Understanding Diabetes Self-Management Behaviors among American Indian Adults

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Dedication

To my father, Randal Patrick Aronson, who died of complications from diabetes on December 21, 1994.

Abstract

Background: American Indians (AI) experience disparate prevalence, complications, and rates of death from diabetes compared to the general population. Diabetes self-management behaviors (DSMB) including healthy eating, physical activity, and medication adherence can improve glycemic control and prevent long-term complications. Prior studies, generally in non-AI populations, have suggested that distress negatively and resources positively impact DSMB participation, but have often studied influential determinants in isolation. In addition, the influence of contextual social-ecological determinants on personal determinants has been neglected.

Aim: This work describes the frequency of DSMB and tested a proposed model, based upon Andersen's Behavioral Model, to understand the relationships between appraisal of community distress and resources, personal distress and resources, and DSMB among a clinic sample of AI adults with type 2 diabetes.

Method: A cross-sectional computer assisted personal interview survey was administered to a random sample of 194 AI adults with a recent diagnosis of type 2 diabetes using care at Indian Health Service facilities in one of five upper Midwest reservation communities. Survey items included measures of healthy eating, physical activity, medication adherence, personal distress, personal resources, appraisal of community distress, appraisal of community resources, and demographic variables. Relying on Andersen's Behavioral Model as the conceptual framework, one model for each DSMB was tested using structural equation modeling.

Results: The mean days per week of healthy eating and physical activity reported by participants were 2.93 and 2.95, respectively. Based upon the 4-item Morisky Medication

Adherence scores 27.5% of the participants using medications met criteria for high and 20.5% for low adherence. The structural equation models for healthy eating and medication adherence displayed good fit and accounted for 60.4% and 29.6% of the variance in the DSMB, respectively. The model for physical activity did not fit the data and explained only 17% of the variance in physical activity. Personal resources and personal distress had strong direct relationships with healthy eating, while both gender and income had significant indirect relationships. Personal distress had a direct negative relationship with medication adherence, and both gender and education had indirect effects in this model. Indirect effects in each model were primarily due to paths through personal distress and personal resources. No significant direct or indirect paths were observed for appraisal of community distress or appraisal of community resources.

Conclusion: Rates of healthy eating and medication adherence found in this study are somewhat lower than previous estimates in other Native and non-Native samples. The proposed models fit well for healthy eating and medication adherence, but not for physical activity. For individuals from these communities, physical activity behaviors are not explained by this model and may be induced by other mechanisms. Given the strength of the relationships in the models, personal distress and personal resources may influence DSMB. In addition, several demographic variables may exert indirect influence upon DSMB: female gender through a strong positive relationship with personal distress, and income and education through a strong positive relationship with personal resources. The failure of appraised community determinants in the model may indicate the use of poor measured indicators of the latent constructs.

Implications: Facilitating and building personal resources and mitigating personal distress are potentially important clinical targets to improve healthy eating and medication adherence. Although appraised community level factors did not have relationships with DSMB, education and income had positive indirect effects. The community and contextual environment influence these demographic factors, thus future research may explore the possible distal relationship here. The findings also suggest that diabetes distress may act as a mediator between gender and DSMB.

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Preface: Definitions and Limitations Therein

Diabetes Self-Management Behaviors

Diabetes self-management behaviors (DSMB) are self-care activities recommended for all individuals with diabetes in order to maximize positive health outcomes. For the purpose of this study, DSMB refer specifically to medication adherence, healthy eating, and physical activity. These DSMB were chosen based upon: 1) their inclusion in disease management guidelines, 2) the evidence supporting their impact on disease management and outcomes, and 3) empirical evidence of the importance of these specific behaviors for disease management from individuals from the communities participating in this research. In practice a dialogue between health provider and care seeker should determine the best plan for health. It should not be a one-sized fits all approach. While this dissertation presumes the importance of DSMB, I acknowledge the limitations of blindly looking at DSMB as an outcome rather than determining how well individuals take care of themselves in a way that is best for them with a plan they have decided is best.

Medication Adherence

Medication adherence is defined for the purposes of this study as the consistency with which an individual takes their diabetes medications in the intended manner, or according to a plan developed in collaboration with and agreed upon by the person taking the medication (World Health Organization, 2003; Balkrishnan, 2005). This is readily operationalized as a measure of adherence that encompasses both intentional and unintentional non-adherence. Given this definition, I believe all plans for medication use and health management should take into considerations the patient's medication beliefs, cultural health beliefs, and other patient related factors (e.g., insurance, ability to use, social support, side-effects, comorbid conditions). I erroneously and naively assume in this work that all plans are developed in collaboration, and thus that medication adherence is based upon the individual's plan for their medication.

CHAPTER 1: INTRODUCTION

Diabetes is a colossal problem in the United States (U.S.) and globally, with enormous prevalence, staggering morbidity and mortality, and burgeoning costs for the health care system. American Indians and Alaska Natives (AI/ANs) are disproportionately impacted by diabetes. AI/ANs have the highest age-adjusted prevalence of any racial/ethnic group in the U.S. (Indian Health Service, 2007; Acton, Burrows, Moore et al., 2002; Harjo, Perez, Lopez, & Wong, 2011; Roberts, Jiles, Mokdad, Beckles, & Rios-Burrows, 2009; Blackwell, Lucas, & Clarke, 2014; Schiller, Lucas, & Peregoy, 2012), higher rates of complications due to diabetes (Barnes, Adams, & Powell-Griner, 2010; O'Connell, Yi, Wilson, Manson, & Acton, 2010), and are more likely to die from a diabetes-related complication than the general U.S. population (National Center for Health Statistics, 2012; Golden et al., 2012). These grave statistics signal the importance of investigating diabetes among AI/ANs.

Diabetes complications and deaths can be prevented or minimized through appropriate disease management. Disease management and care for an individual with diabetes generally includes the performance of certain disease specific care activities, or diabetes self-management behaviors (DSMB). This study will focus on the DSMB of medication adherence, healthy eating, and physical activity. Prior work has demonstrated a link between DSMB and improved diabetes-related outcomes (Encinosa, Bernard, & Dor, 2010; Farrell, Hains, Davies, Smith, & Parton, 2004; Peyrot, McMurry, & Kruger, 1999; Daly, Hartz, Xu, et al., 2009; Krapek, King, Warren, et al., 2004; Rhee, Slocum, Ziemer, et al., 2005; Dalewitz, Khan, & Hershey, 2000; Gibson, Song, Alemayehu, et al., 2010; Farmer, Rogers, Lonergan, et al., 2016). The importance of DSMB in the personal management of diabetes is clear.

Yet while these behaviors are linked with improved disease outcomes, there are many things that may influence a person to engage in, or not engage in, DSMB. In general, access to personal and social resources and support increases the likelihood, whereas distress and lack of resources reduces the likelihood. Resources like diabetes self-efficacy (Hernandez-Tejada, Campbell, Walker, Smalls, Davis, & Egede, 2012; Rosland, Kieffer, Israel, et al., 2008), coping efficacy (Hart & Grindel, 2010), general social support (Sherbourne, Hays, Ordway, DiMatteo, & Kravitz, 1992), and diabetes-specific social support (Wilson, Ary, Biglan, Glasgow, Toobert, & Campbell, 1986; Rosland et al., 2008; Tang, Brown, Funnell, & Anderson, 2008), are all positively correlated with engaging in DSMB. General stress (Farrell et al., 2004), diabetes distress (Polonsky, Fisher, Earles, et al., 2005), and depression (Lin, Katon, Von Korff, et al., 2004; Gonzalez, Safren, Cagliero, et al., 2007; Bell, Andrews, Arcury, Snively, Golden, & Quandt, 2010) all reduce the likelihood of engaging in DSMB.

A significant gap exists regarding the relationship between resources and distress on DSMB among AI adults with type 2 diabetes, and how community and personal determinants interplay. Most prior research has been conducted in non-AI populations, has investigated the impact of key determinants in relative isolation of one another, and has generally neglected the influence of community determinants on personal determinants. Providing knowledge regarding the rates of DSMB may aid clinicians in the community to identify areas where patients could need assistance to improve behaviors. Improving the understanding of factors impacting these behaviors will aid in empowering community members to promulgate and implement plans to positively impact the performance of DSMB, thereby improving disease management and health outcomes.

Aims

This research investigated DSMB among 191 AI individuals with a recently documented diagnosis of type 2 diabetes. I explore the relationship between appraisal of community distress and resources, personal distress and resources, and DSMB using an adapted form of Andersen's Behavioral Model of health care utilization. In this work I hypothesize that distress will negatively and resources positively impact DSMB, and that appraised community factors will be associated with personal factors. The specific aims of this study are:

Aim 1: To describe the frequency of DSMB (i.e., healthy eating, physical activity, and medication adherence) in 191 AI adults recently diagnosed with type 2 diabetes.

Aim2: To examine the empirical relationship between appraisal of community distress and resources, personal distress and resources, and DSMB in 191 AI adults recently diagnosed with type 2 diabetes.

Aim 3: To evaluate the fit of and relationships within a model to understand the relationship between appraised community and personal determinants and DSMB in 191 AI adults recently diagnosed with type 2 diabetes.

Local and Scientific Significance

This work has significance for the tribal communities partnering in this research and for the broader scientific community. For the communities involved, this research provides an understanding of constructs that are related to DSMB. Clinicians from the partnering communities will be armed with knowledge regarding what patients from these clinics are and are not doing to care for their diabetes, allowing practice improvements to be made. Strategies to improve performance of DSMB are postulated based upon the findings from this work. There is also a much broader significance to this work. Influential determinants of DSMB may be transferable to other AI/AN populations, other rural and minority population, and the general population at large. This work aims to improve the understanding of societal and personal determinants of DSMB, and explore the relationship between these multiple levels of influence in order to strengthen the body of literature surrounding these behaviors.

Conceptual Framework

In this study I have tried to incorporate and honor Indigenous perspectives on health. Prior Indigenous scholars' work has provided guidance and served as a reminder to acknowledge and interpret the findings in the context of the socio-historical experiences of Indigenous peoples. The Indigenist Stress-Coping Model is one example of such work (Walters, Simoni & Evans-Campbell, 2002). This model expands upon prior stress-coping models to include culturally specific traumas and buffers. In essence the model highlights the role of contextual and contemporary stressors that have resulted from genocidal and ethnocidal efforts of colonial forces. These traumas have negative effects on the individual level, and also on the family and social structure of Indigenous people as a whole (Evans-Campbell, 2008). Yet even more importantly, the model tells us what Indigenous people have known long before it was published: the positive impact of Indigenous culture, including family and community, spiritual coping, traditional health practices, identity attitudes, and enculturation (Walters et al., 2002). Here I highlight both the unfortunate cause of many health disparities and the strengths within Indigenous peoples.

Community-based participatory research (CBPR) also provides a theoretical orientation towards this research. Within this orientation, the traditional power dynamics of 'the researcher' and 'the researched' are muted in favor of an equal partnership (Minkler & Wallerstein, 2003). The basic tenets of CBPR are: 1) Recognizing the community as a unit of identity; 2) Building on strengths and resources of the community; 3) Facilitating collaborative partnerships in all phases of the research; 4) Integrating knowledge and action for mutual benefit of all partners; 5) Promoting a co-learning and empowering process that attends to social inequalities; 6) Involves a cyclical and iterative process; 7) Addresses health from both positive and ecological perspectives; 8) Disseminates finding and knowledge gained to all partners; and 9) Involves a long-term commitment by all partners (Israel, Schulz, Parker, & Becker, 1998). These principles have been contextualized and additional recommendations offered for collaborations with tribal communities (LaVeaux & Christopher, 2009). Importantly, these recommendations suggest: 1) Acknowledging historical experience with research and with health issues and work to overcome the negative image of research; 2) Recognize tribal sovereignty; 3) Differentiate between tribal and community membership; 4) Understand tribal diversity and its implications; 5) Plan for extended timelines; 6) Recognize key gatekeepers; 7) Prepare for leadership turnover; 8) Interpret data within the cultural context; and 9) Utilize Indigenous ways of knowing (LaVeaux &

Christopher, 2009). These principles are incorporated, followed, respected, and adapted in this research from conceptualization to dissemination.

The choice of conceptual framework for this research was based on several considerations. Namely, the ideal conceptual framework for this work must: 1) predict health decisions, 2) recognize both the personal and broader (i.e., community, or contextual) determinants of those personal health decisions, and 3) be mutable or adaptable for use in different populations and with variables relevant to the participants of this research. These requirements are necessary given the socio-historical context under which this research is performed. Further discussed in Chapter 2, but stated briefly here, the health of AI communities and AI people have been negatively impacted by colonialism, racism, and exploitative researchers. Use of a model that does not acknowledge the role of social inequities on behaviors and health would be remiss. A mutable framework allows the model to be adapted to meet the needs of the community, thus becoming a model that the community owns, rather than interpreting the results of this work through the Eurocentric lens of traditional theoretical frames.

Many theories, models, and frameworks have been used to understand health behaviors. Among these are the Health Belief Model, Theory of Planned Behavior, Social Cognitive Theory, and Andersen's Behavioral Model. The Health Belief Model was originally created to understand participation in health screenings, and contains four elements used to understand the behavior: perceived susceptibility, perceived severity, perceived benefits, and perceived barriers (Champion & Skinner, 2008). Perceived susceptibility and severity together make up the component perceived threat. Some early forms of the health belief model also included cues to action. Additional components have entered the Health Belief Model since its origin, including potential modifying factors (i.e., sociodemographic and structural variables) and the borrowed concept of perceived self-efficacy. The Health Belief Model has been criticized for neglecting culturally relevant constructs and external or contextual constructs. Given its limitations and failure to understand the impact of contextual factors on behaviors, the Health Belief Model does not provide a suitable framework for this work. The Theory of Planned Behavior grew out of attitudinal research and the Theory of Reasoned Action (Montano & Kasprzyk, 2008). The Theory of Planned Behavior includes external variables, but these variables are operationalized on a personal level (e.g., demographics, personality traits). The main components of the Theory of Planned Behavior are attitude, subjective norm, and behavioral control; each of these components can be broken down to their respective parts. The model posits attitude, subjective norm, and behavioral control directly influence the intention to perform a behavior, which subsequently influences the behavior itself. The Theory of Planned Behavior provides a useful framework for the study of DSMB in general. Distress and resources, as facilitators and barriers of DSMB, may influence perceived behavioral control, yet the broad construct of perceived behavioral control does not capture the nuance within the relationship of stress and resources. For the purposes of this study, the Theory of Planned Behavior does not provide the flexibility needed to understand the relationships between factors empirically identified in earlier work with the communities partnering in this research. Social Cognitive Theory resulted from the integration of cognitive psychology concepts within Social Learning Theory, and has been further influenced by concepts from sociology, political science, and humanistic psychology (McAlister, Perry, & Parcel, 2008). Unlike the Health Belief Model and the Theory of Planned Behavior, Social Cognitive Theory is grounded in reciprocal determinism, illustrating the influence of personal and environmental factors on personal behavior, and personal behavior back on personal and environmental factors. Said another way, Social Cognitive Theory recognizes the interaction between person and environment, a clear strength over other personal models of health behaviors. However, Social Cognitive Theory has been criticized for ignoring the individual experience. The core elements of Social Cognitive Theory are knowledge of risks and benefits of the behavior, perceived self-efficacy, outcome expectations about the costs and benefits of the behavior, goals, perceived facilitators, and impediments. Additional components include observational learning, self-regulation, and moral disengagement. A strength and shortcoming of Social Cognitive Theory is its broadness. While this theory provides an attractive framework for the study of health behaviors, it does not provide a model to understand how the elements within the theory are related. In this manner, Social Cognitive Theory does not serve as a suitable guide to test the interrelationships between important determinants of DSMB. The idea of reciprocal determinism, which serves as a possible strength of Social Cognitive Theory, complicates the process of modeling relationships based upon the theory. Additionally, the bulk of the literature testing Social Cognitive Theory focuses on only one element: self-efficacy (Allen, 2004). Therefore, while Social Cognitive Theory recognizes environmental determinants of behaviors, its limitations preclude use as the theory of choice for this work.

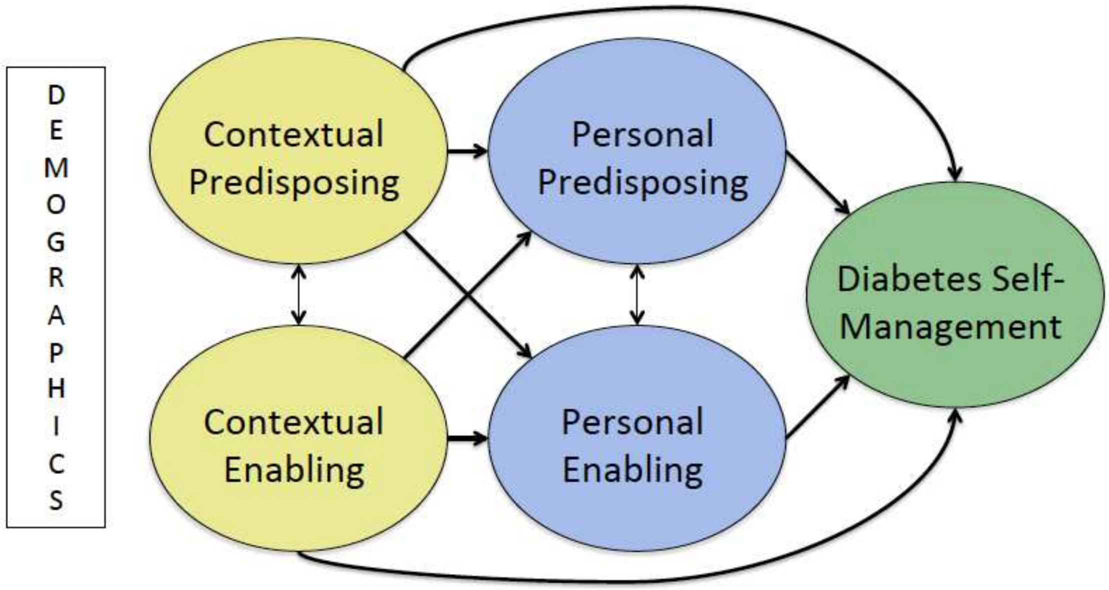
This research utilizes Andersen’s Behavioral Model (henceforth: Behavioral Model) as the guiding conceptual framework. The Behavioral Model (Andersen, 1968) was initially created to understand why health service utilization differed among different families; in particular this line of inquiry resulted from perceived inequities in the quality and quantity of medical care received by minority, inner city, and rural persons (Andersen & Newman, 1973). The Behavioral Model suggests that service use and outcomes are influenced by societal and individual determinants of health (Andersen & Newman, 1973). The model posits that health care is utilized when an individual or family is predisposed to receive health care, when there are appropriate factors which enable an individual or family to use the services, and when there is a real and perceived need for the services. Predisposing factors are characteristics that incite one to utilize health care services. Enabling factors are characteristics that influence, either by facilitating or impeding, health care utilization. Need factors include both the evaluated and perceived need for utilizing a particular health service. By understanding the predisposing, enabling, and need factors, the utilization of health care could be predicted.

The model has gone through numerous iterations over the past several decades (Andersen, 1995; Andersen, 2008), and has expanded to include predisposing, enabling, and need factors at both the contextual and individual level (see Appendix 1). Contextual characteristics include community characteristics, health organization and provider-related factors, generally measured at more of an aggregate rather than individual level. Individual characteristics are those determinants that are specific to an individual or a family. An example of an individual-level predisposing factor would be age, whereas a contextual predisposing factor may be the age-structure of the community. An example of an individual-level enabling factor would be social support, whereas a contextual-level enabling factor would include availability of assistance programs and number of providers in the community. The model has also been expanded to include personal health practices more broadly, as well as “downstream” outcomes including perceived and evaluated health, and consumer satisfaction (Andersen, 2008). It now incorporates feedback loops to illustrate that health behavior and outcomes can influence the contextual- and individual-level characteristics.

The outcome of interest in this work is DSMB, a health decision regarding one’s personal behaviors. The expanded Behavioral Model includes an element, Personal Health Practices, which encompasses DSMB. Researchers have used the Behavioral Model as a framework for researching a variety of Personal Health Practices; for instance, oral hygiene practices are included as a health behavior in one expanded form of the Behavioral Model (Andersen & Davidson, 1997). The DSMB of medication adherence (Unni & Farris, 2011; Wu, Erickson, Piette & Balkrishnan (2012); Coe, Moczygemba, Gatewood, Osborn, Matzke, & Goode, 2015; Ou, Mukherjee, Erickson, Piette, Bagozzi, & Balkrishnan, 2012), healthy eating (Glanz, Kristal, Sorensen, Palombo, Heimendinger, & Probart, 1993; Kristal, Patterson, Glanz, et al., 1995), and physical activity (Baernholdt, Hinton, Yan, Rose & Mattos, 2012; Suzuki, Krah, McCarthy & Adams, 2007) have all been utilized as outcomes in studies applying the Behavioral Model. The Behavioral Model recognizes both the societal and personal determinants of health decisions, referred to in the model as contextual and individual level characteristics. The constructs within the Behavioral Model are determined by the health decision of interest and the population being studied. For instance, in a study of homeless individuals, Gelberg, Andersen, and Leake (2000) adapted the model to include several elements specifically germane to the individuals participating in the research, including acculturation, victimization, and hunger. By using the Behavioral Model, factors identified by the community and prior literature can be infused in the model in order to guide the inquiry of determinants of DSMB. The Behavioral Model has been applied to wide and varied populations, including classical and adapted forms used for AI/ANs (Coughlin & Thompson, 2005; Hsiao, Wong, Godstein, et al., 2006; Cunningham & Cornelius, 1995).

An adapted form of the Behavioral Model guided this inquiry (see Figure 1 below). The components included in this model (appraisal of community distress, appraisal of community resources, personal distress, personal resources) were chosen based upon prior literature, as detailed in Chapter 2, and empirical data from the communities partnering in this research. Specifically, focus groups were held in each community during the summer of 2013 with people who had diabetes. Thematic analysis of these transcripts produced several themes relevant to diabetes management. Among these themes were: community stress in several forms, community infrastructure problems interfering with disease management, diabetes as an overwhelming source of stress, and social support as key to success in diabetes management (Soper, Hautala, & Walls, 2012; Hautala, Soper, & Walls, 2012; Walls, 2013). Distress at both a community and personal level were conceived to be predisposing factors, inciting one to engage or not engage in DSMB. Community and personal resources were supposed to be enabling factors, their presence facilitating and absence hindering DSMB. The hypothesized relationships between all constructs and DSMB are displayed in Table 1. The directional influence of factors on DSMB is based upon prior literature as detailed in Chapter 2 and Chapter 3.

Figure 1. Adapted Behavioral Model



Adapted from Andersen, R.L. (2008). *Medical Care*, *46*, 647-653.

Table 1. Hypothesized relationship between study constructs and DSMB

Behavioral Model Label	**Study Construct**	**Hypothesized Direction of Relationship with DSMB**
Contextual Predisposing	Appraisal of community distress	Negative
Personal Predisposing	Personal Distress	Negative
Contextual Enabling	Appraisal of community resources	Positive
Personal Enabling	Personal Resources	Positive

DSMB = Diabetes self-management behaviors

Several demographic variables are included in multivariable analyses this study. Gender, age, income, educational attainment, and living on reservation lands were controlled for given their potential important relationships with the other variables in this study. Prior literature has suggested that DSMB may differ by age (Zivin, Ratliff, Heisler, Langa, & Piette, 2010; Lee, Wang, Lui, Morisky, & Wong, 2013; Lee, Ahn, & Kim, 2013) and gender (Lopez et al., 2014; Zivin et al., 2010), and as traditional control variables, they are included here as well. Additionally, distress may differ by gender, with women historically having higher rates. Income and educational attainment are also included in this study as markers of socioeconomic status, supposed to be negatively related to personal distress, and positively related to personal resources and DSMB. In prior studies we have controlled for living on reservation lands due to disparities in material and structural goods found for those living on reservation lands compared to those who do not live on reservation lands. It is supposed that living on reservation lands will be negatively associated with income and appraisal of community resources, and positively associated with appraisal of community distress. If the findings support a strong indirect relationship between residing on reservation lands and attenuated DSMB, it serves as impetus for possible policy aimed at improving communities and providing funding for tribal communities. It would indicate that, consistent with recent literature (Bradley, Canavan, Rogan, et al., 2016), spending more on social services and public health than health care services might be an effective strategy to improve health.

CHAPTER 2: REVIEW OF THE LITERATURE

Cultural Context for AI Health

The ongoing health disparities that have afflicted AI communities have been well documented (Jones, 2006). To appropriately understand these disparities, however, one must look back to their origins. A series of traumatic events over many generations have had enduring consequences for AI individuals, families, and communities, including negative effects on health (Brave Heart & DeBruyn, 1998; Evans-Campbell, 2008). While these traumatic events and historical outrages are not the focus of this work, the interpretation of data regarding the individuals and communities affected cannot be appropriately interpreted without regard to the colonial and post-colonial context which impacts them. In order to set the contextual backdrop for this work, one must recognize the impact of colonialism.

Colonialism can be conceptualized as western European nations' dominance and subjugation over Indigenous peoples in Indigenous peoples' homelands (Ashcroft, Griffiths, & Tiffin, 2000). AI peoples have been subjected to diseases, forced relocation, massacres, theft of children for education in boarding schools, oppression of traditional belief systems and ways of living, and genocidal and ethnocidal efforts of the colonizers (Evans-Campbell, 2008). The trauma is not purely historical, for the ramifications of past atrocities of colonization have persistent effects on AI individuals and communities (Evans-Campbell, 2008). Unresolved grief and anger over theft of culture, language, land, and traditional ways of living are stressors that a large proportion of AI individuals, adults as well as youths, think of on a daily basis (Whitbeck, Adams, Hoyt & Chen, 2004; Whitbeck, Walls, Johnson, Morrisseau & McDougall, 2009). Additional contemporary stressors, such as poverty, racism and discrimination, child abuse and neglect, and violence, are direct byproducts of the economic and political systems perpetuated by practices and policies of colonialism. Pearlin's (1981) stress process model describes how stress exposure can lead to negative mental and physical health consequences. The differential exposure of stress for AI groups has resulted in disparate rates of disease.

Type 2 Diabetes: An Epidemic for AI Communities

One such disparity is in the prevalence of type 2 diabetes, complications from diabetes, and diabetes-related mortality. AIs as a group have 2.1 times higher prevalence of diabetes than the general population (17.8% vs. 8.5%; Summary Health Statistics for U.S. Adults: National Health Interview Survey, 2014). Consistently, AI/ANs have the highest age-adjusted prevalence of diabetes among all racial and ethnic groups (Blackwell et al., 2014; Schiller et al., 2012; Centers for Disease Control and Prevention, 2011). The disturbing trend of a growing rather than shrinking disparity has been seen for the past 26 years (Indian Health Service, 2007; Acton et al., 2002; Harjo et al., 2001; Roberts et al., 2009). In an analysis of the California Health Interview Survey, Harjo and colleagues (2011) reported that the prevalence of diabetes was highest among AI individuals (14.9%) compared to all ethnic groups, and this disparity remained after controlling for age, gender, other risk factors, and lifestyle characteristics. Other past studies have also demonstrated a higher prevalence of diabetes among AIs compared with the general U.S. population (Lee, Howard, Savage, et al., 1995; Will, Strauss, Mendlein, Ballew, White, & Peter, 1997). For AI individuals under 35 years of age, from 1990-1998, the prevalence of diabetes increased by 46%, from 6.4 per 1000, to 9.3 per 1000 population (Acton et al., 2002). More recent data similarly suggests a widening disparity.

During the time period from 1994 to 2000, AI/AN young adults aged 18 – 34 were 1.7 times more likely than non-Hispanic White young adults to be diagnosed with diabetes (Roberts et al., 2009). From 2001 to 2007, the odds increased, with AI/AN young adults 2.5 times more likely to be diagnosed (Roberts et al., 2009). Likewise, in 2001 AI/AN youth aged ten to nineteen were 9 times more likely to be diagnosed with type 2 diabetes than non-Hispanic Whites (SEARCH for Diabetes in Youth Study Group, 2006).

Indigenous adults in the U.S. have statistically higher rates of morbidity (i.e., more complications from diabetes) compared to other U.S. adults (O'Connell et al., 2010; Barnes et al., 2010; National Center for Health Statistics, 2012), and are 1.6 times more likely to die from a diabetes-related complication than the general U.S. population (34.5 vs. 21.8 per 100,000; National Center for Health Statistics, 2012). Compared to non-Hispanic White persons, non-Hispanic AI/ANs from 2000 to 2009 had age-adjusted rates of diabetes-related deaths 2.5 to 3.5 times higher (Cho, Geiss, Rios Burrow, Roberts, Bullock, & Toedt, 2014). In 2013 diabetes was the 4th leading cause of death among AI/AN of all ages (Murphy, Xu, Kochanek, & Bastian, 2016). Diabetes is clearly an enormous public health problem for AI individuals and communities.

Before proceeding, it is important to recognize the diversity of AI/AN groups and peoples. AI/ANs come from 566 Bureau of Indian Affairs Federal Registry recognized tribes, many state recognized tribes, and other non-recognized tribes, and speak more than 200 different languages. There is also great diversity in diabetes prevalence and health beliefs between tribal groups from different areas of the U.S. Prevalence rates of diabetes across AI/AN groups range from 5.5% among AN adults to 33.5% among AI adults in southern Arizona (Centers for Disease Control and Prevention, 2011). AIs from

Great Lakes tribes have relatively high rates of diabetes (14.98), with an age-adjusted prevalence in 1998 second only to AIs from Southeast tribes (Burrows, et al., 2000).

Diabetes Self-Management Behaviors

Diabetes leads to kidney failure, non-traumatic lower-limb amputation, and blindness more so than any other causes (Centers for Control and Prevention, 2011). It also is a major cause of heart disease and stroke (Centers for Control and Prevention, 2011). In order to reduce disease complications, the American Diabetes Association (ADA) Standards of Medical Care (2016) endorse guidelines for the diagnosis and management of diabetes. Among these management strategies are several DSMB, including: healthy eating, physical activity, and medication adherence (American Diabetes Association, 2016). These behaviors are embedded in guideline because they have been associated with improved outcomes in patients with diabetes.

Several studies have linked DSMB to glycemic control (Farrell et al., 2004; Peyrot et al., 1999; Daly et al., 2009; Dalewitz et al., 2000). Structured physical activity has been shown to lower A1C by over 0.5% over 8 weeks (Boulé, Haddad, Kenny, Wells, & Sigal, 2001), with higher intensity resulting in greater reductions in A1C (Boulé, Kenny, Haddad, Wells, & Sigal, 2003). The ADA and American College of Sports Medicine summarize the benefits of exercise for individuals with type 2 diabetes outcomes in their joint position paper (Colberg, Sigal, Fernhall, et al., 2010). Diet interventions also improve glycemic control (Franz, Monk, Barry, et al., 1995; Lemon, Lacey, Lohse, Hubacher, Klawitter, & Palta, 2004). An ADA position statement summarizes the evidence for, and details specific nutritional recommendations for persons with diabetes (Bantle, Wylie-Rosett, Albright, et al., 2008). Individuals with better medication adherence have lower A1c levels (Krapek et al., 2004; Rhee et al., 2005; Egede, Gebregziabher, Echols, & Lynch, 2014). Encinosa and colleagues (2010) reported that medication adherence was associated with decreased hospitalizations, decreased emergency department visits, improved glycemic control, and decreased long-term disease complications. In addition, for every $1 spent on drugs to treat diabetes, there is $1.14 cost offset for averted hospitalizations and emergency department visits (Encinosa et al., 2010). Medication adherence is also associated with lower rates of amputation/ulcers, heart attack, neuropathy, nephrotic syndrome, and retinopathy (Gibson et al., 2010).

Rates of DSMB vary depending upon the specific activity and various other factors. In a multiethnic sample of elders and using the Summary of Diabetes Self-Care Activities (SDSCA), Schoenberg and colleagues, (2008) reported the highest adherence to medication regimens, followed by diet and foot care activities, slightly lower self-monitored blood glucose (SMBG), and the lowest rates for performance of physical activity (a median of 6, 5, 5, 4, and 3 days per week respectively). In a sample of Native Hawaiian and other Pacific Islanders, medication adherence was highest (4.8), followed by SMBG (4.2), specific diet and foot care (3.7), general diet (3.6), and diet days (3.5) (Inouye, Li, Davis, & Arakaki, 2012). At baseline, in a sample of aboriginal adults with type 2 diabetes, average days per week of healthy eating were 4.5 for general diet, 4.2 for consuming the recommended quantity of fruits and vegetables, 3.1 for eating low fat foods, and 3.1 for exercise (Dreger, Mackenzie, McLeod, 2015). In a sample of Cherokee adults with type 2 diabetes using the SDSCA, individuals reported highest rates for medication adherence, followed by foot care, SMBG, and lowest rates of exercise and diet (Mashburn, 2012). Other studies have reported similar trends, with adherence to a medication regimen being performed more consistently than other behaviors, and diet and exercise being performed least consistently (Ruggiero, Glasgow, Dryfoos, et al., 1997).

Factors Impacting Diabetes Self-Management Behaviors

Previous research has identified several correlates of DSMB. After conducting a systematic review of the literature surrounding factors influencing medication adherence among those with type 2 diabetes from different racial/ethnic groups, Peeters and colleagues (2011) provided several compelling recommendations for future research. While their insights were concerned with medication adherence, they transcend to all DSMB. Among these recommendations are to: 1) use the findings from qualitative research to inform quantitative measurement, 2) involve members from the ethnic or racial group "under study" in the design, conduct, and analysis of the research, and 3) not limit variable selection to those used in the majority culture (Peeters et al., 2011). Given the import of resources and distress, identified in both prior qualitative and quantitative literature and empirically by the communities partnering in this research, I focus on these elements here.

Prior literature has implicated distress as having a negative relation with performance of DSMB. Distress from the environment or the experience of living in a particular community could negatively influence behaviors. For instance, in a qualitative study Schoenberg and colleagues (2008) found that stressful environments negatively impacted the ability of individuals to engage in DSMB. Alternatively, distress on an individual may impact behaviors. Higher levels of general stress have been linked to less adherent behavior as measured by the Diabetes Compliance Questionnaire, a marker of dietary adherence, medication adherence, and glucose testing (Farrell et al., 2004). Diabetes-related emotional distress is negatively associated with diet and medication adherence (Fisher, Glasgow, & Stryker, 2010a; Fisher, Skaff, Mullan, et al., 2007; Fisher, Skaff, Mullan, Glasgow, & Masharani, 2008a). Depression, one of four modifiable barriers to medication adherence (Gellad, Grenard, & McGlynn, 2009), is significantly and inversely related to engaging in DSMB (Lin et al., 2004; Gonzalez et al., 2007; Bell et al., 2010). While depression has been implicated, diabetes distress has been shown more predictive of glycemic control than depression (Fisher et al., 2007; Fisher et al., 2008a; Fisher et al., 2010a; Fisher, Mullan, Arean, Glasgow, Hessler, & Masharani, 2010b). Also, diabetes distress exhibits greater persistence over time compared to affective and anxiety disorders (Fisher et al., 2007).

Resources are positively connected to DSMB. Resource challenges in a community may negatively influence DSMB (Shoenberg et al., 2008). Conversely, personal resources positively impact behaviors. Higher levels of diabetes empowerment, a marker of diabetes self-efficacy, are significantly associated with adherence to medication, diet, exercise, SMBG, and foot-care recommendations (Hernandez-Tejada et al., 2012). In a qualitative study with AI/AN adults with type 2 diabetes, self-efficacy was indeed one of the identified components that had a positive impact on diabetes management (Shaw, Brown, Khan, Mau, & Dillard, 2013). Among an AI/AN sample, disease specific self-efficacy was strongly related to DSMB including diet, exercise, blood glucose testing, foot care, and not smoking (Turner DePalma, Trahan, Eliza, & Wagner, 2015). Social support is another resource positively associated with DSMB (Sherbourne, Hays, Ordway, DiMatteo, & Kravitz, 1992). Diabetes-specific social support is associated with several DSMB including diet, exercise, medication adherence, SMBG, and foot-care (Wilson et al., 1986; Tang et al., 2008; Rosland, et al., 2008). These quantitative findings are echoed in a qualitative work with AI/AN adults, where social support was perceived to be helpful in managing diabetes (Shaw et al., 2013).

Summary of Literature

DSMB are important to improve disease outcomes and reduce disease morbidity and mortality, and both resources and distress are related to the behaviors. The influential determinants of DSMB have mainly been studied in isolation, and the influence of contextual social-ecological determinants on personal determinants has been neglected. In other words, the interplay between demographic factors, community factors, personal factors, and behaviors remains unknown. Furthermore, despite the breadth of literature examining prevalence and correlates of DSMB in the general population, a significant gap exists regarding these behaviors in AI adults with type 2 diabetes. A recent systematic literature review found only twenty studies in the twenty-seven year period from 1987 to 2014 investigating emotional and behavioral aspects of diabetes care among AI/ANs (Scarton & de Groot, 2016). Knowledge regarding the performance of these behaviors will help clinicians in the community identify areas where patients need assistance. Knowledge of the factors impacting these behaviors will aid the development of interventions to expand engagement in DSMB, which will improve disease management and health outcomes.

CHAPTER 3: METHODOLOGY

The purpose of this research was to determine how psychosocial factors and material and structural resources influence DSMB among AI adults recently diagnosed with type 2 diabetes. Using an adapted form of the Behavioral Model, distress and resources at the individual and community level were explored. I hypothesize that DSMB are positively impacted by resources (i.e., social support, diabetes empowerment, and appraisal of community resources), and negatively impacted by distress (i.e., diabetes distress and community stress); additionally, it is postulated that these determinants operate in tandem to impact DSMB according to a hypothesized model. The specific aims of this study are:

Aim 1: To describe the frequency of DSMB (i.e., healthy eating, physical activity, and medication adherence) in 191 AI adults recently diagnosed with type 2 diabetes.

Aim2: To examine the empirical relationship between appraisal of community distress and resources, personal distress and resources, and DSMB in 191 AI adults recently diagnosed with type 2 diabetes.

Aim 3: To evaluate the fit of and relationships within a model to understand the relationship between community and personal determinants and DSMB in 191 AI adults recently diagnosed with type 2 diabetes.

Data source

Data are from the Maawaji' idi-oog mino-ayaawin (Gathering for Health; NIH R01-DK09091250, PI M. Walls) study, a community-based participatory research collaboration between five AI communities and university research partners (University of Minnesota Medical School, Duluth campus, University of Nebraska-Lincoln, and Oklahoma State University). All five communities provided tribal resolutions to support the project, and the Indian Health Service (IHS) clinics in these communities have provided letters of support. Both the University of Minnesota Institutional Review board (IRB) and IHS national IRB have provided approval (IRB study number 1206S16361, and protocol N13-BE-07, respectively). The Maawaji' idi-oog mino-ayaawin study is a mixed methods sequential exploratory study to improve the measurement and understanding of stress processes among AI adults, as well as the understanding of interactions between stress processes, adherence, and type 2 diabetes management and control. A representation of the study model is displayed below (Figure 2). Ge-Waden and Gabrielle Dunkley designed this model, with conceptual input from Gathering for Health Community Research Council members. This model represents an Ojibwe interpretation of the stress process underlying the Gathering for Health research study. Ge-Waden and Gabrielle Dunkley provided the following interpretation of the model:

> *"The stress measures are by the berries to show that you can pick them off and measure them as with the risk factors. The treatment compliance (disease management) and Mental Health are the vines that represent what the stress and risk has to go through to reach you, the flower in the center. The sun in the center top representing the coping resources and responses that can help grow the flower. This is all on the vine to represent that no matter who you are all these aspects affect you and you will have to carry all of these with you on your personal vine."*

Figure 2. Gathering for Health Conceptual Model*

**Created by Ge-Waden & Gabrielle Dunkley, with conceptual guidance from the Gathering for Health Community Research Council members*

The qualitative phase consisted of two sets of focus groups. The first set of focus groups attempted to understand the breadth of stressors and methods of coping with stress among AI adults with type 2 diabetes. Focus group data was transcribed verbatim and thematically analyzed by university research partners in order to guide the selection and creation of instruments for the second set of focus groups and quantitative phase of the project. The second set of focus groups, with different participants, was conducted to evaluate and gain feedback on the potential stress survey items. In addition to focus group data, Community Research Councils from each community provided feedback, and the survey was pilot tested by several individuals self-identifying as AI. These sources of feedback were used iteratively to modify existing scales for use in the quantitative phase. Modification of standardized measures allowed the community members to shape the research and added significantly to the face validity of the measures. Despite the strengths of adapting the measures, a rigorous psychometric evaluation of these measures would ensure content and criterion validity further.

The quantitative phase is ongoing and includes longitudinal collection of data over the course of 18 months (i.e., Baseline, 6 months, 12 months, 18 months) from surveys administered by computer-assisted personal interviews (CAPI), salivary cortisol samples, and medical chart reviews. I used baseline CAPI survey data to address the research questions and specific aims detailed above. Specifically, the survey data provides a self-report from AI with newly diagnosed diabetes on their current self-management practices. It also provides assessments of their perceptions regarding personal and appraisal of community distress and resources.

Sample and recruitment

Each of the five tribal communities partnering in this research have reservation health care facilities. At the beginning of four sequential 6-month recruitment periods from 2013 to 2015, trained clinic staff at each site randomly selected patients from clinic records. Inclusion criteria for this study were a recent diagnosis of diabetes, age 18 or older, and self-identification as AI. Clinic staff first established a sampling frame by creating a list of individuals 18 or older with a diagnosis of diabetes documented within the last 5 years using the clinic's electronic medical record. This list was generated and randomly sampled from at the beginning of each of the four first study periods. Interviewers queried sampled individuals to determine if they met these criteria, in particular, did they self-identify as American Indian, and had they been diagnosed with diabetes. A total of 344 individuals were sampled. Of those sampled, 43 were excluded from participation (i.e., did not meet inclusion criteria), 11 were unable to be contacted, and 96 declined participation. The baseline study response rate was 66.9%, with 194 providing consent to participate in the study. CAPI survey data for this study includes 191 cases. VOXCO data for two cases was lost due to technical errors involving the VOXCO survey software uploads for two participants. Additionally, one participant failed to complete the majority of the VOXCO survey and is excluded from these analyses as they completed only the demographic items.

Procedure

Clinic staff contacted sampled individuals using a postal mailing to the residences on file from clinic records. The information included an invitation letter, study brochure, and both telephone and prepaid mail-in options for refusal. Trained community interviewers contacted non-refusing sampled individuals to screen for study eligibility and formally ask for their participation. Individuals agreeing to participate underwent the consent process and completed HIPAA authorization forms. The CAPI survey was administered in a location of the participants' choice using 2 computer administered survey software programs, VOXCO for most survey items and Blaise for diagnostic interviews. Participants received a $50 incentive for completion of the CAPI survey, as well as an additional $50 for correct completion of salivary cortisol samples. Consistent with cultural norms, a small traditional gift of wild rice was also provided. Interviewers transmitted the encrypted survey data electronically to secure servers, where it was converted to SPSS data files and cleaned by university research partners at the University of Nebraska-Lincoln.

Measures

The complete list of items is shown in Appendix 2. All survey measures in this research underwent a review process with possible adaptation to ensure items were relevant to community members with diabetes and culturally appropriate, as described above. In addition, slight adaptations were made given the nature of a CAPI (i.e., interviewers read the questions aloud, whereas many scales were designed to be self-administered). Because scales were significantly adapted for community use or created based upon qualitative data, I inspected the wording of each item in the context of the scale, conceptual fit with other scale items, interviewer feedback from administering the survey, inter-item correlations, and Cronbach's alpha to construct scales to be used in further analyses. Adaptations are described below for each scale, where applicable.

Medication Adherence. The 4-item Morisky Medication Adherence Scale (MMAS-4) was used to measure medication adherence to diabetes medications (Morisky, Green, & Levine, 1986). In the initial demonstration of this scale, an alpha reliability of 0.61 was reported, along with concurrent and predictive validity for blood pressure control (Morisky et al., 1986). Among those with diabetes, the MMAS-4 correlates well with A1C (Krapek et al., 2004). A similar measure, the 8-item Morisky Medication Adherence Scale, has a strong correlation with pharmacy fill rates (Krousel-Wood, Islam, Webber, Morisky, & Muntner, 2009), suggesting despite its subjective nature, the Morisky scale correlates well with other non-humanistic markers of adherence. The MMAS-4 has been slightly updated and reworded from the initial scale based upon focus group comments (Morisky & DiMatteo, 2011), with the current form allowing for study of medications for a particular disease state (for instance, diabetes medications). Urine drug levels, one method of determining actual medication adherence in some medications, significantly correlates with the reworded MMAS-4, and the criterion and discriminant validity has been established as well (Morisky, Malotte, Choi, et al., 1990; Morisky & DiMatteo, 2011). MMAS-4 items are answered as either Yes or No, and include representative items such as “Do you sometimes forget to take your diabetes medicine?” Affirmative responses were coded as 0 with items summed for a possible score ranging from 0 to 4. A higher score indicates higher adherence. A cutoff of 0 or 1 indicates low adherence, 2 or 3 medium adherence, and 4 high adherence. Only 2 individuals had missing data, both on the second item of the scale. Missing data were handled differently for the MMAS-4 per standard criteria for the MMAS scales; individuals with missing data on only one item had the median value for that item imputed (D. Morisky, personal communication, November 2, 2015). This means that I manually imputed a response of “No” for the second item for those 2 missing responses. The Cronbach’s alpha in this study was 0.654.

Healthy Eating and Physical Activity. Both healthy eating and physical activity were assessed using the Summary of Diabetes Self-Care Activities scale (SDSCA; Toobert & Glasgow, 1994; Toobert, Hampson, & Glasgow, 2000). The complete SDSCA provides estimates of adherence to several DSMBs including: diet, exercise, blood-glucose testing, foot care, and smoking. SDSCA items have high inter-item correlations within each DSMB (or subscale), with a mean correlation of 0.47, except the specific-diet item (Toobert et al., 2000). This measure correlates well with other self-report measures of self-care, and has moderate test-retest correlations (0.4) (Toobert et al., 2000). The SDSCA has been used as a measure of DSMB among AIs, with an alpha value of the entire scale of 0.775 (Mashburn, 2012). One prior study in AI/ANs found a low Cronbach's alpha for the specific diet items (Turner DePalma et al., 2015). Five items from the SDSCA were used to assess healthy eating (3 items) and physical activity (2 items). The SDSCA asks participants, "On how many of the past seven days" they followed particular recommendations including eating five or more servings of fruits and vegetables in a single day, and participating in at least 30 minutes of physical activity. Responses range from 0 to 7. Items in each scale are averaged, with a higher score representing greater performance of the DSMB. One of the original diet items from the SDSCA ("On average, over the past month, how many DAYS PER WEEK have you followed your eating plan") was not administered based upon feedback that the item was difficult to understand and duplicative with the first diet item. Interviewers flagged one administered item as possibly misinterpreted and poorly performing during CAPIs. This item asked individuals: "Did you eat high fat foods such as high-fat meat or full fat dairy products?" Indeed, this item did not correlate well with the other two healthy eating items (bivariate correlations of 0.267 and 0.040) and was dropped. The Cronbach's alpha of the healthy eating and physical activity subscales were 0.595 and 0.670, respectively.

Appraisal of community distress. Appraisal of community distress was operationalized using items surrounding community-wide stress (CWS) developed from the Phase 1 focus group data. Transcripts from the five communities were analyzed and coded by research assistants to develop themes. The themes were used to develop items in order to create a measure of general stress surrounding the wellbeing of the community. Face validity was established through expert review, Community Research Council feedback, and pilot testing with individuals who self-identified as American

Indian. The resultant preliminary scale contained 7 items rated from Strongly Disagree (0) to Strongly Agree (3). Two items were reverse coded to match the directionality of the other items. Inspection of the items yielded three main theoretical domains, future generation worry (3 items), optimism for future economic climate (2 items), and financial worry for others (2 items). The future generation worry items were used for further analysis, and had a Cronbach's alpha of .708. A sum score was created where a higher score indicates higher community stress.

Personal Distress. Personal distress was operationalized using diabetes distress, a type of diabetes-related emotional distress. Diabetes distress was measured using the Diabetes Distress Screener (DDS-2). Originally, the 17-item Diabetes Distress Scale (DDS) was developed in order to assess diabetes-related emotional distress (Polonsky et al., 2005). Diabetes distress has been negatively associated with self-care activities (Polonsky et al., 2005), and with glycemic control (Fisher et al., 2007; Fisher et al., 2008a; Fisher et al., 2008b; Fisher et al., 2010a; Fisher et al., 2010b). A brief 2-item screening instrument, the DDS-2, was created from the initial 17-items DDS (Fisher et al., 2008b). The DDS-2 has a sensitivity and specificity of 0.95, correctly screens 96.7% of respondents, has a false negative rate of 3.3%, and a false positive of 15.1% (Fisher et al., 2008b). It also discriminates between A1C, non-HDL cholesterol, saturated fat % consumed, and kilocalories consumed per day (Fisher et al., 2008b). The DDS-2 asks respondents to rate on a 6-point scale (adapted for CAPI use to read: '1' not at all bothersome, '6' very bothersome) the degree to which the items have distressed or bothered them over the past month (Fisher et al., 2008b). Items include feeling overwhelmed by the demands of living with diabetes, and feeling of often failing with diabetes regimen. The 2-item screener was chosen over the full DDS to reduce participant burnout, and due to the sensitivity, specificity, and high percentage of participants who would be correctly screened. Individuals who score ≥ 6 are considered to have diabetes distress (Fisher et al., 2008b).

Appraisal of community resources. Appraisal of community resources was operationalized through perceptions of neighborhood design features and walkability, as measured using an adapted version of the Neighborhood Environment Walkability Scale (NEWS; Saelens, Sallis, Black, & Chen, 2003). The complete NEWS contains several subscales intended to measure perceptions of neighborhood design, including: residential density, land-use mix diversity, land-use mix access, street connectivity, infrastructure and safety for walking, aesthetics, traffic hazards, and crime, among others (Saelens et al., 2003). This scale was significantly adapted during the review process given that the original scale was designed for an urban cohort. Items were originally worded as agree or disagree statements. The items were reworded to yes or no question format based upon focus group and Community Research Council input. Additionally, the word neighborhood was changed to community based upon qualitative feedback. As an example, one item originally read, "There are many attractive natural sights in my neighborhood" and was changed to, "Are there attractive natural sights in your community?" Three reworded items from the infrastructure and safety for walking subscale, and three reworded items from the aesthetics subscale were kept. One additional item for infrastructure and safety for walking was added based upon the community review process ("Are you concerned about dogs or other animals coming after you when you walk?"). Items in each subscale were summed to create a score ranging from 0 to 4 for infrastructure subscale, and 0 to 3 for aesthetics. The Cronbach's alpha for the infrastructure and safety for walking and aesthetics subscale were 0.517 and 0.625 respectively.

Personal Resources. Personal resources were operationalized as diabetes self-efficacy and diabetes-related social support. Diabetes self-efficacy was assessed using the Michigan Diabetes Research and Training Center's Diabetes Empowerment Short-Form (DES-SF), an 8-item measure of diabetes-specific perceived self-efficacy (Anderson, Fitzgerald, Gruppen, Funnell, & Oh, 2003). The DES-SF has an internal reliability of 0.84 (Anderson et al., 2003). The DES-SF has established content validity, correlating with DSMB as measured by the MMAS-4 and SDSCA (Hernandez-Tejada et al., 2012). The scale includes representative items such as: "I know what parts of taking care of my diabetes that I am dissatisfied with" and "I can try out different ways of overcoming barriers to my diabetes goals." The original scale was rated on a 5-point scale from Strongly disagree (0) to Strongly agree (4). The scale was adapted in this study to force an opinion (i.e., no "neutral" response option). Items were summed to create a self-efficacy score ranging from 0 to 24, with higher scores representing higher levels of self-efficacy. Cronbach's alpha for this measure was 0.838.

The Michigan Diabetes Research and Training Center's Diabetes Care Profile Support Received Scale (DCP-SRS; Fitzgerald et al., 1996) was used to measure diabetes-specific social support. The DCP-SRS has demonstrated an internal reliability of 0.92 in a Caucasian American population, and 0.93 in an African American population (Fitzgerald et al., 1998). This scale asks participants if family and friends provide support in elements of their diabetes care (e.g., following meal plan, getting physical activity, handling feelings about diabetes). One item from this scale (taking care of feet) was removed based upon prior community review. In unpublished data from a pilot study including adults with type 2 diabetes from two of the study communities, the DCP-SRS had a Cronbach's alpha of 0.87. The original scale was rated on a 5-point scale from Strongly disagree (0) to Strongly agree (4). The scale was adapted in this study to force an opinion (i.e., no "neutral" response option). Items were summed to create a social support score ranging from 0 to 15, where a higher score indicates more received support. Cronbach's alpha in this study was 0.859.

Demographics. Several demographic variables were used as control variables in multivariable analyses. Gender, educational attainment, relationship status, age, on or off reservation, and per capita household income were collected from participants. Gender was reported as either female (1) or male (0). Educational attainment responses included less than high school (0), high school or GED (1), some college, vocational or technical training (2), and college graduate or advanced degree (3). Relationship status was consolidated to in a committed relationship (1) or not (0). I calculated age in years at time of interview from the date of interview recorded in VOXCO and the participant date of birth. Participants reported if they currently lived on reservation lands (1), or off (0). I calculated per capita household income by first assigning the center of the income range to a participant, and then dividing this income estimate by the reported number of individuals living in the household.

Analysis

I analyzed data using the Statistical Package for Social Sciences (SPSS, Version 23), and MPlus (Version 7; Muthén & Muthén, 1998-2012). To address Aim 1, I used descriptive statistics and frequencies produced by SPSS to characterize participation in DSMB.

Aim 2 was addressed by investigating the bivariate and multivariate relationships between variables. Summary statistics were calculated for all demographic variables. Then, bivariate correlations between all study variables were computed. This allowed me to determine if the assumption of multicollinearity was met for further multivariable analyses, as well as determine the strength of association between study variables on a bivariate level. Lastly, determinants and demographic variables listed in Table 2 were regressed on the three DSMB (i.e., medication adherence, healthy eating, and physical activity) in separate models. I assessed the assumption of multicollinearity by examining the variance inflation factor (VIF) and Tolerance statistic. I inspected the Q-Q plot and histogram of standardized residual errors to ensure that the errors were normally distributed. And lastly, I checked the assumption of homoscedasticity, or constant variance, by visually inspecting the residual errors to predicted values scatterplot. Due to list-wise deletion, the health eating and physical activity models contained 180 cases, and the medication adherence model contained 158 cases.

Structural equation modeling was used to address Aim 3. The proposed relationship between determinants and DSMB based upon the Behavioral Model was evaluated. Structural equation modeling takes into account measurement error and allows the influence of direct and indirect effects to be investigated (Kline, 2005). In other words, it allows a more complex picture to be established; not only the direct influence of community and personal distress and resources upon DSMB, but the relationships between and through those factors on DSMB. Missing data on endogenous variables was

Table 2. Hypothesized relationship between study variables and DSMB

Construct	Item/scale used	Number of items	Hypothesized direction of relationship with DSMB
Appraisal of community distress	Community-Wide Stress (CWS)	3	Negative
Personal distress	Diabetes Distress Screener (DDS-2)	2	Negative
Appraisal of community resources	Neighborhood Environment Walkability Scale (NEWS) Infrastructure and Safety for Walking subscale	4	Positive
	NEWS Aesthetics subscale	3	Positive
Personal resources	Diabetes Empowerment Scale Short-Form (DES-SF)	8	Positive
	Diabetes Care Profile- Support Received Scale (DCP-SRS)	5	Positive
Demographic variables	Living on reservation lands	Single item indicator	Unknown
	Age	Single item indicator	Positive
	Gender (female)	Single item indicator	Negative or null
	Educational attainment	Single item indicator	Positive
	Income	Single item indicator	Positive

DSMB = Diabetes self-management behaviors

estimated using full information maximum likelihood, with deletion of cases with missing information on exogenous variables (i.e., control variables). Model fit was assessed using joint criteria of standardized root mean square residuals (SRMR) and comparative fit index (CFI). Root mean square error of approximation (RMSEA) was also taken into consideration. Standard criteria for these fit indices were used; namely an SRMR value less than or equal to 0.08, CFI greater than or equal to 0.95, and RMSEA less than or equal to 0.06 (Hu & Bentler, 1999). Alternatively, many researchers use a CFI of 0.9 or above, which can be interpreted as reasonably good fit (Hu & Bentler, 1999). Additionally, RMSEA less than or equal to 0.05 indicate close approximate fit, 0.05 to 0.08 indicate reasonable error of approximation, and values greater than or equal to 0.10 indicate poor fit (Kline, 2005). Model chi-square values, degrees of freedom, and *p* values are reported below as well. In structural equation modeling the model chi-square tests the null hypothesis that the model is correct (more accurately, the model is one plausible explanation), or in other words that the model fits the data (Kline, 2005). Thus a significant *p* value would indicate the model does not fit the data, and a non-significant *p* value would support the proposed model. While a non-significant *p* value is desirable, it is sensitive to sample size, with larger sample sizes sometimes being unjustly rejected (Kline, 2005). Therefore, model chi-square values are presented but should not be used exclusively to judge the fit of the models.

A two-step process (Anderson & Gerbing 1988) was used to estimate the models. First, a measurement model for each DSMB was fit and evaluated, as shown in Appendix 3. In these models, the parameter for the first measured indicator's loading was constrained to 1 (i.e., NEWS infrastructure and safety subscale score, CWS item 5, DDS-2 item 1, DES-SF sum score, and SDSCA diet subscale item 1), and the disturbance of the latent variable was estimated. In the case of the physical activity and medication adherence models, the error variance of the sole indicator for the DSMB in each model (SDSCA physical activity subscale score, and MMAS-4 score) was constrained to 0, and the path for the loading constrained to 1. Modification indices were generated for models with poor fit of the measurement model, but no modifications were made based upon these indices (i.e., no theory-justified modifications could improve model fit). The second step was to impose structural constraints (i.e., paths connecting latent variables) in each model. Appraisal of community distress and appraisal of community resources were allowed to covary, as were personal distress and personal resources. Both appraisal of community distress and appraisal of community resources had direct paths to personal distress and personal resources. All four community and personal latent variables had direct paths estimated with the DSMB. After this first structural model, demographic variables were added as measured indicators with paths to all latent variables as illustrated in Appendix 4. The healthy eating and physical activity models contained 191 observations, and the medication adherence model contained 166 observations.

CHAPTER 4: RESULTS

Overall, the participants in this study were on average age of 46.3 years, had an average per capita household income of $9,767, 55.7% were female, and 78.7% currently lived on reservation lands.

Aim 1: Frequency of DSMB

Table 3 displays the average number of days participants in this study reported healthy eating and physical activity as assessed by the SDSCA. Because non-performance or relatively consistent performance of the behavior is an important metric to evaluate, Table 3 also shows the percent of participants reporting 0 days and 5 or more days per week. Almost a quarter of participants did not follow a healthful eating plan any day of the week, and even more (36.4%) reported zero days in the past week where they had consumed the recommended daily servings of fruits and vegetables. Alternatively, 30.7% of the participants here followed a healthful eating plan 5 or more days a week. Nearly 40% of participants reported 5 or more days with at least 30 minutes of physical activity, whereas fewer reported days participating in a specific exercise session.

Table 3. Healthy eating and physical activity in the past week (n = 182)

On how many of the past seven days…	Mean days	Median days	0 days per week (%)	5 days or more (%)
Have you followed a healthful eating plan?	3.1	3	22.8%	30.7%
Did you eat five or more servings of fruits and vegetables in a single day?	2.0	2	36.4%	12.8%
Did you not eat high fat foods?*	3.7	4	15.1%	38.7%
Did you participate in at least 30 minutes of physical activity?	3.7	3	17.0%	39.4%
Did you participate in a specific exercise session?	2.2	1	42.6%	19.7%

* Item was asked in reverse: “Did you eat high fat foods?”

A total of 166 participants in this study used some type of prescription medication to treat their diabetes and were asked the items of the MMAS-4. Of those who used prescription medications, 124 used oral medications only, 10 used insulin only, and 32 used both oral medications and insulin. Responses of those using prescription medications to the MMAS-4 items are shown in Table 4. Based upon MMAS-4 scores, 20.5% of those using prescription medications in this study met criteria for low medication adherence (MMAS-4 score < 2), while 27.7% met criteria for high adherence (MMAS-4 score = 4).

Table 4. Participant responses to the Morisky Medication Adherence Scale (MMAS-4)

	Yes (%)
Do you ever forget to take your diabetes medication?	66.3%
Do you ever have problems remembering to take your diabetes medication?*	32.9%
When you feel better, do you sometimes stop taking your diabetes medicine?	25.3%
Sometimes if you feel worse when you take your diabetes medicine, do you stop taking it?	21.7%

* n = 164 for this item

Aim 2: Relationship between DSMB and personal and contextual determinants

Inter-item correlations and summary statistics for items in each of the study scales (i.e., healthy eating, physical activity, medication adherence, diabetes empowerment, diabetes support, diabetes distress, community-wide stress, infrastructure and safety for walking, and aesthetics) are shown in Appendix 5. Bivariate correlations, as well as mean values and percentages for all study variables are shown in Table 5. On the bivariate level, healthy eating was significantly positively associated with diabetes empowerment, diabetes support, age, and per capita household income, and negatively associated with diabetes distress. Physical activity was positively associated with diabetes empowerment and diabetes support. Medication adherence was positively associated with diabetes empowerment, age, education, and income, and negatively associated with diabetes distress and female gender. Healthy eating was also positively associated with both physical activity and medication adherence. No significant correlation was found between medication adherence and physical activity.

Detailed findings from the ordinary least squares regression analyses for the independent variables of healthy eating, physical activity, and medication adherence are shown in Appendix 6 (i.e., ANOVA table, Q-Q plot, histogram of standardized residual errors, and residual errors to predicted values scatterplot). All three models had significant ANOVA values, suggesting the fit regression equations accounted for a statistically significant portion of the variance in the DSMB. Bivariate correlations as well as VIF and Tolerance statistic values did not suggest a serious problem with multicollinearity. Visual inspection of the Q-Q plot and histogram of standardized residual errors did not reveal major violations of the assumption of normal distribution of errors. And the assumption of homoscedasticity did not appear to be violated upon inspection of the residual errors to predicted values scatterplot.

The coefficients, standard errors, and standardized coefficients from ordinary least squares regression models for healthy eating, physical activity, and medication adherence are shown in Table 6. Net the effects of other variables, age ($\beta = .192$, $p = .008$), diabetes support ($\beta = .222$, $p = .003$), and diabetes empowerment ($\beta = .188$, $p = .012$) were positively associated with healthy eating, while diabetes distress ($\beta = -.223$, p

= .003) was negatively associated. The adjusted R^2 value for this model was 0.196. Diabetes empowerment (β = .170, *p* = .035) remained the sole variable significantly positively associated with physical activity in the regression model for physical activity. Of note, the adjusted R^2 value for this regression model was 0.055, suggesting that the variables in the model accounted for a very low amount of the variation in physical activity. In the regression model for medication adherence, age (β = .273, $p < .001$) was positively and diabetes distress (β = -.260, *p* = .002) was negatively related to medication adherence net the effects of the other variables. The adjusted R^2 value for the medication adherence model was 0.173.

Aim 3: A model to understand DSMB

The two-step process to build and modify models was used, but no modifications were made to the models. The fit indices for each model (i.e., healthy eating, physical activity, and medication adherence) are shown in Table 7. In the first step (measurement model), both the healthy eating and medication adherence models had acceptable values of CFI, SRMR, RMSEA, and model chi-square. The measurement model for the physical activity outcome had a CFI value (0.931) below the 0.95 or higher cutoff suggested by Hu & Bentler (1999), but above the commonly used 0.90. The physical activity measurement model also had an RMSEA value (0.063) close to, but slightly above, the recommended 0.06 or lower cutoff (Hu & Bentler, 1999). Additionally, the chi-square test for this model was significant. Only the SRMR value for the physical activity measurement model was acceptable. Modification indices for this model were examined, but no theoretically justified modifications could improve fit significantly. I therefore

Table 5. Bivariate correlations between study variables														
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1. Healthy Eating	1													
2. Physical Activity	.197*	1												
3. Medication Adherence	.307*	.061	1											
4. Safety/ infrastructure	.041	.105	-.051	1										
5. Aesthetics	.093	.123	-.057	.529*	1									
6. Community-wide Stress	.106	-.043	.022	-.243*	-.233*	1								
7. Diabetes Empowerment	.322*	.188*	.195*	-.070	-.021	.180*	1							
8. Diabetes Support	.311*	.171*	.131	-.080	.038	.057	.331*	1						
9. Diabetes Distress	-.206*	-.138	-.307*	-.156*	.024	.212*	-.103	-.041	1					
10. Gender (female = 1)	.003	-.079	-.161*	-.008	.049	.134	.008	-.160*	.200*	1				
11. Age	.200*	-.114	.280*	-.065	.110	.026	.019	.011	-.003	.034	1			
12. Education	.091	.011	.156*	.016	.043	.037	.122	.026	-.181*	.127	.112	1		
13. Living on reservation lands	.069	-.070	.011	-.303*	-.311*	.243*	.054	.023	.157*	.022	-.130	-.117	1	
14. Per capita Income	.207*	-.030	.171*	.146*	.153*	-.030	.178*	.161*	-.145*	.038	.237*	.335*	-.220*	1
Mean / % (standard deviation)	2.55 (1.88)	2.92 (2.18)	1.46 (1.26)	2.08 (1.16)	2.01 (1.05)	7.00 (1.60)	16.03 (2.90)	8.68 (3.15)	2.56 (1.38)	55.7%	46.32 (12.21)	2.55 (0.91)	78.7%	$9,767 ($8,901)

* $p < 0.05$

Table 6. Regression Analyses of Health-related Outcomes

Independent Variables	Healthy Eating n = 180			Physical Activity n = 180			Medication Adherence n = 158		
	B	Std. error	β	B	Std. error	β	B	Std. error	β
Constant	-3.107	1.186		1.912	1.522		.482	.857	
Gender (female = 1)	.174	.265	.047	-.233	.338	-.053	-.361	.196	-.143
Age (years)	.030	.011	.192*	-.024	.014	-.134	.028	.008	.273***
Living on/off reservation (on = 1)	.763	.341	.167	-.418	.436	-.078	.154	.255	.049
Educational attainment	-.045	.149	-.022	.034	.191	.014	.133	.110	.096
Household per capita income	.016	.016	.076	-.028	.020	-.114	.002	.012	.016
Diabetes support	.134	.044	.222**	.078	.056	.109	.020	.031	.052
Diabetes distress	-.302	.099	-.223**	-.173	.128	-.108	-.241	.075	-.260**
Diabetes empowerment	.120	.047	.188*	.131	.061	.170*	.055	.033	.131
Community-wide stress	.101	.086	.086	-.015	.109	-.011	.019	.061	.025
Infrastructure and safety	.102	.134	.064	.043	.170	.023	-.018	.098	-.017
Aesthetics	.139	.149	.077	.230	.189	.108	-.034	.107	-.028
Adjusted R^2		.196			.055			.173	

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

reject the physical activity model, and must conclude that the proposed model does not explain the underlying data. The physical activity structural equation model is reported below for posterity, however parameters estimates are likely incorrect or biased given the model does not fit the data.

Table 7. Fit Indices for Structural Equation Modeling Steps

Model		**CFI**	**SRMR**	**RMSEA (90% CI)**	**Chi-square (df, *p*)**
Healthy Eating (n = 191)	Measurement Model	.969	.045	.040 (.000-.070)	44.45 (34, .108)
	Structural Model	.969	.045	.040 (.000-.070)	44.45 (34, .108)
	Final Model	.918	.046	.053 (.030-.073)	98.80 (64, .003)
Physical Activity (n = 191)	Measurement Model	.931	.050	.063 (.031-.093)	45.82 (26, .010)
	Structural Model	.931	.050	.063 (.031-.093)	45.82 (26, .010)
	Final Model	.885	.046	.065 (.043-.086)	92.40 (51, .000)
Medication Adherence (n = 166)	Measurement Model	.980	.043	.035 (.000-.074)	31.24 (26, .220)
	Structural Model	.980	.043	.035 (.000-.074)	31.24 (26, .220)
	Final Model	.925	.044	.054 (.025-.079)	75.89 (51, .014)

Final model = structural model with demographic measured indicators; CFI = comparative fit index; SRMR = standardized root mean square residual; RMSEA = root mean square error of approximation; df = degrees of freedom

In all three models, all factor loadings were significant with the exception of the unstandardized loading for the NEWS aesthetic variable on appraisal of community resources. I constrained the disturbance of the latent appraisal of community resources variable to 1, and removed the constraint for the factor loading from the NEWS safety and infrastructure for walking variable on appraisal of community resources. After this adjustment to the models, all factor loadings were significant, as shown in Table 8.

Table 8. Factor loadings from measurement models

	Community Distress			Community Resources			Personal Distress			Personal Resources			DSMB		
	B	*p*	β	B	*p*	β	B	*p*	β	B	*p*	β	B	*p*	β
<u>Healthy Eating</u>															
CS5	1.000		.589												
CS6	1.181	.000	.656												
CS7	1.389	.000	.775												
NW1				.900	.005	.777									
NW2				.714	.005	.681									
DDS1							1.000		.651						
DDS2							1.217	.006	.739						
DES-SF										1.000		.616			
DCP-SRS										1.518	.000	.533			
SDSCA-D1													1.00		.726
SDSCA-D2													.682	.000	.591
<u>Physical Activity</u>															
CS5	1.000		.591												
CS6	1.156	.000	.645												
CS7	1.401	.000	.785												
NW1				1.079	.003	.931									
NW2				.596	.004	.569									
DDS1							1.000		.849						
DDS2							.717	.021	.567						
DES-SF										1.000		.739			
DCP-SRS										1.054	.036	.444			
<u>Medication Adherence</u>															
CS5	1.000		.577												
CS6	1.136	.000	.607												
CS7	1.530	.000	.870												
NW1				.934	.000	.876									
NW2				.586	.000	.605									
DDS1							1.000		.629						
DDS2							1.299	.000	.755						
DES-SF										1.000		.609			
DCP-SRS										1.542	.009	.541			

The second step, imposing structural constraints, did not significantly change the fit of any of the models. When demographic variables were added as measured indicators with paths to all latent variables, the CFI fell and model chi-square statistic became significant for the healthy eating and medication adherence models. However, the SRMR and RMSEA values for both indicated good fit, and the CFI value for both models was above the 0.90 criteria commonly used for acceptable model fit. Figures 3, 4, and 5 display the structural models with demographics. In all cases, appraisal of community distress, community resources, personal distress, personal resources, and the DSMB are latent variables, and living on reservation lands (on = 1), gender (female = 1), age, per capita household income, and educational attainment are observed indicators. For ease of presentation only standardized path coefficients are shown, while non-significant paths, factor loadings, and error and disturbance terms are excluded. Full estimates for these models are provided in Appendix 7. Because the hypothesized model contains several indirect paths that could be illustrative in understanding the relationship between demographic, community, and personal determinants of DSMB, Table 9 provides the direct, indirect, and total effects for each DSMB.

In the final structural equation model for healthy eating (Figure 3), personal distress was negatively associated with healthy diet, while personal resources and age had positive associations. Several significant relationships emerged between demographic indicators and latent variables. Living on reservation lands was positively related to appraisal of community distress, and negatively related to appraisal of community resources. Gender was positively related to both community and personal distress.

Table 9. Decomposition of Effects for Diabetes Self-Management Behaviors

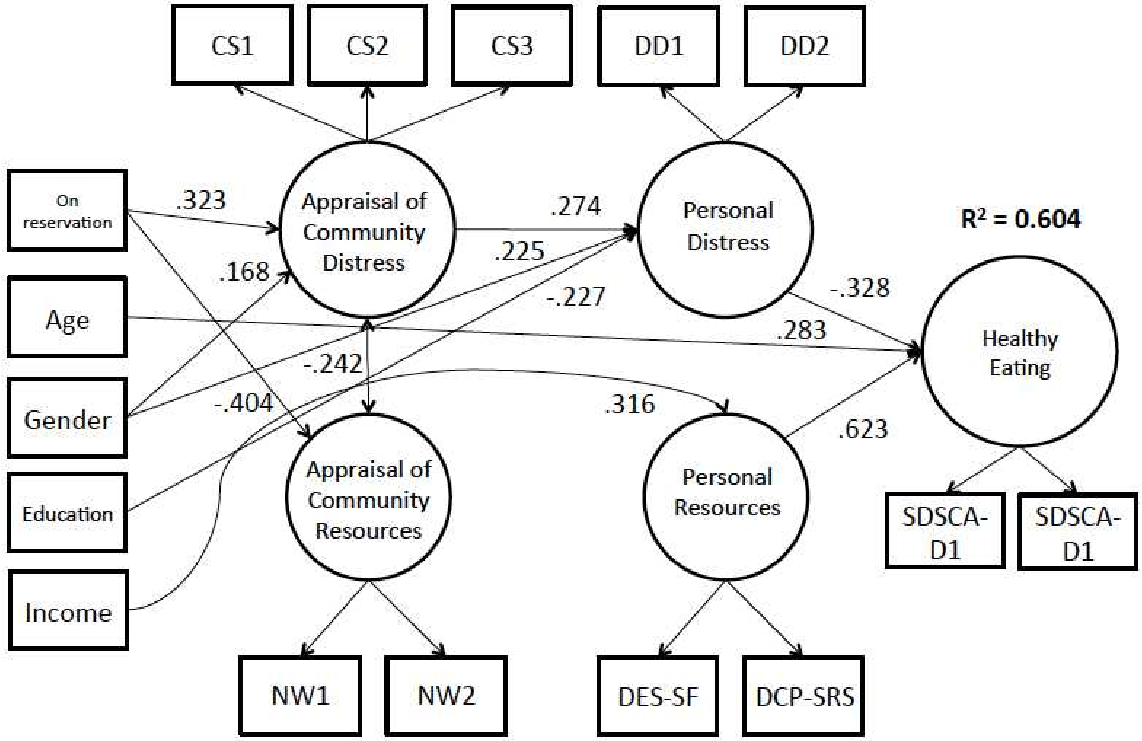
	Healthy Eating			**Physical Activity**			**Medication Adherence**		
	Direct β	Indirect β	Total β	Direct β	Indirect β	Total β	Direct β	Indirect β	Total β
Gender	.199	**-.178***	.020	-.014	-.064	-.079	-.076	**-.118***	**-.194***
Age	**.283***	-.035	**.248***	-.103	-.021	-.125	**.258***	.005	**.263***
Education	-.035	.100	.065	.006	.024	.030	.028	**.101***	.129
On reservation	.169	-.008	.161	-.043	-.050	-.094	.041	.039	.079
Income	-.029	**.247***	**.218***	-.169	**.143***	-.026	-.018	.113	.095
Community distress	.057	.035	.092	-.062	.071	.008	.069	-.047	.022
Community resources	.142	-.031	.112	.178	-.014	.165	-.069	.014	-.055
Personal Distress	**-.328***	**-**		-.052	-		**-.382***	**-**	
Personal Resources	**.623***	**-**		**.371***	**-**		.173	-	

* $p < 0.05$

Appraisal of community distress was negatively related to appraisal of community resources, and positively related to personal distress. Educational attainment on the other hand, was negatively related to personal distress, and per capita income had a positive relationship with personal resources. Female gender had a negative indirect relationship with healthy eating, primarily through personal distress. Income had positive indirect and total effects on healthy eating, primarily through personal resources. No other significant indirect effects were observed. The R^2 value for healthy eating in the model was 0.604.

The model for physical activity is shown below despite the poor fit indices and rejection of this model. If this model had fit the data, it could be stated that only personal resources had a direct effect on physical activity. Living on reservation lands and female gender were both positively related to appraisal of community distress. Living on

Figure 3. A Structural Equation Model to Understand Factors Related to Healthy Eating*

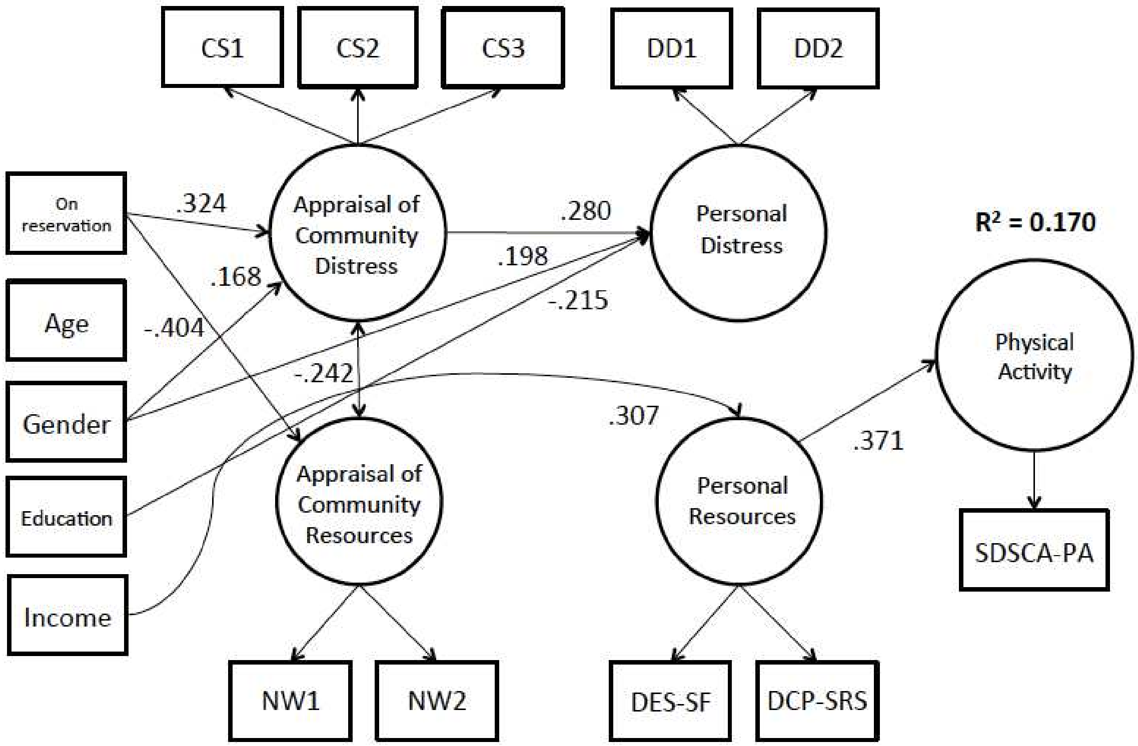


* Only significant paths ($p < .05$) shown

reservation lands was also negatively related to appraisal of community resources. Female gender and appraisal of community distress were both positively related to personal distress, whereas educational attainment was negatively related to personal distress. Income was positively related to personal resources. Appraisal of community distress and appraisal of community resources were negatively related to one another. One significant indirect relationship was observed between income and physical activity, primarily through personal resources. The R^2 for physical activity was 0.170.

In the final model for medication adherence, I found a negative direct effect of personal distress on medication adherence, and a positive direct effect of age. Female gender was positively associated with appraisal of community distress. Living on

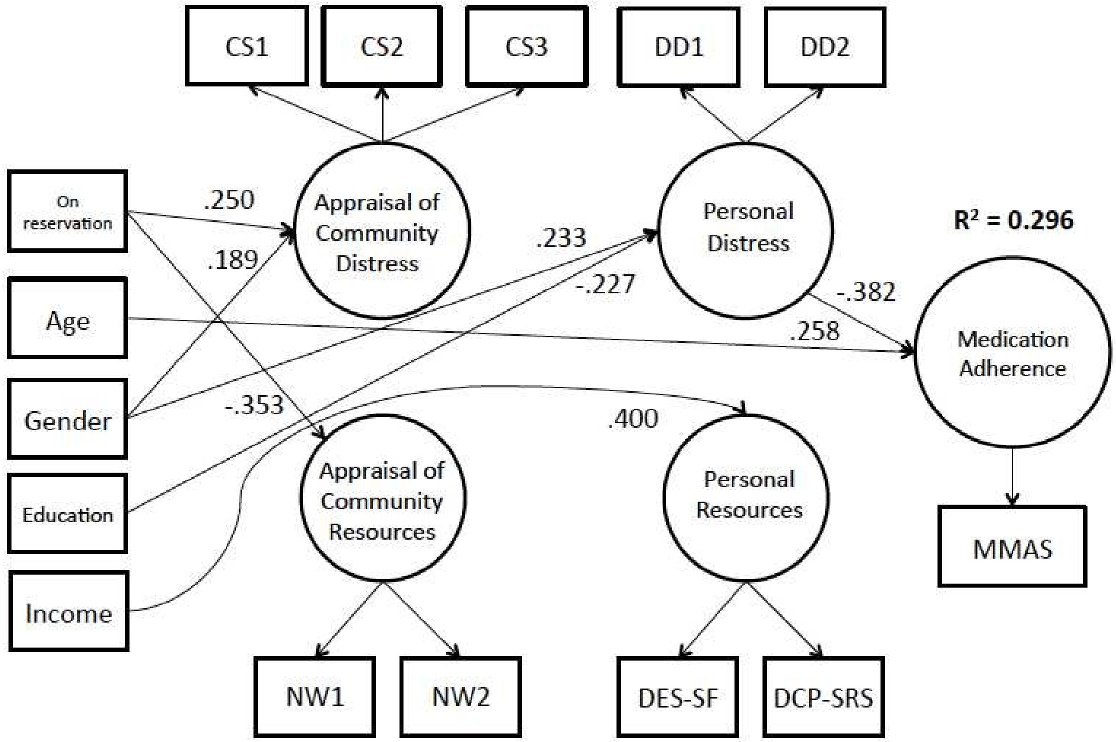
Figure 4. A Structural Equation Model to Understand Factors Related to Physical Activity*



* Only significant paths ($p < .05$) shown

reservation lands was positively associated with appraisal of community distress and negatively associated with appraisal of community resources. Income was positively related to personal resources. Female gender was positively and educational attainment negatively associated with personal distress. Significant indirect effects on medication adherence were found for gender and education. Female gender was associated with negative indirect and total effects on medication adherence, primarily through personal distress. Education had a positive indirect effect on medication adherence through a negative relationship with diabetes distress. The R^2 for medication adherence was 0.296 in this model.

Figure 5. A Structural Equation Model to Understand Factors Related to Medication Adherence*



* Only significant paths ($p < .05$) shown

Lastly, Table 10 displays the support or lack of support for the hypothesized relationships between study variables in general.

Table 10. Support for hypothesized relationship between study constructs and DSMB

Study Construct	**Hypothesized relationship**	**Findings support relationship**
Appraisal of community distress	Negative with appraisal of community resources	**Yes**
	Positive with personal distress	**Yes**
	Negative with personal resources	No
	Negative with DSMB	No
Appraisal of community resources	Negative with personal distress	No
	Positive with personal resources	No
	Positive with DSMB	No
Personal Distress	Negative with personal resources	No
	Negative with DSMB	**Yes**
Personal Resources	Positive with DSMB	**Yes**

DSMB = Diabetes self-management behaviors

CHAPTER 5: DISCUSSION

This work determined the frequency of DSMB, evaluated the relationship between personal and appraisal of community distress and resources, and tested a proposed model to understand the interrelationships between DSMB and those influential factors among a sample of AI from the Midwest with recently diagnosed type 2 diabetes.

Aim 1: Frequency of DSMB

I found lower rates of healthy eating days per week than past estimates. In this study, the average healthy eating days per week reported by participants (the average of the three healthy eating items) was 2.93. Past estimates of healthy eating days per week estimated using various items of the SDSCA in Indigenous populations have ranged from means of 3.6 to 4.5, and median values of 4 to 5 (Dreger et al., 2015; Inouye et al., 2012; Mashburn, 2012). The average days per week of healthy general diet (i.e., following a healthful eating plan) and healthy specific diet (i.e., 5 or more servings of fruits or vegetables in a single day) reported here are also lower than past estimates. I found mean values of 3.1 general diet and 2 specific diet days per week, with median values of 3 and 2. In a sample of Native Hawaiian and other Pacific Islanders, Inouye and colleagues (2012) reported a mean for general and specific diet days per week of 3.6 and 3.7, respectively. In a sample of Canadian aboriginals, Dreger and colleagues (2015) reported a mean days per week for general diet of 4.5, and specific diet of 4.2 days per week. On the other hand, not eating high fat foods in this sample was similar to past reports (3.7 days per week in this study compared to 3.9 days per week in Dreger et al., 2015), although interviewers believed participants misinterpreted this question.

When considering the estimates of healthy eating, it becomes helpful to alternatively inspect the proportion of participants who performed the behavior with some consistency, or failed to perform the behavior at all. Of the participants in this study, 30.7% indicating they generally followed a healthful eating plan five or more days a week, and only 12.8% ate five or more servings of fruits and vegetables per day five or more days a week. Viewed another way, 22.8% in this sample never followed a healthy meal plan, and 36.4% never eat five or more servings of fruits in vegetables in a single day. The high proportions of recently diagnosed adults with type 2 diabetes in these communities who do not follow a healthy eating plan or eat the recommended daily servings of fruits and vegetables on a regular basis is alarming. Community-developed or provider-based interventions may help to improve healthy eating. Access to fresh fruits and vegetables may be partially attributable to the low rate of specific diet days reported in the current study. In the focus groups during the first phase of this study, one woman stated, “We can’t follow the right diet, because we can’t get the right foods.” Some reported that those healthy foods were not available, like this woman: “I like bananas, I like oranges, [but] when you’re there [local store], there isn’t nothing on the shelves.” Others stated that food prices were a significant obstacle to healthy eating.

Averaging across the two physical activity items, the mean physical activity days per week reported by participants in this study was 2.92, on par with prior reports of approximately 3 days per week (Schoenberg et al., 2008; Dreger et al., 2015; Mashburn, 2012). Current recommendations advocate 150 minutes per week of moderate-intensity aerobic physical activity (American Diabetes Association, 2016; U.S. Department of Health and Human Services, 2008). Nearly 4 in every 10 participants in this study reported that they partook in at least 30 minutes of physical activity 5 or more days a week, thus meeting or exceeding current recommendations. This represents a potential strength and opportunity in the communities that have partnered in this research. While 39.4% of participants in this study met guidelines recommended levels of aerobic activity, this leaves over half of the sampled individuals who could improve their level of physical activity. Activity levels in the general U.S. population vary dramatically by income. In a recent analysis of the 2014 National Health Interview Survey adult sample, poverty status was a major contributor to meeting the recommended levels of physical activity, with 34.8% of those in families with incomes below the poverty threshold meeting the guidelines, and 66.8% of those in families with incomes greater than six times the poverty threshold (Centers for Disease Control and Prevention, 2016). Many participants in the focus groups provided community relevant ways to get physical activity, including use of community centers and fitness facilities on the reservations, getting outdoors, and involvement in traditional activities (e.g., dancing at powwows). Aside from the benefits for physical health and diabetes control, these activities were used to cope with stress and promote positive mental health.

In the current study, I found that 27.7% of the participants taking medication for diabetes could be categorized as having high medication adherence (MMAS-4 score = 4), and 20.5% could be categorized as having low adherence (MMAS-4 score less than 2). Comparatively, this means that a smaller proportion of participants in this study have high adherence, and a larger proportion in this study have low adherence, when compared to prior research among non-AI samples. In the original study of the MMAS-4 using an adult sample with hypertension, 43% met criteria for high adherence, and 13% met criteria for low adherence (Morisky et al., 1986). Among a sample of adults with diabetes 48.8% met criteria for high adherence, and 16% met criteria for low adherence (Krapek et al., 2004). This disparity between the current and former studies is disconcerting given the evidence that medication adherence is linked to improved outcomes (Krapek et al., 2004; Rhee et al., 2005; Encinosa et al., 2010; Egede et al., 2014; Gibson et al., 2010; Farmer et al., 2016). A recent study even suggested that medication adherence is more predictive of low A1C than other DSMB such as general diet, specific diet, exercise, and self-monitored blood glucose testing (Osborn, Mayberry, Kim, 2016).

Research probing the medication experience intimates that individuals interact with medications as symbols within their life in several different ways (Shoemaker & de Oliveira, 2008). For some participants in this study, medications may have entirely different meanings than others. These unobserved differences between individuals serve as a potential explanation for the lower rates of medication seen here. For some in this study, medications may directly conflict or be inconsistent with their cultural health beliefs. For others, the problem may lie in the symbolic nature of medications given the context of AI health. At a Gathering for Health joint Community Research Council meeting, one elder provided a very important statement that must be considered here. Medications could be viewed as a tool of the biomedical health care system, inspiring potential latent angst and anger; medication could be viewed as a tool that perpetuates the influence of colonization on an individual level. Instead of serving to improve health, medications could serve as a reminder of historical traumas and reinforcement of colonization. Given the context of IHS provided (i.e., U.S. government controlled) health care and the possible meaning of medications, it would not be inadmissible to believe that our measure of adherence may be inadequate to capture the complexities of the medication use process and medication experience for AI adults with type 2 diabetes. Indeed, this notion is supported by prior research where non-adherence to medical recommendations was perceived as socially desirable among some AI elders holding a particular ‘model of diabetes’ (Henderson, 2010). Henderson (2010) notes that elders holding this model had strong AI cultural identity and strongly valued traditional AI culture. These elders viewed the biomedical care system, or in their words “white doctors,” as authoritative. Following the medical authority’s recommendations “put the elder outside their peer group,” and conversely non-adherence to biomedical recommendations created a sense of solidarity among AI elders within the community (Henderson, 2010). Understanding DSMB in this light is helpful when avoiding blame for low participation; non-participation in DSMB becomes the rational health decision given certain context. Given the potential negative symbol of medications some participants may hold, it would not be surprising to suspect I would find lower rates of medication adherence and higher discontinuation rates. Of note, Henderson (2010) also describes another model characterized by a higher degree of acceptance of biomedical care, DSMB. I too have found varied preferences towards biomedical care for help with a mental or emotional problem among a random sample of AI adults who had used the biomedical system for type 2 diabetes care in the past (Aronson, Johnson-Jennings, Kading, Smith, & Walls, 2016).

Drawing upon the qualitative work from the first phase of this project, many individuals spoke of low quality of health care, issues with specific providers and clinics, and past issues with feeling discriminated by their health providers. It is possible that patient-provider relationship, previous microaggressions in health care, and perceived quality of care may influence medication adherence as well. Past research has suggested that AI populations may receive lower quality of care (Roubideaux & Zuckerman, 2004) and face more discrimination in healthcare (Walls, Gonzalez, Gladney, & Onello, 2015), thus possibly explaining the lower rates of adherence seen here. Future research could investigate how these factors influence medication adherence, and investigate the interaction between culture and medication experience among AI people.

Despite its weaknesses, the MMAS-4 does provide feedback that is valuable in shaping interventions to improve medication adherence. For instance, in this study nearly a quarter of participants reported that they had sometimes stopped taking their diabetes medication when they felt better, and 21.7% report sometimes stopping their medication when it makes them feel worse, or in other words, when they experience side effects. This is consistent with focus group participant comments. Specific individualized strategies could be adopted to tailor education and the medication regimen based upon these answers to the MMAS-4. Additionally, 66.3% of the participants in this study taking medications sometimes forget to take their diabetes medication, and 32.9% have problems remembering to take their diabetes medication. Various behavioral change strategies could be implemented to improve medication adherence for these individuals, simply by mitigating the forgetting (e.g., cues to action such as reminder devices or incorporating into part of daily routine). A recent meta-analysis showed large effect sizes in improvements of medication taking behavior for interventions that include prompts and linking behaviors to habits (Conn et al., 2016). However, interventions should also bear in mind patient medication beliefs, as these are important predictors of both intentional and unintentional medication adherence (Unni & Farris, 2011). Henderson's (2010) models of diabetes among AI elders highlights the importance of health beliefs in understanding DSMB. Without an understanding of what an individual believes to be important and values, attempts to improve health will be futile.

Aim 2: Relationship between DSMB and personal and appraised contextual determinants

On a bivariate level the DSMB somewhat clustered together, with healthy eating significantly correlated with physical activity and medication adherence, but physical activity and medication adherence were not significantly related to one another. This is in contrast to Osborn and colleagues (2016) who found significant correlations between diet, exercise, and medication adherence among a sample of low-income minority adults. Of note, Osborn used the SDSCA for all DSMB, whereas I used the MMAS-4 for medication adherence and SDSCA for healthy eating and physical activity. Thus, the differences here could either be a measurement artifact between the SDSCA and MMAS-4, or could represent a difference between how behaviors cluster among the participants of the current study.

Healthy Eating. In the regression model, age, social support and diabetes empowerment were positively related to, and diabetes distress negatively related to healthy eating. The independent variables in the regression model account for 19.6% of the variation on healthy eating. Interventions that work to improve social support and diabetes empowerment while addressing diabetes distress may have large impacts on healthy eating. However, these results do not provide a complete picture of the mechanisms that underlie these relationships. The relationships between social support, diabetes empowerment, and diabetes distress have yet to be determined. For instance, does diabetes empowerment buffer the effects of diabetes distress on healthy eating? Will increases in social support increase diabetes empowerment? Future research could illuminate the relationships and temporal ordering between these variables of interest related to healthy eating.

Physical Activity. In the regression model only diabetes empowerment was related to physical activity, with an R^2 value of only 0.055. In other words, the independent variables included in this model explain very little variance in physical activity behavioral among participants. Another prior study found that diabetes self-efficacy and not social support was related to physical activity (Tang et al., 2008; Rosland et al., 2008). However, this finding is in contrast to others who have found that diabetes distress (Polonsky et al., 2005) and diabetes social support (Tang et al., 2008) are related to physical activity. The stark contrast between number of significant coefficients and total variance accounted for in healthy eating regression model compared to physical activity regression model using the same independent variables is notable. The mechanisms whereby physical activity behaviors are induced are clearly not the same as healthy eating behaviors. Other factors may play a stronger role here, such as perceived behavioral norms, access to exercise facilities, time-costs, and lack of professional support. This work does not provide great insight for interventions to improve physical activity. Instead, focus groups with community members and input from Community Research Council members may serve fruitful here.

Medication adherence. Net the effects of other factors in the regression model, age was positively and diabetes distress negatively related to medication adherence, and accounted for 17.3% of the variation of medication adherence scores. Prior literature has linked increased age to increased adherence (E.T. Lee et al., 2013; G.K.Y. Lee et al., 2013; Zivin et al., 2010). This finding taken together with the high prevalence of diabetes among young AIs prompts the need to facilitate and engage in a conversation around medication treatment and adherence. Community-based interventions could be applied that tap into cultural norms of learning from elders and respect for elders to teach younger ones. Diabetes distress has been linked to medication adherence previously (Gonzalez et al., 2015). In the present study, diabetes empowerment did not meet the desired p value of < 0.05, whereas Gonzalez and colleagues (2015) also found a significant relationship between self-efficacy and medication adherence in multivariable analysis. Based upon the current study, diabetes distress becomes an attractive target for intervening and possibly improving medication adherence.

Aim 3: A model to understand DSMB

The results from SEM analyses based upon a theoretical model provide a more detailed picture of the interrelations between my latent variables as well as demographic variables. The healthy eating and medication adherence models fit the data well. Using the Behavioral Model to understand the relationship between appraised community distress and resources, personal distress and resources, and the individual DSMB appears to be appropriate for these two behaviors. The physical activity model did not meet criteria for good model fit. Indeed, the lack of significant relationships in the model, and even bivariate correlations with physical activity, suggests that the hypothesized model is perhaps misspecified (i.e., contain paths that the data would suggest do not exist). Another value of interest is the percent of variability of the latent DSMB, which provides insight to the ‘predictive’ ability of the variables and paths specified within the model. The value of R^2 for both healthy eating and medication adherence was quite high (0.604 and 0.296, respectively), while the value for physical activity was much lower (0.170). Because the model for physical activity did not fit the data, path estimates are not reliable and as such discussion of these coefficients is absent below. As suggested above, physical activity appears to be driven by alternate processes that do not relate to personal distress or resources, at least as measured in this study. Healthy eating and medication adherence are both relatively low cost behaviors, not to say both are without difficulty, but neither involve a dramatic departure from the ordinary routine of life. Changes in physical activity, on the other hand, for many people will require significant changes to routine, and will be impacted by many factors beyond those measured in this work. Using the Behavioral Model for physical activity in this sample and with these variables did not appear to work. Instead, one could consider numerous other health behavior theories and their components to understand physical activity. The Health Belief Model, Theory of Planned Behavior, and Social Cognitive Theory all have potentially relevant constructs that could be operationalized. For instance, knowledge of and availability of resources or facilities (e.g., bike or fitness center) could significantly impact one’s likelihood to further engage in physical activity. Time constraints would hamper physical activity, and interact with many other factors like income. Perceived behavioral norms, active peers, and ability or perceived ability to engage in physical activity are just a few other influences that would likely play an important role. Future research could operationalize these ideas. Physical activity could alternatively be measured using other indicators, such as minimized sedentary time or a less subjective step counter. A more encompassing measurement of physical activity may reveal more relevant and meaningful findings. Future work could test alternative health behavioral models to understand physical activity.

A Structural Equation Model for Healthy Eating. The strong direct relationship between healthy eating and both personal distress and personal resources is of potential importance for interventions. Enhancing resources and mitigating distress should be goals for adults recently diagnosed with type 2 diabetes. Female gender was related to personal distress in the model, and through personal distress had significant negative indirect effects on healthy eating. The relationship with diabetes distress is consistent with prior literature, where females with type 2 diabetes had higher rates of diabetes distress compared to males (Fisher et al., 2008a). The indirect path observed suggests that females in particular may benefit from targeted screening for diabetes distress and appropriate care based upon the results. Zagarins and colleagues (2012) reported on a diabetes education intervention that improved diabetes distress, as well as DSMB and A1C, among 234 people with type 2 diabetes. Income had significant indirect and total effects on healthy eating, through the relationship with personal resources. This finding pairs well with the voices of participants from the first wave focus groups. Personal, family, and community financial stress were thought to get in the way of DSMB, and the cost of healthy foods inhibitory for many to eat right. While I did not find a direct relationship here between income and healthy eating, the indirect relationship suggests that DSMB are influenced by income. I found no effect from the community variables in this model; however, the contextual environment is linked to income disparities, high rates of unemployment, and a myriad of financial stressors likely acting through income in the model. Future work may investigate how community factors operate through socioeconomic conditions to influence DSMB. Policy and funding for job growth and aimed at reducing income disparities may have consequences for the health of individuals with type 2 diabetes in these communities. Of note, the community variables were operationalized as individual perceptions of the community factors, rather than direct measures of the environment or community conditions. Alternate forms of measuring community level factors may be needed to see an effect.

A Structural Equation Model for Medication Adherence. Within this model age and personal distress had strong direct relationships on medication adherence, analogous to those found and discussed above in the regression analyses. Because younger individuals may be less likely to adhere to their medications they could be targeted for discussions surrounding medication use and adherence. As indicated above, community-based interventions that tap into cultural norms may prove effective to improve younger AIs DSMB. Here again, diabetes distress reveals itself as a potential target for intervention. Similar to the SEM for healthy eating, female gender had negative indirect effects on medication adherence mainly through higher personal distress. Prior research has suggested that female gender is associated with lower medication adherence (Lee et al., 2013; Zivin et al., 2010; Lopez et al., 2014). In this study, however, no significant direct relationship was found between female gender and medication adherence in both the regression and SEM analyses. Others have similarly found no significant relationship (Marcum, Zheng, Perera, et al 2013; Al-Qazaz, Hassali, Shafie, et al., 2011), and a dated review article suggested previous findings with gender and medication adherence were inconsistent (Balkrishnan, 1998). The indirect findings in the current study suggest that the relationship between gender and medication adherence may be mediated through personal distress. Said another way, if the higher rates of internalizing disorders faced by women are not controlled for, they appear to have worse medication adherence.

Appraised community factors. The contextual factors, appraisal of community distress and resources, while related to each other failed to have significant direct or indirect effects with DSMB in all SEMs. Appraisal of community distress was significantly related to personal distress in the healthy eating model; however, I found no indirect effects through personal distress to DSMB. Other studies have consistently shown the impact of contextual factors on health behaviors and outcomes. For instance Lippert (2016) found that growing up in a low-income neighborhood increases odds of adult obesity, whereas moving out of the low-income neighborhood before adulthood buffers that risk, and moving into a low-income neighborhood increases risk (Lippert, 2016). In addition, Bronfenbrenner's Social-Ecological Model posits that broader contexts (i.e., macrosystem, exosystem, mesosystem, and microsystem) will influence the individual's health behavior (Bronfenbrenner, 1977; Bronfenbrenner, 1994). It is possible that my operationalization and variable selection of these community factors was not adequate to encompass the full contextual milieu that would impact DSMB specifically. The items that were used may have not been adequate representations of community distress or community resources. Future work may operationalize community distress and resources using alternate indicators, or aggregate data with multilevel modeling. Community members have identified the financial status of the community as a very relevant stressor impacting DSMB. This could be measured through rates of poverty, unemployment, or aggregated financial stress and strain. A social network analysis may provide a more in depth picture of the groupings of individuals and their peer/family groups than solely grouping by community or by ZIP code. Stress related to family members is another possible measure of community distress that could be explored, as this was frequently mentioned in focus groups. Community resources could be measured alternatively through availability of health care resources, and self-care resources on a community level. Availability could include accessibility, choice, hours, cost, and perceived quality. The impact of historical food related changes and commodity programs and IHS provided biomedical care are certainly contextual considerations that may have indirect impacts, but prove potentially more difficult to measure. Availability of health care and self-care resources is also influenced significantly by time as a personal resource, so there is a clear interaction between the personal and the contextual. There are several likely community indicators beyond those postulated here that may provide further insights. Alternatively, community factors may influence relevant demographic indicators to exert their influence on DSMB. For instance, in this study both educational attainment and income, traditional measures of socioeconomic status, had significant positive indirect effects on DSMB. These demographic characteristics are highly influenced by the contextual environment; an alternate model could take this into consideration and examine the possibility of further distal impacts of community on DSMB.

Limitations

There are limitations to the inferences made from this research. Firstly, this cross-sectional study cannot determine causality due to the lack of ability to make temporal inferences. Relationships within the SEM analyses show directionality; however, this does not mean that one causes the other. Without longitudinal data I cannot declare, for instance, that personal distress causes lower medication adherence. Another limitation of this work mentioned above is the operational measures for appraisal of community distress and resources. There may exist better measures or different methods of operationalizing these constructs. Several measures from this study were adapted or created for this study, limiting the ability to inherently declare their validity and reliability from past research studies (Bradley, 1994). However, it can be argued that the extensive process used to ensure the measures were relevant enhanced rather than detracted from the validity of the measures, and that this process ensured the appropriateness of items given the local context (Bradley, 1994). The low Cronbach's alpha values from the two SDSCA diet items is potentially concerning from a measurement standpoint, however, it is on the border of possibly acceptable and these problems did not hinder the findings from the confirmatory factor analysis. It is possible that these two items are not measuring a unidimensional construct as this research posits, and thus estimates from this SEM have potential to be biased. The SDSCA was created to have two food subscales from four items (i.e., general diet, specific diet). Future analyses could model diet as a multidimensional construct from these items, and/or include other measures of healthy eating (for instance the revised Self-Care Inventory; Weinger, Butler, Welch, & La Greca, 2005). Furthermore, this research used adaptations of standardized measures, and although the measurement adaptation process was rigorous, the measures used in this work have not been psychometrically validated. That stated, the results themselves serve to provide some justification to their validity, as the results presented here in many ways mirror prior findings. Recall bias and social desirability bias, as with most any survey research, may have contaminated my findings. If this is the case and levels of DSMB are actually inflated, the low levels of healthy eating and medication adherence found in this work become even more disconcerting. It could be argued that use of interviewers from each community may have buffered or conflated these biases (Israel et al., 1998). In this work self-efficacy and social support were used together as indicators of personal resources. While this was empirically supported, it may not be fully theoretically supported. Another approach would be to treat them as two separate latent constructs, self-efficacy as a personal resource, and social support as a social resource. Separating these two separate constructs more wholly would allow a greater understanding of the contributions of different types of resources, and prove more useful as a guide for future interventions.

Lastly, while the models fit the data, the presented final SEMs may not be the most parsimonious solutions available. Several variables included in the final SEM model have weak or null relationships with the DSMB and other relevant variables in the models. Removing extemporaneous variables and creating a more parsimonious model would likely improve fit indices. However, this research was confirmatory and not exploratory in nature. Future investigation could propose and evaluate alternate models, or use a process of model trimming to arrive at the most parsimonious solution. Overall, given the fit of the proposed models, the Behavioral Model appeared to provide a useful organizational framework for understanding the relationships between stress and resources on healthy eating and physical activity. That said, in this instance it did not work for physical activity, and appraised community factors did not have significant direct or indirect relationships with the behaviors. Alternate variables or a more traditional approach for measuring community level variables (i.e., measured at the aggregate level) would be advisable for future research. Of note, several elements from the Behavioral Model were withheld from this study given the nature of this research. Participants in this study were identified from clinic records documenting their recent diagnosis of type 2 diabetes, which is the result of both a laboratory value and a health care visit. Thus, both the process of care (e.g. ordering of appropriate labs) and use of health services (i.e. service utilization) may be falsely elevated. Complicating things further, the temporal order of variables at baseline is in reverse of those supposed by the model for health outcomes. For instance, if DSMB were initiated immediately after diagnosis, hemoglobin A1c (A1C), a marker of glycemic control over time, would still take several months to change. The use of current self-report of DSMB to predict past hemoglobin A1C values (with the potential for only one baseline A1C value) is troublesome, and could be confounding when considering the cross-sectional nature of this research proposal. The longitudinal data from this study could establish temporal ordering of factors related to the processes of care, use of health services, and health outcomes over time.

Conclusions

Among AI adults with recently diagnosed type 2 diabetes, estimates of healthy eating and medication adherence are lower than previous estimates, suggesting that there is room for improvement. While the context, lived experience, and individual stories of participants in this study is potentially different than non-AI populations in various ways, the findings from this study in mirror prior literature. In other words, the variables used in this study seem to operate similarly to previously studied populations. I found that, consistent with prior literature in non-AI populations with diabetes, self-efficacy, social support, and diabetes distress are important determinants of DSMB. This study did not include other culturally unique or distinct constructs; these unmeasured culturally salient variables may have importance to explain DSMB. Linear regression and SEM analyses here intimate minimizing personal distress (i.e., diabetes distress) and fostering personal resources (i.e., diabetes-specific social support, diabetes empowerment) as potential targets to improve healthy eating and medication adherence. Age is positively related to health eating and medication adherence, suggesting younger age could be one indicator prompting targeted interventions or conversations surrounding DMSB. The SEMs also provide an understanding of indirect relationships between gender, income, and educational attainment. For both healthy eating and medication adherence, personal distress appears to mediate the relationship between female gender and lower levels of DSMB. This can be addressed through simple screening and subsequent intervention. While perceptions of community factors failed to have direct or indirect effects on DSMB, traditional socioeconomic indicators (income and educational attainment) impacted by the contextual environment had indirect effects on DSMB. Future work may further examine these relationships. Overall, these findings support a multi-faceted and patient-tailored approach to improving DSMB as a whole.

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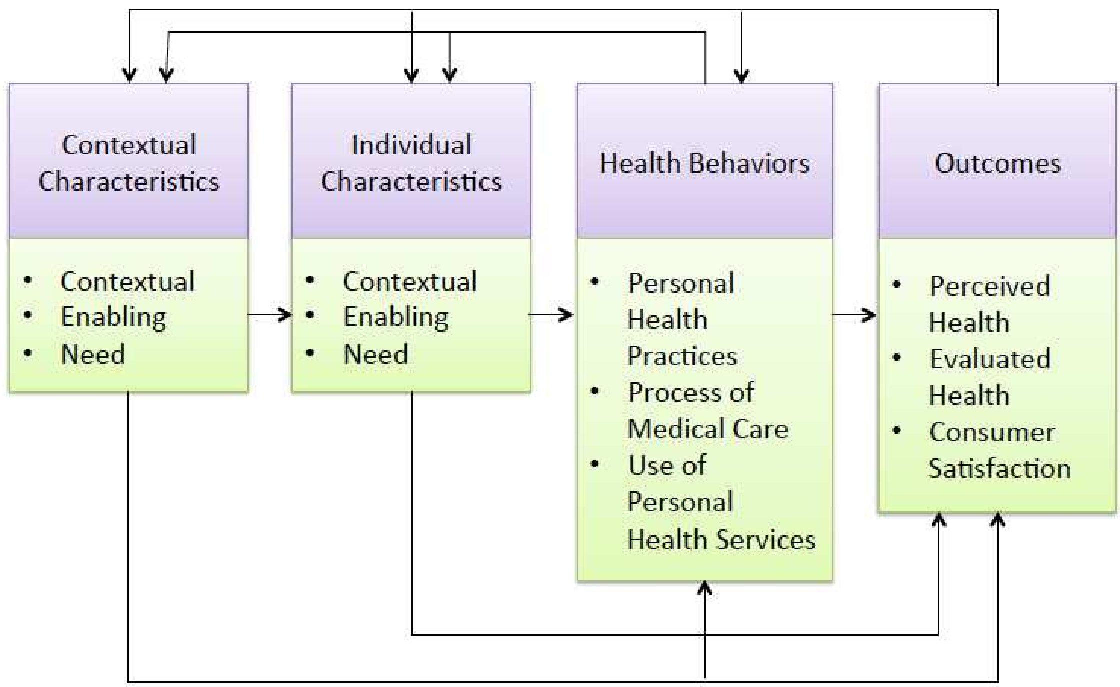
APPENDICES

APPENDIX 1: ANDERSEN'S BEHAVIORAL MODEL



Adapted from: Andersen, R.L. (2008). *Med Care*, 46, 647-653.

APPENDIX 2: COMPLETE LIST OF SCALES

Scale	Items	Response Options (coded as)
Morisky Medication Adherence Scale (MMAS-4)	1. Do you ever forget to take your diabetes medicine? 2. Do you ever have problems remembering to take your diabetes medication? 3. When you feel better, do you sometimes stop taking your diabetes medicine? 4. Sometimes if you feel worse when you take your diabetes medicine, do you stop taking it?	(0) No (1) Yes
Summary of Diabetes Self-Care Activities (SDSCA)	1. How many of the last SEVEN DAYS have you followed a healthful eating plan? 2. On how many of the last SEVEN DAYS did you eat five or more servings of fruits and vegetables in a single day? 3. On how many of the last SEVEN DAYS did you eat high fat foods such as high-fat meat or full-fat dairy products?[A] 4. On how many of the last SEVEN DAYS did you participate in at least 30 minutes of physical activity? 5. On how many of the last SEVEN DAYS did you participate in a specific exercise session (such as swimming, walking, biking) other than what you do around the house or as a part of your work?	(0) 0 days (1) 1 day (2) 2 days (3) 3 days (4) 4 days (5) 5 days (6) 6 days (7) 7 days
Community-Wide Stress (CWS)	1. I worry about there being enough jobs for everyone who wants to work in this community 2. My community has resources in place to address poverty[A] 3. I see the effects of poverty in this community on a daily basis 4. I am optimistic about the future economy of this community[A] 5. I worry about the behavior of young people in our community	(0) Strongly disagree (1) Disagree (2) Agree (3) Strongly Agree

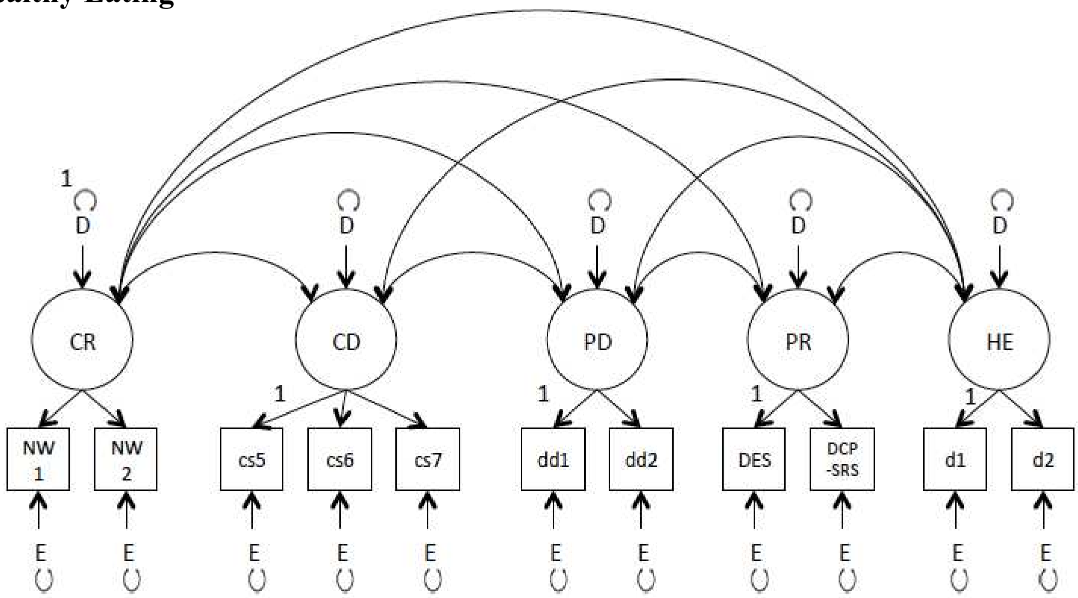
	6. I am worried that Native values and traditions are NOT being passed on to future generations 7. I think the young people in this community are often steered in the wrong direction	
Diabetes-Distress Screener (DDS-2)	Consider the degree to which the next two items may have distressed or bothered you in the past month. On a scale from 1 to 6, where 1 means not at all bothersome, and 6 means very bothersome, please rate how bothersome each are. 1. Feeling overwhelmed by the demands of living with diabetes 2. Feeling that I am often failing with my diabetes regimen	(1) 1. Not at all bothersome (2) 2. (3) 3. (4) 4. (5) 5. (6) 6. Very bothersome
Neighborhood Environment Walkability Scale (NEWS)	*Infrastructure and safety* 1. Are there places in your community that are safe to walk? 2. Are there bicycle, walking, or hiking trails in or near your community? 3. Are your community roads or walking trails well lit at night? 4. Are you concerned about dogs or other animals coming after you when you walk? *Aesthetics* 1. Are there attractive natural sights in your community? 2. Are there attractive buildings or homes in your community? 3. Is your community generally free from litter?	(0) No (1) Yes
Diabetes Empowerment Scale-Short Form (DES-SF)	In general, I believe that I: 1. Know what parts of taking care of my diabetes that I am dissatisfied with 2. Am able to turn my diabetes goals into a workable plan 3. Can try out different ways of overcoming barriers to my diabetes	(0) Strongly disagree (1) Disagree (2) Agree (3) Strongly agree

	goals 4. Can find ways to feel better about having diabetes 5. Know the positive ways I cope with diabetes-related stress 6. Can ask for support for having and caring for my diabetes when I need it 7. Know what helps me stay motivated to care for my diabetes 8. Know enough about myself as a person to make diabetes care choices that are right for me	
Diabetes Care Profile Support Received Scale (DCP-SRS)	My family or friends help and support me a lot to… 1. Follow a healthy meal plan 2. Take my medicine 3. Get enough physical activity 4. Test my sugar 5. Handle my feelings about diabetes	(0) Strongly disagree (1) Disagree (2) Agree (3) Strongly agree
Demographics	*Gender* Many of the questions that we will ask throughout this interview depend on your gender. To make sure we skip you into the right questions, please tell me if your gender is male or female.	(0) Male (1) Female
	Education What is the highest level of education you have completed?	(0) Less than high school (1) High school or GED (2) Some college, vocational or technical training (3) College graduate (3) Advanced degree
	Relationship Status Which of the following best describes your current relationship status? Are you…	(1) Married (1) Living with a partner (1) In a relationship but not living together

		(0) Separated (0) Divorced (0) Widowed (0) Single (0) Other
	Age What is your date of birth?	Continuous variable based upon date of birth and interview date
	On/off reservation Do you currently live on reservation land?	(0) No (1) Yes
	Income Which of the categories best describes your total annual combined household income from all sources?	Continuous variable calculated by centering the value in the middle of the range and dividing by the number of individuals residing in household Less than $5,000 $5,001 to $9,999 $10,000 to $14,999 $15,000 to $19,999 $20,000 to $29,999 $30,000 to $39,999 $40,000 to $49,999 $50,000 to $59,999 $60,000 to $69,999 $70,000 or more
[A] Reverse coded		

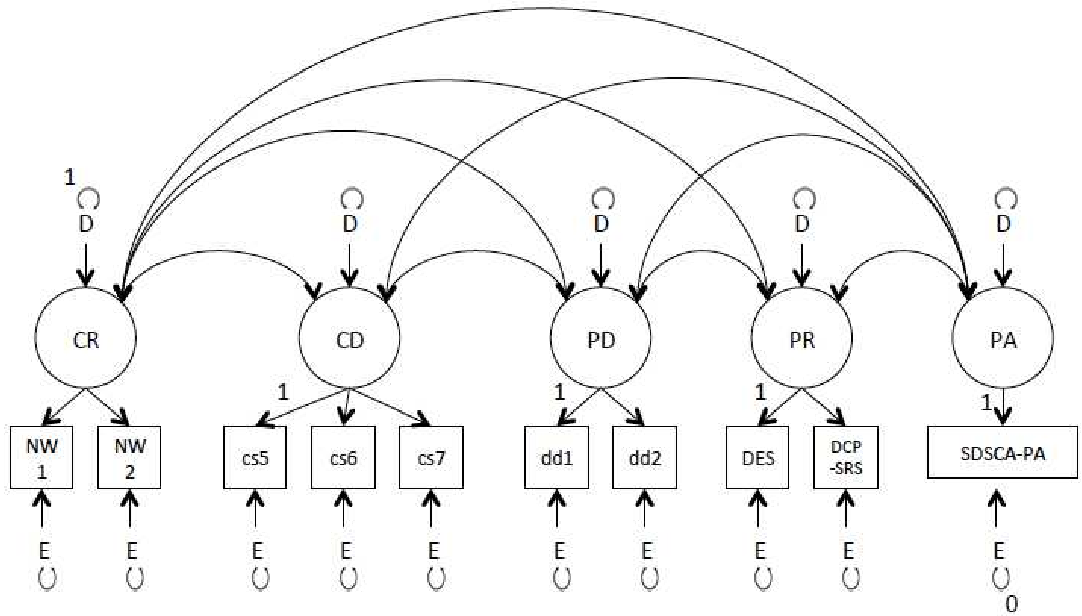
APPENDIX 3: CONFIRMATORY MEASUREMENT MODELS

Healthy Eating



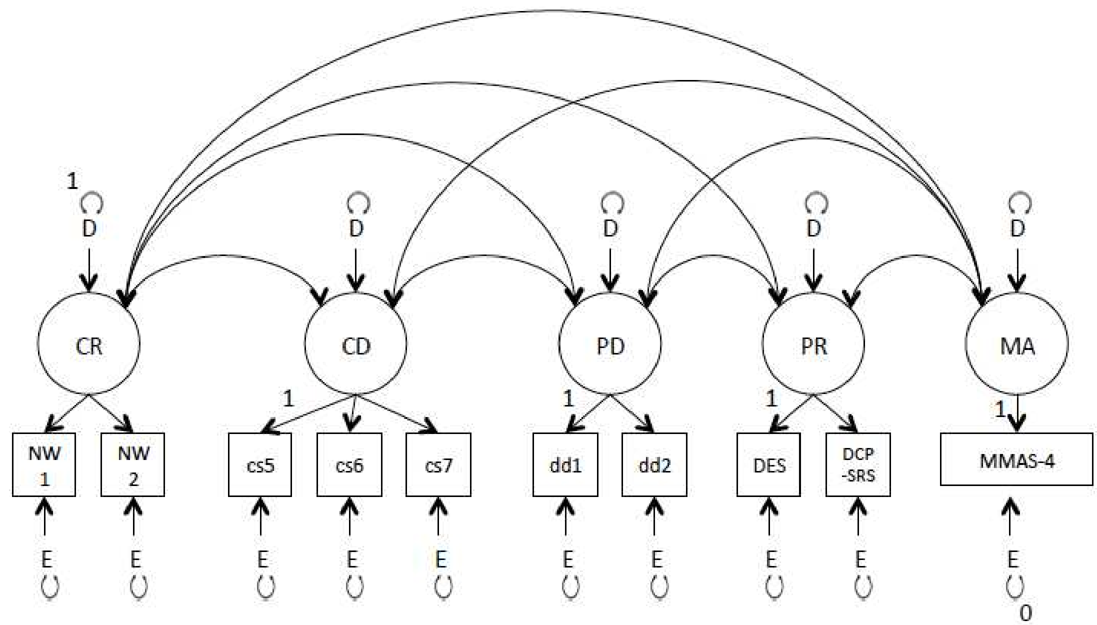
CR = appraisal of appraisal of community resources; CD = appraisal of community distress; PD = personal distress; PR = personal resources; HE = healthy eating; NW1 = Neighborhood Walkability infrastructure and safety subscale; NW2 = neighborhood environment walkability aesthetics subscale; cs = Community-Wide Stress items; dd = Diabetes Distress Screener items; DES = Diabetes Empowerment Scale, DCP-SRS = Diabetes Care Profile support received scale; d = Summary of Diabetes Self-Care Activities diet items

Physical Activity



CR = appraisal of community resources; CD = appraisal of community distress; PD = personal distress; PR = personal resources; PA = physical activity; NW1 = Neighborhood Environment Walkability infrastructure and safety subscale; NW2 = Neighborhood Environment Walkability aesthetics subscale; cs = Community-Wide Stress items; dd = Diabetes Distress Screener items; DES = Diabetes Empowerment Scale, DCP-SRS = Diabetes Care Profile support received scale; SDSCA-PA = Summary of Diabetes Self-Care Activities physical activity subscale

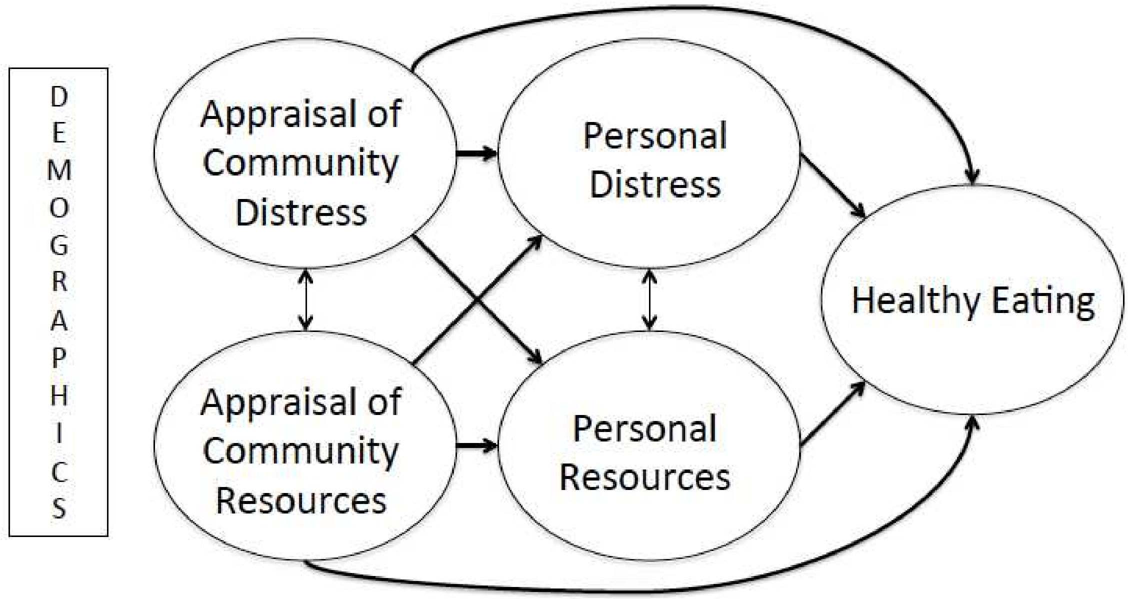
Medication Adherence



CR = appraisal of community resources; CD = appraisal of community distress; PD = personal distress; PR = personal resources; MA = medication adherence; NW1 = Neighborhood Environment Walkability infrastructure and safety subscale; NW2 = Neighborhood Environment Walkability aesthetics subscale; cs = Community-Wide Stress items; dd = Diabetes Distress Screener items; DES = Diabetes Empowerment Scale, DCP-SRS = Diabetes Care Profile support received scale; MMAS-4 = 4-item Morisky Medication Adherence Scale

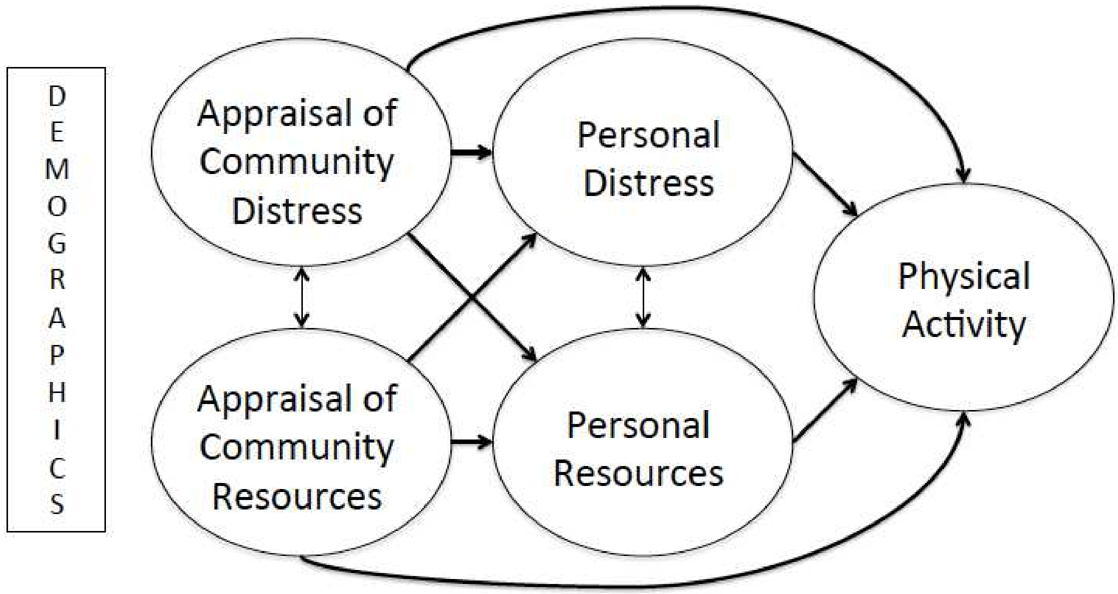
APPENDIX 4: STRUCTURAL MODELS

Structural Model for Healthy Eating



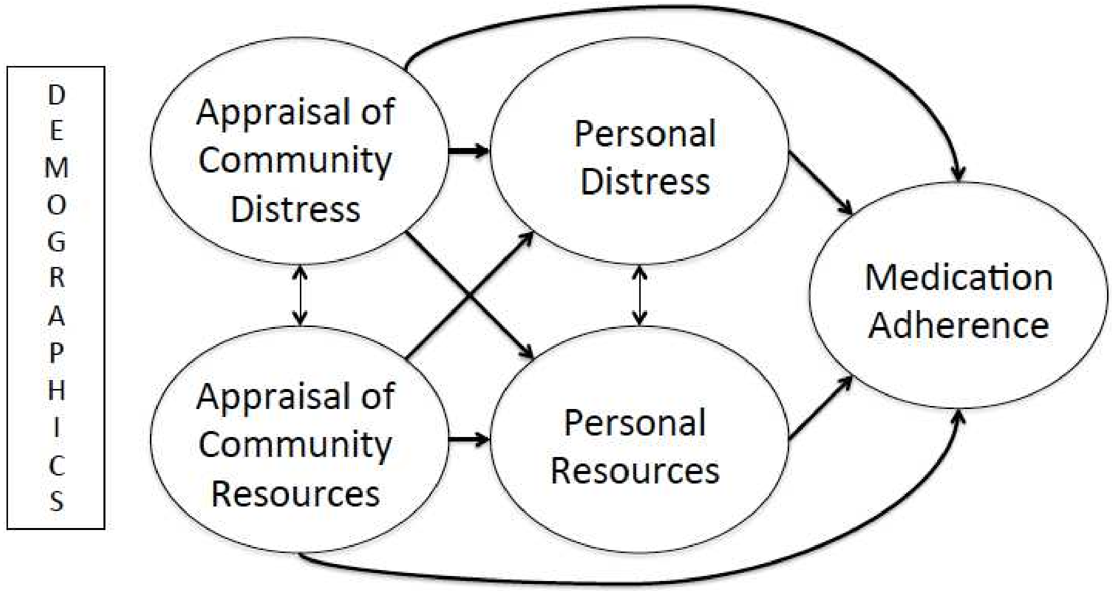
*Demographic factors were included as measured indicators and have direct paths to all latent variables

Structural Model for Physical Activity



*Demographic factors were included as measured indicators and have direct paths to all latent variables

Structural Model for Medication Adherence



*Demographic factors were included as measured indicators and have direct paths to all latent variables

APPENDIX 5. RESULTS OF INDIVIDUAL SCALES

Healthy Eating (n = 182)

	1.	2.	3.	Mean (SD)
1. SDSCA-D1	1			3.16 (2.42)
2. SDSCA-D2	0.424***	1		2.03 (2.04)
3. SDSCA-D3	.0270***	0.043	1	3.66 (2.23)

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Physical Activity (n = 182)

	1.	2.	Mean (SD)
1. SDSCA-PA1	1		3.67 (2.54)
2. SDSCA-PA2	0.526***	1	2.20 (2.50)

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Medication Adherence (n = 166)

	1.	2.	3.	4.	% Yes
1. MMA-1	1				66.3%
2. MMA-2 (with imputed values)	.414***	1			32.5%
3. MMA-3	.327***	.187*	1		25.3%
4. MMA-4	.221**	.321***	.467***	1	21.7%

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Diabetes Empowerment (n = 184)

	1.	2.	3.	4.	5.	6.	7.	8.	Mean (SD)
1. DES-1	1								1.98 (.65)
2. DES-2	.318***	1							2.09 (.54)
3. DES-3	.224**	.339***	1						1.92 (.52)
4. DES-4	.291***	.341***	.627***	1					2.03 (.50)
5. DES-5	.142	.307***	.464***	.422***	1				1.98 (.47)
6. DES-6	.276***	.412***	.469***	.449***	.532***	1			2.10 (.53)
7. DES-7	.244**	.310***	.507***	.522***	.430***	.698***	1		2.02 (.48)
8. DES-8	.265***	.391***	.383***	.374***	.600***	.515***	.507***	1	1.96 (.54)

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Diabetes Support (n = 190)

	1.	2.	3.	4.	5.	Mean (SD)
1. DCP-1	1					1.67 (.84)
2. DCP-2	.641***	1				1.89 (.79)
3. DCP-3	.651***	.581***	1			1.66 (.75)
4. DCP-4	.445***	.519***	.430***	1		1.65 (.83)
5. DCP-5	.539***	.580***	.540***	.559***	1	1.79 (.74)

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Diabetes Distress (n = 188)

	1.	2.	Mean (SD)
1. DD-1	1		2.53 (1.55)
2. DD-2	.481***	1	2.59 (1.65)

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Community-wide Stress (n = 188)

	1.	2.	3.	4.	5.	6.	7.	Mean (SD)
1. CS-1	1							1.38 (.73)
2. CS-2	-.030	1						1.93 (.74)
3. CS-3	.102	.231**	1					2.07 (.69)
4. CS-4	.291***	-.145*	-.100	1				1.18 (.74)
5. CS-5	.018	.177*	.323***	-.295***	1			2.37 (.64)
6. CS-6	.073	.117	.248**	-.205***	.363***	1		2.31 (.68)
7. CS-7	.050	.140	.380***	-.135	.469***	.510***	1	2.32 (.68)

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Infrastructure and safety for walking (n = 191)

	1.	2.	3.	4.	% Yes
1. NEWS1-1	1				83.3%
2. NEWS1-2	.287***	1			50.8%
3. NEWS1-3	.159*	.344***	1		24.6%
4. NEWS1-4 (reverse coded)	.082	.246**	.137	1	49.7%

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Aesthetics (n = 191)

	1.	2.	3.	% Yes
1. NEWS2-1	1			75.9%
2. NEWS2-2	.586***	1		66.5%
3. NEWS2-3	.223**	.260***	1	58.6%

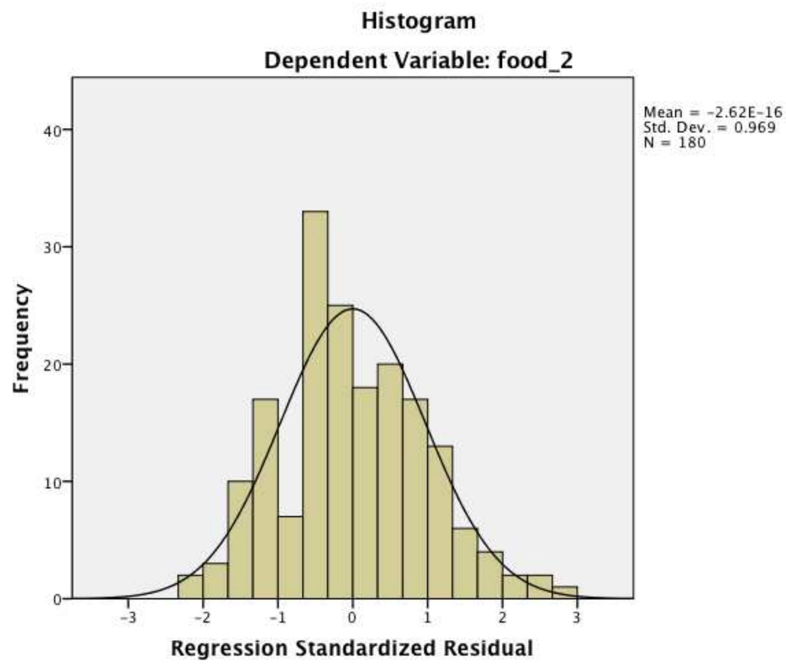
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

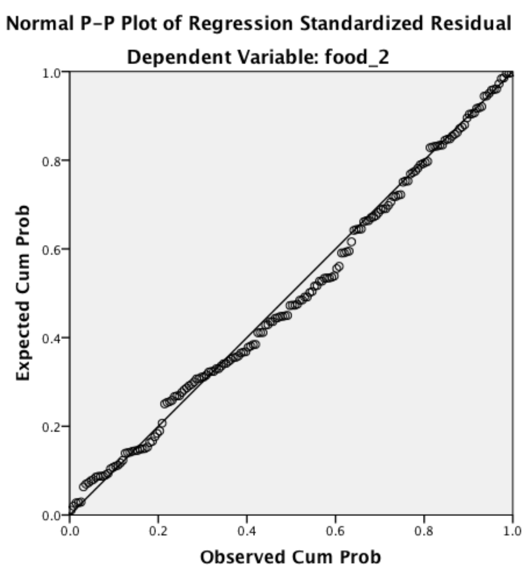
APPENDIX 6. SELECTED RESULTS OF LINEAR REGRESSION MODELS

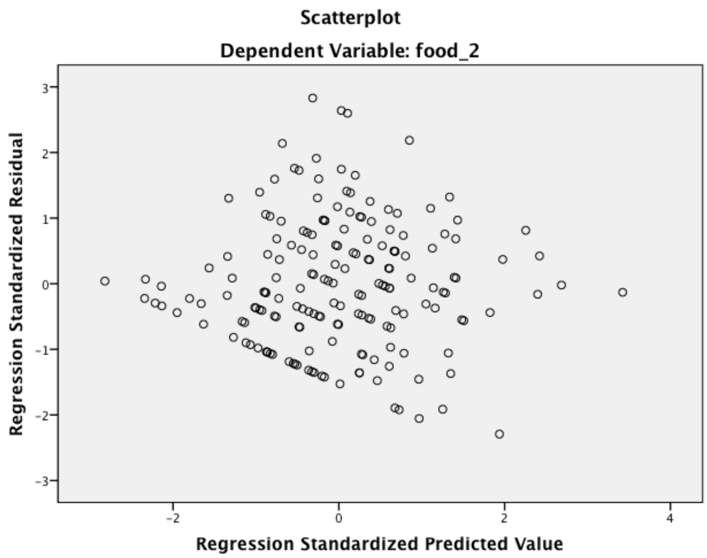
Healthy eating

ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	153.656	11	13.969	4.970	.000
Residual	472.193	168	2.811		
Total	625.849	179			



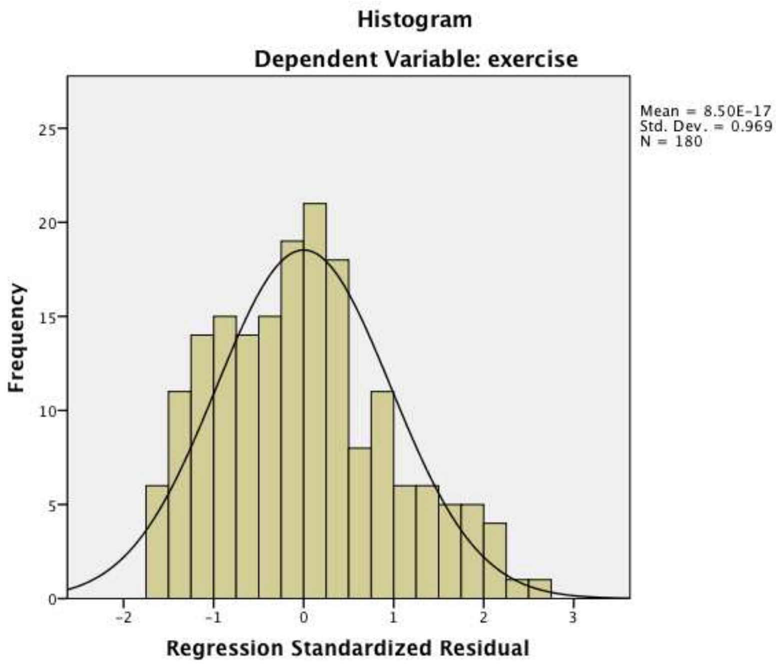


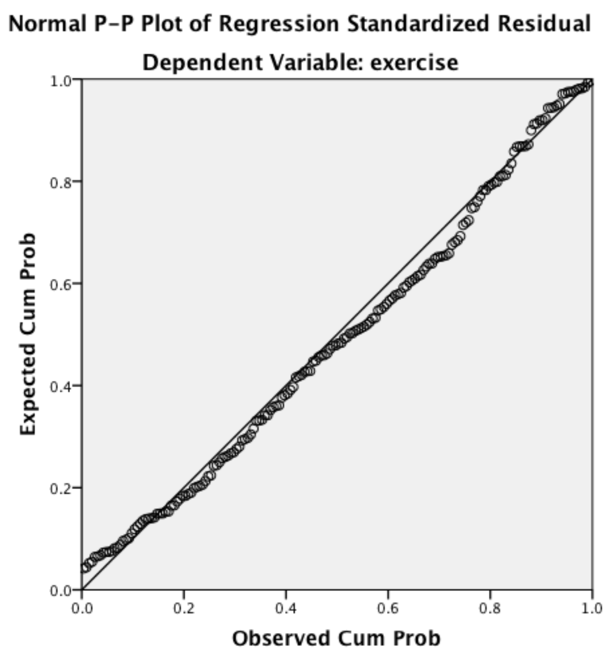

Scatterplot
Dependent Variable: food_2
Regression Standardized Residual
Regression Standardized Predicted Value
3
2
1
0
−1
−2
−3
−2
0
2
4

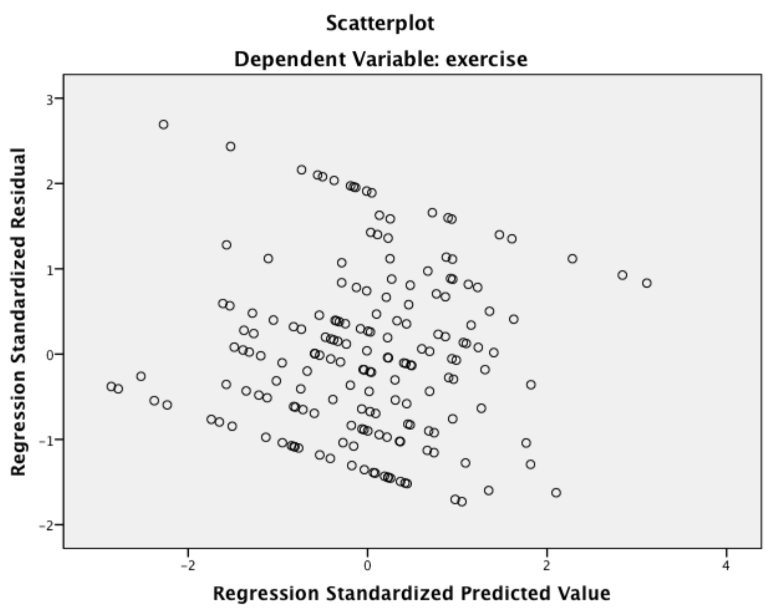
Physical activity

ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	97.655	11	8.878	1.941	.037
Residual	768.256	168	4.573		
Total	865.911	179			



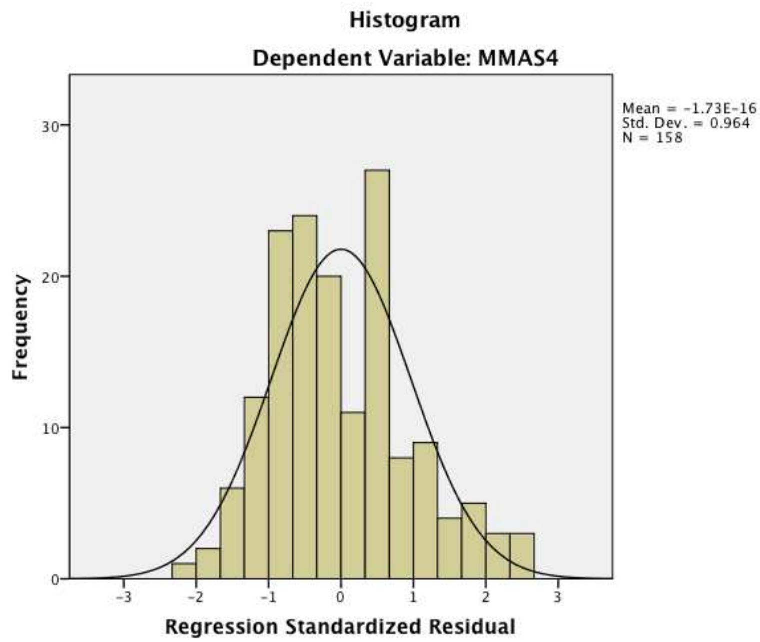

Normal P-P Plot of Regression Standardized Residual
Dependent Variable: exercise
Expected Cum Prob
Observed Cum Prob
0.0
0.2
0.4
0.6
0.8
1.0

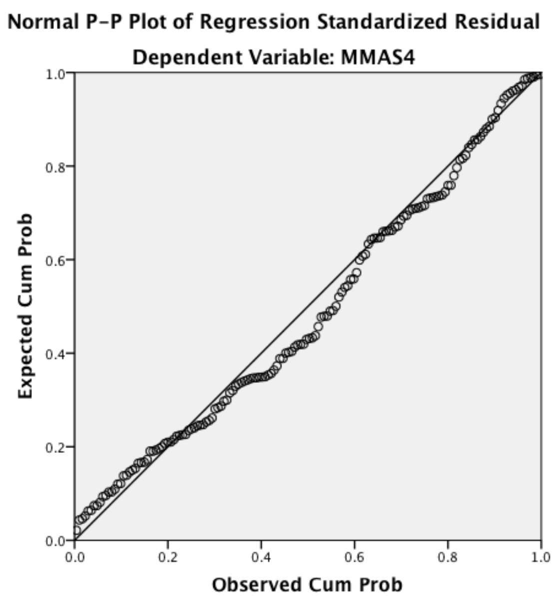

Scatterplot
Dependent Variable: exercise
Regression Standardized Residual
Regression Standardized Predicted Value
-2
0
2
4
-1
1
3

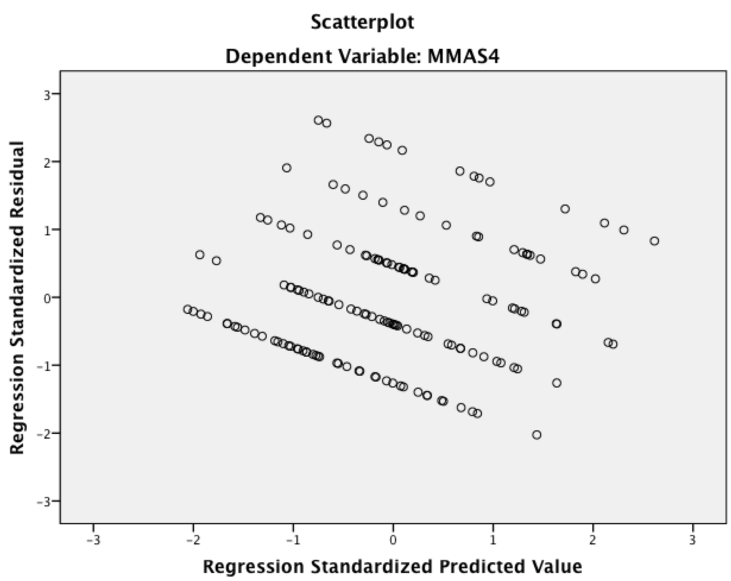
Medication adherence

ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	58.067	11	5.279	3.991	.000
Residual	193.123	146	1.323		
Total	251.190	157			




Normal P-P Plot of Regression Standardized Residual
Dependent Variable: MMAS4
Expected Cum Prob
Observed Cum Prob
0.0
0.2
0.4
0.6
0.8
1.0


Scatterplot
Dependent Variable: MMAS4
Regression Standardized Residual
Regression Standardized Predicted Value
-3
-2
-1
0
1
2
3

APPENDIX 7. DETAILED RESULTS OF STRUCTURAL EQUATION MODELS

Estimates of Structural Equation Model for Healthy Eating (n = 191)

	Appraisal of community distress (CD)			Appraisal of community resources (CR)			Personal Distress (PD)			Personal Resources (PR)			Healthy Eating		
	B	*p*	β	B	*p*	β	B	*p*	β	B	*p*	β	B	*p*	β
Factor Loadings															
CS5	1.000		.576												
CS6	1.111	.000	.603												
CS7	1.530	.000	.834												
NW1				1.000		.749									
NW2				1.137	.000	.706									
DDS1							1.000		.729						
DDS2							.968	.000	.658						
DES-SF										1.000		.548			
DCP-SRS										1.914	.000	.598			
SDSCA-D1													1.000		.804
SDSCA-D2													.560	.000	.537
Path Coefficients															
Gender	**.125**	**.036**	**.168**	.015	.667	.035	**.508**	**.010**	**.225**	-.079	.055	-.199	.775	.059	.199
Age	.001	.576	.046	-.001	.532	-.065	.004	.660	.039	.000	.767	-.030	**.045**	**.002**	**.283**
Education	.020	.552	.050	-.013	.518	-.056	**-.281**	**.015**	**-.227**	.010	.681	.044	-.075	.711	-.035
On reservation	**.290**	**.000**	**.323**	**-.213**	**.000**	**-.404**	.179	.561	.065	.022	.700	.046	.798	.094	.169
Income	.000	.974	-.003	.004	.111	.149	-.013	.277	-.104	**.007**	**.009**	**.316**	-.006	.790	-.029
CD							**.832**	**.031**	**.274**	.106	.185	.200	.299	.656	.057
CR							.012	.988	.002	-.044	.756	-.048	1.271	.274	.142
PD													**-.566**	**.032**	**-.328**
PR													**6.147**	**.001**	**.623**
Covariance															
CD				**-.016**	**.042**	**-.242**									
PD										-.019	.492	-.105			

Estimates of Structural Equation Model for Physical Activity (n = 191)															
	Appraisal of community distress (CD)			Appraisal of community resources (CR)			Personal Distress (PD)			Personal Resources (PR)			Physical Activity		
	B	*p*	β	B	*p*	β	B	*p*	β	B	*p*	β	B	*p*	β
Factor Loadings															
CS5	1.000		.576												
CS6	1.103	.000	.603												
CS7	1.530	.000	.834												
NW1				1.000		.749									
NW2				1.180	.000	.706									
DDS1							1.000		.729						
DDS2							.773	.001	.658						
DES-SF										1.000		.548			
DCP-SRS										1.482	.005	.598			
SDSCA-PA													1.000		1.000
Path Coefficients															
Gender	**.125**	**.035**	**.168**	.016	.647	.038	**.501**	**.018**	**.198**	-.075	.112	-.167	-.063	.864	-.014
Age	.001	.576	.045	-.001	.575	-.058	.005	.547	.052	.000	.799	-.026	-.019	.175	-.103
Education	.020	.552	.050	-.013	.523	-.056	**-.298**	**.012**	**-.215**	.014	.591	.058	.014	.944	.006
On reservation	**.292**	**.000**	**.324**	**-.210**	**.000**	**-.404**	.290	.385	.095	.027	.676	.050	-.299	.623	-.043
Income	.000	.975	-.003	.004	.117	.148	-.014	.272	-.100	**.008**	**.007**	**.307**	-.042	.067	-.169
CD							**.953**	**.016**	**.280**	.139	.130	.230	-.368	.570	-.063
CR							.111	.898	.019	-.036	.823	-.034	1.823	.104	.178
PD													-.090	.667	-.052
PR													**3.613**	**.021**	**.371**
Covariance															
CD				**-.016**	**.043**	**-.242**									
PD										-.023	.499	-.101			

Estimates of Structural Equation Model for Medication Adherence (n = 166)

	Appraisal of community distress (CD)			Appraisal of community resources (CR)			Personal Distress (PD)			Personal Resources (PR)			Medication Adherence		
	B	*p*	β	B	*p*	β	B	*p*	β	B	*p*	β	B	*p*	Β
Factor Loadings															
CS5	1.000		.577												
CS6	1.136	.000	.607												
CS7	1.530	.000	.870												
NW1				1.000		.876									
NW2				.836	.002	.605									
DDS1							1.000		.629						
DDS2							1.299	.000	.755						
DES-SF										1.000		.609			
DCP-SRS										1.542	.009	.541			
MMAS-4													1.000		1.000
Path Coefficients															
Gender	**.141**	**.027**	**.189**	-.003	.949	-.005	**.445**	**.023**	**.233**	-.088	.080	-.193	-.190	.345	-.076
Age	.002	.453	.064	-.003	.210	-.121	-.001	.862	-.017	-.001	.620	-.054	**.027**	**.001**	**.258**
Education	.027	.461	.065	-.012	.619	-.043	**-.239**	**.041**	**-.227**	.016	.593	.062	.039	.725	.028
On reservation	**.234**	**.007**	**.250**	**-.227**	**.000**	**-.353**	-.002	.995	-.001	.045	.515	.078	.128	.616	.041
Income	-.001	.823	-.020	.005	.061	.166	-.015	.176	-.140	**.010**	**.001**	**.400**	-.003	.849	-.018
CD							.547	.084	.215	.122	.169	.200	.233	.478	.069
CR							-.364	.424	-.098	-.121	.311	-.137	-.336	.482	-.069
PD													**-.503**	**.003**	**-.382**
PR													.953	.197	.173
Covariance															
CD				-.015	.089	-.183									
PD										-.025	.381	-.150			