition Examination Survey (NHANES) cycles 2003 – 2006 were studied. SES was measured as poverty to income ratio (PIR), education level, and annual household income. Mean ± SD for BMI was 31 ± 8, and 14ng/ml ± 7ng/ml for vitamin D level. Only 8% of the sample had diabetes (n = 49). One hundred-eighty lived in areas with abundant sunshine.

RESULTS: BMI independently predicted the vitamin D level without regard for SES, or geographical locale. Vitamin D supplement use emerged as an independent predictor of vitamin D on covariate analysis. SES did not explain significant variation in the vitamin D level. A moderating influence of diabetes could not be determined.

CONCLUSIONS: BMI inversely predicts vitamin D level independent of geographic locale in AA women. Ethno/cultural measures to reduce BMI should be standard in

caring for AA women which may affect vitamin D level and/or reduce morbidity and mortality in this group. Persons with low vitamin D suffer with more adverse health outcomes, and future research should examine if vitamin D deficiency accelerates risks for poor health outcomes where BMI is high.

CHAPTER 1

Introduction

An important function of nursing is to design, communicate, and implement interventions that promote health. These functions have taken on added significance in the past three decades as poverty, obesity and chronic disease has become more prevalent. It is widely known that poverty and its related socioeconomic conditions increase the risk for poor health. African Americans are three times as likely to live in poverty in the United States (U.S. Census Bureau, 2011b), and experience chronic disease conditions at higher rates than other ethnic groups. In 2010, 27.4% of African Americans reported incomes below the poverty threshold verses 9.9% of non-Hispanic white Americans. The most recent downturn in America's economy severely affected the African American community as unemployment rates were twice as high as the national average in their communities (Reidenbach, 2010). Because health insurance in America is largely employment based, high unemployment affects access to preventive healthcare and health management services for those affected (Mauersberger, 2012). With unemployment and underemployment, nutritious foods are less attainable. The low socioeconomic living conditions associated with poverty reduces access to nutritious foods, and health care; and these conditions promote opportunities for adverse health outcomes to develop.

More than 65% of Americans are classified as overweight or obese and the numbers have increased most sharply in African Americans (Centers for Disease Control, 2011b). Seventy percent of African American men, and 80% of African American women are overweight or obese (Office of Minority Health, 2011). Nationwide, the increase in obesity and diabetes has occurred concurrently, so it is no coincidence that diabetes and obesity incidence are both highest in African American women (Centers for Disease Control and Prevention, 2011). More than 90% of people with diabetes have type 2 diabetes, and obesity is inextricably linked with its occurrence. The overt presence of overweight/obesity in African Americans, specifically women, has advanced the rate of diabetes and other obesity related chronic illnesses in this community.

Vitamin D deficiency also has a significant presence in African Americans (Yanoff et al., 2006). Though vitamin D is commonly referenced as 'the sunshine vitamin,' even African Americans residing in the sun-sufficient, southern United States have demonstrated deficiency (Egan et al., 2008). Vitamin D deficiency correlates positively with impaired insulin secretion, and insulin resistance (A. G. Pittas, J. Lau, F. B. Hu, & B. Dawson-Hughes, 2007); and these are the defining attributes of type 2 diabetes (DeFronzo & Tripathy, 2009). Research citing the health benefits of vitamin D in bone metabolism and calcium absorption are consistent and abundant; however clinical studies examining the role of vitamin D in glucose metabolism are limited. Observational studies consistently demonstrate relationships among vitamin D deficiency, hyperglycemia, and obesity, but few interventional studies to date have been done evaluating the significance of vitamin D in the development and treatment of these conditions. Consistently, scientists have acknowledged that more randomized controlled

research trials (RCT's) are necessary to determine the clinical relevance of these relationships (J. Mitri, Muraru, & Pittas, 2011). To address the knowledge gap regarding vitamin D's role in chronic disease prevention, disease management and/or health maintenance, 784 interventional clinical trials were registered with ClinicaTrials.org in 2011, 160 in 2012, and an additional 15 registered as of January 2013. The impetus for many of these began with recognition of the relationship trends of low vitamin D levels and prevalence rates of the most costly chronic diseases nationally; which are disproportionately present in the African American community. Generally speaking, African Americans are underrepresented in randomized prospective clinical trials, and this is often cited as a research limitation. It is important for future studies examining the role of vitamin D deficiency in glucose metabolism to include sufficient African American representation to aptly reflect their prevalence in this community.

Purpose

In light of the high presence of poverty, obesity, diabetes, and vitamin D deficiency among African American women, the aims of this research are to examine the relationships between socioeconomic status (SES), body mass index (BMI), and vitamin D levels in African American women residing in areas with abundant sunshine. This research will also examine these relationships for a moderating effect by diabetes. Given the nation's costly obesity and diabetes epidemic, and the prevalence of vitamin D deficiency in persons affected by these disease states, it is important to consider the conditions encouraging their development. Likewise, it is reasonable to consider the influence of diabetes on these relationships given the numerous correlations noted in the current observational research. The long-term goal of this research is to build upon the

evidence that explains the practical and apt use of nurses in reducing the broad impact of chronic diseases in African American communities, and to identify modifiable determinants of the type 2 diabetes risks in African American women. Survey responses from subjects participating in the National Health and Nutrition Examination Survey (NHANES) between 2003 – 2006 were analyzed for this study.

Statement of the Problem

Vitamin D deficiency is a widespread phenomenon with considerable prevalence in African Americans. Low levels of vitamin D are pervasive throughout this community, but are lowest in African American women (Egan et al., 2008). Obesity increases the type 2 diabetes risk and affects bioavailability of vitamin D (Wortsman, Matsuoka, Chen, Lu, & Holick, 2000). The incidence and prevalence rates of overweight/ obesity, and type 2 diabetes are highest in African American women (Office of Minority Health, 2011). More African Americans experience poverty than other ethnic groups (U.S. Census Bureau, 2011b). Adequate access to sources of vitamin D are reduced among persons with low SES, and this relationship has not been previously discussed in the literature.

Specific Aims for this Research

1. To examine the relationship between SES and vitamin D levels in African American women residing in areas with abundant sunshine
2. To examine the relationship between BMI and vitamin D levels in African American women residing in areas with abundant sunshine
3. To explore the moderating effect of diabetes mellitus on those

relationships in African American women residing in areas with abundant sunshine

Research Questions

1. What is the relationship between SES and BMI on vitamin D levels among African American women in areas with abundant sunshine?

2. What is the effect of diabetes mellitus on the relationships between BMI, SES, and vitamin D in African American women in areas with abundant sunshine?

Significance of this Research

The cost of managing chronic diseases and their related complications are economically crippling to healthcare. Nearly 50% of Americans have at least one chronic disease, and more than 75% of healthcare resources are committed to their management (Centers for Disease Control and Prevention, 2009). Of the numerous proposed influences of vitamin D, its potential as an economically savvy option in chronic disease prevention and care has not been overlooked. With respect to diabetes and obesity, direct and indirect costs of medical care and economic loss from morbidity and mortality are $245 billion and $147 billion every year respectively (American Diabetes Association, 2013a; Centers for Disease Control and Prevention, 2011; E. A. Finkelstein, J. G. Trogdon, J. W. Cohen, & W. Dietz, 2009). This cost burden rests on an escalating trajectory now estimating that 1 in 3 American adults will have diabetes by 2050 (Boyle, Thompson, Gregg, Barker, & Williamson, 2010). Diabetes is the seventh leading cause of death nationally (National Center for Health Statistics, 2012), and it is recognized as a

coronary heart disease (CHD) risk equivalent (National Cholesterol Education Program, 2001). This reflects a presumption of established coronary artery disease in persons with diabetes. Heart disease is the number one cause of mortality in the United States (National Center for Health Statistics, 2012), which coincidentally, has been linked to vitamin D deficiency as well (Artaza et al., 2011; Fiscella & Franks, 2010; Grant & Peiris, 2010; Harris, 2006; S. S. Harris, 2011).

In an analysis of observational data, Harris (2011) found a disproportionate prevalence of type 2 diabetes and cardiovascular disease in African Americans, and reported that their prevalence was most considerable where vitamin D deficiencies were noted. Vitamin D deficiency is linked to the impairments in insulin secretion and insulin utility that characterize type 2 diabetes. Some of the earliest evidence linking these impairments with vitamin D deficiency was noted in the research of University of California professor, Anthony Norman, in the 1980's. In the pancreas specimens of rodents with engineered vitamin D deficiency, in vitro research demonstrated that β-cell insulin biosynthesis was significantly better in vitamin D repleted rodents, when compared to β-cell specimens of vitamin D depleted rodents (Norman, Frankel, Heldt, & Grodsky, 1980). These findings catalyzed a host of observational research studies examining the vitamin D trends in persons with, and at risk for diabetes, obesity, and related chronic diseases for the decades that followed.

Vitamin D is ubiquitously identified as a fat-soluble vitamin that is attainable from natural or fortified food sources, and from vitamin supplements. It is likewise a steroid pro-hormone produced proportionately in the skin with exposure to ultra violet sunlight (M. F. Holick, 2009). Because vitamin D receptors are located on pancreatic β

cells and on skeletal muscle cells, glucose metabolism is one of many metabolic pathways influenced by vitamin D (A. G. Pittas et al., 2007). Insulin release is a calcium dependent function that is heavily influenced by the availability of vitamin D (Wollheim & Sharp, 1981). Adipose tissue has been shown to sequester vitamin D (Blum et al., 2008) and consequentially, may promote its deficiency. This relationship is important because the greatest increase in persons with diabetes has been among African American women, and 80% of this group is overweight or obese (Centers for Disease Control & Prevention, 2011). There seems to be no shortage of risk factors in African American communities for diabetes and obesity, but deeper insight into their determinants is necessary and important for developing meaningful interventions to reduce rates of prevalence.

Among African Americans, low socioeconomic living conditions and lactose intolerance are familiar phenomena. These conditions promote opportunities for vitamin D deficiency to develop (Jarvis & Miller, 2002). Low socioeconomic living conditions may also compromise food choice, time spent in sunlight, and involvement in physical activity. Davis (2011) explained the common traits between vitamin D deficiency and type 2 diabetes in African Americans, and emphasized that living conditions associated with poverty compromises opportunities for vitamin D adequacy. Where SES is low, overweight and obesity is influenced by concerns for outdoor safety, proximity to recreational facilities, proximity to healthy food retail, and the calorie density of low cost food items.

Vitamin D deficiency is pervasive throughout the world (Michael F Holick & Chen, 2008), and persons with darker complexions incur a higher risk for its occurrence.

The hue of skin is proportional to the amount of melanin it contains and melanin slows cutaneous production of vitamin D (Rajakumar, Greenspan, Thomas, & Holick, 2007b). In the continuous National Health and Examination Survey (NHANES) cycles 2001-2004, vitamin D levels were ≥ 20 among 30% of Whites, 10% of Hispanics, and 5% of African Americans; and in a range of severe deficiency (<10ng/ml) in 3% of Whites, 7% of Hispanics, and 30% of African Americans (Melamed et al., 2009). The fact that African Americans as an aggregate have lower vitamin D levels, and are more vitamin D deficient than Hispanic, or White Americans seems intuitive; but vitamin D adequacy is not explained entirely by skin complexion. It has been proposed that the inherent roles of cultural and other acquired lifestyle practices significantly affect the vitamin D level (Artaza, et al., 2011; Martins et al., 2007; Scragg, Sowers, & Bell, 2007; Zadshir, Tareen, Pan, Norris, & Martins, 2005). For the cultural and lifestyle trends known to augment the risk for diabetes, obesity, and vitamin D deficiency, these are areas that have been rightfully targeted for exploration of opportunities to reduce the prevalence of these conditions.

Sunshine alone may be insufficient to achieve adequate vitamin D levels. In a cross-sectional study of 395 men and women age 40 to 79 that participated in the Southern Community Cohort Study, Eagan et al. (2008) examined the prevalence and predictors of vitamin D deficiency in African American and Whites living in the southeast United States. Forty-five percent of all the African Americans that participated were vitamin D deficient, compared to 11% of the Whites. Fifty-three percent of the African American women in sample had vitamin D levels $\leq$ 15ng/ml (2008). Trends in vitamin D levels observed in this study were not different from previous research

findings despite sufficient access to sunlight. Another research group used a cross sectional design approach to examine the relationships between serum 25 (OH) vitamin D levels, BMI, and seasonal variations in 800 reproductive aged women of multiple races in southeast Texas (McKinney, Breitkopf, & Berenson, 2008). In this study, 54% of the sample had 25 (OH) vitamin D levels < 20ng/ml. The lowest of those vitamin D levels were among the Hispanic, and non-Hispanic Black women respectively (2008). Cutaneous production of vitamin D diminishes with age (MacLaughlin & Holick, 1985). The youthful age of the research participants in this study did not result in higher vitamin D trends despite age and residence in an area receiving consistent sunshine year round.

Theoretical Framework

The model depicted in Figure 1 denotes the hypothesized relationships of the variables studied in this research. Studies have shown that people whom are overweight or obese have lower vitamin D levels. Poverty is a condition associated with low SES and its associated conditions can increase the risk for vitamin D deficiency (Davis, 2011). Obesity is common in persons affected by poverty (Drewnowski & Specter, 2004), and obesity is present in over 80% of persons with type 2 diabetes (Centers for Disease Control & Prevention, 2011). Vitamin D deficiency is likewise, common in people with diabetes (A.G. Pittas, J. Lau, F.B. Hu, & B. Dawson-Hughes, 2007). The relationship between SES and vitamin D level, BMI and vitamin D level, as well as the product of BMI by SES, and vitamin D level may be different when diabetes is present. These perspectives have not been previously examined.

Conceptual Definitions

African American – African American is used to describe anyone with Black African ancestry and raised in a manner that is culturally germane to the conduct of persons in the United States of America.

Obesity - Obesity is characterized by excessive adipose deposition in the body that can impair health and reduce life expectancy (The Obesity Society).

Socioeconomic Status (SES) - A concept encompassing income, education, and occupation that affects health and health behavior at varying degrees (Duncan, 2003).

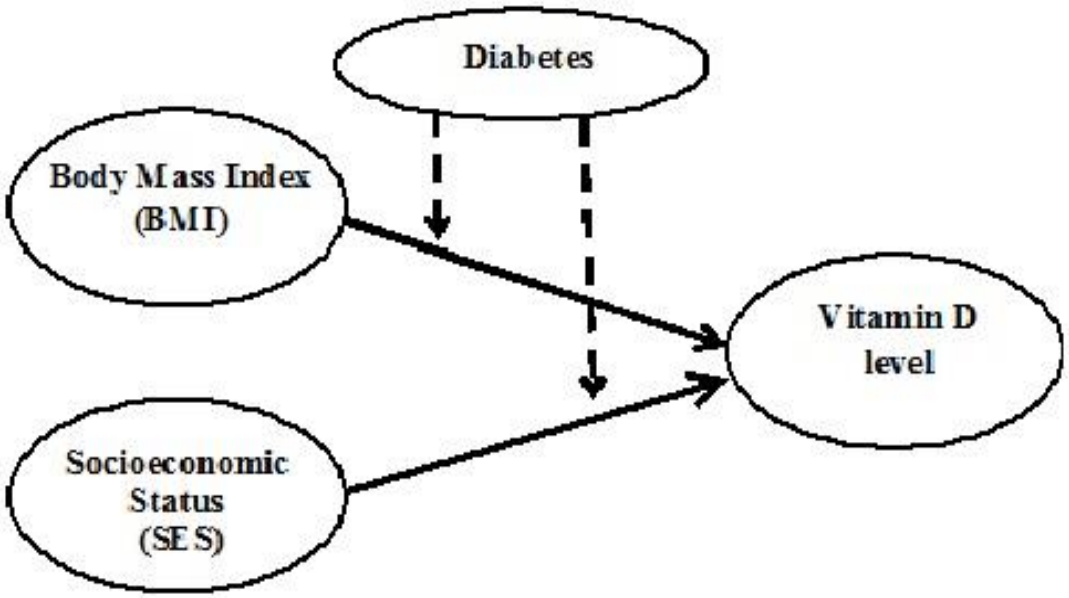

Figure 1. Illustrates the proposed relationships between SES and BMI on vitamin D levels in this research. It also denotes a potential moderating effect of diabetes on these relationships.

Vitamin D – Vitamin D is a fat-soluble vitamin and pro-hormone that is acquired from dietary sources, dietary supplements, or produced in the skin proportionately with exposure to ultraviolet light rays. Vitamin D deficiency is defined as 25 (OH) vitamin D

≤ 20ng/ml, and vitamin D insufficiency occurs when vitamin D is 21 to 29ng/ml, sufficient vitamin D is ≥ 30ng/ml (M. F. Holick, 2009).

Diabetes – Diabetes is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both (American Diabetes Association, 2011).

Operational Definitions

African American - African American ethnicity in this study was determined by the self-report of the NHANES respondents in survey cycles 2003 – 2006 that met inclusion criteria.

Obesity - As a continuous variable, was quantified using BMI.

Socioeconomic Status (SES) – Income and education are determinants of SES (Duncan, 2003). The ratio of income to the level of poverty quantifies the depth and scope of its condition (U.S. Census Bureau, 2010). In 2009, a family of four was considered living in poverty if household income was under $21,954, and under $17,098 for a family of three (U.S. Census Bureau, 2009). Poverty to income ratio (PIR) was one measure used to gauge the SES of survey participants in this study. Self-reported education levels and annual household income were also analyzed.

Vitamin D – The adjusted vitamin D levels from cycles 2003 – 2004, and 2005 - 2006 were obtained from the NHANES laboratory assessment file. NHANES updated measurement and evaluation procedures for serum 25 (OH) vitamin D after these cycles and adjusted the results obtained prior to the update, for better comparison with future samples obtained. Greater detail on the rationale for this adjustment by NHANES is discussed in the methods section.

Diabetes - The dichotomous variable diabetes was determined by self-report. Participants that reported using insulin were also included in this group.

Summary

The growing epidemic of diabetes is most rampant among African Americans, and the high rates of obesity in this group, contributes significantly to its prevalence. Obesity and diabetes have been associated with low vitamin D levels, and each of these is associated with high morbidity, high mortality, and greater use of health resources. The largest increases in diabetes prevalence and obesity are in African American women. Many African Americans also experience vitamin D deficiency and socioeconomic disparities. Low socioeconomic conditions support opportunities for vitamin D deficiency to manifest. Greater exploration of these relationships may yield new perspectives in nursing for innovative alternatives to existing interventions targeting diabetes and obesity epidemics in this group. This research aims to first, determine the relationship among SES, obesity, and vitamin D levels of African American women residing in areas with abundant sunshine. Research examining the prevalence of vitamin D deficiency in African Americans living in the sun sufficient areas of the United States is limited, and none to date have examined the influence of diabetes on vitamin D in African American women in areas of the United States receiving consistent amounts of sunshine. Therefore, a second goal is to explore if diabetes moderates the relationships between SES and vitamin D, BMI and vitamin D, and the relationship of SES by BMI and vitamin D levels in African American women living in areas with abundant sunshine year round.

The next chapter will discuss the literature highlighting common traits in vitamin D deficiency, obesity, low SES, and diabetes.

CHAPTER 2

Introduction

This chapter presents the literature for this research that identifies relationships between the variables SES, BMI, and vitamin D in African American women. The epidemic presence of diabetes in African Americans is also reviewed.

Review of the Literature

Relationships observed between the hallmarks of type 2 diabetes, and vitamin D deficiency have inspired novel considerations for impacting the diabetes epidemic and affecting occurrence rates for its complications (Borges, Martini, & Rogero, 2011). In the United States, the burden of managing the diabetes epidemic is vast, and will be difficult to control at the projected rate of increase. Insulin resistance and impairments in insulin secretion, have been observed in patients with vitamin D deficiency (A. G. Pittas et al., 2007), and vitamin D deficiencies are common where there is obesity (Yanoff et al., 2006). These phenomena are all widespread amongst African Americans. Thus, deeper insight into the nature of these relationships is important.

The social and physical conditions of a community, influences the health of its residents. Neighborhoods with low SES are commonly positioned where options for nutritional variety and food quality are limited (Dubowitz et al., 2008). Restricted access to fresh fruits and vegetables, coupled with low access to safe recreational facilities promote low activity lifestyles and weight gain (Krishnan, Cozier, Rosenberg, & Palmer,

2010). According to the U.S. Census Bureau (2011), between 25.8% and 27.4% of African Americans, live at or below the poverty level. In most cases, living in poverty is an experience weighted with physical and psychosocial stress. Stress has long been associated with chronic disease and allostatic load, which increases risk for disease and death (McEwen & Stellar, 1993).

As low SES conditions can compromise opportunities for sufficient sun exposure and cutaneous production of vitamin D, dark skin, lactose intolerance, and a diet otherwise low in sources of vitamin D also promote its deficiency (Davis, 2011). Anatomically, the influence of vitamin D is pleiotropic. Its function in regulating inflammation (Chagas, Borges, Martini, & Rogero, 2012; Wu & Sun, 2011), glucose metabolism (A. G. Pittas et al., 2007), and cardiovascular function (S. S. Harris, 2011), may be salient in explaining the high rates of diabetes and related consequences in African American women. Research examining vitamin D repletion for diabetes treatment, prevention, and development is ongoing. At present however, most vitamin D research findings have been gleaned through analysis of previously collected data. Relationships among obesity, SES, vitamin D, and diabetes have not been collectively examined in African American women. Further, no previous research has studied relationships between low SES conditions and vitamin D in African American women, unrelated to bone health. Thus, examination of contributing factors to vitamin D adequacy in populations with high prevalence rates of diabetes, obesity, and associated co-morbidities is prudent and imperative.

Vitamin D: Background

Vitamin D is acquired from three main sources: from sunlight, from the diet, and from supplements. Food sources of vitamin D_3 include oily fish, eggs, meats, as well as foods that have been fortified such as milk and bread. Ergosterol (D_2) is plant-derived and is most prevalent in fungi, like shiitake and other types of mushrooms (M. F. Holick, 2007). These plants produce vitamin D_2, or ergocalciferol when exposed to ultraviolet light. Most vitamin D_2 supplements are Food and Drug Administration (FDA) regulated and available by prescription. Over-the-counter supplements of vitamin D_2, are not subject to FDA oversight. Vitamin D_2 supplements are less potent than vitamin D_3 varieties and thus, require higher doses to achieve measurable clinical outcomes (Moyad, 2008; National Institutes of Health Office of Dietary Supplements, 2010). Most over-the-counter vitamin D supplement preparations are vitamin D_3 (cholecalciferol).

Vitamin D is most known as a fat-soluble nutrient obtained from food intake or dietary supplements as vitamin D_2 or vitamin D_3 (M. F. Holick, 2009), but vitamin D is also a pro-hormone that is produced in the skin (Rajakumar et al., 2007b). With sufficient stimulation by ultraviolet rays, the skin produces 7-dehydrocholesterol that is converted to pre-vitamin D (Rajakumar, Greenspan, Thomas, & Holick, 2007a). Once pre-vitamin D is manufactured by the skin or ingested, cholecalciferol is formed and a two-step hydroxylization process follows. First, in the liver, the enzyme 25-hydroxylase is added to generate 25 (OH) vitamin D_3. Vitamin D in this form has a half-life of several weeks and hence, serum measurement of 25 (OH) vitamin D_3 is considered the gold standard for assessing vitamin D status (M. F. Holick et al., 2011). The second step takes place in the kidney to formulate the physiologically active 1,25 $(OH)_2$ vitamin D

(calcitriol), which is regulated via the homeostatic influence of the vitamin D and parathyroid hormone feedback loop (Feldman, Pike, & Glorieux, 2008). Parathyroid hormone (PTH) promotes renal calcium absorption and skeletal calcium resorption. This action, in turn, controls expression of the enzyme 1α-hydroxylase, which is necessary to assemble calcitriol (M. Holick, 2006). This is the primary pathway used to form the physiologically active 1, 25, $(OH)_2$ vitamin D, however extra-renal activation of vitamin D can also occur. These processes are cytokine mediated and dependent on tissue specific activity (Prosser & Jones, 2004). Some of the extra-renal pathways make vitamin D_3 activation possible in the pancreas, lungs, colon, and within macrophages (2004).

Vitamin D Deficiency

There is no present consensus on the optimal level for 25 (OH) vitamin D. Recommendations for optimal levels vary and are based on observational studies, and expert consensus. There is greater agreement, however, on the parameters defining vitamin D deficiency. Because clinical trial data demonstrating relationships between vitamin D and chronic disease are limited, deficiency parameters in vitamin D are based on randomized clinical trials for bone health (Institute of Medicine, 2010b). Studies examining vitamin D in bone health define deficiency as the level at which PTH production increases (R. P. Heaney, 2000).

Parathyroid hormone is inversely related to vitamin D, and elevated PTH results in bone loss and increased risk for fracture (Feldman et al., 2008). Malabanan, Veronikis, and Holick (1998), tested the effect of 50,000 IU of vitamin D_2 weekly on PTH levels in 169 adult men and women, between ages 49 and 83 for eight weeks. Serum samples of 25 (OH) vitamin D, PTH intact, and calcium were obtained before and after

treatment with vitamin D, and mean differences in the vitamin D levels were compared in intervals. Mean improvements in 25 (OH) vitamin D levels from 11ng/ml to 15.9ng/ml decreased the PTH intact level from 80pg/ml (*SD*=12) to 46pg/ml [(*SD*=6), p <0.02]; and improvements in 25 (OH) vitamin D levels from 16ng/ml to 19.9ng/ml decreased PTH intact from 57pg/ml (*SD* = 5) to 41pg/ml [(*SD* = 5), $p < 0.001$]. Changes in PTH intact levels were not statistically significant when 25 (OH) vitamin D levels were ≥ 20ng/ml (1998). No appreciable changes in the serum calcium levels occurred in the study. The authors concluded that 25 (OH) vitamin D levels ≥ 20ng/ml are sufficient to prevent elevations in PTH, and subsequent bone loss. This study provided an important point of reference for clinical trials investigating risk for fracture, and is the basis for the deficiency threshold most advocated (Dawson-Hughes B., 2005; M. F. Holick, 2007; Lips, 2004). Because parathyroid hormone levels increase as age advances (Dawson-Hughes, Harris, & Dallal, 1997), and other reviews of fracture reduction data suggest that the threshold defining vitamin D deficiency be increased for this reason. However, support for this prospective amongst vitamin D experts is inconsistent.

Numerous observational studies and a limited number of interventional trials have shown an association between higher vitamin D levels, and lower risk for diabetes, hypertension and other chronic diseases. These trends though novel, are based on research designs lacking the rigor needed to promote change in recommendations for vitamin D intake. In late 2010, the Institute of Medicine (IOM) declared that most North Americans receive adequate amounts of calcium and vitamin D, and that the evidence to support vitamin D supplementation for extra-skeletal benefits is inadequate (Institute of Medicine, 2010a). Soon after this publication, some of the foremost scientists and

organizations in vitamin D research expressed disagreement with this position. One such organization, the International Osteoporosis Foundation (IOF) advocates for prevention, treatment, and research of bone related diseases. Their published recommendations for vitamin D intake are higher for persons over age 60, than the recommendations made by the IOM for persons in the same age group. Bischoff-Ferrari et al., (2009) examined data from nearly 10,000 men and women ≥ 20 years of age from the NHANES III survey to evaluate the role of calcium intake and vitamin D status on bone mineral density (BMD). Six groups were formed based on gender, and vitamin D level (<20ng/ml, 20ng/ml - 30ng/ml, and >30mg/ml). Their results indicated that calcium intake indeed correlated positively with BMD in women (not men) when 25 (OH) vitamin D levels were ≤ 20ng/ml ($p = 0.005$). However, when 25 (OH) vitamin D exceeded 20ng/ml, BMD increased in a graded fashion with improvements in 25 (OH) vitamin D levels (2009). These findings suggest that vitamin D is important to building and maintaining BMD, and that a 25 (OH) vitamin D levels below 20ng/ml are not sufficient to protect against bone loss. Similar outcomes were noted when Bischoff-Ferrari and Willett (2009), conducted a meta-analysis of eight double-blinded RCT ($n = 2426$). This research found that serum vitamin D levels < 24ng/ml, and that vitamin D supplement dosing < 700 IU daily, were insufficient to reduce the risk for bone fracture. Cutaneous vitamin D production traditionally declines as age advances (M. A. Dawson-Hughes B, Bonjour J. P., Boonen S., Burckhardt P., Fuleihan G. E., Josse R. G., Lips P., Morales-Torres J., Yoshimura N, 2010; MacLaughlin & Holick, 1985), and this trend is exacerbated by sedentary lifestyles, reduced sun exposure, low variety in nutritional intake, and chronic health conditions. Based on these outcomes, the IOF's recommendation for higher

vitamin D intake (800 IU to 1000 IU) for persons over age 60 has minority support. The IOM recommendation limits vitamin D supplement use to 600 IU daily until age 70.

Less conservative definitions of vitamin D deficiency than the levels proposed by the IOM have been advocated by other organizations as well. The Endocrine Society published clinical practice guidelines for the evaluation, treatment, and prevention of vitamin D deficiency (M. F. Holick et al., 2011), and further highlighting the contrasting perspectives amongst experts in the field. Their guidelines define vitamin D deficiency as 30ng/ml, and recommend that children and adults aim to keep serum levels between 40 and 60ng/ml (2011). The vitamin D research community has promoted inclusion of outcomes from cohort, case-control, and ecological studies as future positions are comprised, as well as consideration of studies examining serum vitamin D levels and chronic disease prevalence (H. Bischoff-Ferrari, Willett W., 2011; Gorham, 2011; Robert P. Heaney & Holick, 2011). These varied positions among experts validate the need for more research that tests the influence of vitamin D on chronic disease that is randomized, controlled, and well powered.

As indicated, the parameters that define vitamin D adequacy are based on bone health studies, as they are the best designed interventional studies to date evaluating the influence of vitamin D on health outcomes (Grant & Holick, 2005; Institute of Medicine, 2010a). The recommendations from the IOM on vitamin D intake are conservative, and indicate minimums necessary to *maintain health* (2010a). Though the IOM report recognizes that the research to base recommendations for *disease prevention and/or treatment* is insufficient, greater acknowledgement of the foremost trends in vitamin D and chronic disease research may have better addressed the contentions of a prominent

segment of that community. The controversy, however, underscored present gaps in vitamin D research, and catalyzed the advance of clinical trials targeting these gaps more directly. On the whole, the discussions on vitamin D research have heightened public awareness of its potential role in chronic disease development and potential clinical utility for disease state improvement.

Vitamin D in Glucose Metabolism

Impairments in insulin secretion and insulin resistance are the defects that define type 2 diabetes (DeFronzo & Tripathy, 2009; Weyer, Bogardus, Mott, & Pratley, 1999). Vitamin D is important for optimal β – cell function and insulin utility in the pancreas. The role of vitamin D in insulin secretion from pancreatic β - cells was initially identified nearly three decades ago in a study by Dr. Anthony Norman and colleagues (Norman et al., 1980). They compared the hormone release patterns of insulin and glucagon in vitamin D-deficient, and vitamin D-replenished rodent pancreas specimens in vitro. Glucose and arginine were administered to the specimens using a weight-based dosing standard. Post infusion insulin response began early and peaked after three minutes in the vitamin-D repleted specimens. This response was 48% lower in specimens that were vitamin D depleted ($p < 0.05$). This outcome provided the basis for many other studies to examine the role of vitamin D on glycemia in the years that followed.

The influence of vitamin D on insulin secretion is indirect. It is actually calcium that regulates insulin secretion in the pancreatic β - cell, and this function is reliant on adequate vitamin D inventories (Palomer, González-Clemente, Blanco-Vaca, & Mauricio, 2008; Reis, Hauache, & Velho, 2005). The regulatory role of calcium results from a series of intracellular operations that produce its concentration dependent

transport across membranes. The mechanism causing the release of insulin from pancreatic β - cells is the trans-membranous influx of calcium, or facilitated diffusion (Hou, Min, & Pessin, 2009; Wollheim & Sharp, 1981). This action is potentiated in the presence of glucose (1981), however there is a threshold for this response. Davies, Gibbons, Steward, & Ward (2008) examined human epithelial colorectal cells in vitro for evidence of a mediating effect of extracellular calcium on its transport, by investigating the actions of calcium sensing receptors. This case controlled experiment found that the trans-membrane flux of calcium is indeed a concentration dependent effect, and that excessive extracellular calcium causes resistance, and decreases calcium transport efficiency (2008). Though the action of calcium in this research was studied in human colorectal cells, it is reasonable to infer that elevations in extracellular calcium may affect insulin secretion in β - cells in a similar way. In a step-wise multiple regression procedure, Sun, Vasdev, Martin, Gadag, and Zhang (2005) investigated relationships between fasting serum glucose, serum calcium, β-cell function, insulin, and insulin resistance in 1,182 men and women. After adjusting for age, serum phosphorus, serum magnesium, and central adipose composition, significant positive correlations were found between serum calcium and fasting serum glucose ($r = 0.31$ in women, $r = 0.22$ in men; $p < 0.001$ in both). Significance was also noted in the relationships between serum calcium and insulin resistance ($r = 0.13$; $p < 0.001$ in women, $r = 0.14$ in men; $p < 0.05$), (Sun et al., 2005). Interestingly, an inverse correlation between β - cell function and serum calcium levels ($r = - 0.17$; $p < 0.001$) was observed only among the female participants in the sample (2005). These relationships emphasize the importance of the vitamin D mediated ebb and flow of calcium across the β - cell membrane. Consequently,

conditions that alter calcium homeostasis may adversely affect insulin secretion and/or insulin sensitivity, particularly among women. Parathyroid hormone functions to increase serum calcium concentrations in part, by boosting conversion of 25 (OH) vitamin D to 1,25 $(OH)_2$ vitamin D_3, increasing bone resorption and mineral release, and by increasing calcium absorption in the small intestine (Feldman et al., 2008). Hence, PTH release is inversely proportional to the presence of 25 (OH) vitamin D. The resulting increase in serum calcium from chronically elevated PTH in theory, can alter glucose metabolism by affecting calcium transport (McCarty & Thomas, 2003).

Chiu et al., (2000) implored a cross sectional study design to examine the relationship between insulin sensitivity and parathyroid hormone, using the hyperglycemic clamp method to determine insulin sensitivity and glucose tolerance thresholds in 52 healthy men and women. In this study, insulin sensitivity and PTH levels correlated inversely (r = -.32, p = .02). Another study tested this relationship in vitro, which also demonstrated a progressive decrease in insulin stimulated glucose uptake in rodent adiposites after 1 hour of exposure to PTH (Chang, Donkin, & Teegarden, 2009). Here, the intracellular functions moderating glucose uptake were attenuated with prolonged exposure to PTH (2009). These outcomes indicate that extracellular calcium elevations may promote insulin resistance in fat cells.

The relationship of the vitamin D dependent action of calcium in insulin secretion, and glucose uptake is made clearer in understanding their function in β-cell physiology. Though sufficient research has not been completed to label the relationship between vitamin D deficiency and impaired glucose metabolism as causal, the disparate

prevalence of these conditions in African Americans supports the need for intensified research efforts within this community.

Vitamin D Deficiency in African Americans

The greatest prevalence of vitamin D deficiency in America is in the African American community (Egan et al., 2008; Grant & Peiris, 2010; Zadshir, Tareen, Pan, Norris, & Martins, 2005). Zadshir, et al., (2009) studied vitamin D adequacy in American adults by examining participant responses from NHANES III. According to these data, a significant portion of the U.S. population has low serum 25 (OH) vitamin D levels (< 28ng/ml), and that most are female. Of more than 15,000 cases examined, African American female participants had the lowest mean 25 (OH) vitamin D levels at 18ng/ml $p < 0.0001$, (2009). In another study, Egan, et al. (2008), used a cross sectional study design examining vitamin D levels in 395 African American and White men (n= 99 and 99) and women (n= 99 and 98) aged 40 to 79. They found that vitamin D deficiency was present in 45% of African Americans compared to 11% of the White Americans. The data did not show that vitamin D levels differed where education and income levels varied among African Americans (2008). However, data collection methods for this research were imperfect in that vitamin D intake was estimated via review of the participant responses to the NHANES III dietary questionnaire; and ultra violet exposure was projected based on geographical estimates. Despite these limitations, the findings are consistent with other research examining vitamin D trends in African American communities.

While ultra-violet rays of sunlight stimulate vitamin D production in skin, skin complexion, and the amount and timing of sun exposure also influences the efficiency of

this process (Chen et al., 2007). Cutaneous vitamin D production is also affected by choice of clothing, changes in season, use of sunscreen, and geographical latitude. Melanin acts as a natural sun block, and accordingly, vitamin D deficiencies are common among African Americans and other ethnic groups with darker skin (Rajakumar et al., 2007b). Though southern states are positioned in latitudes that receive consistent amounts of sun light year round, vitamin D levels in African Americans residing in these regions do not appear to benefit from the increased opportunity for sun exposure. Looker, Dawson-Hughes, Calvo, Gunter, and Sahyoun (2002) examined NHANES III laboratory assessment outcomes of survey participants residing in sun sufficient, southern latitudes (*M* latitude = 32° N) and found that 53% – 76% of non - Hispanic blacks compared with 8% – 33% of non-Hispanic whites had 25 (OH) vitamin D levels below 20 ng/ml when tested in winter months. Moreover, a review of the literature by Grant and Peiris (2010) explored reasons for disparities in chronic disease prevalence and all-cause mortality among African Americans and White Americans. I this study, mean 25 (OH) vitamin D was 16ng/ml in African Americans, and 26 ng/ml in White Americans, and they discussed that vitamin D deficiency may augment risks for chronic disease and mortality in those affected (2010). Further prospective research is important to best elucidate the significance of low vitamin D physiologically, and to determine if vitamin D deficiency has a causal role in the disparate prevalence of diabetes and other chronic diseases in African Americans.

Dietary Sources for Vitamin D in African Americans

Opportunities for dietary intake of vitamin D are reduced with lactose intolerance because dairy food items are commonly vitamin D fortified. Real or perceived lactose

intolerance is significant in African Americans and lower intake of nutrients from dairy food is appreciated across the age spectrum in this community (Simoons, 1978). Van Horn et al. (2011) conducted a longitudinal diet analysis for vitamin D rich food intake of 2379 African American and White girls starting from age nine or ten. In the decade that the participants were observed (1987 to 1997), race was the most stark predictor of vitamin D intake, where African American girls consumed fewer amounts of vitamin D rich foods compared to the other participants (2011). Milk was the top source of vitamin D in both groups, however meats and oils were much more prevalent in the diet of African American girls. Both groups had reduced milk intake in adolescence, but this reduction was more substantial in the African American group (2011). Also interesting was that overall intake of fat decreased as age advanced in White girls, but not in the diets of African American girls. Higher fat food items like whole milk and processed meats were reported as significant components of the African American diet throughout the period of data collection (2011). This study did not include 25 (OH) vitamin D levels for the participants or information on sun exposure, however much can be inferred about the differences in BMI between adolescent African American and White girls. With this information, quantifying the impact of food choice on vitamin D levels may have been possible. Diet assessments were conducted by certified, method trained dieticians, thus the data were recall dependent and subject to error in that respect.

Though not independently causal, low dairy intake and lactose intolerance is an exacerbating factor for vitamin D deficiency in African Americans. Fulgoni et al., (2007) analyzed 24 hour dietary recall data from the Continuing Survey of Food Intakes by Individuals (CSFII) cycles covering the years of 1994 - 1996, and 1998; and NHANES

1999 -2000 to determine the general intake of calcium and dairy foods in African Americans. Chi square statistics were used to test for differences between the number of dairy food servings recalled by African American (n = 2414) and non-African American (n = 16,428) survey participants. The sample was further stratified by gender and age to assess for differences in dairy intake. Prior to this study, dairy food consumption in African Americans had not been quantified (2007). Fulgoni et al. (2007) found that the diets of most African Americans are considerably deficient in calcium, magnesium, and phosphorus because of low intake of dairy foods. This research also found that amongst African Americans, intake of calcium rich food sources was lowest among African American women (2007). Low milk intake due to actual intolerance, perceived intolerance, or preference, necessitates that persons affected consume other sources rich in vitamin D. According to Jarvis and Miller (2002), culture and dietary traditions may be more responsible for low intake of dairy foods in African Americans than actual lactose intolerance. Lactose intolerance is largely self-diagnosed and based on the experience of gastrointestinal symptoms, and is rarely diagnosed clinically (Byers & Savaiano, 2005).

Oily fish, mushrooms, and egg yolks, are the lone sources of food with naturally occurring vitamin D and they cost more to consume than fortified sources like milk and cereals (Drewnowski & Specter, 2004). These foods can be tougher to access among persons with income limitations and low SES. Also, these foods are not common place in traditional African American diets (Kulkarni, 2004). Milk and breakfast cereals are the main food sources fortified with vitamin D in the United States (Calvo, Whiting, & Barton, 2004), and they are generally consumed together. Milk is a common and

accessible source of vitamin D that unfortunately is under-consumed by African Americans. Therefore, low milk consumption indeed contributes to the prevalence of hypovitaminosis D in this community.

Diabetes and African Americans

The yearly incidence of diabetes continues to increase in the United States despite new discoveries about its origins, treatment, and management, and countless awareness campaigns. More than 90% of people with diabetes have type 2 diabetes, and the insulin resistance and impaired insulin secretion it ensues (DeFronzo & Tripathy, 2009). National estimates are that 25.8 million Americans are affected by diabetes, and 18.7% of this total are African American (Centers for Disease Control and Prevention, 2011). The CDC estimates that one in three Americans will have diabetes by the year 2050 (Boyle et al., 2010), and this estimate is legitimized by the 79 million Americans currently estimated to have pre-diabetes (Centers for Disease Control & Prevention, 2011). The highest annual incidence of new diabetes cases is among African Americans, as they are more than three times as likely to incur a diagnosis of diabetes as non - Hispanic whites (2011). Public health interventions aiming to reduce diabetes in America must include specific objectives that address its disparate presence and incidence in African American communities.

The risk factors for type 2 diabetes mirror the conditions and behaviors that influence prevalence rates for vitamin D deficiency. The risk for type 2 diabetes increases with African-American or minority race, obesity, and insulin resistance (Centers for Disease Control & Prevention, 2011; DeFronzo & Tripathy, 2009; S. S. Harris, 2011). These risks are amplified by sedentary lifestyle and intake of calorie - dense and nutrient

deficient foods. Low SES and its associated living conditions can also pose access challenges for safe recreational activity, as well as access to nutritious foods (Drewnowski & Darmon, 2005; Drewnowski & Specter, 2004).

Obesity

Sixty-five percent of Americans are overweight or obese and African American women represent the majority of this group (Centers for Disease Control and Prevention, 2011). Four out of 5 African-American women are overweight or obese, (Office of Minority Health, 2007) and a BMI reading of 35 or greater increase the diabetes risk 93-fold according to the Nurses' Health Study, (Hu, Li, Colditz, Willett, & Manson, 2003). Obesity is the leading cause for type 2 diabetes development.

Arunabh, (2003) examined 25 (OH) vitamin D levels in healthy women with a BMI range of 17–30 kg/m^2 and observed that these levels were negatively correlated with BMI, even when confounding influences of ethnicity, age, diet composition, and season were adjusted for ($r = -.13$, $p = .013$). Excessive adipose tissue functions as a storage space for vitamin D (Blum et al., 2008), and the inverse relationship between 25 (OH) vitamin D_3 and obesity is well established (Earthman C. P., 2012; Pittas, 2010; Pittas, 2007). The rationale for this relationship is unclear and research outcomes aiming to yield clarity have not been consistent. As obesity may promote sequestration of vitamin D and increase the risk for its deficiency, low vitamin D levels can result in compensatory elevations in PTH (Saab et al., 2010). Elevations in PTH stimulate the production of the physiologically active form of vitamin D (1, 25 $(OH)_2$ vitamin D_3). According to Arunabh, Pollack, Yeh, and Aloia (2003), and Wortsman, et al. (2000), elevated 1, 25 $(OH)_2$ D_3 stimulates lipogenesis and triglyceride accumulation, as well as inhibits

lipolysis by affecting intracellular calcium. Parikh et al. (2004), refuted these claims and noted that in both studies, the sample sizes were small and lacked ethnic diversity. These limitations were addressed in their research that examined a cross section of 302 obese and non-obese persons from multiple ethnic groups, and compared BMI, 25 (OH) vitamin D, PTH, and 1,25,$(OH)_2$ vitamin D levels in each group. They observed that 25 (OH) vitamin D levels were lower in the obese group (23.5ng/ml ± 12.2 ng/ml, $p < .0001$) versus the non-obese group (31ng/ml ± 14.4 ng/ml), PTH levels were higher in the obese group ($p < .0001$), and that 1, 25,$(OH)_2$ vitamin D was actually lower among the obese participants of the study ($p < .0001$). Body mass index and body fat composition via DEXA analysis correlated negatively with 1, 25 $(OH)_2$ D_3 levels (BMI $r = -.26$; body fat $r = -.24$; respective $p < .0001$), and were much higher in the non-obese group, though not significantly ($p = 0.11$). These relationships were observed without regard to the participant's ethnicity and suggest that lipogenisis is probably not a consequence of elevated 1, 25 $(OH)_2$ vitamin D levels. Though associations between vitamin D deficiency and obesity are significant, there is insufficient evidence to identify vitamin D deficiency as the cause or the outcome of obesity. Among African-American women however, reasons for obesity's pervasiveness are varied and multi-factorial. Cultural and social trends in the African American community are likely contributors to the obesity epidemic in their midst.

Obesity and African American Women

Cultural diversity among Americans is vast any many ethnic communities have preserved facets of the traditions and ontologies germane to their heritage. Perspectives on weight loss and need for health education are not nationally or culturally uniform. In

some cohorts of African American women, large body size is valued as a positive physical attribute. Thus, factors contributing to weight gain are not necessarily perceived as detrimental to overall wellness. A survey of 813 hospital employees was examined to explore weight loss behaviors in a racially diverse group. This research found that self – perceived weight, not BMI, and female gender were important factors motivating the African American study participants toward weight loss practices (Zapka, Lemon, Estabrook, & Rosal, 2009). These perspectives have been examined qualitatively as well. Befort, Thomas, Daley, Rhode, and Ahluwalia (2008), directed several focus groups exploring sensitivities and attitudes about body size, weight, and weight loss in middle aged, obese African American women. They found that health improvements of any kind stimulated participant willingness to lose weight. Interestingly, these participants likewise believed that women could be attractive, large sized, and healthy simultaneously (2008). In African American women, conventional strategies to encourage motivation toward weight loss may be less effective.

Perspectives on acceptable body size and meal preferences begin long before adulthood. Obesity is now observed in youth that are even school aged. These early obesity trends have spurred development of type 2 diabetes at earlier ages and these trends mirror obesity and type 2 diabetes trends nationally. Twelve African American females aged 12 to18 shared their attitudes on weight, diet, and physical activity in a semi-structured pilot interview (Boyington et al., 2008). The participants discussed that their outlook on these issues is influenced by time to participate, neighborhood safety, personal aesthetics (sweating, hair style maintenance, etc.) and immediate social circle. Taste, appearance, and context of meal intake all superseded nutritional value when

making decisions on food meal intake (2008). Such viewpoints may understandably compromise the success potential for interventions promoting weight reduction, and personal motivation to adopt health-promoting behaviors. Some research has acknowledged this heightened tolerance for obesity in facets of the African American community. Lynch, Chang, Ford, and Ibrahim (2007), directed a focus group of adult African American women to identify attitudes toward weight loss and bariatric surgery. Participants expressed that body size was a way of identifying with social networks, and that weight loss can actually result in less social support amongst friends, family, and/or in intimate relationships (2007). As obesity is more prevalent in African American women, these atypical perceptions of its biological consequences, psychological influence, and social role warrant thoughtful consideration as programs to improve community health outcomes are devised.

African Americans and Poverty

Large segments of the African-American population are concentrated in urban areas where access to the resources needed to undertake healthy lifestyle practices are limited. There are often safety concerns that affect decisions to participation in outdoor activity such as crime and illicit activity that is not uncommon in low-income communities (Burdette & Whitaker, 2004). The U.S. Census Bureau indicates that the poverty income threshold for a family of four with two adults and two children is $22,113 (U.S. Census Bureau, 2011b). More than 15% of Americans live at or below the poverty brink. For African American families, the reach of poverty is far greater. Median household income for an African American family in the United States was $32,068 in

2010, and 27.4% of African American families lived at or below the poverty threshold (2011).

Poverty limits access to healthy foods and compromises opportunities for diet choices that promote health. These limits can originate from income barriers, transportation barriers, or a general lack of knowledge regarding what constitutes healthy food choices. Fruits, vegetables, and produce products are naturally lower in calories and saturated fats, but may be difficult for some to obtain because of cost, or poor neighborhood proximity. Processed foods have longer shelf lives than fresh foods and contain excessive trans-fat, refined sugar, and/or sodium for preservation. These additives lower nutritional content, and increase caloric density of foods which in turn, encourages obesity (Katz et al., 2005). Urban and low income neighborhoods are often located near to fast food restaurants and convenience stores, and the vast majority of their decisions on food choices are made giving significant consideration to proximity. Access and cost are important in considering ways to positively affect health in low resource groups.

Monsivais and Drewnowski (2007) studied the relationship of food cost and calorie density in a cross-sectional examination of grocery items from several Seattle based stores. The strong inverse relationship indicated that calorie dense foods were cheaper and less nutritious ($r = - 0.62$); thus, policy measures that increase access to healthy foods via cost reduction can assist in reducing obesity and the chronic diseases linked to it (2007). As noted, foods sources that naturally contain vitamin D are more expensive and atypical in the diet of most African Americans. Vitamin D fortified milk and dairy foods are more accessible to these families because of their relative low cost

and availability on publicly funded nutrition programs. Dairy product consumption however, is commonly low among African Americans (Jarvis & Miller, 2002). The abundance and location of low quality food retail in low SES communities does not comprehensively explain the high prevalence of obesity and diabetes in poor minority communities, however further exploration into significant associations of diabetes and other obesity related conditions, as well as the reduced access to healthy food options is may help to disclose sources of inspiration that motivate members of this community toward health.

Low SES and Vitamin D

The physical surroundings of neighborhoods that house low income residents can discourage outdoor recreation. Perceived neighborhood safety influences family decisions on outside recreation and leisure (Lopez & Hynes, 2006). A qualitative study examined barriers and facilitators to physical activity that emerged from a series of focus group interviews with middle school students and their parents, living in rural and urban neighborhoods (Moore et al., 2010). The extent of safety measures necessary for outdoor recreation was concerning to the parents as well as the students. Of these concerns, limited adult availability to shield vulnerable youth from gang activity and peer violence was a leading issue for the parents. The students however, expressed the need for better balance between supervision and autonomy, as well as discontent with school policies that limit outdoor physical activity (2010). States with poverty rates that exceed the national average have the highest incidence of obesity, diabetes, and inactivity (Centers for Disease Control, 2011b; U.S. Census Bureau, 2011a). In light of the growing incidence of obesity in America's youth, policy oriented measures that address

neighborhood safety and physical activity in schools should be included in the solutions aimed at curbing obesity and its consequences in America's youth. Greater opportunities for outdoor activity and sun exposure may lower risks for vitamin D deficiency. Likewise, outdoor activity can lower the risk for obesity and diabetes in persons that participate despite their age.

Food cost is an important factor affecting food choice and obesity (Drewnowski & Specter, 2004). As noted, families with low SES, the quality of diet choice is a matter of quantity, proximity, as well as affordability. Li, Harmer, Cardinal, Bosworth, and Johnson-Shelton (2009) used a cross sectional multi-level study design to investigate concentrations of fast food outlets and socio-demographic characteristics of residential areas. Participants were recruited from U.S. census population blocks that were selected randomly. Study participants were next sorted by living standard, income, and ethnicity. Though most participants (n = 166), were male (57%) and White (92%), incomes reported were ~$30,000 annually (73%). Participants reported eating fried foods one to two times weekly (72%), and/or visiting fast food restaurants twice weekly (24%). The density of neighborhood fast food retail was associated with obesity and lifestyle choices that improve health such as low physical activity M = 1.792, 95% CI [1.006, 3.190], and weekly visits to fast food restaurants M = 1.878, 95% CI [1.006, 3.496], (2009). These data can be used to substantiate more rigorous study designs, as these findings are limited by low subject diversity, the cross sectional study design, use of databases to determine area restaurant density, and participant recall for intake assessment. A more current descriptive analysis of data from the Early Childhood Longitudinal Study- Kindergarten Cohort Lee (2012), compared more specific food retail data in an effort to determine the

type of food exposure, to the change in BMI in children over five years. This study addressed limits to previous research via analysis of longitudinal data. The data collected on food establishments included the scale, scope, and address of the business for improved acuity in comparison. These data in fact demonstrated greater proximity to fast food chain restaurants to the affluent communities, and that access to supermarkets neighborhoods with high poverty rates has improved according to the U.S. Department of Agriculture Report (2009). These changes in the proximity of low SES communities to supermarkets came in response to the designation of food deserts to communities where fresh food and nutritional resources were scare. Despite these new findings, African American and Hispanic children participating in the study demonstrated the greatest increases in BMI. Body mass index correlated inversely with maternal education (Lee, 2012). The added life stress that accompanies the living conditions of poverty can tax the body's capacity to adapt to environmental change, and compromise health. Poverty can pose significant challenges to the family and individual health stability.

Summary

African Americans experience the low socioeconomic conditions of poverty, obesity, and type 2 diabetes more often than other ethnic groups, and these influences may affect access to sources of vitamin D, or its bioavailability. Vitamin D deficiency among African Americans is also vast and greater than its prevalence in any other ethnic group in America (Yanoff et al., 2006). As current research continues to identify the relationships among vitamin D deficiency, obesity, and diabetes, finding the significance of these connections may reveal solutions to diminish their occurrence. Low vitamin D levels affect insulin secretion and insulin utility; and low levels of vitamin D correlate

inversely with obesity and diabetes. As conditions of living in low socioeconomic environments threaten access to basic physical and safety needs, motivation toward personal choices that benefit health and well-being is outweighed. Reduced access to nutritious food, outdoor activity, and sun exposure, for varied reasons, supports the expansion of obesity and diabetes epidemics within America's poorest communities. The sum of these experiences can be significant enough to impair allostasis, and in theory, increase the risk for developing vitamin D deficiency, obesity, diabetes, and other chronic diseases.

Health care costs associated with managing obesity, diabetes, and its complications are substantial. Small scale randomized interventional trials with vitamin D supplementation have demonstrated potential, but firmly acknowledge that well-designed larger scaled studies are imperative to support recommendations for higher vitamin D intake for disease prevent and/or control (J. Mitri, Dawson-Hughes, Hu, & Pittas, 2011). With the findings noted in this review, research generating more information on the determinants of chronic diseases like obesity, diabetes, and other chronic diseases has high merit. The literature reflects that vitamin D has received considerable attention because of its potential role of deficiency in the development and/or exacerbation of these disease states. The knowledge gap regarding the full scope of vitamin D's physiological importance is more evident as a result of these studies.

As the trends in ongoing vitamin D research continue to connect deficient levels with negative health outcomes, empirical evidence to support cost effective methods to reduce the rates of occurrence show promise and utility for nursing. This study will examine relationships between vitamin D and SES, vitamin D and BMI, and explore the

influence of diabetes on these relationships in African American women residing in areas with abundant sunshine, in an effort to add to the evidence substantiating innovative approaches by nursing in reducing the incidents of type 2 diabetes in African American communities.

The next chapter will discuss the methods used to investigate the relationships amongst the variables in this research.

CHAPTER 3

Introduction

This chapter describes the research design and methods used to address the aims, and research questions for this study. It contains inclusion criteria for the sample, rationale for the variables selected, and the processes undertaken for human rights protections. Procedures for data analysis are also discussed.

Method

A cross-sectional descriptive and analytical research design was employed to examine the relationships between SES and vitamin D, BMI and vitamin D, and the potential moderating effect of diabetes on these relationships in African American women residing in areas with abundant sunshine. Data from the National Health and Nutrition Examination Survey (NHANES) were accessed for this research analysis. NHANES is a nationwide survey distributed by the National Center for Health Statistics (NCHS) of the Centers for Disease Control and Prevention (CDC). Its purpose is to assess the general health, nutritional status, and disability of Americans via physical examination, blood analysis, and interview. The genesis of NHANES came in response to the National Health Survey Act of 1956. Since 1999, data collection for NHANES has been a continuous appraisal of the health and nutrition of non-institutionalized American children and adults, and these data are released in 2-year intervals. Hence, the study has alternatively been referred to as the 'continuous NHANES' since the data reporting

intervals were modified (Centers for Disease Control, 2011a). Prior to this time, data were released in phases.

Sample

NHANES Survey Design

NHANES participants were recruited from multiple geographic regions of the United States, and from multiple ethnic groups. In order to mirror the changing demographic and economic landscape in the United States, some groups are purposely oversampled. Since 2007, Hispanic Americans in general are oversampled; where previous cycles oversampled only Mexican Americans in this group (National Center for Health Statistics, 2011). African Americans, poor Americans, and Americans over age 60 have traditionally been among the groups oversampled; and this practice continues (2011). Purposive sampling techniques based on age, gender, and ethnic group were used to identify communities on the United States census rosters for NHANES participant recruitment.

Neighborhoods from these communities, and households within the neighborhoods were randomly selected. The interview component of the survey took place in the participants' homes. NHANES deployed mobile examination centers (MEC) to conduct physical examinations, collect blood and urine specimens, and for the computer aided and dietary recall components of the interview. Permission to collect these data was issued by the NCHS Institutional Review Board, and all NHANES participants provided informed consent and/or assent for the interview, specimen collection, and physical examination portions of the survey. A comprehensive

description of the NHANES design and methodology is discussed elsewhere (National Center for Health Statistics, 2007 - 2008, 2009 - 2010).

Sample Size and Statistical Power

The sample size requirement and estimates of statistical power were based on data from NHANES respondents in the public data set. These respondents were non-pregnant African-American women age 20 and older, with documented vitamin D levels. The target sample size was also based on an estimated proportion of women residing in latitudes at or below 35°, and could not be deduced from the public dataset. Moreover, sample size requirements and statistical power were estimated based specifically on study aims 1 and 2. Aim 3 was developed to examine the potential moderating effect of diabetes, and considered exploratory.

Of the nationally representative sample of 41,474 respondents to NHANES cycles 2003 - 2006, 611 African American women met inclusion criteria for this research sample. A priori assumptions were that at least 500 women would meet inclusion criteria and that at least 125 (25%) would reside in latitudes at or below 35°. For aims 1 and 2, a sample size of 125 respondents provided 80% power ($\alpha = .05$) to detect a "modest" non-zero correlation coefficient of at least 0.25. As it happened, twenty-nine percent ($n = 180$) of the full sample resided in areas lying at or below the 35° latitude line, which receive consistent quantities of sunlight year round in the United States. Thus, statistical power was somewhat higher than planned.

Variable labels identifying survey respondents by geographic latitude are classified as restricted. As data linked to geographical identifiers carry the potential to compromise the anonymity of survey respondents, a separate proposal was submitted to

the NCHS, Research Data Center (RDC) for permission to access the respondent surveys this way.

Criteria for Inclusion

Only female survey participants aged 20 and older with self-reported ethnicity of African American or black were selected. Variables representing the vitamin D level, PIR, education level, annual household income, BMI, diabetes status, and vitamin D supplement use in the 30 days prior to the survey were also analyzed. Women with self-reported pregnancy at the time of data collection, or a positive urine pregnancy test were excluded from the sample. Women with missing values for variables important in the analysis such as vitamin D level, PIR, education level, annual household income, BMI, diabetes status, and vitamin D supplement use in the 30 days before the survey, were also excluded.

Vitamin D. Serum 25 (OH) vitamin D has been collected routinely as a nutritional biomarker since 1988 (Centers for Disease Control, 2011a). Vitamin D specimens obtained from the survey participants in 2003- 2006 data collection cycles were analyzed using the DiaSorin radioimmunoassay (RIA) method, and 2006 was the last time this method was used. The DiaSorin method was discontinued as a result of instrument calibration problems, and inconsistencies in product formulations that affected outcome interpretability, and most notably, comparability of serum vitamin D levels between cycles (Centers for Disease Control, 2010; Yetley et al., 2010). Over the years, updates in these kits brought about changes in antibody detection methods, and the vitamin D outcomes from the affected cycles were adjusted in accord with these changes. Beginning in 2007, the liquid chromatography-mass spectrometry (LS-MS/MS) analysis

technique was implemented per the recommendations of the National Institute of Standards and Technology (NIST). This change improved analytical accuracy, precision, and specificity when compared to the DiaSorin RIA method. The NIST also developed standards and procedures to improve comparability between vitamin D levels analyzed in the cycles before 2007, and those taken afterward (2010). Consequently, the 25 (OH) vitamin D levels collected in cycles 2003 – 2006 were amongst those adjusted; and the files analyzed in this research were included. All laboratory specimens were collected as outlined by NHANES procedures, which are available in the public domain. Vitamin D levels archived by geography however, are only accessible through the NCHS RDC, (2011). A more detailed description for serum 25 (OH) vitamin D analysis methods and rationale for the new ones are described elsewhere (Yetley et al., 2010).

Socioeconomic Status (SES). Hollingshead (1975) indicated that SES is a product of education, occupation, gender and marital status. The sum of the four-factor scale is no longer a valid psychometric measure of SES, because occupational merit, gender, and marital perceptions have changed over the decades. Education and income however, are reliable in predicting and estimating SES as each increases and decreases in a predictable and graded fashion (Van Horn, 2011;Duncan, 2003) The ratio of income to the level of poverty quantifies the depth of poverty (U.S. Census Bureau, 2010). In 2009, a family of four was considered living in poverty if household income was under $21,954, and under $17,098 for a family of three. (U.S. Census Bureau, 2009). Poverty to income ratio (PIR) is one measure used to gauge the SES of survey participants in this study. Variables representing self-reported education levels and annual household income were obtained from the NHANES demographic questionnaire, and analyzed as well.

Body Mass Index (BMI). Body Mass Index (BMI) was used to examine the relationship between body weight and vitamin D deficiency. The literature review discusses that obesity and serum vitamin D levels are inversely related. Obesity is characterized by BMI of ≥30. In order to calculate BMI, NHANES data collectors used height and weight measurements obtained during the physical exam. These measurements were taken according to the protocol outlined in the NHANES Anthropometry and Physical Activity Monitor Procedures Manual (National Health and Nutrition Examination Survey, 2005).

Diabetes. The NHANES continuous survey includes self-reports of diabetes, use of anti-diabetic medications, and laboratory measures of glycemic control. For this study, diabetes was defined by identified by self- reported status or reported use of insulin.

Accessing NHANES Data

Submission of a proposal to the NCHS RDC was necessary to gain access to the variable identifying the geographical latitude of survey respondents, (see Appendix A). Any indicator of geographical specificity beyond residence in the United States is access restricted. The restricted variable latitude (LAT), and a variable to identify participant survey sequence (necessary for merging restricted and non-restricted data) were requested through this process. This was the only available method to determine the geographic locale of survey participants meeting inclusion criteria. Of the RDC options available to access these participants, the remote access option was the most feasible. Use of this option required proficiency with Statistical Analysis Software (SAS) or Sudaan statistical analysis software, completion of an online confidentiality orientation, as well as notarized confidentiality affidavits by the doctoral candidate, as well as the doctoral committee members. The complete RDC proposal process is explained elsewhere

(National Center for Health Statistics). Access to the restricted variables was approved after completion of this process (see Table 1).

Table 1. NHANES Restricted Research Variables

Variable Label	*Variable Label*
SEQN	Sequence Number – Used for Merging to Public Data
LAT	Latitude of Residence

To generate the data set for this study, data files matching the inclusion criteria from NHANES cycles 2003 – 2004, and 2005 – 2006, were obtained from the public domain (National Health and Nutrition Examination Survey Questionnaire, 2003 - 2006). These variables were used to generate syntax in the required *.SAS7bdat* format, which was then sent to the NCHS for merge with the variable "LAT." Once completed, notice was sent outlining the remote access process to conduct the analysis. Table 2 lists the NHANES variables obtained from the public domain that were used to create this research sample.

Table 2. NHANES Research Variables from Public Domain

Questionnaire File	
Variable Name	***Variable Name***
DIQ010	Doctor told you have diabetes
DIQ160	Ever told you have pre diabetes
DIQ050	Taking insulin now

Table 2. NHANES Research Variables from Public Domain (cont.)

Demographic File	
Variable Name	***Variable Name***
SEQN	Sequence Number – Used for Merging Public Data and Restricted Data
RIAGENDR	Gender
RIDRETH1	Race/Ethnicity
DMDEDUC2	Education Level – Adults aged 20 and older
INDFMPIR	Ratio of family income to poverty
INDHHIN2	Annual Household Income
RIDEXPREG	Pregnancy at the time of the examination
WTINT2YR	Full Year Sample 2 Year Interview Weight
WTMEC2YR	Full Year Sample 2 Year MEC Exam Weight
Vitamin D Supplement Use	
Variable Name	***Variable Name***
DSQDOC_E.xpt	30 – Day Dietary Supplement Use
Body Measurements	
Variable Name	***Variable Name***
BMXWT	Weight (kg)
BMXHT	Standing Height (cm)
BMXBMI	Body Mass Index (kg/m^2)

Table 2. NHANES Research Variables from Public Domain (cont.)

Laboratory Measurements	
Variable Name	***Variable Name***
URXPREG	Urine Pregnancy Test Result
LBXGH	Glycohemoglobin (%)
LBDVID	25 OH Vitamin D (ng/ml)

Analysis

Statistical Analysis Software (SAS) was used to analyze the data files. NHANES provides sampling weights than are used to produce unbiased national estimates. These weights reflect the unequal probabilities of selection, non-response adjustments, as well as adjustments to independent population controls (NHANES, 2005). Because the primary goals of this analysis were to examine relationships among likely predictors of vitamin D levels, verses produce estimates of prevalence within this extremely specific subset of NHANES respondents, the individual (raw) data were used without weighting. Moreover, the inclusion criteria limited sample characteristics by age, gender, race, and pregnancy status. Thus, the methodological basis for use of participant weights in this highly specific subset is not apparent.

Analytical Statistics for Research Aims

Means, medians, and standard deviations were used to describe sample attributes of continuous variables. Categorical variables were described using frequencies. Parallel analyses were carried out for the full sample, and then separately among respondents residing above the 35° latitude line, as well as in respondents residing at or below this line. The latter represented areas receiving abundant sunshine year round.

For specific aim #1, Pearson product-moment correlation coefficients were calculated to examine the relationship between each measure of SES and vitamin D level. As noted previously, SES was represented by PIR, where 1.0 is the poverty threshold, 1.1 is 10% above the poverty threshold, and so on; education level and annual household income as determinates of SES were also regarded (Duncan, 2003). These tests were followed by analysis of variance (ANOVA) to compare mean levels of vitamin D by PIR, education level, and annual household income, which were categorized into groups of five, five, and four levels, respectively. These analyses were repeated for exploration (ANCOVA) to compare mean levels of vitamin D, by the categorical measures of SES adjusted for age, BMI, and use of vitamin D supplementation.

For specific aim #2, Pearson and Spearman correlation coefficients were calculated between BMI and vitamin D levels. Body mass index was collapsed into 5 categories. Means and adjusted means of vitamin D levels by BMI status were then compared using ANOVA and ANCOVA procedures respectively. Finally, for aim #3, the correlation, ANOVA, and ANCOVA methods described for aims 1 and 2 were implored, and the data were next stratified by presence versus absence of diabetes. The ANCOVA models containing main effect terms for SES and diabetes, products of their interaction, and relevant covariates, were formally tested for interaction between diabetes and each measure of SES. As a follow up, the methods described above were again utilized substituting BMI in place of SES, and examined for associations with the vitamin D level. Statistical significance was set at $\alpha < .05$ in each analysis.

Human Protection

This research required no human contact and participant consent was obtained prior to survey participation by the NHANES data collection personnel. For this reason, the University of South Florida Institutional Review Board (IRB) granted permission to proceed with this research with the status 'Certified Exempt' (see Appendix B). Data from persons participating in NHANES are de-identified before they are made accessible in the public domain. The NCHS takes added steps to protect participant identity by restricting access to variables with any potential to be linked to survey respondents, and merging restricted access variables with the public files internally before permitting their use for specialized analysis. Variables that involve geographical location, time of data collection, detailed ethnicity information, unique genetic information, and connections with Medicare/mortality/social security/air-quality information, are classified as restricted.

Summary

This chapter discussed the research design and method used to examine the relationships between SES and vitamin D, and BMI and vitamin D in African American women in areas with abundant sunshine; as well as methods to explore if these relationship are different among those women with and without diabetes. Sample characteristics and steps taken for human rights protection were also discussed. Data analysis procedures to answer the research questions for this study were also described.

CHAPTER 4

Introduction

This chapter summarizes the data and the statistical analysis performed to address the aims of this research. The sections that follow describe the sample demographics and outcomes specific to each aim. Tables are included to illustrate the most salient findings from this research.

Results of Demographics

The age distribution for the sample was essentially normal with the oldest and youngest reporting ages 59 and 20 respectively (M = 39, SD = 11). The mean PIR was 2.4 (n = 586, SD = 1.6). Of the total sample, 20% (n = 120) had not completed high school, 22% (n = 138) reported a high school or high school equivalent education, 40% (n = 244) reported some college or having an AA degree, and 18% (n = 109) were college graduates or had post graduate education. Nearly 50% of the sample reported an annual household income of less than $35,000 ($n$ = 286), 20% reported income between $35,000 and $55,000 ($n$ = 123), 11% between $55,000 and $75,000 thousand ($n$ = 62), and 19% reported household income over $75,000 annually ($n$ = 109). Obesity was pervasive in the sample as mean BMI was 31 (n = 606, SD = 8). The majority of the sample did not report having diabetes or use insulin. Low representation of persons with diabetes in this research sample was reinforced by mean glycohemoglobin levels at 5.6% (n = 609, SD = 0.9%), which falls short of nationally recognized thresholds that identify pre – diabetes (American Diabetes Association, 2013). Respondents actually reporting

pre - diabetes (measured as borderline diabetes) were few (n = 5), hence they were categorized as not having diabetes. The aforementioned frequencies are represented in the next table (see Table 3).

Table 3. Characteristics of the Full Study Sample

	Frequency	**Percent**	**Frequency (∑)**	**Percent (∑)**
PIR				
0 to 1	143	24.40	143	24.40
>1 to 2	157	26.79	300	51.19
>2 to 3	90	15.36	390	66.55
>3 to 4	174	12.63	464	79.18
>4 to 5	122	20.82	586	100.00
Missing	25			
Education				
> High School	120	19.96	120	19.64
High School/GED	138	22.59	258	42.23
Some College/AA	244	39.93	502	82.16
College Graduate	109	17.84	611	100.00
< $20,000	154	26.55	154	26.55
$20,000 to < $35,000	132	22.76	286	49.31
$35,000 to < $55,000	123	21.21	409	70.52
$55,000 to < $75,000	62	10.69	471	81.21
$75,000 or more	109	18.79	580	100.00
Missing	31			

Table 3. Characteristics of the Study Sample (cont.)

BMI				
Less than 25	120	19.96	120	19.64
30 to < 35	142	23.43	435	71.78
35 to <40	90	14.85	525	86.63
40 or more	81	13.37	606	100.00
Missing	5			
Ever told to have diabetes or taking insulin				
'No diabetes'/insulin	557	91.16	557	91.16
Borderline	5	0.82	562	91.98
'Yes diabetes'/insulin	49	8.02	611	100.00

Consistent with the literature, hypovitaminosis D was ubiquitous in the sample, as mean vitamin D was 14ng/ml (n = 611, SD = 7 ng/ml). The vitamin D levels of respondents in this sample ranged from 3 ng/ml to 43ng/ml. Twenty-six percent of the sample reported using vitamin D supplements in the 30 days preceding NHANES (n = 159). Throughout the sample analysis, univariate procedures indicated that the variables examined were normally distributed. Cases with missing values were excluded from the analysis because their frequencies were insufficient to positively, or adversely affect statistical power.

Results of Inferential Statistics

AIM 1: The relationship between SES and vitamin D levels in African American women

In the full sample, PIR data on 25 of the 611 survey respondents were missing from the data file. Among the remaining 586 cases analyzed, a small but significant relationship between PIR and vitamin D level was found ($r = .09$, $p = 0.03$). Similar findings were noted in the respondents living above the 35° latitude line ($n = 415$, $r = .11$, $p = 0.03$). Significance was not observed in this relationship among the respondents living at or below the 35° latitude line ($n = 171$, $r = .04$, $p = 0.57$). The significant positive relationships noted between PIR and the vitamin D level suggests that low SES is associated with lower vitamin D levels in African American women. Though significance did not emerge in the respondents living at or below the 35° latitude line, similar correlation coefficients in all three groups suggests a possibility for such in a larger sample, despite nominal magnitude. Neither education, nor annual household income was statistically associated with vitamin D level. (See Table 4).

Table 4. Pearson Analysis of the Full Study Sample

	Pearson r with vitamin D level	***p***	**N**	**N with missing data**
Full Sample				
SES as PIR	.09	.03*	586	25
SES as Education	.05	.23	611	
SES as Annual Household Income	.03	.50	580	31

*** $p < .05$**

Table 4. Pearson Analysis of the Full Study Sample (cont.)

Above 35° Latitude				
SES as PIR	.11	.03*	415	16
SES as Education	.04	.46	431	
SES as Annual Household Income	.05	.29	412	19
At or Below 35° Latitude				
SES as PIR	.04	.57	171	9
SES as Education	.07	.34	180	
SES as Annual Household	- .03	.68	168	12

*** $p < .05$**

In the ANOVA, PIR as a measure of SES did not significantly explain variation in the vitamin D level despite the significant Pearson correlation coefficient in the full sample [$F(4, 581) = 1.89$, $p = .11$], nor was significant variation explained in vitamin D by respondents residing above the 35° latitude line [$F(4, 410) = 1.77$, $p = .13$]. This discrepancy may be the result of collapsing PIR, a continuous variable, into 5 categories for the ANOVA (see Table 5). Because remote access to NHANES data do not permit the SAS syntax statement "contrast" if merged with variables designated as restricted, the more precise single degree of freedom test for linear trend was not possible. The relationship between PIR and vitamin D level was thus examined via ANCOVA, adjusting for age, BMI, and use of vitamin D supplements. In the full sample, the combined set of PIR and covariates explained 16% of the variation in the vitamin D level [$R^2 = .16$, $F(7, 573) = 16.12$, $p < .0001$]. This more specific examination of variance disclosed that the model's significance in aggregate, was principally attributed to BMI [$F(1, 573) = 26.73$, $p < .0001$)] and vitamin D supplement use [$F(1, 573) = 69.07$, $p < .0001$)]. The variance in vitamin D explained by PIR was not statistically significant (F=

0.30, p = .88) when BMI and vitamin D supplement use were included in the analysis. Table 6 denotes the alternate sources of explained variation in vitamin D in an adjusted model.

Table 5. General Linear Model Categories for PIR, Full Sample

	N	Vitamin D Levels ng/ml	
		Mean	Std. Dev.
Full Sample			
PIR			
0 to 1	143	13.65	6.04
>1 to 2	157	13.68	6.52
>2 to 3	90	14.97	6.25
>3 to 4	174	14.07	6.57
>4 to 5	122	15.46	7.69

Table 6. ANCOVA: PIR as SES and Vitamin D, Adjusted Model for Full Sample

	Df	**Type III SS**	**Mean Square**	**F**	***p***
Full Sample					
Source					
PIR	4	45.17	11.29	0.30	0.88
Age	1	0.14	0.14	0.00	0.95
BMI	1	995.36	995.36	26.73	<.0001*
Vit D Supplement Use	1	2572.19	2572.19	69.07	<.0001*

**** p < .05***

The variation in vitamin D level explained by PIR was not significant in persons living above the 35° latitude line (p = .13). The adjusted model however, demonstrated that the combined influence of PIR, and covariates age, BMI, and use of vitamin D supplements improved the total variation explained in levels of vitamin D [R^2 = .18, F(7,

403) = 12.32, $p < .0001$]. As in the full sample, the strongest predictors of vitamin D level were BMI [$F(1, 403) = 26.20$, $p < .0001$)], and vitamin D supplement use [$F(1, 403) = 44.28$, $p < .0001$)]. Closer scrutiny of PIR with ANCOVA disclosed that none of the measures of SES in survey respondents living in areas with abundant sunshine accounted for significant variation in the vitamin D level. The sum of these findings are that SES was not a reliable predictor of vitamin D levels in the African American women in this sample. These results were consistent without regard for geographical residence. Body mass index and vitamin D supplement use consistently accounted for most of variation in the vitamin D level when the models were adjusted for.

Table 7. Adjusted Main Effect of PIR (as SES) on Vitamin D Level by Group

Group	*Df*	Type III SS	Mean Square	F	*p*
Full Sample	4	45.17	11.29	0.30	0.88
Above 35° Latitude	4	108.21	27.05	0.71	0.58
At or Below 35° Latitude	4	99.00	24.75	0.72	0.58

p < .05

AIM 2. The relationship between BMI and vitamin D levels in African American women

Significant negative correlations were observed between BMI and vitamin D in the full sample (n = 606, $r = -.23$, $p < .0001$), among those residing above the 35° latitude line ($n = 427$, $r = -.27$, $p < .0001$), as well as in those living in areas with abundant sunshine year round ($n = 179$, $r = -.15$, $p = .04$). These findings indicate that high BMI in African American women is associated with low vitamin D levels without regard for resident locale.

A significant main effect of BMI explained 6% of the variation in the vitamin D level in the full sample [R^2 = .06, F(4, 601) = 9.48, p < .0001]. Adjustment for age and vitamin D supplement use as covariates resulted in 16% of the variation in vitamin D level explained [R^2 = .16, F(6, 599) = 19.28, p < .0001]. Similar outcomes were observed among respondents living above the 35° latitude line. In this group, the main effect of BMI predicted 7% of the variation in the vitamin D level [R^2 = .07, F(4, 422) = 8.46, p < .0001], and this effect also increased after adjustment for age, and vitamin D supplement use [R^2 = .16, F(6, 420) = 13.34, p < .0001]. The ANCOVA indicated that the model's significance in aggregate, was most attributed to BMI [F(1, 5) = 7.11, p < .0001)], and vitamin D supplement use [F(1, 5) = 42.92, p < .0001)].

This predictive effect of BMI was less apparent in the respondents living in areas with abundant sunshine [R^2 = .05, F(4, 174) = 2.10, p = .08]. The number of respondents in this group (n = 180) was much smaller than in the group of respondents living above the 35° latitude line (n = 431) and though adequately powered, the reduced significance in variance explained appeared to be a consequence of low sample size. Vitamin D supplement use was a strong predictor of vitamin D level in this group also.

Interaction of SES and BMI. The product of the respective measures of SES (PIR, education level, and annual household income) and BMI were tested for an effect on the vitamin D level. In each case, there was a significant main effect of SES by BMI on vitamin D level in the full sample, and in the group of respondents residing above the 35° latitude line. This was not the case however, in the group living at or below the 35° latitude line (see Table 8). Covariate analysis revealed that the variation in vitamin D was due to BMI; and such was the case in the full sample (PIR [F(9,571) = 4.84, p <

.0001], education [$F(1, 598) = 29.70$, $p < .0001$], income [$F(1, 565) = 19.64$, $p < .0001$]); and in respondents above the 35° latitude line (PIR [$F(9, 401) = 4.88$, $p < .0001$], education [$F(1, 419) = 31.46$, $p < .0001$], income [$F(1, 398) = 20.35$, $p < .0001$]). The product of SES and BMI did not explain variation in the vitamin D level. These outcomes further support BMI as an independent predictor of vitamin D level.

Table 8. Main Effect of SES x BMI Interaction on Vitamin D Level

SES x BMI	**N**	***df***	**Std. Error**	**SS**	**F**	***p***
Full Sample						
PIR x BMI	581	9	571	1809.34	4.84	<.0001*
Education x BMI	606	7	598	1520.91	5.13	<.0001*
Income x BMI	575	9	565	1473.92	4.05	<.0001*
Above 35° Latitude						
PIR x BMI	411	9	401	1834.10	4.88	<.0001*
Education x BMI	427	7	419	1484.25	5.01	<.0001*
Income x BMI	408	9	398	1520.53	4.19	<.0001*
At or Below 35° Latitude						
PIR x BMI	170	9	160	432.26	1.20	0.30
Education x BMI	179	7	171	295.79	1.00	0.43
Income x BMI	167	9	157	371.75	1.02	0.42

**** p < .05***

AIM 3. To explore the moderating effect of diabetes mellitus on the relationships between SES, BMI, and vitamin D in African American women

Of the total sample for this research, only 8% ($n = 49$) met criteria for having diabetes and assigned to the 'yes diabetes' group. As a result, correlation coefficients

among the remaining respondents in the 'no diabetes' (n = 562) groups, were very similar to the correlation coefficients in the respective non stratified groups.

Among respondents with diabetes, the sample size restricted test power and application of findings to this group only. Of the 180 respondents residing in the sunniest areas in the United States, there were only twelve respondents that met criteria for diabetes. Despite such, interesting trends emerged in the analysis. Among the 49 respondents with diabetes (full sample), a significant negative correlation was present between BMI and the vitamin D level, when using Pearson's correlation methods. Spearman's correlation methods were also implored to examine the correlation between BMI and the vitamin D level. Both tests demonstrated significant inverse relationships, and are depicted in Table 9.

Table 9. Correlation Models: BMI and Vitamin D Levels, Full Sample

Model	*r*	*p*	N	N with Missing Data
Pearson's Model	-.50	.0003*	48	1
Spearman's Model	-.52	.0001*	48	1

*** $p < .05$**

Body mass index explained 34% of the variation in the vitamin D level in respondents with diabetes [$R^2 = .34$, $F(4, 43) = 5.62$, $p = .001$]. The testing limits of the remote access protocol prohibited more precise within group testing, and tests for liner trend. Table 10 conveys the model categories for the aforementioned ANOVA. Here, the inverse correlation between BMI and vitamin D seems apparent.

Table 10. General Linear Model Categories for BMI in 'Yes Diabetes' Group

BMI	N	Vitamin D Levels ng/ml Mean	Std. Dev.
Less than 25	5	19.60	6.88
25 to < 30	9	17.11	4.83
30 to < 35	9	11.78	3.31
35 to < 40	10	13.70	3.37
40 or more	15	10.27	5.12

Other Testing

T- tests were performed to explore if the SES, BMI, and vitamin D levels were different among NHANES respondents with diabetes, and without diabetes. Statistically, these measures were homogenously present in all respondents. In addition, BMI was regressed onto each measure of SES for further insight into the relationships suggested in the current literature. Among these respondents, a small but significant amount of variation in BMI was explained by PIR [$R^2 = .02$, $F(4, 576) = 2.49$, $p = .04$], and income [$R^2 = .01$, $F(4, 570) = 2.99$, $p = .02$]. The significance of these relationships was not made apparent in this analysis; however these outcomes are consistent with research observations linking SES and BMI.

Summary

These data were analyzed to examine the relationship between SES and BMI on vitamin D levels in African American women, living in areas with abundant sunshine. Despite small correlations, neither PIR, education, nor annual household income explained significant variation in the vitamin D level. BMI independently predicted the

vitamin D level without regard for SES, or geographical locale; but possibly more predictive in the presence of diabetes. Vitamin D level was also significantly associated with vitamin D supplement use. A small amount of the variance in BMI was explained by PIR and household income. Finally, the sample of respondents living in areas with abundant sunshine that have diabetes was insufficient to reliably assess for moderation by diabetes.

Chapter five discusses the research outcomes delineated in this chapter. It will also talk about research limitations, delimitations, nursing and public health implications, and considerations for future research.

CHAPTER 5

Introduction

This final chapter summarizes the purpose, and aims for this research. The analytical findings, are interpreted and compared/contrasted with the existing evidence. Limitations, implications for nursing practice, and direction for future research is also discussed.

Review of Purpose and Aims

This study was undertaken to examine the relationship between SES, BMI, and vitamin D levels in African American women living in areas with abundant sunshine; and to explore if these relationships were different in the presence of diabetes. Over the past ten to fifteen years, countless associations have been observed linking vitamin D deficiency with obesity, cardiovascular disease, diabetes and other chronic conditions. Costs associated with managing these conditions threaten the vitality of America's healthcare system as their rate of incidence increases. The greatest number of new diabetes cases diagnosed continues to be among African American women, and more than 90% to 95% of those affected incur type 2 diabetes, the type where risks factors are most influenced by lifestyle.

Poverty and unemployment in African American communities affects prevalence rates of obesity and diabetes. Throughout the United States, nutritious and affordable food options are limited in low income residential areas, and the most comprehensive health coverage plans are employment based. Consequently, low SES families must

leverage meal decisions and motivation to participate in health promoting activities (ie: exercise, outside recreation, home meal preparation, preventive health screening) against their ability to meet basic needs for safety and nourishment. Socioeconomic status is a known indicator of health, where the factors move in tandem on their respective continuums. These conditions perpetuate indoor dwelling, sedentary lifestyles, and obesity that in turn reduce opportunities for vitamin D intake and production. Unfortunately, these are not uncommon experiences among African Americans.

This research was the first to directly examine the relationship between SES and vitamin D levels in a manner unrelated to cancer risk or bone health, and the first to examine the relationships of BMI and vitamin D in only African American women. Among African Americans, poverty rates are the highest; and nationwide, African American women are the most overweight/obese, have the most incidence of diabetes, and are the most vitamin D deficient. Six hundred and eleven NHANES participants from survey cycles 2003 – 2006 met inclusion criteria and were studied in this research. Using a combination of statistical methods, the survey responses were analyzed to address study aims and to examine if the relationships expressed in the literature between SES, BMI, and vitamin D level are present in a nationally representative sample of African American women with and without diabetes, living in areas with abundant sunshine year round.

Major Findings

Research Question #1

What is the influence of SES and BMI on vitamin D levels among African American women living in areas with abundant sunshine?

AIM 1. The relationship between SES and vitamin D levels in African American women. Poverty to income ratio was the only measure of SES to correlate with the vitamin D level. The relationship was weak, but consistent. No other measure of SES was related to vitamin D level. The lack of strength in the PIR/vitamin D relationship was not completely explained by this research. In the adjusted analysis, the covariates, save age, accounted for most all of the variance attributed to PIR (as SES). The review of literature discussed many conditions associated with low SES, capable of limiting vitamin D intake and production, and not all of these elements were included in the covariate analysis. Body mass index and vitamin D supplement use were better indicators of vitamin D level in the lot of responses analyzed. Vitamin D levels ultimately were not well explained by any measure of SES. Socioeconomic status though related, did not predict vitamin D levels in a nationally representative sample of African American women. Geographical residence had no bearing on these outcomes.

AIM 2. The relationship between BMI and vitamin D levels in African American women. This research confirmed that high BMI in African American women is associated with low vitamin D levels, without regard for resident locale. These outcomes are important because they uphold BMI as an independent predictor of the vitamin D level. Also, collectively, and in the respective groups above the 35° latitude line and areas with abundant sunshine, vitamin D supplement use was a strong predictor of vitamin D level. This effect was independent of BMI. These outcomes are consistent with observations and findings from current literature.

Interaction. The conditions of low SES encourage obesity development undoubtedly, as these relationships have been reviewed extensively. Thus, the significant variance explained in vitamin D by the interaction term, SES and BMI, was expected. The complete absence of variance explained by SES in the vitamin D level however, was not expected. Covariate analysis revealed that the variance in vitamin D was due to BMI, and again affirmed its strength as a predictor of vitamin D level.

Research Question #2

What is the effect of diabetes mellitus on the relationships between BMI, SES, and vitamin D in African American women living in areas with abundant sunshine?

AIM 3. The moderating effect of diabetes mellitus on the relationships between SES, BMI, and vitamin D in African American women. A very small number of respondents were identified with diabetes in light of the highly specific criteria for sample inclusion. Moreover, estimation of power was affected by the criteria governing sample access by latitude. In the participants with diabetes, the coefficient of determination was such (R^2 = .32) that it is plausible that BMI may be an even stronger predictor in this group. With insufficient power to address this aim, these outcomes cannot be generalized.

Discussion

The most salient outcome of this research analysis was the strength of BMI as a predictor of the vitamin D level. Its highly significant influence on the vitamin D level consistently emerged on various ANOVA tests, independently and when adjusted for. So, what is the consequence of vitamin D deficiency on health? The core of the debate

on what levels define vitamin D adequacy rests on the answer to this question. The effects of vitamin D on the incidence and/or prevalence of obesity, diabetes, and related chronic disease, have yet to be fully elucidated. To date, no firm answers have emerged from the RCT's that have been completed in an effort to determine the direct effect of vitamin D on health.

It is known however, that vitamin D functions as a pro-hormone, and is significant to normal glucose metabolism. It has inspired hypothesis testing of its clinical utility beyond its known benefits to bone health. Since the IOM (2010) reported that most people in North America can sustain health with 600 IU of vitamin D daily, the number of studies examining the effect of vitamin D on chronic disease has increased multifold. Despite the observational findings made central in the grievances of those opposing the IOM position, the research meeting standards to base recommendations for more vitamin D intake remains insufficient. Several interventional trials with vitamin D have since been initiated to address this gap in existing evidence, and examine its potential role in chronic disease prevention and management directly.

A 16 week double-blinded, placebo controlled trial conducted by (Mitri et al., 2011), assessed the influence of 2000 IU vitamin D_3 daily, and calcium (400mg b.i.d.) on risk factors for type 2 diabetes, in 92 adults with pre/ new onset diabetes not treated with medication. Participants were randomized in a 2 x 2 factorial research design. Twenty-five (OH) vitamin D levels, calcium, and measures assessing insulin secretion, insulin sensitivity, and β-cell function, were collected at baseline and at the end of the study. The group treated with vitamin D (62ng/ml ± 39ng/ml) had significant improvements in the measurements for insulin secretion when compared with its

placebo control (36ng/ml ± 37ng/ml; $p = 0.05$). Insulin sensitivity and glycemic control (A1c) were not significantly affected by vitamin D_3, calcium, or their interaction (2011). In contrast, von Hurst, Stonehouse, and Coad (2010), studied daily vitamin D_3 supplement use (4000IU) on insulin resistance for a six month period. Eighty-one women (mostly Asian Indian ethnicity) aged 23 to 68 with established insulin resistance (but not diabetes), and hypovitaminosis D (below 20ng/ml) were randomized to either the intervention, or control group. Outcomes, reported in quartiles, were significant for higher vitamin D levels at intervals 25% and 75% from baseline (Δ8.4ng/ml, Δ26.4ng/ml, $p < .001$) in the group supplemented with vitamin D_3. These changes were likewise significant compared to the control group ($R^2 = .12$, $p = .02$). More importantly, this development seemed to induce improvements in insulin sensitivity, evidenced by the difference in the HOMA1 –IR measurement from baseline to 6 months, between treatment and placebo groups (respective Δ-.25, 0.36, $p = 0.03$). The between group differences in change in fasting insulin levels (treatment verses placebo) were also significant and further substantiated improvements in insulin sensitivity (respective Δ-1.3mU/l, 1.1mU/l, $p = 0.02$) (2010). Improved insulin sensitivity was the primary endpoint in this research.

Though the studies were similar in size, scope, power, and somewhat by design, the conclusions drawn were very different. The stark differences in outcomes may have resulted from discrepancies in treatment dose, study duration, and possibly ethnicity, as the sample participating in the research by Mitri et al. (2011), was 72% white, and participants in the research by von Hurst et al. (2010), were 92% Asian Indian, and 9% were from Sri Lanka or Pakistan. With regards to testing for their respective endpoints,

the study designs were strong; but the homogeneity in the sample, short duration, and small sample size for each study, limited their capacities to build merit in arguments supporting higher vitamin D intake.

Experts in cardiology likewise designed RCT's using vitamin D supplements as treatment, in order to determine if the consistent inverse relationships between vitamin D deficiency and cardiovascular disease, would afford new insight toward its management and control. Gepner et al. (2012), randomized 114 post-menopausal women to a treatment group receiving 2500 IU vitamin D_3 daily, or a placebo over a four month period. The study assessed differences in measures of CVD, and the predictive strength of vitamin D between these groups. The study concluded without identifying significant variance in CVD explained by vitamin D. Likewise, significance in the relationship between vitamin D and CVD beyond association, was not found when Wood et al. (2012) assessed their connection in a more complex research design with greater controls, over a one year period. This between group, double-blinded, placebo-controlled RCT evaluated 305 healthy women aged 60 to 70 for the effect of vitamin D supplements on cholesterol, insulin resistance, inflammation, and blood pressure as markers of CVD status. Every two months for the 1 year research period, participants were reassessed, and the data were analyzed via repeated measures ANOVA. Despite the care taken in the research design, none of the primary research endpoints were met.

Although current research on the 'role of vitamin D' has addressed the need for more rigorous research designs to find causal outcomes from hypovitaminosis D, research outcomes have not been consistent. Figure 2 depicts the theoretical model that guided this analysis. As noted, BMI emerged as the most significant predictor of

variance in the vitamin D level. This was not the case with any of the measures of SES. The number of participants with diabetes were not sufficient to assess for a moderating effect on significant relationships in the model.

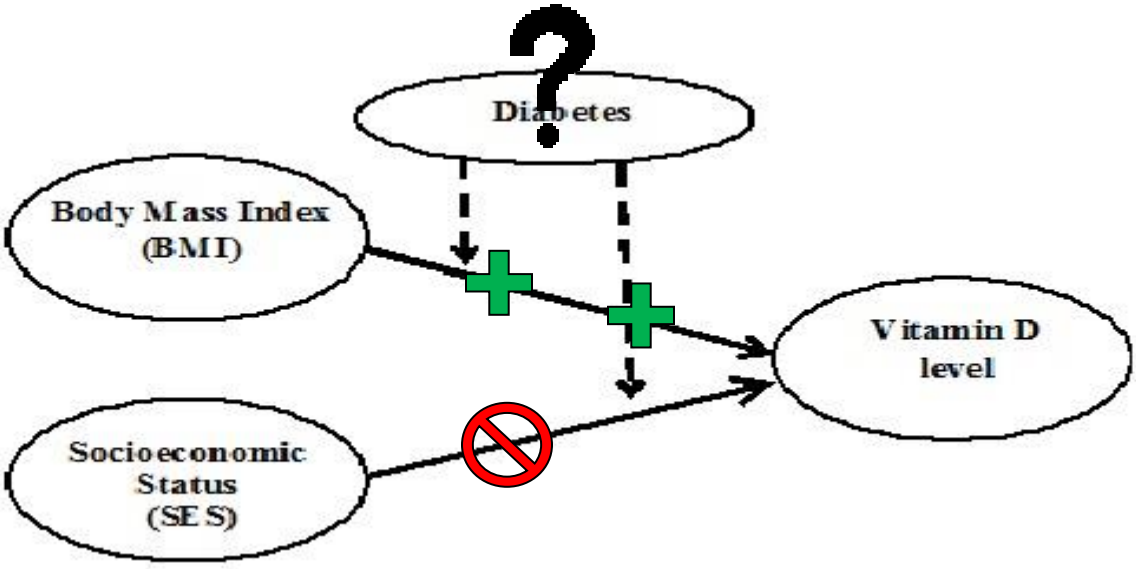

Figure 2. Illustrates the relationships between SES and BMI on vitamin D levels in accord with outcomes from this research. SES does not predict vitamin D level. BMI is a strong predictor of vitamin D level, and the moderating influence of diabetes on these relationships is unknown.

Conclusions

The outcome of this dissertation research has added perspective to the observed relationships amongst the variables for this research. The conditions of low SES can increase the risk for poor health. Though rates of obesity, diabetes, vitamin D deficiency and poverty are present in high rates in African American women, this research did not show that these relationships are linked by SES, or its related covariates.

Body mass index, on the other hand, was shown to explain significant variance in the vitamin D level independently, even when adjusted for in tandem with vitamin D supplement use. The magnitude of the influence from this regression analysis means that

an intervention capable to producing change in BMI will affect vitamin D in a predictable and proportional fashion. Because obesity precipitates a host of undesirable health outcomes, this is an area with important significance to nursing and others vested in primary care, community health care, and health promotion in general. Moreover, obesity related healthcare costs are estimated at $147 billion dollars each year and it is likely that reducing the BMI would result of improvements in health related cost savings.

This research attempted to explore if significant relationships between vitamin D and its predictors were different in African American women with and without diabetes, and the effect of geography on the findings. The sample of respondents living ≤ 35°line with diabetes, in the areas with abundant sunshine year round, was insufficient to reliably assess for moderation by diabetes. However, in this small sample of person with diabetes, BMI accounted for greater variance in the vitamin D level when compared to the remainder of the sample; and though underpowered, these findings amongst the respondents with diabetes are consistent current observational research findings. To date, there is not sufficient evidence from RCT's suggesting that vitamin D supplementation can reverse these trends, but interventional studies investigating its potential as a cost effective approach to mitigate chronic disease risks are ongoing. Twenty-six percent of the research sample used vitamin D supplements within the 30 days preceding the NHANES data collection period; and their use emerged and an independent predictor of vitamin D level. The purpose and influence of vitamin D supplementation should be investigated further in this population.

Reducing the BMI is a health promotional standard of care that can, in theory, result in improved serum 25 (OH) vitamin D_3 levels since excess adipose sequesters

vitamin D. Reduction in BMI also affords known benefits to psychosocial and metabolic health. If higher vitamin D levels in persons with high BMI enhances weight loss efforts or influences diabetes and chronic disease incidence and prevalence remains to be determined.

An Interesting Perspective for Future Research

The main objective of the various clinical trials in development, and those ongoing, is to answer the broader question, 'What is the consequence of vitamin D deficiency on health?' Observational research has consistently linked the traits of overweight/obesity, chronic disease, African American race, and (in some cases) female gender to vitamin D deficiency. The meaning of these connections however, remains unknown and brings rise to a new question: *Could vitamin D level be a <u>catalyst</u> that accelerates potential for morbidity, or risk for mortality* risks *where BMI is high?*

It is possible that vitamin D potentiates the occurrence of morbidity and mortality. Therefore, its *function* as a moderating influence on the state of health is reasonable to investigate. Dobnig H (2008) examined the relationship between 25 (OH) vitamin D, all-cause mortality, and cardiovascular mortality in a prospective cohort study of 3258 patients undergoing coronary angiography. The group was separated into quartiles by 25 (OH) vitamin D levels and 1-25 $(OH)_2$ vitamin D levels, and measured at approximately 7.5 years after the cardiac percutaneous intervention. Of more than 3000 persons evaluated, 737 of them died, and 463 of these deaths were cardiovascular related. Adjusted hazard ratios for the lowest quartiles of the 25 (OH) vitamin D and 1-25 $(OH)_2$ vitamin D_3 levels, were compared to in the higher quartiles respectively for all cause mortality (HR 2.08; 95% CI, [1.60-2.70]; HR 1.53, 95% CI, [1.17-2.01]), and also

respectively for cardiovascular related mortality (HR 2.22; 95% CI, [1.57-3.13]; HR, 1.82; 95% CI, [1.29-2.58]). These data demonstrated an inverse relationship between the 25 (OH) vitamin D level, and mortality, and similar results were noted in the quartiles representing the 1-25 $(OH)_2$ vitamin D. These results were independent of coexisting disease. As several interventional trials have now been done and failed to show improvements in metabolic health from vitamin D supplementation, questions regarding the role of vitamin D in maintaing health, as well as the cosequences of its deficiency resurface. A subset of the above sample (n = 1891) were examined again by Thomas et al. (2012) to determine if the outcomes were different among participants with metabolic syndrome. Among this group, deaths from all causes, and CVD were 462, and 267 persons respectively. This analysis adjusted for metabolic syndrome and found that vitamin D levels ≥30ng/ml were significantly less associated with all causes of death (HR 0.25; 95% CI [0.13-0.46]), and less associated with cardiovascular related mortality (HR 0.33; 95% CI [0.16–0.66]), (2012). In a longitudinal review also examining all cause, and cardiovascular related mortality, Joergensen et al. (2010), studied 289 patients with type 2 diabetes, a for a median of 15 years (range = 0.2 – 23 years). In these data, the hazard ratio for subjects with severe vitamin D deficiency (< 6ng/ml) was 1.96 (95% CI [1.29-2.98]), which were similar to the hazard risks in the research noted earlier (Dobnig H, 2008; Thomas et al., 2012). In light of the observational nature of these studies, future research should focus on the pleiotropic influences, as well as the specific function of vitamin D to best address the core question driving the research interest in vitamin D worldwide; what is the consequence of vitamin D deficiency on health?

Implications for Nursing

Nursing must incorporate core pillars of healthy living into every aspect of care where it is appropriate; especially among groups disproportionately affected by the most costly conditions impacting national health resources. The obesity epidemic and related consequences justify, and warrant health care advocates in every discipline to take these steps. Even in small amounts, weight loss improves health outcomes where chronic diseases like diabetes, hypertension, and cardiovascular disease exists; and slows or arrests the onset of these conditions where there are risks for their development (Hamman, 2006). Nurses operating in the capacity of community health advocates, disease state educators, resource coordinators, and patient care provider, among other roles, have broad potential to reduce obesity prevalence rates. Encouraging lifestyle change using ethno-culturally appropriate methods that reduce opportunities for obesity development is a cost effective alternative to managing its consequences retroactively. The interventions with the greatest potential for success in any group begins with understanding the epistemology of the audience targeted.

Though the significance of vitamin D deficiency continues to be evaluated, this research found a strong inverse relationship between BMI and vitamin D level, where BMI consistently explained significant variance in vitamin D. The findings are consistent with findings observed in current literature, but this was the first known study to examine these relationships in a sample of only (self-identified) African American women from across the nation. Vitamin D deficiency has been linked extensively to adverse health outcomes, including higher mortality rates in those affected. African American women categorically, have the lowest vitamin D levels in the United States.

High BMI, low vitamin D levels, high chronic disease prevalence, and low access to health promoting resources are germane to the African American experience; and these things all advance development of obesity related health adversities, diabetes, chronic disease and other health disparities in these communities. The greatest cost burden to the health care economy nationally are the costs related to the treatment, management, and loss of productivity from diabetes and obesity related morbidity. The highest incidence and prevalence of both obesity and vitamin D deficiency are among African American women. The outcomes for this research add to the foundation of evidence that justify and highlight the unique position of nurses in devising new approaches to address the numerous health disparities in this community. Increasing awareness of the potential for low vitamin D to impact community health is important.

Limitations

Use of NHANES Database

As with any data set, NHANES data are subject to error of sampling, omission, and errors of measurement. The data collected from the questionnaires were self-reported and subject to errors such as impaired recall, and poor understanding of the research questions. In these methods as well, are possible examiner errors, training and trainer errors, problems with lab specimen collection and processing, and instrument control issues.

Study Design

The cross sectional nature of the research only affords a snap shot of the measures used to quantify the variables for this research. It was also an observational study and lacked the presence of a control, which affords insight on cause and effect relationships.

Period of Inquiry

Continuous NHANES cycles 2003 – 2006 were the most complete and comprehensive data sets available at the time of analysis. More is now known by the public about vitamin D than was the case during the time data for these survey cycles was collected. Therefore, it is possible that the behavior of Americans in general has changed, and that the vitamin D ranges and means in the cycles studied, no longer reflect public standards. Cycles 2007 to present had incomplete analysis and was unready for use at the time this research analysis began.

Limits in Analysis

Use of the restricted variable 'LAT' identifying survey respondents by latitude delimited the process of analysis to the RDC standards. More specifically, the use of some SAS commands were prohibited. As a result, covariate analysis of continuous variables lacked the finite precision of single degree of freedom testing. Also use of restricted variables prohibited tests for linear trend.

Summary

In the United States, no demographic has demonstrated lower vitamin D levels than those found among African American women. Type 2 diabetes is most prevalent in African Americans, and its incidence has grown the fastest among African American women. Moreover, national poverty rates in this group are substantial, and the constraints of poverty limit access to healthy food, and safe recreation; and these things escalate opportunities for obesity to develop. The literature review discussed that excessive adipose functions as a storage depot for vitamin D. Obesity increases potential for vitamin D deficiency in persons with obesity. This research reinforced obesity as a

strong indicator of vitamin D status, and nurse led structured weight modification interventions can afford an economically savvy approach to health promotion and systemic cost savings. Effective measures to reduce occurrences of obesity and its consequences can be significant in reducing a number of health disparities, and yield economic benefits that reach beyond the African American community.

Regarding vitamin D deficiency, there are no firm answers on the benefits of supplementation to date, but the vitamin D status of persons that experience the highest rates of chronic disease, health related morbidity, and mortality, are consistently low. The findings from this research have translational merit, and nurses are optimally situated in communities, primary care clinics, patient living centers, schools, and otherwise, for practical use. The most excellent approach to patient intervention and education in any case is systematic, adaptable, evidenced based, and above all, patient centered. With this information, nurses can take the lead in proposing innovative, actionable, and effective strategies to impact our health economy and create a healthier future for patients.

RDC Disclaimer

The findings and conclusions in this paper are those of the author(s) and do not necessarily represent the views of the Research Data Center, the National Center for Health Statistics, or the Centers for Disease Control and Prevention.

REFERENCES

American Diabetes Association. (2011). Diagnosis and Classification of Diabetes Mellitus. *Diabetes Care, 34*(Supplement 1), S62-S69. doi: 10.2337/dc11-S062

American Diabetes Association. (2013). Standards of Medical Care in Diabetes—2013. *Diabetes Care, 36*(Supplement 1), S11-S66. doi: 10.2337/dc13-S011

Artaza, J. N., Contreras, S., Garcia, L. A., Mehrotra, R., Gibbons, G., Shohet, R., Norris, K. C. (2011). Vitamin D and cardiovascular disease: potential role in health disparities. *J Health Care Poor Underserved, 22*(4 Suppl), 23-38. doi: 10.1353/hpu.2011.0161

Arunabh, S., Pollack, S., Yeh, J., & Aloia, J. F. (2003). Body Fat Content and 25-Hydroxyvitamin D Levels in Healthy Women. *J Clin Endocrinol Metab, 88*(1), 157-161. doi: 10.1210/jc.2002-020978

Befort, C. A., Thomas, J. L., Daley, C. M., Rhode, P. C., & Ahluwalia, J. S. (2008). Perceptions and beliefs about body size, weight, and weight loss among obese African American women: a qualitative inquiry. *Health Educ Behav, 35*(3), 410-426. doi: 1090198106290398 [pii]10.1177/1090198106290398 [doi]

Bischoff-Ferrari, H., Willett W. (2011). Comment on the IOM Vitamin D and Calcium Recommendations. For Adult Bone Health, Too Low on Vitamin D—and Too Generous on Calcium [Press release]. Retrieved from http://www.hsph.harvard.edu/nutritionsource/what-should-you-eat/vitamin-d/#iom-vitamin-d

Bischoff-Ferrari, H. A., Kiel, D. P., Dawson-Hughes, B., Orav, J. E., Li, R., Spiegelman, D., . . . Willett, W. C. (2009). Dietary Calcium and Serum 25-Hydroxyvitamin D Status in Relation to BMD Among U.S. Adults. *Journal of Bone and Mineral Research, 24*(5), 935-942. doi: 10.1359/jbmr.081242

Blum, M., Dolnikowski, G., Seyoum, E., Harris, S., Booth, S., Peterson, J., . . . Dawson-Hughes, B. (2008). Vitamin D_3 in fat tissue. *Endocrine, 33*(1), 90-94.

Borges, M. C., Martini, L. A., & Rogero, M. M. (2011). Current perspectives on vitamin D, immune system, and chronic diseases. *Nutrition, 27*(4), 399-404. doi: 10.1016/j.nut.2010.07.022

Boyington, J. E., Carter-Edwards, L., Piehl, M., Hutson, J., Langdon, D., & McManus, S. (2008a). Cultural attitudes toward weight, diet, and physical activity among overweight African American girls. *Prev Chronic Dis, 5*(2), A36. doi: A36 [pii]

Boyle, J., Thompson, T., Gregg, E., Barker, L., & Williamson, D. (2010). Projection of the year 2050 burden of diabetes in the US adult population: dynamic modeling of incidence, mortality, and prediabetes prevalence. *Population Health Metrics, 8*(1), 29.

Burdette, H. L., & Whitaker, R. C. (2004). Neighborhood playgrounds, fast food restaurants, and crime: relationships to overweight in low-income preschool children. *Preventive Medicine, 38*(1), 57-63. doi: http://dx.doi.org/10.1016/j.ypmed.2003.09.029

Byers, K. G., & Savaiano, D. A. (2005). The Myth of Increased Lactose Intolerance in African-Americans. *Journal of the American College of Nutrition, 24*(suppl 6), 569S-573S.

Calvo, M. S., Whiting, S. J., & Barton, C. N. (2004). Vitamin D fortification in the United States and Canada: current status and data needs. *The American Journal of Clinical Nutrition, 80*(6), 1710S-1716S.

Centers for Disease Control. (2010). Revised Analytical Note for NHANES 2000-2006 and NHANES III (1988 - 1994) 25-OH Vitamin D Analysis, 1 - 5.

Centers for Disease Control. (2011a). History of NHANES. http://www.cdc.gov/nchs/nhanes/history.htm

Centers for Disease Control. (2011b). U.S. Obesity Trends: Trends State by State. http://www.cdc.gov/obesity/data/trends.html

Centers for Disease Control and Prevention. (2011). National diabetes fact sheet. http://www.cdc.gov/diabetes/pubs/pdf/ndfs

Centers for Disease Control and Prevention. (2009). Chronic diseases: the power to prevent, the call to control, at-a-glance. http://www.cdc.gov/chronicdisease/resources/publications/AAG/chronic.htm

Chagas, C. E. A., Borges, M. C., Martini, L. A., & Rogero, M. M. (2012). Focus on Vitamin D, Inflammation and Type 2 Diabetes. *Nutrients, 4*(1), 52-67.

Chang, E., Donkin, S. S., & Teegarden, D. (2009). Parathyroid hormone suppresses insulin signaling in adipocytes. *Molecular and Cellular Endocrinology, 307*(1–2), 77-82. doi: 10.1016/j.mce.2009.03.024

Chen, T. C., Chimeh, F., Lu, Z., Mathieu, J., Person, K. S., Zhang, A., . . . Highlight Issue: Vitamin, D. (2007). Factors that influence the cutaneous synthesis and dietary sources of vitamin D. *Archives of Biochemistry and Biophysics, 460*(2), 213-217.

Chiu, K., Chuang, L.-M., Lee, N., Ryu, J., McGullam, J., Tsai, G., & Saad, M. (2000). Insulin sensitivity is inversely correlated with plasma intact parathyroid hormone level. *Metabolism, 49*(11), 1501-1505.

Davies, S. L., Gibbons, C. E., Steward, M. C., & Ward, D. T. (2008). Extracellular calcium- and magnesium-mediated regulation of passive calcium transport across Caco-2 monolayers. *Biochimica et Biophysica Acta (BBA) - Biomembranes, 1778*(10), 2318-2324. doi: 10.1016/j.bbamem.2008.05.013

Davis, S. V. (2011). Vitamin D Deficiency and Type 2 Diabetes in African Americans: The Common Denominators. *Diabetes spectrum : a publication of the American Diabetes Association., 24*, 148-153.

Dawson-Hughes, B., Harris, S. S., & Dallal, G. E. (1997). Plasma calcidiol, season, and serum parathyroid hormone concentrations in healthy elderly men and women. *The American Journal of Clinical Nutrition, 65*(1), 67-71.

Dawson-Hughes, B., Mithal, A., Bonjour, J. P., Boonen, S., Burckhardt, P., Fuleihan, G. E., Josse, R. G., ... Yoshimura, N. (2010). IOF position statement: vitamin D recommendations for older adults. *Osteoporosis International : a Journal Established As Result of Cooperation between the European Foundation for Osteoporosis and the National Osteoporosis Foundation of the USA*, 21, 7, 1151-4.

Dawson-Hughes, B., Heaney, R. P., Holick, M. F., Lips, P., Meunier, P. J., & Vieth, R. (2005). Estimates of optimal vitamin D status. *Osteoporosis International : a Journal Established As Result of Cooperation between the European Foundation for Osteoporosis and the National Osteoporosis Foundation of the USA*, 16, 7, 713-6.

DeFronzo, R. A., & Tripathy, D. (2009). Skeletal muscle insulin resistance is the primary defect in type 2 diabetes. *Diabetes Care, 32*, 157-163.

Dobnig, H., Pilz, S., Scharnagl, H., Renner, W., Seelhorst, U., Wellnitz, B., Kinkeldei, J., ... Maerz, W. (2008). Independent association of low serum 25-hydroxyvitamin d and 1,25-dihydroxyvitamin d levels with all-cause and cardiovascular mortality.*Archives of Internal Medicine, 168,* 12, 1340-9.

Drewnowski, A., & Specter, S. E. (2004). Poverty and obesity: the role of energy density and energy costs. *The American Journal of Clinical Nutrition, 79*(1), 6-16.

Dubowitz, T., Heron, M., Bird, C. E., Lurie, N., Finch, B. K., Basurto-Dávila, R., . . . Escarce, J. J. (2008). Neighborhood socioeconomic status and fruit and vegetable intake among whites, blacks, and Mexican Americans in the United States. *The American Journal of Clinical Nutrition, 87*(6), 1883-1891.

Duncan, G. J., & Magnuson, K. A. (2003). Off with Hollingshead: Socioeconomic Resources, Parenting, and Child Development. In M. H. Bornstein & R. H. Bradley (Eds.), *Socioeconomic status, parenting, and child development* (pp. 83-106). Mahwah (N.J.): L. Erlbaum associates.

Earthman, C. P., Beckman, L. M., Masodkar, K., & Sibley, S. D. (2011). The link between obesity and low circulating 25-hydroxyvitamin D concentrations: considerations and implications. *International Journal of Obesity*.

Egan, K., Signorello, L., Munro, H., Hargreaves, M., Hollis, B., & Blot, W. (2008). Vitamin D insufficiency among African-Americans in the southeastern United States: implications for cancer disparities (United States). *Cancer Causes and Control, 19*(5), 527-535.

Feldman, D., Pike, J. W., & Glorieux, F. H. (2008). Vitamin D (2nd ed., pp. 537-550). London [etc.]: Elsevier Academic.

Fiscella, K., & Franks, P. (2010). Vitamin D, race, and cardiovascular mortality: findings from a national US sample. *Ann Fam Med, 8*(1), 11-18. doi: 10.1370/afm.1035

Fulgoni, V., Nicholls, J., Reed, A., Buckley, R., Kafer, K., Huth, P., . . . Miller, G. D. (2007). Dairy Consumption and Related Nutrient Intake in African-American Adults and Children in the United States: Continuing Survey of Food Intakes by Individuals 1994-1996, 1998, and the National Health and Nutrition Examination Survey 1999-2000. *Journal of the American Dietetic Association, 107*(2), 256-264.

Gepner, A. D., Ramamurthy, R., Krueger, D. C., Korcarz, C. E., Binkley, N., & Stein, J. H. (2012). A prospective randomized controlled trial of the effects of vitamin D supplementation on cardiovascular disease risk. *PLoS One, 7*(5), e36617. doi: 10.1371/journal.pone.0036617

Gorham, E. D., & Garland, C. F. . (2011). Vitamin D and the limits of randomized controlled trials. *Public Health Nutrition, 14*(4), 741 - 743.

Grant, W. B., & Holick, M. F. (2005). Benefits and requirements of vitamin D for optimal health: a review. *Alternative medicine review : a journal of clinical therapeutic, 10*(2), 94-111.

Grant, W. B., & Peiris, A. N. (2010). Possible role of serum 25-hydroxyvitamin D in black-white health disparities in the United States. *J Am Med Dir Assoc, 11*(9), 617-628. doi: S1525-8610(10)00102-7 [pii]10.1016/j.jamda.2010.03.013 [doi]

Hamman, R. F., Wing, R. R., Edelstein, S. L., Lachin, J. M., Bray, G. A., Delahanty, L., . . . Wylie-Rosett, J. (2006). Effect of Weight Loss With Lifestyle Intervention on Risk of Diabetes. *Diabetes Care, 29*(9), 2102-2107. doi: 10.2337/dc06-0560

Harris, S. S. (2006). Vitamin D and African Americans. *J Nutr, 136*(4), 1126-1129. doi: 136/4/1126 [pii]

Harris, S. S. (2011). Does vitamin D deficiency contribute to increased rates of cardiovascular disease and type 2 diabetes in African Americans? *The American Journal of Clinical Nutrition, 93*(5), 1175S-1178S. doi: 10.3945/ajcn.110.003491

Heaney, R. P. (2000). Vitamin D: How Much Do We Need, and How Much is Too Much? *Osteoporosis International, 11*(7), 553-555. doi: 10.1007/s001980070074

Heaney, R. P., & Holick, M. F. (2011). Why the IOM recommendations for vitamin D are deficient. *Journal of Bone and Mineral Research, 26*(3), 455-457. doi: 10.1002/jbmr.328

Holick, M. (2006). Vitamin D. In M. E. Shils & M. Shike (Eds.), *Modern nutrition in health and disease* (10th ed., pp. 376 - 395). Philadelphia: Lippincott Williams & Wilkins.

Holick, M. F. (2007). Vitamin D deficiency. *The New England journal of medicine, 357*(3), 266-281.

Holick, M. F. (2009). Vitamin D and Health: Evolution, Biologic Functions, and Recommended Dietary Intakes for Vitamin D. *Clinical Reviews in Bone and Mineral Metabolism, 7*(1), 2-19.

Holick, M. F., Binkley, N. C., Bischoff-Ferrari, H. A., Gordon, C. M., Hanley, D. A., Heaney, R. P., . . . Weaver, C. M. (2011). Evaluation, treatment, and prevention of vitamin D deficiency: An endocrine society clinical practice guideline. *J. Clin. Endocrinol. Metab. Journal of Clinical Endocrinology and Metabolism, 96*(7), 1911-1930.

Holick, M. F., & Chen, T. C. (2008). Vitamin D deficiency: a worldwide problem with health consequences. *The American Journal of Clinical Nutrition, 87*(4), 1080S-1086S.

Hollingshead, A. d. B. (1975). *Four factor index of social status*. New Haven, Conn.: Yale University, Dept. of Sociology.

Hou, J. C., Min, L., & Pessin, J. E. (2009). Chapter 16 Insulin Granule Biogenesis, Trafficking and Exocytosis. In L. Gerald (Ed.), *Vitamins & Hormones* (Vol. Volume 80, pp. 473-506): Academic Press.

Hu, F. B., Li, T. Y., Colditz, G. A., Willett, W. C., & Manson, J. E. (2003). Television watching and other sedentary behaviors in relation to risk of obesity and type 2 diabetes mellitus in women. *JAMA, 289*(14), 1785-1791. doi: 10.1001/jama.289.14.1785

Institute of Medicine. (2010a). *Dietary reference intakes for calcium and vitamin d*. Washington: National Academies Press.Institute of Medicine. (2010b).

Jarvis, J. K., & Miller, G. D. (2002). Overcoming the barrier of lactose intolerance to reduce health disparities. *Journal of the National Medical Association, 94*(2), 55-66.

Joergensen, C., Gall, M. A., Schmedes, A., Tarnow, L., Parving, H. H., & Rossing, P. (2010). Vitamin D levels and mortality in type 2 diabetes. *Diabetes Care, 33*(10), 2238-2243. doi: 10.2337/dc10-0582

Katz, D. L., O'Connell, M., Yeh, M. C., Nawaz, H., Njike, V., Anderson, L. M., . . . Task Force on Community Preventive, S. (2005). Public health strategies for preventing and controlling overweight and obesity in school and worksite settings: a report on recommendations of the Task Force on Community Preventive Services. *MMWR. Recommendations and reports : Morbidity and mortality weekly report. Recommendations and reports / Centers for Disease Control, 54*(RR-10).

Krishnan, S., Cozier, Y. C., Rosenberg, L., & Palmer, J. R. (2010). Socioeconomic Status and Incidence of Type 2 Diabetes: Results From the Black Women's Health Study. *American Journal of Epidemiology, 171*(5), 564-570. doi: 10.1093/aje/kwp443

Kulkarni, K. D. (2004). Food, Culture, and Diabetes in the United States. *Clinical Diabetes, 22*(4), 190-192. doi: 10.2337/diaclin.22.4.190

Lee, H. (2012). The role of local food availability in explaining obesity risk among young school-aged children. *Social Science & Medicine, 74*(8), 1193-1203. doi: 10.1016/j.socscimed.2011.12.036

Li, F., Harmer, P., Cardinal, B. J., Bosworth, M., & Johnson-Shelton, D. (2009). Obesity and the Built Environment: Does the Density of Neighborhood Fast-Food Outlets Matter? *American Journal of Health Promotion, 23*(3), 203-209. doi: 10.4278/ajhp.071214133

Lips, P. (2004). Which circulating level of 25-hydroxyvitamin D is appropriate? *The Journal of steroid biochemistry and molecular biology., 89-90*, 611-614.

Looker, A. C., Dawson-Hughes, B., Calvo, M. S., Gunter, E. W., & Sahyoun, N. R. (2002). Serum 25-hydroxyvitamin D status of adolescents and adults in two seasonal subpopulations from NHANES III. *Bone, 30*(5), 771-777.

Lopez, R., & Hynes, H. P. (2006). Obesity, physical activity, and the urban environment: public health research needs. *Environmental Health: A Global Access Science Source, 5*(1), 25.

Lynch, C. S., Chang, J. C., Ford, A. F., & Ibrahim, S. A. (2007). Obese African-American women's perspectives on weight loss and bariatric surgery. *J Gen Intern Med, 22*(7), 908-914. doi: 10.1007/s11606-007-0218-0 [doi]

MacLaughlin, J., & Holick, M. F. (1985). Aging decreases the capacity of human skin to produce vitamin D3. *The Journal of clinical investigation, 76*(4), 1536-1538.

Malabanan, A., Veronikis, I. E., & Holick, M. F. (1998). Redefining vitamin D insufficiency. *The Lancet, 351*(9105), 805-806. doi: 10.1016/s0140-6736(05)78933-9

Mauersberger, B. (2012). Tracking Employment-Based Health Benefits in Changing Times. http://www.bls.gov/opub/cwc/cm20120125ar01p1.htm

McCarty, M. F., & Thomas, C. A. (2003). PTH excess may promote weight gain by impeding catecholamine-induced lipolysis-implications for the impact of calcium, vitamin D, and alcohol on body weight. *Medical Hypotheses, 61*(5-6).

McEwen, B. S., & Stellar, E. (1993). Stress and the Individual: Mechanisms Leading to Disease. *Arch Intern Med, 153*(18), 2093-2101. doi: 10.1001/archinte.1993.00410180039004

McKinney, K., Breitkopf, C. R., & Berenson, A. B. (2008). ORIGINAL ARTICLE: Association of race, body fat and season with vitamin D status among young women: a cross-sectional study. *Clinical Endocrinology, 69*(4), 535-541.

Melamed, M. L., Astor, B., Michos, E. D., Hostetter, T. H., Powe, N. R., & Muntner, P. (2009). 25-Hydroxyvitamin D Levels, Race, and the Progression of Kidney Disease. *Journal of the American Society of Nephrology, 20*(12), 2631-2639. doi: 10.1681/asn.2009030283

Mitri, J., Dawson-Hughes, B., Hu, F. B., & Pittas, A. G. (2011). Effects of vitamin D and calcium supplementation on pancreatic β cell function, insulin sensitivity, and glycemia in adults at high risk of diabetes: the Calcium and Vitamin D for Diabetes Mellitus (CaDDM) randomized controlled trial. *The American Journal of Clinical Nutrition, 94*(2), 486-494. doi: 10.3945/ajcn.111.011684

Mitri, J., Muraru, M. D., & Pittas, A. G. (2011). Vitamin D and type 2 diabetes: a systematic review. *Eur J Clin Nutr, 65*(9), 1005-1015.

Moore, J. B., Jilcott, S. B., Shores, K. A., Evenson, K. R., Brownson, R. C., & Novick, L. F. (2010). A qualitative examination of perceived barriers and facilitators of physical activity for urban and rural youth. *Health Education Research, 25*(2), 355-367. doi: 10.1093/her/cyq004

Moyad, M. A. (2008). Vitamin D: A Rapid Review. *Urologic nursing., 28*(5), 343-350.

National Center for Health Statistics. (2007 -2008). National Health and Nutrition Examination Survey 2007 - 2008. from http://www.cdc.gov/nchs/nhanes/nhanes2007-2008/nhanes07_08.htm

National Center for Health Statistics. (2009 - 2010). National Health and Nutrition Examination Survey 2009 - 2010. from http://www.cdc.gov/nchs/nhanes/nhanes2009-2010/nhanes09_10.htm

National Center for Health Statistics. (2011, September, 2006). Analytic Note Regarding 2007-2010 Survey Design Changes and Combining Data Across other Survey Cycles. Retrieved September 3, 2012, from http://www.cdc.gov/nchs/data/nhanes/analyticnote_2007-2010.pdf

National Center for Health Statistics. (2012). Leading causes of death. Retrieved June 5, 2012 http://www.cdc.gov/nchs/fastats/lcod.htm

National Center for Health Statistics. (2012 -2013). The Proposal Process. Retrieved April 2, 2012, from http://www.cdc.gov/rdc/B3Prosal/PP300.htm

National Cholesterol Education Program. (2001). Third Report of the Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (adult treatment panel III). [Bethesda, Md.?]: National Institutes of Health, National Heart, Lung, and Blood Institute, National Cholesterol Education Program.

National Cholesterol Education Program, E. P. o. D. E., & Treatment of High Blood Cholesterol in, A. (2002). *Third report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (adult treatment panel III) : final report*, [Washington, D.C.].

National Health and Nutrition Examination Survey. (2005). http://www.cdc.gov/nchs/data/nhanes/nhanes_05_06/BM.pdfAnthropometry and Physical Activity Monitor 3-1 - 3-4.

National Health and Nutrition Examination Survey Questionnaire. (2003 - 2006). from http://www.cdc.gov/nchs/nhanes/nhanes_questionnaires.htm

National Institutes of Health Office of Dietary Supplements. (2010). *Dietary Supplement Fact Sheet: Vitamin D* Retrieved from http://ods.od.nih.gov/factsheets/VitaminD-HealthProfessional/

Norman, A., Frankel, J., Heldt, A., & Grodsky, G. (1980). Vitamin D deficiency inhibits pancreatic secretion of insulin. *Science, 209*(4458), 823-825. doi: 10.1126/science.6250216

The Obesity Society. What is Obesity. Retrieved June 18, 2013, from http://www.obesity.org/resources-for/what-is-obesity.htm

Office of Minority Health. (2007). Obesity and African Americans Retrieved October 29, 2011 http://minorityhealth.hhs.gov/templates/content.aspx?ID=6456

Office of Minority Health. (2011). Obesity and African Americans Retrieved June 11, 2012 http://healthyamericans.org/reports/obesity2011/Obesity2011Report.pdf

Palomer, X., González-Clemente, J. M., Blanco-Vaca, F., & Mauricio, D. (2008). Role of vitamin D in the pathogenesis of type 2 diabetes mellitus. *Diabetes, Obesity and Metabolism, 10*(3), 185-197. doi: 10.1111/j.1463-1326.2007.00710.x

Parikh, S. J., Edelman, M., Uwaifo, G. I., Freedman, R. J., Semega-Janneh, M., Reynolds, J., & Yanovski, J. A. (2004). The relationship between obesity and serum 1,25-dihydroxy vitamin D concentrations in healthy adults. *J Clin Endocrinol Metab, 89*(3), 1196-1199.

Pittas, A. G., Chung, M., Trikalinos, T., Mitri, J., Brendel, M., Patel, K., . . . Balk, E. M. (2010). Systematic Review: Vitamin D and Cardiometabolic Outcomes. *Annals of Internal Medicine, 152*(5), 307-314. doi: 10.7326/0003-4819-152-5-201003020-00009

Pittas, A. G., Lau, J., Hu, F. B., & Dawson-Hughes, B. (2007). The role of vitamin D and calcium in type 2 diabetes. A systematic review and meta-analysis. *The Journal of clinical endocrinology and metabolism, 92*(6), 2017-2029.

Prosser, D. E., & Jones, G. (2004). Enzymes involved in the activation and inactivation of vitamin D. *Trends in Biochemical Sciences, 29*(12), 664-673. doi: 10.1016/j.tibs.2004.10.005

Rajakumar, K., Greenspan, S. L., Thomas, S. B., & Holick, M. F. (2007a). SOLAR ultraviolet radiation and vitamin D: a historical perspective. *Am J Public Health, 97*(10), 1746-1754. doi: AJPH.2006.091736 [pii] 10.2105/AJPH.2006.091736 [doi]

Reidenbach, L., Weller, C. (2010). The state of minorities in 2010: Minorities are suffering disproportionately in the recession. http://www.americanprogress.org/issues/2010/01/state_of_minorities.html

Reis, A. F., Hauache, O. M., & Velho, G. (2005). REVIEW - Vitamin D endocrine system and the genetic susceptibility to diabetes, obesity and vascular disease. A review of evidence. *Diabetes & metabolism., 31*(4), 318.

Saab, G., Whaley-Connell, A., McFarlane, S. I., Li, S., Chen, S.-C., Sowers, J. R., . . . Bakris, G. L. (2010). Obesity is associated with increased parathyroid hormone levels independent of glomerular filtration rate in chronic kidney disease. *Metabolism, 59*(3), 385-389. doi: http://dx.doi.org/10.1016/j.metabol.2009.08.007

Simoons, F. J. (1978). The geographic hypothesis and lactose malabsorption. A weighing of the evidence. *The American journal of digestive diseases, 23*(11), 963-980.

Sun, G., Vasdev, S., Martin, G. R., Gadag, V., & Zhang, H. (2005). Altered Calcium Homeostasis Is Correlated With Abnormalities of Fasting Serum Glucose, Insulin Resistance, and β-Cell Function in the Newfoundland Population. *Diabetes, 54*(11), 3336-3339. doi: 10.2337/diabetes.54.11.3336

Thomas, G. N., ó Hartaigh, B., Bosch, J. A., Pilz, S., Loerbroks, A., Kleber, M. E., . . . März, W. (2012). Vitamin D Levels Predict All-Cause and Cardiovascular Disease Mortality in Subjects With the Metabolic Syndrome: The Ludwigshafen Risk and Cardiovascular Health (LURIC) study. *Diabetes Care, 35*(5), 1158-1164. doi: 10.2337/dc11-1714

U.S. Census Bureau. (2009). Income, poverty, and health insurance coverage in the United States. http://www.census.gov/prod/2010pubs/p60-238.pdf.

U.S. Census Bureau. (2011a). Small Area Income and Poverty Estimates: Estimates for The United States , 2010. http://www.census.gov/cgi-bin/saipe/national.cgi?year=2010&ascii=

U.S. Census Bureau. (2011b). U.S. Census Bureau Poverty Retrieved December 13, 2011 http://www.census.gov/hhes/www/poverty/data/threshld/index.html

Van Horn, L. V., Bausermann, R., Affenito, S., Thompson, D., Striegel-Moore, R., Franko, D., & Albertson, A. (2011). Ethnic differences in food sources of vitamin D in adolescent American girls: the National Heart, Lung, and Blood Institute Growth and Health Study. *Nutrition Research, 31*(8), 579-585. doi: 10.1016/j.nutres.2011.07.003

Von Hurst, P. R., Stonehouse, W., & Coad, J. (2010). Vitamin D supplementation reduces insulin resistance in South Asian women living in New Zealand who are insulin resistant and vitamin D deficient – a randomised, placebo-controlled trial. *British Journal of Nutrition, 103*(04), 549-555. doi: doi:10.1017/S0007114509992017

Weyer, C., Bogardus, C., Mott, D. M., & Pratley, R. E. (1999). The natural history of insulin secretory dysfunction and insulin resistance in the pathogenesis of type 2 diabetes mellitus. *The Journal of clinical investigation, 104*(6), 787-794.

Wikipedia. (2011a). African American. Retrieved 13 December 2011 14:47 UTC, from Wikipedia, The Free Encyclopedia. http://en.wikipedia.org/w/index.php?title=African_American&oldid=464544556

Wollheim, C. B., & Sharp, G. W. (1981). Regulation of insulin release by calcium. *Physiological reviews, 61*(4), 914-973.

Wood, A. D., Secombes, K. R., Thies, F., Aucott, L., Black, A. J., Mavroeidi, A., . . . Macdonald, H. M. (2012). Vitamin D3 Supplementation Has No Effect on Conventional Cardiovascular Risk Factors. A Parallel-Group, Double-Blind, Placebo-Controlled RCT. *Journal of Clinical Endocrinology & Metabolism*. doi: 10.1210/jc.2012-2126

Wortsman, J., Matsuoka, L. Y., Chen, T. C., Lu, Z., & Holick, M. F. (2000). Decreased bioavailability of vitamin D in obesity. *The American Journal of Clinical Nutrition, 72*(3), 690-693.

Wu, S., & Sun, J. (2011). Vitamin D, vitamin D receptor, and macroautophagy in inflammation and infection. *Discovery medicine, 11*(59), 325-335.

Yanoff, L. B., Parikh, S. J., Spitalnik, A., Denkinger, B., Sebring, N. G., Slaughter, P., . . . Yanovski, J. A. (2006). ORIGINAL ARTICLE: The prevalence of hypovitaminosis D and secondary hyperparathyroidism in obese Black Americans. *Clinical Endocrinology, 64*(5), 523-529.

Yetley, E. A., Pfeiffer, C. M., Schleicher, R. L., Phinney, K. W., Lacher, D. A., Christakos, S., . . . Them, O. f. R. (2010). NHANES Monitoring of Serum 25-Hydroxyvitamin D: A Roundtable Summary. *The Journal of Nutrition, 140*(11), 2030S-2045S. doi: 10.3945/jn.110.121483

Zadshir, A., Tareen, N., Pan, D., Norris, K., & Martins, D. (2005). The prevalence of hypovitaminosis D among US adults: data from the NHANES III. *Ethn Dis, 15*(4 Suppl 5), S5-97-101.

Zapka, J., Lemon, S. C., Estabrook, B., & Rosal, M. C. (2009). Factors related to weight loss behavior in a multiracial/ethnic workforce. *Ethnicity & disease, 19*(2), 154-160.

APPENDIX A

NCHS Proposal to Access the Restricted Variable, Latitude (LAT)

APPENDIX A (continued)

RDC Project Proposal

General Information	
Date:	January 2013
Title of Project:	The Relationship Between Socioeconomic Status and Body Mass Index on Vitamin D Levels in African American Women with and without Diabetes in areas with Abundant Sunshine
Data System and Years:	NHANES 2003 – 2006
Mode of Access: (Check all that apply)	[_] NCHS RDC, Hyattsville, MD (Washington, DC-metro) [_] NCHS RDC, Atlanta, GA **X** Remote Access (ANDRE) [_] Census RDC, specify: _____
Statistical Software: (Check all that apply)	**X** SAS/Sudaan [_] Stata [_] Other, specify: _____ * Remote access users can only use SAS/Sudaan
Proposed Start Date:	March 1, 2013
Funding Source:	n/a
Billing Address: (include contact person)	Rebecca Puig, Director Sponsored Research University of South Florida 3650 Spectrum Blvd, Suite 160 Tampa, FL 33612-9446 grants.gov@research.usf.edu 813-974-2897

Complete as applicable for your project. Everyone listed in this section will need to submit a C.V. and if approved, must complete the Confidentiality Orientation and paperwork. There can only be one ANDRE programmer.

APPENDIX A (continued)

Research Team		
	Primary Investigator	**Co-Investigator**
Name	Shani V. Davis	n/a
Email	sdavis@health.usf.edu	
Phone	813-362-5141	
Institution	University of South Florida College of Nursing	
Mailing Address	12901 Bruce B. Downs Blvd., MDC 22, Tampa, FL 33612	
US Citizen? Y or N	Yes	
	Programmer [_] On-site or **X** ANDRE (account holder)	**Programmer** [_] On-site n/a
Name	Kevin E. Kip, PhD, FAHA	
Email	kkip@health.usf.edu	
Phone	813- 974-9266	
Institution	University of South Florida College of Nursing	
Mailing Address	12901 Bruce B. Downs Blvd., MDC 22, Tampa, FL 33612	
US Citizen? Y or N	Yes	
	Advisor (For Students and Post-Docs) **X** RDC-Student-Advisor Form	**Other, specify: Committee Member**
Name	Maureen Groer, RN, PhD, FAAN, Dissertation Committee Chair	Frances M. Sahebzamani, PhD, ARNP, FAANP , Dissertation Committee Co-Chair
Email	mgroer@health.usf.edu	fsahebza@health.usf.edu
Phone	813- 974- 2703	813-974- 2702
Institution	University of South Florida College of Nursing	University of South Florida College of Nursing
Mailing Address	12901 Bruce B. Downs Blvd., MDC 22, Tampa, FL 33612	12901 Bruce B. Downs Blvd., MDC 22, Tampa, FL 33612
US Citizen? Y or N	Yes	Yes

APPENDIX A (continued)

RDC Proposal Summary Information		
	YES	**NO**
Geographic variables		
Level of geography to be shown in **output** (check all that apply)		
National		X
Regional		X
State		X
MSA		X
County		X
Urban/rural classification		X
Census tract		X
Latitude (only)	X	
Other		X
Will geographic identifier(s) be removed after merge	X	
If yes, can true geographic identifiers be replaced with masked versions of these variables		X
Is GIS or mapping proposed		X
Dates and Temporal information		
Are exact dates requested other than to calculate time of follow-up		X
If more than 1 year/cycle, will years/cycles be presented separately		X
Merging of data with NCHS restricted data		
Are external data being merged with NCHS data		X
Linked Data Products		
Are you requesting linked Medicare/Medicaid files		X
If yes, are you using multiple years	n/a	n/a
Are you using public-use mortality data		X

APPENDIX A (continued)

A. Abstract:

Multiple lines of research suggest that obesity, and diabetes are associated with low vitamin D levels. Obesity and type 2 diabetes are heavily represented in the African American community. The greatest prevalence and incidence of both are among African American women. Hypovitaminosis D is also common in African Americans, even in regions where sunlight is sufficient. Many African Americans and their families have incomes below the poverty threshold and resultant low socioeconomic status. The socioeconomic status of a family may directly or indirectly affect access to sources of vitamin D, as well as access to health resources for detection and management of vitamin D related conditions. There have been few randomized clinical studies examining the influence of vitamin D on obesity and diabetes however, inverse relationships between vitamin D and obesity, and vitamin D and diabetes have been consistently noted in observational research. The direct and indirect cost of managing the diabetes epidemic is great. Thus, an improved understanding of the relationships among phenomena influencing diabetes development in groups with disproportionate prevalence is important.

B. Research Question:

In light of high rates of poverty, obesity, diabetes, and low vitamin D in African American women, this research aims to determine the relationship between SES, BMI, and serum vitamin D levels in African American women in areas with abundant sunshine. This research will also determine if diabetes moderates these relationships. Ultimately, the goal of this research is to strengthen the evidence supporting nursing interventions that target determinants of type 2 diabetes risks in African American women. Survey responses from subjects participating in the National Health and Nutrition Examination Survey (NHANES) between 2003 – 2006 will be analyzed for this research.

Specific Aims for this Research

1. To determine the relationship between socioeconomic status and vitamin D levels in African American women in areas with abundant sunshine
2. To determine the relationship between BMI and vitamin D levels in African American women in areas with abundant sunshine
3. To determine the moderating effect of diabetes mellitus on these two relationships in African American women in areas with abundant sunshine

Research Questions

1. What is the relationship between SES and BMI on vitamin D levels respectively among African American women in areas with abundant sunshine?
2. What is the effect of diabetes mellitus on the relationships between BMI, SES, and vitamin D in African American women in areas with abundant sunshine?

C. Background:

Common trends observed among risk factors for type 2 diabetes and vitamin D deficiency can inspire novel approaches to managing diabetes, and toward reducing the diabetes epidemic (Borges, 2011). Nationally, managing diabetes is fiscally crippling and will be difficult to sustain as the epidemic expands. Pittas et al., (2010) noted that the core defects of type 2 diabetes, insulin resistance and impaired insulin secretion, may be exacerbated when

vitamin D levels are low. Obesity is a known risk factor for developing type 2 diabetes, which is the type that 90 to 95% of Americans has. Moreover, vitamin D and obesity

C. Background (cont.):

are inversely related (Yanoff, 2006), while insulin resistance increases with obesity. Dark skin pigmentation, lactose intolerance, and a diet otherwise low in vitamin D promote deficiency in this group (Davis, 2011). Significant segments of the African-American population experience poverty, obesity, and diabetes, and live concentrated in areas where access to the resources that promote healthy lifestyle practices are limited.

Over 27 % of African Americans live at or below poverty, versus 15% of White Americans. Median household income for an African American family was $32,068 in 2010, and the poverty threshold for a two adult, two child family was $22,113 (U.S. Census Bureau, 2011). Poverty may augment opportunities for vitamin D disparities to manifest because access to sources of vitamin D can be limited in low SES conditions. Low income, transportation challenges, reduced proximity to healthier foods, and concerns for personal and family safety has an influence on time spent outdoors. Unfortunately, these persons are often unaware of their vitamin D status due to low access to health care resources, and reduced access to personnel to promote healthy lifestyle practices.

Sixty-five percent of Americans are overweight or obese and African American women represent the majority of this group (Centers for Disease Control and Prevention, 2011). Four of five African-American women are overweight or obese, and obesity is a modifiable risk factor that frequently precedes the onset of type 2 diabetes. Obesity is inversely related to serum 25 (OH) vitamin D (Pittas, 2010; Earthman, 2011), and vitamin D is important in the process of insulin secretion, and glucose uptake in the muscle and adipose tissue. Excess body weight decreases bioavailability of vitamin D, which likely contributes to the higher prevalence of low vitamin D and diabetes in this group.

Skin complexion affects the rate of vitamin D conversion in the skin. Melanin slows cutaneous vitamin D production at a rate proportional to the amount of melanin present, as well as the amount and timing of sun exposure (Webb, 1988). Ethnic minorities with darker skin hues generally have a higher risk for developing deficiencies in vitamin D for this reason (Rajakumar, 2007). Limits to sun exposure resulting from geographic location, changes in season, use of sunscreen, and personal choice reduce cutaneous vitamin D production. Another reason vitamin D is low in African Americans is because intake of milk and dairy foods is generally below recommended daily intake (Jarvis, 2002). Though not independently causal, real or percieved lactose intolerance is an exacerbating factor for vitamin D deficiency in African Americans. Diets low in milk necessitate that other sources of vitamin D supplement what is produced in the skin. Food sources rich in vitamin D such as oily fish and mushrooms are more costly to consume than dairy products, and low socioeconomic conditions can make these foods economically difficult to access.

APPENDIX A (continued)

A cross-sectional descriptive research design will be employed to determine the relationships between vitamin D and SES, vitamin D and BMI, and the influence of diabetes on these relationships in African American women residing in areas with abundant sunshine. In the United States, cutaneous production of vitamin D decreases as geographical latitude increases, however vitamin D production is unaffected by the earth's angle between latitudes 0° and ± 35° (Webb, 1988). The NHANES data containing geographical specifications are restricted and only available through the Research Data Center (RDC) of the CDC. This research aims to evaluate relationships between SES, BMI, and vitamin D levels in African American women residing in areas with abundant sunshine. This research also seeks to determine if diabetes moderates these relationships. To analyze these data, vitamin D will be regressed onto the explanatory variables BMI, SES, and the mean centered product terms of diabetes and BMI, and diabetes and SES. The influence of vitamin D supplement use will also be examined in the analysis. These relationships have not yet been examined specifically in African American women living in sun sufficient areas of the United States.

D. Public Health Benefit:

The growing epidemic of diabetes is most rampant among African American women, and the high prevalence of poverty and obesity in this group contribute to the rate of increase, and incidence of diabetes in this group. A significant number of African Americans also experience hypovitaminosis D, and the conditions of poverty augment this risk. Obesity and diabetes have been associated with low levels of vitamin D, and exploring these relationships further may yield novel perspectives that strengthen the designs of nursing interventions that lower diabetes prevalence and improve control in this group.

E. Data Requirements:

1. **Survey, Years, Files**
   NHANES
   2003-2006
   Anthropometric measurements
   Demographic variables and sample weights
   Laboratory components: Serum 25(OH) Vitamin D, Glycohemoglobin (%), Fasting Glucose, Fasting Insulin, Urine Pregnancy Test Result
   Dietary Supplement questionnaire
   Dietary supplement questionnaire formats
2. **Restricted Variables:**
   i) LAT (Latitude of Residence) will be used to identify African American women residing in United States geographic areas at and below the 35th latitude.
   ii) Restricted variables will be merged with publicly available files to identify NHANES respondents residing in the region of interest. Use of restricted variables beyond this step is not necessary in this study.
3. **Non-NCHS Data:**
   N/A
4. **Merge Variables:**

i) SEQN will be used to merge the public and restricted data files
ii) N/A

APPENDIX A (continued)

F. Methodology:

1. **Unit or Level of Analysis and Subpopulation(s):**
   Unit of Analysis – individual
   Subpopulation – non-pregnant women aged 20 and older
2. **Analysis Plan:**
   SAS statistical software will be used to analyze relationships among the variables for this research.
   The continuous variable 25(OH) vitamin D will be regressed onto the explanatory variables BMI (continuous), SES (represented by PIR), and the mean centered product terms of the dichotomous variable diabetes (yes or no) and BMI, and diabetes and SES. Glycohemoglobin >6.4% will also affirm diabetes among participants meeting inclusion criteria. Other covariates are age (as a continuous variable in years), education level, and pregnancy at the time of survey participation (yes or no). The use of vitamin D supplements (yes or no) will be included in the analysis. The LAT variable will be used to identify African American women participants for NHANES 2003 – 2006 from areas at and below the 35th latitudinal line.
3. **Complex Survey Design:**
   Sample weights and sample design are accounted for in the existing codes for NHANES cycles 2003 – 2004 and 2005 – 2006.

G. Output:

1. **Overview:** Tables and histograms will be presented to illustrate relationships and the distribution frequencies for BMI, SES, diabetes, pre diabetes, and vitamin D in the final output for this research. These will also be generated to represent the demographic makeup of survey participants meeting inclusion criteria. Transformation techniques may be employed to remedy instances of non-normality when appropriate. A table displaying regression of each predictor variable onto the variable vitamin D level will also be presented. The respective mean centered product terms of BMI and diabetes, and SES and diabetes will also be regressed onto the variable vitamin D level. Last, tables noting variable coefficients, will be included in the output.

2. **Examples/Table Shells:** The following are summary tables denoting the relationships between each covariate and the outcome vitamin D in tertiles. Also to be illustrated in the tables are moderating effects of diabetes on these relationships. Frequency distributions may also be exhibited as histograms for age, education, and other demographic information. Unit of measurement = Individual in all tables

Tables for data illustration

Vitamin D level (mean) ng/ml, n	SES
	Low
	Medium
	High

APPENDIX A (continued)

Vitamin D level (mean) ng/ml, n	BMI
	Low
	Medium
	High

Diabetes	Vitamin D level (mean)ng/ml,n	SES
(+)		Low
		Medium
		High
Diabetes	Vitamin D level (mean)ng/ml,n	SES
(-)		Low
		Medium
		High

Diabetes	Vitamin D level (mean)ng/ml,n	BMI
(+)		Low
		Medium
		High
Diabetes	Vitamin D level (mean)ng/ml,n	BMI
(-)		Low
		Medium
		High

Diabetes	Vitamin D level (mean)ng/ml,n	BMI x SES
(+)		
Diabetes	Vitamin D level (mean)ng/ml,n	BMI x SES
(-)		

APPENDIX A (continued)

IV	B	Std. error	β	t	Sig.
BMI					
SES					
BMI x SES					
BMI x diabetes					
SES x diabetes					
BMI x SES x diabetes					

DV – Vitamin D level

Presentation of Results: Presented to dissertation committee, an audience of professional peers, and potentially peer reviewed journal(s).

H. Data Dictionary:

1. **NCHS Restricted Variables: NHANES 2003 – 2006**

Variable Name	Variable Label
SEQN	Sequence Number – Used for Merging to Public Data
LAT	Latitude of Residence

2. **Public Use Variables: NHANES 2003 – 2006**

Demographic File

Variable Name	Variable Label
SEQN	Sequence Number – Used for Merging Public Data and Restricted Data
RIAGENDR	Gender
RIDRETH1	Race/Ethnicity
DMDEDUC2	Education Level – Adults aged 20 and older
INDFMPIR	Ratio of family income to poverty
INDHHIN2	Annual Household Income
RIDEXPREG	Pregnancy at the time of the examination
WTINT2YR	Full Year Sample 2 Year Interview Weight
WTMEC2YR	Full Year Sample 2 Year MEC Exam Weight

APPENDIX A (continued)

Questionnaire

Variable Name	Variable Label
DIQ010	Doctor told you have diabetes
DIQ160	Ever told you have pre diabetes
DIQ050	Taking insulin now

Vitamin D Supplement Use: 2003 - 2006

Variable Name	Variable Label
DSQIVD	Vitamin D (D_2 + D_3) (mcg)
DSQDOC_E.xpt	30 – Day Dietary Supplement Use

Body Measurements

Variable Name	Variable Label
BMXWT	Weight (kg)
BMXHT	Standing Height (cm)
BMXBMI	Body Mass Index (kg/m^2)

Public Use Variables: NHANES 2003 – 2006 (cont.)

Laboratory Measurements

Variable Name	Variable Label
URXPREG	Urine Pregnancy Test Result
LBXGH	Glycohemoglobin (%)
LBDVID	25 OH Vitamin D (ng/ml)

3. Non-NCHS Data Dictionary: N/A

I. References:

Borges, M. C., Martini, L. A., & Rogero, M. M. (2011). Current perspectives on vitamin D, immune system, and chronic diseases. *Nutrition, 27*(4), 399-404. doi: 10.1016/j.nut.2010.07.022

Centers for Disease Control and Prevention. (2011). National diabetes fact sheet. Retrieved from http://www.cdc.gov/diabetes/pubs/pdf/ndfs

Davis, S. V. (2011). Vitamin D Deficiency and Type 2 Diabetes in African Americans: The Common Denominators. *Diabetes spectrum : a publication of the American Diabetes Association., 24*, 148-153.

Earthman, C. P., Beckman, L. M., Masodkar, K., & Sibley, S. D. (2011). The link between obesity and low circulating 25-hydroxyvitamin D concentrations: considerations and implications. *International Journal of Obesity*.

APPENDIX A (continued)

Jarvis, J. K., & Miller, G. D. (2002). Overcoming the barrier of lactose intolerance to reduce health disparities. *Journal of the National Medical Association, 94*(2), 55-66.

Pittas, A. G., Chung, M., Trikalinos, T., Mitri, J., Brendel, M., Patel, K., et al. (2010). Systematic review: Vitamin D and cardiometabolic outcomes. *Annals of Internal Medicine, 152*(5), 307-314.

Rajakumar, K., Greenspan, S. L., Thomas, S. B., & Holick, M. F. (2007). SOLAR ultraviolet radiation and vitamin D: a historical perspective. *American Journal of Public Health, 97*(10), 1746-1754.

U.S. Census Bureau. (2011). U.S. Census Bureau Poverty Retrieved December 13, 2011 http://www.census.gov/hhes/www/poverty/data/threshld/index.html

Webb, A. R., Kline, L., & Holick, M. F. (1988). Influence of Season and Latitude on the Cutaneous Synthesis of Vitamin D3: Exposure to Winter Sunlight in Boston and Edmonton Will Not Promote Vitamin D3 Synthesis in Human Skin. *Journal of Clinical Endocrinology & Metabolism, 67*(2), 373-378. doi: 10.1210/jcem-67-2-373

Yanoff, L. B., Parikh, S. J., Spitalnik, A., Denkinger, B., Sebring, N. G., Slaughter, P., et al. (2006). ORIGINAL ARTICLE: The prevalence of hypovitaminosis D and secondary hyperparathyroidism in obese Black Americans. *Clinical Endocrinology, 64*(5), 523-529.

J. Other Authors:

N/A

K. Resumes/C.V.: Please include a 2-page C.V. for each member of the research team listed in the initial chart

APPENDIX A (continued)

NAME	POSITION TITLE
Shani V. Davis, MSN, ANP-BC, CDE	Nurse Practitioner, Certified Diabetes Educator, Adjunct Instructor, PhD Candidate
eRA COMMONS USER NAME (credential, e.g., agency login) sdavis	

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	MM/YY	FIELD OF STUDY
Florida A&M University, Tallahassee, FL	BSN	12/97	Nursing
Florida A&M University, Tallahassee, FL	MSN	04/01	Nursing
University of South Florida (USF), Tampa, FL	(PhD student)	n/a	Nursing

A. Personal Statement

The goal of this research is to strengthen the evidence supporting nurse interventions that target risks for type 2 diabetes in African American women. Two such risk factors are socioeconomic status and obesity. Observational data has shown that vitamin D deficiency, African American ethnicity, obesity, and diabetes are significantly correlated. This research examines effects of BMI and SES on vitamin D, as well as the moderating effect of diabetes on these relationships in African American women living in areas with abundant sunshine.

I am extensively experienced in the care and management of people with diabetes. Nurses often are the chief liaison for the patient's diabetes care team, and I believe more nurse directed research will yield important benefits toward a future of less diabetes. I have12 years of advanced practice nursing experience. In addition, I am a certified diabetes educator. As exploration on the importance of vitamin D in maintaining/ achieving optimal glycemia advances, it is essential that nursing research in this area remains current. African Americans and other minority groups incur diabetes at disproportionate rates for a myriad of reasons, some of which are poverty, obesity, and possibly lower vitamin D levels. Thus, research to support novel methods intended to reduce diabetes in communities most affected by the epidemic is important.

B. Positions and Honors

2001- ARNP, Diabetes Educator, Diabetes Interactive Network, Eli Lilly and Company
2001- 2003 ARNP, Health Care Professional Affiliate Staff, Tallahassee Memorial Hospital
2001- 2003 ARNP, North Florida Regional Thyroid Center with Celeste B. Hart M.D., Endocrinology, Tallahassee, FL
2001- 2003 NCLEX Test Preparation Instructor, Kaplan Education Centers, Tallahassee, FL

Positions (cont.)

2001- 2007 ARNP, Osteoporosis/ Forteo Educator, Diabetes Interactive Network, Eli Lilly and Company

2003- 2004 ARNP,BC with Sumesh Chandra, M.D.& Lucia Gilling M.D., Endocrinology, Tampa, FL

2005- 2006 ARNP,BC, CDE for Steps to a Healthier Hillsborough Grant, Community Division in cooperation with the Tampa Community Health Advocacy Partnership (CHAP)

2005- 2008 ARNP,BC, CDE Community Health Advocacy Partnership (CHAP) Co-Clinical Director, and Diabetes Program Director, James O. Brookings, MD, Tampa, FL,

2005- 2008 ARNP,BC, CDE Co-Director of Comprehensive Diabetes Care Program with Patrick Watson M.D. & Rosemay Latortue M.D., Internal Medicine, Tampa, FL

2007- 2008 ARNP,BC, CDE consultant, FMQAI Every Diabetic Counts Project, Technical Support Team, Tampa, FL

2008- 2011 ARNP, ANP-BC, CDE Diabetes and Hormonal Diseases Center with Yuvraj Kumbkarni, M.D., Endocrinology, Tampa, FL

2011- ARNP,BC, CDE Community Liaison, Board Member, Diabetic Charitable Services, Tampa/St. Petersburg, FL

2012 - ARNP,BC, CDE American Diabetes Association (Tampa Bay, Central, and Southwest Florida) Community Leadership Board Member, Tampa, FL

Professional Membership:

2011- Tampa Bay Diabetes Society

2010- American Association of Diabetes Educators (AADE)

2010- Tampa Bay Region Local Network Group of AADE

2004- American Diabetes Association

2004- Tampa Bay Advanced Practice Nursing Council

2002- Sigma Theta Tau International Honor Society of Nursing, Delta Beta at large

Honors:

Fellowship Award:

Graduate Student Success Diversity Fellowship, University of South Florida, $12,000 annual up to three years, Tampa, FL 2009

Awards and Recognition:

Outstanding Diabetes Nurse Educator and Community Servant, Tampa Bay Black Nurses Association, 2/6/10

Scholarship – Sigma Theta Tau Nursing Honor Society, Delta Beta At Large Chapter, University of South Florida, $750, Tampa, FL 2010

January Graduate Student Community Service Award - University of South Florida, College of Nursing, Tampa, FL 2011

C. Peer-reviewed Publication

Davis, S. V. (2011). Vitamin D deficiency and type 2 diabetes in African Americans: The common denominators. *Diabetes Spectrum: a Publication of the American Diabetes Association, 24,* 148-153.

APPENDIX A (continued)

NAME OF SPONSOR (CO-SPONSOR)	POSITION TITLE
Maureen Groër, R.N., Ph.D., F.A.A.N.	Gordon Keller Professor of Nursing; Adjunct Professor of Medicine
eRA COMMONS USER NAME	
Mgroer	

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	YEAR(s)	FIELD OF STUDY
Children's Hospital School of Nursing, Boston	Diploma	1965	Pediatric Nursing
Newton College of the Sacred Heart, Boston, MA	BS	1968	Biology
Boston University, Boston, MA	MA	1970	Biology
University of Illinois Medical Center, Chicago, IL	PhD	1975	Human Physiology & Biophysics
University of Tennessee, Knoxville, TN	MSN	1980	Family Nurse Practitioner (Education)

A.PERSONAL STATEMENT

My background as a maternal-child nurse and as a physiologist with over 35 years of experience provides me with a unique and relevant background. My primary research area is in biobehavioral research, with an emphasis on psychoneuroimmunological mechanisms particularly in mothers and infants. I have experience leading multidisciplinary teams to accomplish study aims. I currently hold one RO1 that is examining the immunophysiology of postpartum thyroiditis, and have recently completed a competing revision under ARRA to examine function of Natural Killer cells in the postpartum, and an administrative supplement to study the neurodevelopment of infants of women with postpartum thyroid disease. I have over 50 publications in refereed journals, have authored several textbooks, am active in several organizations, and review for multiple journals. I am a member of the Nursing and Clinical Research study section at NIH.

B. POSITIONS AND HONORS

1977 - 1983	Associate Professor, University of Tennessee, College of Nursing
1983 - 1992	Professor, University of Tennessee, College of Nursing
1988 - 1992	Director of the Doctoral Program, University of Tennessee, College of Nursing
1992 – 1997	Program Director, Interim President, President, MGH Institute of Health Professions, Boston
1997 - 2005	Associate Dean for Research & Evaluation, University of Tennessee, College of Nursing
2006- present	Gordon Keller Endowed Professor, University of South Florida College of Nursing, Tampa, FL

B. POSITIONS AND HONORS (cont.)

American Academy of Nursing representative (alternate) to United States Breastfeeding Committee (current); The 2009 Healthy Children Research award; 2009 Phi Kappa Phi Chapter 126 artist-scholar award; Honorary Societies: Sigma Theta Tau, Phi Kappa Phi, Sigma Xi, Psychoneuroimmunology Research Society, ellow of the American Academy of Nursing, 1994 – present; Fellow of the Society of Behavioral Medicine, 2001-present; Outstanding Classroom teacher awards (UT College of Nursing), 1999, 2000, 2001, 2002; outside member of multiple NIH IRGS; Current 4 year appointment to Nursing and Clinical Research IRG, NIH.
Board member, International Society for Research in Human Milk and Lactation, current.

C. SELECTED PUBLICATIONS (Five most recent)

1. **Groer, M**., Yolken, R., Xiao, J-C, Beckstead, J., Fuchs, D., Mohapatra, S., Seyfang, A., Postolache, T. (2011). Prenatal depression and anxiety in *Toxoplasma gondii* positive women. *American Journal of Obstetrics and Gynecology*. May;204(5):433.e1-7, .
2. **Groer, M**., El-Badria, N., Manion, M., Szekeres, K. (2011).Fetal Microchimerism: A new paradigm for women's health. *Biological research for Nursing*, Oct;13(4):346-50.
3. **Groer, M**. & Beckstead, J., (2011). Multidimensional scaling of human milk cytokines, *Biological Research for Nursing*, 2011 Jul;13(3):289-96.
4. Okusaga O, Langenberg P, Sleemi A, Vaswani D, Giegling I, Hartmann AM, Konte B, Friedl M, **Groer** MW, Yolken RH, Rujescu D, Postolache TT.Toxoplasma gondii antibody titers and history of suicide attempts in patients with schizophrenia. Schizophr Res. 2011 Dec;133(1-3):150-5.

D. RESEARCH SUPPORT

ACTIVE

R01NR005000 (Groer) 9/13/07-5/31/12 3.0 calendar
NIH/NINR Influence of Lactation on postpartum stress and immunity
The major goals of this project are to characterize the immune trajectory of postpartum thyroiditis in postpartum women at risk compared to those not at risk for this disease. In a one year no-cost extension.

R01NR005000 (Groer) 9-30-09-5/31/12
Minority Supplement to Ronee Wilson

Dept of the Army
Enhancing the Quality of Life of Veterans with PTSD 9/30/10-9/29/12 1.2 calendar

COMPLETED

3 RO1NR005000-06S1 (Groer) 9/30/09-5/31/11 .6 calendar
NIH/NINR
This was a competing revision funded under ARRA to study the Natural Killer cell physiology of postpartum women.

APPENDIX A (continued)

NAME	POSITION TITLE
Sahebzamani Rankin, Frances M.	Assistant Professor
eRA COMMONS USER NAME	
fsahebza	

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	YEAR(s)	FIELD OF STUDY
University of South Florida, Tampa, FL	BS	1993	Nursing
University of South Florida, Tampa, FL	MS	1995	Adult Nursing
University of South Florida, Tampa, FL	PhD	2002	Aging Studies

A. Positions and Honors.

Director, DNP Program 2010-2012
Director, Clinical DNP Program, College of Nursing (2006- 2010)
Assistant Professor, College of Nursing, 2009 - present
Director Primary Care Program, Nurse Practitioner Program, College of Nursing (Spring 2006 through summer 2007)
Assistant Director Research Division of Family Medicine, College of Medicine (2002-2006)
Assistant Professor, Department of Family Medicine, College of Medicine (2002-2006)
Co-Director, USF Prediabetes Treatment and Research Center (2002- present)
Adult and Gerontological Nurse Practitioner, USF Physicians Group (1995 - present
2012 American Academy of Nurse Practitioners State Award for Excellence, 2012
2011-2012 Vice President of Legislative Affairs, Florida Nurse Practitioner Network
2005 Fellow, American Academy of Nurse Practitioners, Inducted, July,2005
2003 - 2004 Sigma Theta Tau, Delta Beta Chapter, Vice-President Elect
1995 - 1999 Graduate Studies Fellowship, Ph.D. in Aging Studies

Selected peer-reviewed publications

1. Coris EE, **Sahebzamani FM**, Curtis A, Jennings J, Walz S, Konin, J, Nugent D, Pescasio MD, Zwygart K. (2012). Preparticipation cardiac screening among national collegiate athletic association division I colleges and universities. *British Journal of Sports Medicine*
2. Coris EE., Farrar T., Bryan S., Pescasio M. Zwygart K., Reese E., **Sahebzamani FM**. (2012). Diagnostic Evaluation of Chest Pain in Athletes. *Journal of Sports Health*.
3. Coris EE, **Sahebzamani FM**, Zwygart K, Pescasio M, Reese E. Survey of Pre-participation cardiac screening among National Collegiate Athletic Association Division I Institutions. *British Journal of Sports Medicine* (2012).
4. Coris EE, **Sahebzamani FM**, Shabnam M, Walz S, Cuppet M, Konin J, Medidi S, Zwygart K, Pescasio M. (2012). Core Temperature Prediction in Collegiate

Selected peer-reviewed publications (cont.)

Football Athletes with Heat Illness Symptom Index (HISI) Scores. British Journal of Sports Medicine (in review).

5.Coris EE, Miller E, **Sahebzamani F**.(2005) *,* Sudden cardiac death in division I collegiate athletics: Analysis of automated external defibrillator (AED) utilization in NCAA division I athletic programs, *Clinical Journal of Sports Medicine,* Vol. 15 (2), 87- 91. (Impact factor 2.111)

A. Research Support.

Sahebzamani FM (2012). American Academy of Nurse Practitioners, Foundation Grant, Malabsorption Anemia, Iron Supplementation, Self-Management Strategies and Adherence in Post- Roux-en-Y Gastric Bypass Patients. $10,000.00.

Coris EE, **Sahebzamani FM**, Zwygart K, Walz S, Cuppet M, Konin J, McElroy T and Pescasio M (2009). Core Temperature Prediction in Collegiate Football Athletes with Heat Illness Symptom Index (HISI) Scores. Funded National Football League $220,000.

Edmonds A, **Sahebzamani** FM, & Babione L (2004) Pedometer and Social Learning Intervention for 5th Grade Students at Bryan Elementary School in Plant City, Florida. USF Collaborative for Children, Families and Communities Grant: $ 8000.00.

Daley E, Woodard L J, **Sahebzamani** F M & Perrin K (2003). Public Sector Medicine Program, Womens Health Collaborative. Funded, Gulfcoast Allied Health and Education Center (AHEC): $42,000.00.

Woodard LJ., **Sahebzamani** FM. & Daley E. (2002). Public Sector Medicine Program, Womens Health Collaborative. Funded, Gulfcoast Allied Health and Education Center (AHEC) $49,998.00.

Sahebzamani FM. & Woodard LJ (2003). Primary care translator program. Funded, Gulfcoast Allied Health and Education Center (AHEC) $9000.00. Received status as a permanently funded program 2003 – present.

RESEARCH (Unfunded)

Sahebzamani, FM. (2012). Primary Care of the Post-Gastric ByPass Patient: A National Survey of Primary Care Providers.

Sahebzamani, FM, Munro CL, Marroquin OC, Diamond DM, Kip KE (2012). Warning - All Statins Are Not the Same: An Analysis of the FDA Adverse Event Reporting System (AERS) and Cognitive Dysfunction.

Ward, M. & **Sahebzamani, FM.** (2012). Phentermine for Weight Loss in Type 2 Diabetes Mellitus: Safety, Efficacy and Cardiovascular Risk Reduction in a University Ambulatory Care Setting: A Retrospective Study. (unfunded research).

Sahebzamani FM & D'Aoust, RF. (2012). Prevalence of Fibromyalgia in Women Veterans at High Risk for Post-traumatic Stress Disorder. Unfunded Sub Study of the pending project funded by the U.S. Army at the University of South Florida, College of Nursing entitled "*Nursing Health Initiative for Empowering Women Veterans,*"

APPENDIX A (continued)

NAME	POSITION TITLE
Jason W Beckstead	Associate Professor, Quantitative Methodologist
eRA COMMONS USER NAME jbeckste	

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	YEAR(s)	FIELD OF STUDY
University of Oklahoma	BS	1983	Psychology
State University of New York at Albany	PhD	1990	Experimental Psychology
Rensselaer Polytechnic Institute	Post-Doc	1990-1993	Specialized in applied experimental design in psychology of lighting & human factors research

Section A. Personal Statement.
My expertise in quantitative methods, experimental design, and cognitive psychology will complement the skills and qualifications of the co-investigators. My skill set adds an important facet to the already rich multidisciplinary approach brought to bear on this important research topic.

Section B. Positions and Honors.
1998 – Present: Quantitative Methodologist, Associate Professor, University of South Florida College of Nursing.

Grant Review Panelist: Human Social Dynamics Program, National Science Foundation, May 2008.

Winner of the Hammond-Brunswik New Investigator Award, Brunswik Society, November, 2008.

Grant Review Panelist: Health Care Delivery and Clinical Science, National Institutes of Health,
February, 2010.

Grant Review Panelist: Decision Risk & Management Sciences, National Science Foundation,
March, 2010.

C. Selected peer-reviewed publications.
Beckstead, J.W. & Boyce, P.R. (1992). Structural equation modeling in lighting research: An application to residential acceptance of new fluorescent lighting. *Lighting Research & Technology, 24*(4), 189-201.

Beckie, T.M., **Beckstead, J.W.** & Webb, M.S. (2001) Modeling women's quality of life after cardiac events. *Western Journal of Nursing, 23*(2) 179-194.
Selected peer-reviewed publications (cont.)

Beckstead, J.W., (2002). Using hierarchical cluster analysis in nursing research. *Western Journal of Nursing Research, 24*(3), 307-319.

Beckstead, J.W. (2002). Confirmatory factor analysis of the Maslach Burnout Inventory among Florida nurses. *International Journal of Nursing Studies, 39*, 785-792.

Beckstead, J.W., & Beckstead, L.G. (2006). A multidimensional analysis of the epistemic origins of nursing theories, models, and frameworks. *International Journal of Nursing Studies, 43*, 113-122.

Beckstead, J.W. (2007). A note on determining the number of cues used in judgment analysis studies: The issue of type II error. *Judgment and Decision Making, 2*(5), 317-325.

Beckstead, J.W., & Stamp, K.D. (2007). Understanding how nurse practitioners estimate patients' risk for coronary heart disease: A judgment analysis. *Journal of Advanced Nursing, 60*(4), 436-446.

Beckstead, J.W. (2008). Modeling sequential context effects in judgment analysis: A time series approach. *Judgment and Decision Making, 3*(7), 570-584.

Beckstead, J.W., Yang, C.Y., & Lengacher, C.A. (2008). Assessing cross-cultural validity of scales: A methodological review and illustrative example. *International Journal of Nursing Studies, 45*, 110-119.

Beckie, T.M. & **Beckstead, J.W.** (2011). The effects of a cardiac rehabilitation program tailored for women on their perceptions of Health: A randomized clinical trial. *Journal of Cardiopulmonary Rehabilitation and Prevention, 31*, 25-34.

Beckie, T.M. & **Beckstead, J.W**., Schocken, F., Evans, M., & Fletcher, G. (2011). The effects of a tailored cardiac rehabilitation program on depressive symptoms: A Randomized Clinical Trial. *International Journal of Nursing Studies, 48*, 3-12.

Beckstead, J.W., & Beckie, T.M. (2011). How much information can the metabolic syndrome provide? An application of Information Theory. *Medical Decision-Making, 31*(1), 79-92.

D. Research Support.

R01 NR005000-04A2, (**Groer, PI**) Project Period: 2007 – 2011
National Institute for Nursing Research
Influence of Lactation on Postpartum Stress and Immunity
Role: Co-Investigator

NAME	POSITION TITLE
Kevin B. Sneed	Professor and Dean
eRA COMMONS USER NAME KSNEED	

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	YEAR(s)	FIELD OF STUDY
Xavier University of Louisiana College of Pharmacy	PharmD	1994-1998	Pharmacy
University of Central Florida	BS	1990- 1992	Biological Sciences; conc. Microbiology

A. Personal Statement

As the founding dean of the USF College of Pharmacy at USF Health, I have dedicated significant effort in activities involving development of clinical practice models used for educational activities. Interprofessional program design and development is important when constructing community-based participatory research, which is a key component of the USF College of Pharmacy learning experience.

B. Positions and Honors.

Positions and Employment

1998-1999	Primary Care Pharmacy Resident, Bay Pines VA Medical Center, Bay Pines, FL
1999-2004	Assistant Professor, Florida A&M University College of Pharmacy, Tampa, FL
2004-	Ambulatory Care Coordinator, Florida A&M University College of Pharmacy, Tampa, FL
2004- 2007	Associate Professor, Florida A&M University College of Pharmacy, Tampa, FL
2007-2009	Assistant Dean, Clinical Director, University of South Florida College of Medicine
2009-	Dean, University of South Florida College of Pharmacy/USF Health

Other Experience and Professional Memberships

1997-	American Society of Health-Systems Pharmacists 1997- present
1998-	National Pharmaceutical Association 1998- present
2000-2010	Florida Pharmacy Association 2000- present
1998-2002	Florida Society of Health-Systems Pharmacists 1998- 2002
1998-2003	Association of Black Hospital Pharmacists 1999- present
1998-2001	American Pharmaceutical Association 1998- 2001
1994-1998	Student National Pharmaceutical Association 1994-1998
1994-1998	Academy of Students of Pharmacy 1994-1998

Honors

2007	Teacher of the Year, FAMU College of Pharmacy
2003	Preceptor of the Year, FAMU/ TGH Pharmacy Practice Residency

2002	Preceptor of the Year, FAMU College of Pharmacy Elected by Student Body – Tampa Division
2001	Young Pharmacist of the Year, NPHA
2001	Teacher of the Year, FAMU College of Pharmacy
2000	Dean's Award, Florida A & M College of Pharmacy
1998	Knights of Peter Claver – Gilbert Faustina Award
1998	Xavier University Service Key Award
1998	American Society of Health-Systems Pharmacist Student Leadership Award
1998	Louisiana Pharmacist Association Outstanding Student Award

C. Peer-reviewed publications (most recent in chronological order).

1. **Designing a Community-Based Lay Health Advisor Training Curriculum to Address Cancer Health** Clement K. Gwede, Atalie A. Ashley, Kara McGinnis, F. Alejandro Montiel-Ishino, Maisha Standifer, Julie Baldwin, Coni Williams, Kevin B. Sneed, Deanna Wathington, Lolita Dash-Pitts and B. Lee Green published online 14 September 2012 *Health Promot Pract*
2. **Proteomic response to acupuncture treatment in spontaneously hypertensive rats.** Lai X, Wang J, Nabar NR, Pan S, Tang C, Huang Y, Hao M, Yang Z, Ma C, Zhang J, Chew H, He Z, Yang J, Su B, Zhang J, Liang J, **Sneed** KB, Zhou SF.
   PLoS One. 2012;7(9):e44216. Epub 2012 Sep 12.
3. **An Innovative Approach for Community Engagement: Using an Audience Response System** Davis JL, McGinnis KE, Walsh ML, Williams C, Sneed KB, Baldwin JA, Green BL.. *Journal of Health Disparities Research and Practice*: 2012, Vol. 5: Iss. 2, Article 1
4. **Herb-Drug Interactions and Mechanistic and Clinical Considerations** Xiao-Wu Chen, Kevin B. Sneed, Si-Yuan Pan, Chuanhai Cao, Shu-Feng Zhou *Current Drug Metabolism, 2012, Vol. 13, No. 5 640-651*
5. **Computational and in vitro studies on the inhibitory effects of herbal compounds on human cytochrome P450 1A2.** Yang LP, Zhou ZW, Chen XW, Li CG, Sneed KB, Liang J, Zhou SF. Xenobiotica. 2011 Oct 4.
6. **Clinical Herbal Interactions with Conventional Drugs: From Molecules to Maladies.**
   Chen XW, Serag ES, Sneed KB, Liang J, Chew H, Pan SY, Zhou SF.
   Curr Med Chem. 2011 Sep 15.
7. **Pharmacokinetic profiles of anticancer herbal medicines in humans and the clinical implications.** Chen XW, Sneed KB, Zhou SF. Curr Med Chem. 2011;18(21):3190-210. Review.
8. **Ligand- and Protein-Based Modeling Studies of the Inhibitors of Human Cytochrome P450 2D6 and a Virtual Screening for Potential Inhibitors from the Chinese Herbal Medicine, Scutellaria Baicalensis (Huangqin, Baikal Skullcap)**

APPENDIX A (continued)

NAME	POSITION TITLE
Kip, Kevin E.	Associate Professor, Executive Director, Research Center
eRA COMMONS USER NAME Kevinkip	

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	YEAR(s)	FIELD OF STUDY
University of Central Florida, Orlando, FL	BA	1984	Psychology
University of Central Florida, Orlando, FL	MS	1987	I/O Psychology
University of Alabama-Birmingham, Birmingham, AL	MSPH	1994	Epidemiology
University of Pittsburgh, Pittsburgh, PA	PHD	1998	Epidemiology

A. Personal Statement. In brief, I have 12 years experience as an epidemiologist and biostatistician on NIH-funded studies encompassing all of the major epidemiologic study designs (both observational and randomized clinical trials). I am currently PI on two federally-funded studies (SAMHSA and U.S. Army Medical Research and Materiel Command) to study novel therapies for symptoms of post-traumatic stress disorder (PTSD) and other emotional problems. I have several publications in mental health and substance abuse research.

B. Positions and Honors

1994 - 1998 *Epidemiologist/Biostatistician*, University of Pittsburgh, Dept. of Epidemiology, Pittsburgh, PA
1998 *Adjunct Instructor - Epidemiology*, University of South Florida, Tampa, FL,
1998 - 1999 *Epidemiologist/Biostatistician*, Jaeb Center for Health Research, Inc. Tampa, FL,
1999 - 2002 *Assistant Professor - Epidemiology and Mental Health*, University of South Florida, Tampa, FL
2002 - 2007 *Assistant/Associate Professor - Epidemiology and Medicine*, University of Pittsburgh Graduate School of Public Health and Division of Cardiology, Pittsburgh, PA
2007 – pres *Associate Professor (tenured), Executive Director, Research Center*, University of South Florida, College of Nursing, Tampa, FL
2007 – pres *Affiliate Associate Professor*, Dept. of Epidemiology and Biostatistics, University of South Florida, College of Public Health, Tampa, FL

Other Experience and Professional Memberships

Referee: American Heart Journal (2004); American Journal of Cardiology (2002–present); American Journal of Medicine (2003); Archives of General Psychiatry (2007); Archives of Internal Medicine (2004); Archives of Ophthalmology (2004); Circulation

(2004-present); Critical Care Medicine (2006); JAMA (2000,2005); Journal of American College of Cardiology (1998-present); Journal of Behavioral Health Services & Research (2000 – 2002); Metabolism (2006); Nature Clinical Practice Cardiovascular Medicine (2008); Nursing Research (2008); Ophthalmology (1999-2004); Obesity Research (2006)

1999 – present	Member, Society for Epidemiologic Research
2003 – present	Member, American College of Epidemiology
2006 – present	Fellow, American Heart Association (FAHA)
2001	Invited Grant Reviewer, SAMHSA, Center for Substance Abuse Treatment
2003 – present	Invited Grant Reviewer, National Inst. Diabetes and Digestive and Kidney Diseases (NIDDK)
2009 – present	Invited Grant Reviewer, National Heart, Lung, and Blood Institute (NHLBI)
2004 – 2009	Member, Data Safety and Monitoring Board, NIDDK, Azathioprine in Crohn's Disease
2011 – present	Member, Data Safety and Monitoring Board, NIDDK, Action for Health in Diabetes" (Look AHEAD) Study

Honors.

Delta Omega Omicron Chapter - Doctoral Dissertation Award, Best Dissertation in the Department of Epidemiology, University of Pittsburgh, 1998

C. Selected peer-reviewed publications or manuscripts in press (from more than 100).

Kip KE, Bourassa MG, Jacobs AK, et al. Influence of Pre-PTCA Strategy and Initial PTCA Result in Patients with Multivessel Disease: The Bypass Angioplasty Revascularization Investigation. *Circulation*. 1999; 100:910-7.

Kip, KE, Cohen, F, Cole, SR, et al. Recall bias in a prospective cohort study of acute time-varying exposures: example from the herpetic eye disease study. *Journal of Clinical Epidemiology*, 2001; 54:482-7.

Kip, KE, Alderman, EL, Bourassa MG, et al. Differential influence of diabetes mellitus on increased jeopardized myocardium after initial angioplasty or bypass surgery: The Bypass Angioplasty Revascularization Investigation (BARI). *Circulation*, 2002; 105:1914-20.

Kip KE, McCreath HE, Roseman JM, et al. Absence of risk factor change in young adults after family heart attack or stroke: The CARDIA study. *American Journal of Preventive Medicine*, 2002; 22:258-66.

Selected Ongoing Research Support

Research to Improve Emotional Health/Quality of Life of Service Members with Disabilities

(Kip PI)

09/08/2010 – 10/07/2012. This project with the U.S. Army Medical Research and Materiel Command is evaluating psychological therapies (e.g. Acceptance Commitment Therapy, Accelerated Resolution Therapy) for service members and veterans with emotional symptoms of post-traumatic stress disorder (PTSD) and mild traumatic brain injury (TBI).

The NCHS Research Data Center
RDC – Student – Advisor Agreement

The RDC has worked with many students over the years. We can provide some help and expertise with the data you have chosen, however, we cannot replace the advisor in guiding the research process. The following agreement summarizes the general RDC rules and proposal process. **We ask all students and their advisors to read and acknowledge the following document and submit it along with their proposals.**

1. RDC services include:
   - Reviewing your proposal for feasibility and disclosure risk
   - Creating an analytic file consisting of public and restricted data
   - Reviewing the results of your statistical analysis for disclosure risk

2. RDC services **do not** include:
   - Giving extensive methodological or analytical advice – please consult the public use documentation and your advisor. While preparing your proposal, be sure to consult the public use documentation for each year you request. Files, concepts, variable names, and the availability of certain variables may change over time.
   - Helping you write statistical code
   - Creating public use files
   - Giving you any type of data file to use with you

3. The RDC Proposal Review Committee will usually make a decision within 6-8 weeks of receiving a complete proposal. We may approve, approve with conditions, or request that you submit a revised version. It is rare for us to reject a proposal; we prefer to work with you toward approval. The process is often iterative, with your RDC Analyst channeling comments from the reviewers to you. Please respond to our concerns as soon as possible, or the process may take substantially longer. Please allow us enough time so that you can meet any thesis or grant application deadlines.

4. Approval of a proposal allows you access to restricted data. It is not an endorsement of your research.

5. Your research protocol may change over time. Your methodology and analyses may change, and you may find you need to request additional variables. Please stay in touch with your RDC Analyst about any major changes, as you may need to submit the modifications for additional approval.

6. We strongly discourage the release of intermediate output. Advisors, this may mean that you cannot review all output generated by the student without coming on site to the RDC.

7. The output review process takes time depending on the mode of access, quantity of the output, and RDC staff workload. Output review may take five days or more, so please plan accordingly. Approved output will be emailed to the researcher.

I have read and agreed to the above statements and will plan accordingly. I have also read the , and agree to abide by all rules and restrictions of the NCHS Research Data Center.

Student: Shawn V. Davis Signature: Shawn V. Davis Date: 12/3/12

Advisor: Maureen Corcoran Signature: Maureen Corcoran Date: 12/6/12

Last Updated 3/1/2011

APPENDIX B

IRB Approval

APPENDIX B (continued)

From: eirb@research.usf.edu [eirb@research.usf.edu]
Sent: Tuesday, April 30, 2013 11:51 AM
To: Davis, Shani
Subject: eIRB: Amendment Approved

IRB Amendment Approved

To:	Shani Davis
RE:	Amendment 1 for IRB Study #Pro00005875 Vitamin D & AA Women
PI:	Shani Davis
Link:	Ame1_Pro00005875
	You are receiving this notification because the above listed amendment has received Approval by the IRB.To begin your review, navigate to the project workspace by clicking the Link above.