2019

Natural Environment Associations with Mental Health and Obesity Status

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The Office of the Provost

Walden University
2019

Abstract

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MPA, Grand Valley State University, 2004

BS, Ferris State University, 1998

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

Mental health and obesity were ranked among the health priorities of the 2014 and 2017 Community Health Needs Assessments in Kent County, Michigan. Exposure to nature is correlated to improved health outcomes across a variety of morbidities including poor mental health and obesity. This cross-sectional study set within the frameworks of attention restoration theory, environmental health, and pathways to health benefits from nature assessed county survey data including self-reported nature exposures/interactions separated into 3 domain areas: access to nature, attitudes about nature, and physical activity in nature or in nature-based activities. Binary logistic regression analyses of the 653 respondents found that those who self-reported higher frequency of physical activity in nature or in nature-based activities possessed lower odds of also reporting poor mental health ($p < .001$, *OR* .652, 95% *CI* .535, .795) and obesity ($p < .001$, *OR* .666, 95% *CI* .548, .808) with each ascending level of agreement with the physical activity statement question. Ascending levels of agreement with the ease of access to nature statement question was found to be associated with lower odds of poor mental health ($p < .001$, *OR* .585, 95% *CI* .470, .797); however, no correlation was found between this variable and obesity status. The attitudes about nature domain statement questions were not consistently found to be associated with either mental health or obesity status. The significantly associated independent nature variables demonstrated weak effects (Nagelkerke $R^2 < .300$) on their respectively linked health outcomes. These findings may equip public health officials with information to develop more effective interventions for addressing mental health and obesity in their respective communities.

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Dedication

I dedicate this to the 10 most influential people in my life. To my mother who always supported me and encouraged me to reach my potential. To my father who taught me to focus my abilities toward serving God through service to others. To my children: Zachary, Nicholas, Sydney, Samuel, Lucas, Elizabeth, and Theodore. I have been blessed far beyond anything I deserve to be your dad. You each inspire me in your unique ways to be a better person. I pray that I might inspire you to light your own lamps, ask many questions, and seek truth.

"On the way of wisdom I direct you, I lead you on straight paths. When you walk, your step will not be impeded, and should you run, you will not stumble. Hold fast to instruction, never let it go; keep it, for it is your life." (Proverbs 4:11-13, New American Bible, Revised Edition)

Finally, and most importantly, I dedicate this work to my beautiful wife, Anne. This achievement would not have been possible without your support and love.

Acknowledgements

This dissertation, as the final achievement of many years of formal education, would not have been possible without significant contributions from many special people. I would like to acknowledge all the educators I had the honor of learning from at Big Rapids Public Schools, Ferris State University, Grand Valley State University, and Walden University. I was not always a great student, but your patience and persistence eventually paid dividends. I would like to acknowledge the two most recent County Administrators I have served under, Dr. Daryl Delabbio and Mr. Wayman Britt. Your mentoring and support have been essential to my professional growth. I would also like to acknowledge the public health colleagues that I have worked alongside and others that I have learned with as students. Thank you for all the problems we solved and the lessons we learned together. Most of all, thank you for all you do to serve, protect, and promote healthy communities for all people everywhere. Finally, I would like to acknowledge the talented people who served on my research committee: Dr. Leslie Elliott, Dr. Cynthia Newell, and Dr. Manoj Sharma. Your attention to detail and priceless suggestions greatly improved my experience and this dissertation. The encouragement of my Chair, Dr. Leslie Elliott, was especially important during this long and sometimes frustrating process. I will forever be indebted to all of you.

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Chapter 1: Introduction to the Study

Introduction

Poor mental health and obesity are two of the greatest challenges facing public health officials in the 21st century. The occurrence of mental illness is common in the United States, causing diminished quality of life and contributing to the development other ailments such as stroke, Type 2 diabetes, and heart disease (Centers for Disease Control and Prevention [CDC], 2018a). Obesity is a dangerous and perplexing problem linked to many leading causes of mortality; it is challenging to solve because multiple factors contribute to its development (CDC, 2018b). Addressing these chronic issues requires an improved understanding of the factors influencing them. This knowledge can be used to develop innovative interventions. Determining how and where to invest resources for positive social change through improved public health policy is a priority for government agencies and other stakeholders. Human exposures to nature and natural settings may have positive benefits for the overall health of communities. However, scholars have not examined access to natural areas, attitudes about nature, or physical activity in nature or in nature-based recreation relative to each other and improved health status.

The beneficial qualities of exposure to nature and nature-based activities have been hypothesized for many years. Humboldt claimed that the health of species, including humankind, is connected to the health and presence of nature (as cited in Wulf, 2016). Humboldt influenced subsequent generations of thinkers to embrace nature as more than unconsumed resources. In March of 1845, Thoreau built a small cabin in the

Massachusetts woods near a pond named Walden (Thoreau & Cramer, 2006). Thoreau's time at Walden Pond was a period of self-discovery and rejection of the popular laboring lifestyle. Thoreau's embrace of nature has influenced others to study the relationship between nature exposures and wellness. This research was intended to build upon this pursuit of knowledge and contribute to understandings that can be used to improve public health and influence positive social change.

In this study, I sought to better understand how nature and nature-based activities are associated with mental health and obesity status in a Michigan county. The improved understandings resulting from this study may help to inform an approach to these issues and the language that describes them. This knowledge could also empower public health practitioners to develop policies designed to advance positive social change.

Background

Public health agencies, especially those operating at the local level, frequently work in conjunction with nonprofit health care systems and other stakeholders to assess the population health needs and priorities of their respective communities. Mental illness and obesity are among the issues identified as priorities. These agencies seek to find solutions to the challenges of the modern era. Local health departments in Michigan and in most other states have regular programming related to mandated public health services such as food safety, drinking water quality, vaccination clinics, hearing and vision screening, sexually transmitted illnesses, and others established by legislation and state policy. In Michigan, these programs do not include a mandate or regular financial support for mental illness and obesity programming. Developing interventions for these

community priorities is difficult because of funding limitations and lack of clarity about where to invest for maximum results. Exposures to nature and nature-based activities, or the lack thereof, may be associated with the types of concerns identified by communities. A more developed understanding of these relationships could empower public health agencies and officials with new tools and knowledge for promoting and protecting public health.

Problem Statement

In 2014 and in 2017, a coalition of healthcare organizations in Kent County, Michigan conducted community-based initiatives to assess the community's health needs. Community Health Needs Assessments (CHNA) are required by federal legislation and were performed by the county's local health department in partnership with five local nonprofit health care systems and many other stakeholder organizations for understanding population health status and community priorities. The CHNA process was a participative project that collected input from residents throughout the county via Internet-based survey tools, townhall meetings, and other mechanisms. The residents identified and ranked priority health issues they wanted community resources directed toward.

The 2014 CHNA process identified mental health and obesity as the county's leading community health concerns (Healthy Kent, 2014). These priorities were reaffirmed in the 2017 CHNA that determined that the community was most concerned about (a) mental health, (b) substance use disorders, and (c) obesity/nutrition (Kent County Health Department & Healthy Kent, 2017). Furthermore, 38.1% of the 2017

needs assessment respondents also identified stress as a health concern (Kent County Health Department & Healthy Kent, 2017). Communities use these needs assessment findings for developing plans with commitment from many stakeholders to address the priority areas expressed by the residents. It is, however, difficult to develop these types of plans when evidence-based information about effective interventions is lacking or is insufficient.

Human health status may be influenced by relationships to nature. The reasons underpinning this idea were expressed by Fromm (1964) and the concept of biophilia which holds that humans are innately connected to the natural world and that separation from it is disordered. This disordered relationship stresses human health and/or recuperative functions. Wilson (1984), Kaplan and Kaplan (1989), and Louv (2005) further advanced Fromm's ideas through (a) a deeper exploration of biophilia, (b) the development of attention restoration theory (ART), and (c) by summarizing them for the general public under the title of nature-deficit disorder (NDD), respectively. These authors proposed that human health is related to relationships to nature and the surrounding environment. These thoughts have informed the development of nature-assisted therapies (NAT) and a variety of related approaches. Although the understanding of these relationships is expanding, there is a gap in the current understanding related to what type of experience with nature is associated with better health outcomes.

Although recognition of NDD as an idea explaining the harmful influence of separation from nature has grown in recent years (Palomino, Taylor, Goker, Isaacs, & Warber, 2015), understanding of the influence of pathways and moderating factors on

prioritized community health issues is still insufficient (Shanahan et al., 2015). Further exploration of the possible nature-based factors and health outcomes is needed (Day, Theurer, Dykstra, & Doyle, 2012). A more developed understanding of these factors, and many other social and behavioral domains, is needed to identify components essential for affecting population health outcomes and influencing subsequent health strategies (Kondo, South, & Branas, 2015; Shanahan et al., 2015).

If a deficit of exposure to nature is associated with the type of community health priorities identified in Kent County, the leaders in that community should understand the factors associated with these conditions. Recognizing the possible significance of access to nature, a person's attitudes or feelings of connectedness to nature, and/or nature-based activity and how those independent variables relate to health status is consistent with the level of learning described in Rudestam and Newton (2001) as being essential for quality research. It is also imperative for public health experts to have a better operational definition of the nature variable. Prior scholars have presented a diverse array of definitions for nature factors (Bowler, Buyung-Ali, Knight, & Pullin, 2010). The knowledge produced by this study should serve to advance social change in communities struggling to identify evidence-based approaches to improve overall community health.

Purpose of the Study

This intent of this study was to better understand associations between two issues prioritized in the subject county's 2014 and 2017 CHNA: mental health and obesity status, and the following factors related to nature: access, attitudes, and physical activity. In addition to data from the needs assessments, I also used secondary data from the

county's Stress and Nature Mini-Survey that were collected during August and early September of 2018. This survey gathered self-reported health status from residents of Kent County, Michigan. These data allowed quantitative analyses to be conducted for measuring the associations between the nature-based independent variables and the health outcome dependent variables.

The findings from this study will help build an understanding of these nature factors and empower future researchers to advance the literature and for public health officials to apply these lessons learned toward policy development. Nature-based therapies and programs could also be created or enhanced with improved nature dynamics to more effectively achieve public health goals (Maier & Jette, 2016). The improved understanding of these identified health issues and their associated factors will empower positive social change and better public health through improved programming, planning, and policy.

Research Questions and Hypotheses

Research Question (RQ) #1: Is mental health status in a Michigan county associated with the ability to access nature areas as measured by the county's Stress and Nature Mini-Survey?

$H_0$1: Mental health status in a Michigan county is not associated with the ability to access nature areas as measured by the county's Stress and Nature Mini-Survey.

H_a1: Mental health status in a Michigan county is associated with the ability to access nature areas as measured by the county's Stress and Nature Mini-Survey.

RQ #2: Is mental health status in a Michigan county associated with attitudes about connectedness to nature as measured by the county's Stress and Nature Mini-Survey?

$H_0$2: Mental health status in a Michigan county is not associated with attitudes about connectedness to nature as measured by the county's Stress and Nature Mini-Survey.

H_a2: Mental health status in a Michigan county is associated with attitudes about connectedness to nature as measured by the county's Stress and Nature Mini-Survey.

RQ #3: Is mental health status in a Michigan county associated with physical activity in natural areas or in nature-based activities as measured by the county's Stress and Nature Mini-Survey?

$H_0$3: Mental health status in a Michigan county is not associated with physical activity in natural areas or in nature-based activities as measured by the county's Stress and Nature Mini-Survey.

H_a3: Mental health status in a Michigan county is associated with physical activity in natural areas or in nature-based activities as measured by the county's Stress and Nature Mini-Survey.

RQ #4: Is obesity (as represented by body mass index) in a Michigan county associated with the ability to access nature areas as measured by the county's Stress and Nature Mini-Survey?

H_o4: Obesity in a Michigan county is not associated with the ability to access nature areas as measured by the county's Stress and Nature Mini-Survey.

H_a4: Obesity in a Michigan county is associated with the ability to access nature areas as measured by the county's Stress and Nature Mini-Survey.

RQ #5: Is obesity (as represented by body mass index) in a Michigan county associated with attitudes about connectedness to nature as measured by the county's Stress and Nature Mini-Survey?

H_o5: Obesity in a Michigan county is not associated with attitudes about connectedness to nature as measured by the county's Stress and Nature Mini-Survey?

H_a5: Obesity in a Michigan county is associated with attitudes about connectedness to nature as measured by the county's Stress and Nature Mini-Survey?

RQ #6: Is obesity (as represented by body mass index) in a Michigan county associated with physical activity in natural areas or in nature-based activities as measured by the county's Stress and Nature Mini-Survey?

H_o6: Obesity in a Michigan county is not associated with physical activity in natural areas or in nature-based activities as measured by the county's Stress and Nature Mini-Survey.

H_a6: Obesity in a Michigan county is associated with physical activity in natural areas or in nature-based activities as measured by the county's Stress and Nature Mini-Survey.

Conceptual Model

This study was informed primarily within the framework of ART. The model for the interaction between exposures and health outcomes was aligned with the environmental health perspective and in accordance with the pathways to health benefits

from nature framework presented by Shanahan et al. (2015). Environmental health is the understanding that human health is influenced by factors in the world surrounding humans. The National Environmental Health Association (2013) defined environmental health as follows:

> Environmental health is the science and practice of preventing human injury and illness and promoting well-being by identifying and evaluating environmental sources and hazardous agents and limiting exposures to hazardous physical, chemical, and biological agents in air, water, soil, food, and other environmental media or settings that may adversely affect human health. (p. 72)

Promoting wellbeing by limiting exposure to settings that may adversely affect human health, such as areas or activities separate from natural features, is within the scope of the environmental health definition; yet, this application of the definition is not frequently applied in practice. It is, however, consistent with ideas about how the environmental health perspective is a conceptual framework to understand new and systemic challenges (Briggs, 2008). Environmental stressors are agents or conditions that are harmful to human wellbeing. In the case of the nature/health relationship, and for the purposes of this study, the stressor of concern was exposure to environments devoid of the natural features as described by Wilson (1984).

The social determinants of health conceptual model also aligns with the understanding of this study. This model presents a framework in which a variety of social processes affect health outcomes (Solar & Irwin, 2010). A number of social dynamics correlate to the factors of interest explored in this study: access, activity, and attitudes

respectively. Using a social determinants of health framework is supported within the literature (Hordyk, Hanley, & Richard, 2015). This perspective is important because people living in urban environments may face a different array of obstacles and challenges. Inner city youth focus groups, for example, report fear of violence, animals, costs and fees, and unfamiliarity with nature-based recreation as significant barriers to visiting natural areas (Blanton, Oregon, Flett, Gould, & Pfeiffer, 2013). Recognizing the importance of these features within the study was consistent with the applicable frameworks.

The frameworks of environmental health and the social determinants of health are consistent with ART and are combined into a research framework proposed by Shanahan et al. (2015). This pathways to health benefits from nature framework presents six steps. Step 1 is to identify a factor in nature that is specific and measurable. Step 2 is to identify a unique characteristic of that nature factor. Step 2 may lead directly to an identified effect on people (Step 4), or it may lead to Step 3 that considers moderating factors. Under Step 3, the researcher identifies variables that could impact the ecosystem's influence on people through physical, social, cultural, or behavioral factors. Step 3, like Step 2, can lead to the observation of health effect(s) that are identified in Step 4. Step 5 is to describe the factors influencing the relationship between effect(s) and associated benefits. Finally, Step 6 is to identify the human health benefit. In the methodology section of this document, I demonstrate how the elements of this study approached and satisfied the steps of the Shanahan et al. framework.

The research questions presented in this study were framed within the possibility that mental health and obesity are influenced by both the environmental health concept of health status because exposure, or lack thereof, to the nature environment may correlate to health outcomes for either better or for worse, and the social determinants of health concept because social dynamics, such as access and attitudes, may also correlate to those same health outcomes. The study design of this research in consistent with the Shanahan et al. research framework.

Nature of the Study

I used quantitative analyses of cross-sectional survey data collected in Kent County, Michigan. These data allowed for an observational study of the relationships between nature factors, collected as responses to seven nature statement questions, and health status. Three independent variable domains were included in this study. The first domain was the level of access survey respondents reported having to natural areas. Data for this first variable were captured by three access-relevant statement questions within the survey. The second domain was the attitude, also called connectedness, toward nature held by the respondents. Data for this second variable were captured by three attitudes-relevant statement questions within the survey. The third domain was the level of activity in nature or in nature-based activities reported by the survey respondents. The data for this third variable were captured in one statement question on the survey that addressed frequency of physical activity in nature areas or participating in nature-based activities.

Data for each of these independent variables existed in ordinal form as the result of Likert scale-based survey statement questions. Each of these independent variables

were compared to two dependent health status variables. The first of these dependent variables was self-reported poor mental health status as defined as 14 or more days of poor mental health within the past 30 days. These mental health data exist as categorical data. The other dependent variable was obesity as measured by body mass index (BMI) of 30 or greater. The obesity data were also presented as categorical data. The knowledge gained from this study can empower community health improvement by informing local leaders about how and where to most appropriately invest limited resources.

Assumptions

It was assumed that questionnaire respondents answered the Stress and Nature Mini-Survey honestly. The survey questionnaire did not ask for personal identifiers and assured confidentiality. The respondents voluntarily participated in the survey, and no compensation was provided. The survey was offered in English and Spanish, and it was assumed that the respondents possessed the literacy to understand the questionnaire. The questionnaire declared that participation was sought from adults aged 18 years or older only. The survey also declared that participation was only intended from Kent County residents. It was, therefore, assumed that respondents complied with those directives and that minors and nonresidents did not participate. Social media websites Facebook and Twitter were the primary tool for distributing the questionnaire, and I assumed that the general population had a similar level of access to those sites. Furthermore, it was assumed that the followers of the local health department's social media venues were generally representative of the county's population. These assumptions did present some limitations to the study that will be addressed later.

It was also assumed that the data available from the Stress and Nature Mini-Survey satisfied the assumptions of binary logistic regression testing listed below.

1. Dependent variables consist of binary categorical data.
2. Independent predictor variables consist of continuous data, or categorical/ordinal data that can be treated as continuous, and there are no influential outlying values creating distortion.
3. No multicollinearity among the independent predictor variables.
4. A linear relationship between the independent predictor variables and the logit transformation of the dependent variable.

Scope

This research included persons who completed the county's Stress and Nature Mini-Survey and reported being at least 18 years of age and living in this Michigan county. The survey was made available in English and Spanish languages. There was also a temporal scope to this study because the survey data were collected during the August and early September of 2018.

Limitations

The diversity of definitions pertaining to the nature variable in existing literature presented a limitation for this study. The design of this study was intentionally considerate of those definitions and included an operational definition for nature that was mindful of those prior models and based upon Wilson's (1984) description of the ideal human habitat.

The survey conducted by the local health department could not claim to be representative of the county's overall population. This limitation exists in part because social media sites Facebook and Twitter were the primary tools for distributing the questionnaire. Questionnaires were also made available in the health department's clinics and at partner locations throughout the county. These offerings made the survey available to a diverse array of people; however, it was not reasonable to assume that this sort of limited public inquiry provided a truly representative sample. Another challenge was that the survey tool measured the variables of interest at a fixed moment in time and assumed that they answered questions about height, weight, and health status honestly. Longitudinal understanding of the population's exposure to nature over a life course would have been more informative if those historical data would have been available (Pearce, Shortt, Rind, & Mitchell, 2016). The cross-sectional design of this data set was not appropriate for the assignment of causation, merely association.

The survey was made available in English and Spanish, which were the county's two largest linguistic groups. There were, however, a much broader assortment of languages spoken in this county. The exclusion of these additional languages is considered a limitation of this study. Another limitation was that the survey data were collected during a short period of time, approximately 1 month, during the late summer of 2018. It is possible that opinions about accessibility of nature, attitudes about nature, and physical activity in nature or nature-based recreation could vary seasonally. The possibility of seasonal opinion variation was not explored by this study.

Significance

Population health burdens related to mental health and obesity status are among the most common and challenging to deal with. Gaining an improved understanding of the factors affecting those health challenges is useful for advancing positive social change. Communities, such as this county in Michigan, have identified their health priorities through needs assessments and strive to develop solutions to the health issues prioritized in those assessments. The ability to solve these complex problems are often beyond the ability of any one organization to solve. If factors related to nature are in any way impactful to these complicated issues, it is imperative that they are studied and better understood. Understanding these associations between access, attitudes, and activity factors and health status is important when designing interventions for protecting the health of vulnerable populations. Empowering positive social change is dependent upon research exposing information that can be used to construct improved CHNA and Community Health Improvement Plan (CHIP) initiatives. Urban parks users, for instance, may be more influenced by personal attitudes than by accessibility of natural areas (Lin, Fuller, Bush, Gaston, & Shanahan, 2014). Fears, unfamiliarity, and financial barriers may also exist in urban areas (Blanton et al., 2013). Public health agencies, local units of government, and nonprofit health systems can invest resources more effectively if they understand which, if any, of these nature-based variables correlates to health outcomes.

Summary

Poor mental health status and obesity are two of the most pressing issues facing communities in the United States. These issues have also been expressed as priorities by

the 2014 and 2017 versions of the CHNA conducted in the Michigan county of interest. Addressing these chronic health problems will require innovative thinking and the consideration of many factors. Proponents of ideas and theories such as biophilia, ART, and NDD propose that separation from nature leads to a lack of wellness across many health measures. Although a body of literature supports these theories, there is a general lack of understanding about the variables that affect the relationship between nature exposures and health outcomes. In this study, I sought to better understand the associations between access to natural areas, attitudes about nature, and actual physical activity in nature, with the health outcome dependent variables of mental health status and obesity. This understanding can empower public health officials and other decision-makers with knowledge that could inform more efficient and effective policy. Chapter 2 provides a review of the literature related to nature exposure and human health status.

Chapter 2: Literature Review

Introduction

An apparent relationship between health and exposure to nature has been noted by many authors. Humboldt and Thoreau extolled the healthful value of time spent in nature. These writers, and others like them, challenged the thinking of their times. A substantial amount of study has subsequently developed; however, significant knowledge gaps remain. The following review presents the present body of literature as it relates to this subject.

Literature Search Strategy

A search was conducted using the library database resources of Walden University including Academic Search Premier, CINAHL Plus, MEDLINE, ProQuest, PubMed, and Thoreau Multi-Database. The Google Scholar search engine was also used to locate peer-reviewed primary research. Search terms included the following: *nature, greenspace(s), nature-based activities, wilderness,* and *parks* as the first terms, and *health, public health, environmental health, obesity*, and *mental health*. I also reviewed the library of articles and information available at the county of interest's local health department. Peer-reviewed research articles published between 2012 and 2019 were given preference in this study. Documents that were older, or were not from peer-reviewed publications, were only included if they presented data or perspectives essential to the current understanding of the research questions. Thousands of articles were identified through this search strategy. These articles were briefly reviewed for relevance

and included for full review if their content was consistent with the topic and questions of this study.

Contemporary Literature

King was one of the earliest to apply the belief that nature and health are associated. King used farming and outdoor recreation as therapy for asylum residents in Seacliff, New Zealand between the years of 1889 and 1922. While unconvincing discharge rates and other health metrics cast doubt on the efficacy of King's treatment regimen at that time, the approach inspired like-minded experimentation from other institution administrators and care givers (Stock & Brickell, 2013). Fromm is generally recognized as the first modern scientist to propose the concept of biophilia in 1964. The idea of biophilia holds that humans have an innate affection for nature and other species and that this connection is integral to human wellness. Fromm's approach, founded largely on the humanist perspective, allowed the consideration of issues of environmental worth to human welfare during the mid-1960s (Gunderson, 2014).

Wilson advanced this body of thought further in 1984. Wilson proposed that human affection for nature and affiliation with other organisms has developed over eons of evolutionary interaction between the human species and the natural world. This is in accordance with biological principles about the importance of habitat selection as critical for the survival of species. The human mind, according to Wilson, is "primed to respond most strongly to some narrowly defined qualities that had the greatest impact on survival in the past" (p. 106). The qualities that Wilson identified are consistent with the savannas in Africa, Europe, and Asia where most of the human experience has occurred (p. 109).

Wilson concluded that large grasslands with groves of trees and water features are the most ideal setting for humans and it was within these settings that the upright bipedal human form was ideally matched for optimum survival. Wilson stated, “it seems that whenever people are given a free choice, they move to open tree-studded land on prominences overlooking water” (p. 110). This concept of biophilia posits that organisms are less stressed in, and drawn towards, habitats aligned with optimal conditions from their evolutionary history. The description of that ideal habitat setting may be useful for a practical understanding of what ingredients a natural area contains.

Kaplan and Kaplan (1989) understood that focused attention on anything for prolonged periods leads to mental fatigue, and that this sort of fatigue was associated with negative consequences for mental health. In consideration of the works of prior researchers, Kaplan and Kaplan formulated the ART to explain how nature impacts wellbeing. Nature, according to ART, causes fascination and healthful distraction that contributes to recuperation of the brain’s attentive faculties (Kaplan & Kaplan, 1989). Humans have a preference toward viewing and spending time in natural rather than urban settings, and ART is useful for understanding how people benefit from the presence of nature (Joye, Pals, Steg, & Evans, 2013). It is consistent with ART that one of the most important reasons people visit natural areas is to relax and escape the regular stresses of life (Irvine, Warber, Devine-Wright, & Gaston, 2013).

Louv (2005) advanced these ideas further and proposed the concept of NDD. Louv contended that absence from nature contributes to many health problems and that children are less healthy today because they spend less time outdoors in natural settings.

In 2011, Louv expanded this position to include adults and their diminishing overall health as related to societal withdrawal from nature and nature-based activities in preference for other types of recreation. Louv's perspectives were largely consistent with the concept of biophilia and ART.

Pursuant to the works of Wilson, Kaplan and Kaplan, Louv, and others, there have been initiatives to design and deliver NAT to address short-term recovery from stress and mental fatigue, improved recovery from illness, and long-term better health (Annerstedt & Währborg, 2011). There have also been recommendations for increasing nature contact as part of a public health approach to creating healthier communities (Largo-Wight, 2011; Piccininni, Michaelson, Janssen, & Pickett, 2018). Measuring the effect of these programs has been challenging due to a lack of conformity of definitions and insufficient theoretical models for informing additional research (Annerstedt & Währborg, 2011). NAT is valuable for public health intervention for mental health issues, obesity, and other conditions; however, diversity of intervention strategies and definitions make specific recommendations difficult (Annerstedt & Währborg, 2011). A general lack of negative or null findings in the literature is also cause for inquiry because although it may indicate extraordinary support for a strong relationship, it may also suggest a general unwillingness to publish negative/null findings (Holland, Powell, Thomsen, & Monz, 2018).

Nature-based rehabilitation (NBR) is another model of nature centric programming designed to foster health improvement. Pálsdóttir, Persson, Persson, and Grahn (2014) identified three primary phases that are important for the realization of

health benefits: the prelude phase that includes receptiveness to nature, the recuperating phase that includes peaceful connectedness to nature, and the empowerment phase that includes self-efficacy and readiness to address challenges. The findings of these scholars have motivated additional practitioners to recommend the inclusion of nature-based elements into other programs such as the Exercise is Medicine initiative to improve mental health (Maier & Jette, 2016). Programs that encourage engagement with natural environments are recognized to generally improve health status and generate substantial economic benefits for communities (White et al., 2016; Wolf & Robbins, 2015).

Scholars support separation from nature, as described in NDD and elsewhere, as at least partially explanatory of a number of modern public health challenges and NAT as beneficial for health restoration. There is, however, criticism that NDD as described by Louv (2005) is insufficient for diagnosis (Dickinson, 2013). This critique of NDD holds that cultural and emotional dynamics also need to be considered and that public health officials should be careful to avoid diagnosing problems and framing solutions solely within the context of the experiences of the majority culture. Surveying the attitude people have towards nature and nature-based activities may be a step towards gaining a deeper understanding of cultural and emotional complexities. However, additional criticisms of NDD hold that the use of nature as an entity that people are disconnected from assumes that humans are somehow outside of the natural world and perpetuates what may be a faulty binary understanding of human existence (Fletcher, 2017a).

Although supporting literature is substantial, some scholars have reported doubt about the clarity of the relationships between nature and health. For instance, Bowler et

al. (2010) concluded an overall positive impact on wellbeing but also concluded that absence of a standard definition of natural environment and greenspace was complicating analyses. Yet, Tillman, Tobin, Avison, and Gilliland (2018) found that about half of the articles reported statistically significant relationships but that more rigorous studies and objective measures are needed.

Concern for separation from nature may itself be harmful because it reinforces the idea that humans and nature are inherently different. It may also be possible that technology can stimulate environmental affection absent exposure to actual natural settings (Fletcher, 2017b), or that technology can be used to help form a richer understanding of the subject (Beute, de Kort, & Ijsselsteijn, 2016; Craig, Logan, & Prescott, 2016; Doherty, Lemieux, & Canally, 2014). The association between variables and the need for particular interventions may not be as obvious as some of the literature would suggest. Scholars have presented a variety of recommended exposures ranging from nature gardens to merely listening to recordings of natural sounds (Largo-Wight, 2011). This array of possible factors needs to be considered in future research.

Another concern related to NDD is centered upon how this idea is perceived by the general public. Palomino et al. (2015) reviewed the use and recognitions of NDD amongst the general population and examined 176,494 posts on the Twitter social media platform provided by 74,485 users and reviewed those postings for similarities and other significant observations. The term NDD was generally communicated attached to negative connotations within the narrative of social media correspondence while other, gentler sounding, names were viewed more favorably. Palomino et al. concluded that the

concept of NDD is not comprehensively recognized by that title or by any other. A deeper understanding of the many factors and issues related to nature and human health could aid in the development of universally accepted terminology.

These critiques should be considered as professionals seek to develop informed definitions of nature, associated terminology, and subsequent health programming. The severity of chronic public health challenges such as mental illness and obesity demand that public health officials explore possible solutions from unconventional approaches such as improved access to nature, attitude forming about nature, and/or promoting physical activity in natural areas or in nature-based recreation. Effective interventions will need to be informed by building hypotheses, testing research questions, and contributing to theories and/or frameworks for understanding the association between nature variables and human health.

The body of literature about nature exposures and human health has grown, suggesting that researchers also have a growing interest in this field of study. Scholars present a challenging diversity of definitions and understandings about what nature, green space, and related terms mean. Hartig, Mitchell, de Vries, and Frumkin (2014) found that the number of published articles has increased from two between 1990-1999, 34 between 2000-2009, and 45 between 2010 to June of 2013. The remainder of this literature review includes an overview of the scholarly writings from this expanding field of study. Information is presented regarding how the literature relates to both mental health and obesity. Attention was given to understanding how the authors defined terms such as

nature and green space. Consideration was also given to how the authors described the content of the independent variables.

Access and activity in nature are associated generally with a variety of beneficial health outcomes (James, Banay, Hart, & Laden, 2015; Kuo & Taylor, 2004; McEachan et al., 2016; Shanahan et al., 2016; Tillman et al., 2018; Warber, DeHudy, Bialko, Marselle, & Irvine, 2015). This literature is not exclusive to the United States or any singular culture. A substantial portion of this research has occurred in European nations and Japan (Flaskerud, 2014). In the Netherlands, Jonker, van Lenthe, Donkers, Mackenbach, and Burdorf (2014) concluded that proximity to green spaces, and especially to quality green spaces, correlated to longer lifespan. Adolescents exposed to an urban forest initiative reported higher rates of physical activity and lower rates of risky behaviors (Tesler, Plaut, & Endvelt, 2018). These findings are generally consistent with the findings of other international papers.

The scope of exposure types and health status relationship are diverse. There is, for example, information supporting the idea that mere proximity to green space may be sufficient for improving birth outcomes (Hystad et al., 2014) and that breast cancer survivor quality of life and health is associated positively with nature-based experiences (Ray & Jakubec, 2014). Proximity to green space and health outcomes does not, however, universally demonstrate significant associations (Lachowycz & Jones, 2014; Tillman et al., 2018; van den Bosch, Östergren, Grahn, Skärbäck, & Währborg, 2015). Although proximity to natural areas corresponds with increased frequency of park visits,

positive orientation towards nature is more powerfully associated with frequent park use (Lin et al., 2014).

Attitudes about nature and health status have been studied less frequently than access or proximity, but scholars support feelings of connectedness to nature as being correlated to psychological wellbeing, sense of meaningfulness, and vitality (Cervinka, Röderer, & Hefler, 2012). Positive feelings are associated with better health in general as demonstrated throughout this literature review. Furthermore, feelings about connectedness to nature are related to rates of physical activity in nature (Caloguiri, 2016; Haluza, Simic, Höltje, Cervinka, & Moshammer, 2014; Lin et al., 2014). These positive feelings about nature may, in turn, cause future public health benefits as individuals develop environmentally friendly behaviors (Annerstedt van den Bosch & Depledge, 2015). An attitude of conviviality with nature has also been proposed as a necessary element of public health programs seeking to address human health challenges (Bentley, 2013).

Understanding the mechanisms through which nature influences health status will be necessary for advancing public health interventions (Holland et al., 2018). There are many potential pathways through which nature may influence health: air quality, physical activity in nature, social cohesion, and stress reduction (Hartig et al., 2014). Hartig et al. also proposed categorizing these pathways into two groupings of effect modifiers. The first group of effect modifiers they proposed include distance, other accessibility factors, weather, perceived safety, and societal/cultural context, while the second group of effect modifiers include gender, age, socioeconomic status, occupation, and societal/cultural

context. The influence of this secondary group of effect modifiers is consistent with the observation that nature encounters can provide respite from the type of stresses caused by social/cultural barriers (Hordyk et al., 2015).

Understanding possible physiological pathways between the exposure and observed health effects is also essential. Exposure to sunlight is one such possible mechanism, consistent with other research related to the benefits of moderate sunlight exposure, by which nature may influence health (Fleury, Geldenhuys, & Gorman, 2016). Lengthy walks in natural settings decreases self-reported anxiety and neural activity in the parts of the brain associated with depression and mood disorders while walks of similar length in urban settings do not (Bratman, Hamilton, Hahn, Daily, & Gross, 2015). This observed effect on brain activity may be yet another physiological pathway through which physical activity in nature positively influences health status. However, average energy expenditure varies depending on the type of natural environment (Elliott, White, Taylor, & Herbert, 2015). This type of detail must be considered by researchers and public health officials.

The influence of technology is another factor that has been considered. Doherty et al. (2014) used smartphone technology to provide 15 users of The Pinery Provincial Park in Ontario, Canada with a phone-based survey tool to collect data about health, emotions, and physical activities within the park. Doherty et al. found that the participants were willing to contribute information through this portal and that this sort of technology might be useful for gathering broader population level feedback in the future. Beute et al. (2016) also recognized that people are already using technology for tracking many

personal wellness data points and that these data, especially when combined with global positioning systems, could improve the quality of future nature/health studies by reducing the need for creating literate descriptions of nature and related terms. They concluded that this sort of technology application could better capture environmental and restoration characteristics, distinguish effects between and within individuals, bridge gaps between laboratory and epidemiological research, and advance theory by incorporating this field of study into a broader range of lifestyle and environmental data collected by the technology (Beute et al., 2016). Capturing these broader fields of data with smart personal technology, remote sensing, satellite-based mapping tools, and more will help researchers explore the nature/health connection within a broader context of data and disciplines (Craig et al., 2016). Although improved technology promises to provide researchers with better information, the literature available for current review is primarily based on survey-based research.

A framework of nature characteristics and effect pathways in conjunction with considerations for exposure dosage and frequency could demonstrate significant public health and cost savings (Shanahan et al., 2016). The potential economic benefits of associations between nature and health add further importance to this issue. A study in England found that regular visits to natural environments by just 19.5% of their population contributed 109,164 (95% Confidence Interval [*CI*] 101,736 to 116,592) Quality Adjusted Life Years at a value of between £2.03 and £2.33 billion annually (White et al., 2016). Addressing priority public health issues like mental illness and obesity, along with growing health care costs, depends in part upon the ability of public

health to identify these challenges and opportunities for improved well-being through non-conventional approaches.

Mental Health

The United States is either in the midst of an emerging mental health crisis or coming to terms with the enormity of problems that have always been present. According to information provided by the National Institute of Mental Health (2017), 44.7 million Americans, 18.3% of the overall population, experienced mental illness in 2016. Women reported a higher prevalence (22.7%) than their male counterparts (14.5%). People of multi-racial background had the highest rate (26.5%) among racial categories while Asians had the lowest reported rate (12.1%). There is a notable difference between prevalence of reported mental illness in adolescents (13-18 years of age) and that in people aged 50 years or older (14.5%). The occurrence of mental illness in the United States warrants focused research for building evidence-based solutions and equipping public health officials with effective interventions for reducing the rate of these illnesses.

Poor mental health can manifest itself in many forms. The current epidemics of opioids overdose death and suicide in the United States of America are two of the most tragic results of unresolved mental illness. The rates of these twin epidemics have also increased in recent years. The economic impacts from mental health and its related outcomes are also important because they diminish productivity and compromise growth for all socioeconomic classes.

Disease Burden in Kent County, Michigan

Residents of Kent County, Michigan, identified mental health as the greatest community health priority in both the 2014 and 2017 CHNA. In the latest report, a concerning rate of residents reported their mental and emotional health as poor (7.5%) or failing (2.1%). A rate of 13.4% of county residents responding to the CHNA survey reported 14 or more poor mental health days in the past 30 days. The prevalence of poor mental health was noteworthy in the lowest socio-economic brackets. One-third of individuals with an annual household income of less than $25,000 reported 14 or more poor mental health days in the past 30 days. A rate of 23.6% of the middle school students responding to a youth health survey and 32.2% of the high school students responding to that same survey stated that they had ceased their usual activities because they felt sad for long periods of uninterrupted time during the prior year.

Suicide is the most terminal and tragic outcome of unresolved mental illness. While not the only important measure, suicide is a powerful indicator of the overall state of mental health in a community. The youth survey asked high school students about suicidal thoughts during the past 12 months; 15.8% of those student respondents reported seriously considering suicide, 13.3% had made a plan, and 6.9% stated that they had made a suicide attempt at least once. Approximately one in five (20.6%) middle school student respondents reported having considered suicide, 13.0% had made a plan, and 7.8% reported that they had attempted suicide at least once. According to data from the Kent County Medical Examiner's Office (2018), the number (53 to 89) and rate (8.79 to

13.72 per 100,000 of population) of suicides increased in this county between 2010 and 2017.

Relationships to Nature

There is an abundance of contemporary literature suggesting a relationship between mental well-being and nature. Kaplan and Kaplan (1989) presented the idea that nature offers an opportunity for escapism that is recuperative and healthy for people. This potential benefit from nature exposure has inspired the pursuit of research centered on NAT. These therapies are designed in alignment with ART and the understanding that exposure to nature, in any number of ways, has a positive association with mental health and improved recuperation.

The body of literature supporting the protective and restorative quality of nature exposures relating to mental health status is expansive but not conclusive. People who engage in physical activity in forests and wooded areas have lower odds (0.557; 95% *CI* 0.323, 0.962) of poor mental health compared with people who do not (Mitchell, 2012). To better understand the relationship between nature exposure and attention deficit/hyperactivity disorder (ADHD), a survey of parents of children that had been diagnosed with ADHD was designed to gather information about *green activities* that the children participated (Kuo & Taylor, 2004). Kuo and Taylor collected 452 qualified survey responses and concluded that engaging in green outdoor activities reduced ADHD symptoms more than participation in other types of activities. Another positive finding was identified in a study of 53 adults enrolled in one of three initiatives designed to improve mental health status: green exercise, swimming, or social activities (quizzes,

bingo, games, crafts, and music) (Barton, Griffin, & Pretty, 2012). Those researchers concluded that the green exercise program produced significantly greater improvements, even after just one green exercise session, in self-esteem than the other two interventions ($p < 0.001$) (Barton et al., 2012). Nature, within the context of the green exercise program, was defined by Barton et al. as "the environment in which organisms or their biotopes expressly manifest themselves." That definition may have been useful for internal intervention design purposes but probably has little merit for public surveying due to its complex language.

Same-sex twin pairs, a total of 4,338 individuals living in the United States, were assessed to weigh the importance of nature access on their mental health (Cohen-Cline, Turkheimer, & Duncan, 2015). The sample of twin pairs was chosen as an approach to limit the influence of confounding factors such as genetic and familial differences. Data were made available to the researchers through a registry maintained by the University of Washington. Access to nature was measured by proximity from address to vegetation density as described by the Normalized Difference Vegetation Index (NDVI). The findings from the Cohen-Cline et al. (2015) study concluded that proximity to dense vegetation was inversely related to rates of depression, however, no such relationship was identified with stress or anxiety.

The value of proximity to nature using the NDVI was replicated in a study of 2,111 young people in Spain between the ages of 7 and 10 years (Amoly et al., 2014) and in a study in the United States using the NDVI to assess depressive symptoms in early childhood and adolescence related to distance to green areas (Bezold et al., 2018). Amoly

et al. (2014) used the index to measure buffer distances between home addresses and areas identified as green and blue spaces. The blue spaces included beaches and surface water features. Health status variables included scores on a strengths and difficulties questionnaire designed to assess mental stress and attention deficit/hyperactivity disorder. Their study identified significant inverse relationships between playing time in green space and beachgoing with the occurrence of the mental health conditions. The relationship between proximity to green spaces was not conclusive. The study conducted by Bezold et al. (2018) found a 6% lower incidence of high depressive symptoms among children and adolescents living nearer to green areas as defined by the NDVI.

Feelings and attitudes toward nature have been shown to be significant as well. A longitudinal study of 24,945 Swedes found no significant relationship between proximity to defined nature qualities and mental health but did identify exposure to environments described as serene as protective of mental health status for women in the study (van den Bosch et al., 2015). A quantitative cross-sectional study of 1,500 Austrian adults identified a relationship between high rankings of self-reported connectedness to nature for both males and females and participation in outdoor sports ($p < 0.0001$; males: Odds Ratio [*OR*] 1.42, 95% *CI* 1.01, 1.99; females: *OR* 2.05, 95% *CI* 1.43, 2.93) (Haluza et al., 2014). Haluza et al. (2014) described connectedness to nature by capturing attitudes about nature using a Likert scale with 10 gradations. The mean score was used to separate low from high connectedness to nature and the results were categorized as low (0-7 on the Likert scale) and high (8-10) connectedness to nature. Although the body of supportive literature is substantial, other findings suggest that the relationships may be

more complex. For instance, a study of 17,249 Canadian youth primarily between the ages of 11 and 16 years concluded that the associations between natural features and emotional health were inconsistent and not particularly strong (Huynh, Craig, Janssen, & Pickett, 2013). That study did, however, report a modest protective effect for emotional well-being related to natural features in small cities. Another study of Canadian youths found that adolescents who reported connection to nature as being important were associated with a 25% lower prevalence of psychosomatic symptoms (Piccininni et al., 2018).

The relative value of actual physical activity in nature is also questionable. It has been found that engaging in thirty minutes of activity outdoors correlates to lower rates of psychosomatic symptoms for girls aged 11-15 years than for boys of that same age group (Piccininni et al., 2018). A study of children in the United Kingdom (UK) found very little benefit to exercising in natural-areas compared to urban areas (Reed et al., 2013). Psychological well-being, along with meaningfulness and vitality, have been found to be strongly associated with nature connectedness, and not necessarily access or activity, elsewhere (Cervinka et al., 2012). In contrast, Mitchell (2013) found that regular use and activity in natural environments was found to correspond with lower odds of poor mental health (*OR* = 0.557; 95% *CI* 0.323, 0.962), however, this benefit did not extend to general wellbeing.

Understanding the complexities of this relationship may be particularly useful for public health officials considering differences in how people in urban versus rural communities relate to nature. There are also issues relevant to social determinants of

health in urban areas as evidenced by the finding that children of low socio-economic status are at increased risk of developing behavioral problems (Hillemeier, Lanza, Landale, & Oropesa, 2013). The impact of urban environments on human health was further explored in a qualitative study tracking the health of immigrants to Montreal, Canada. This study of seven immigrant families found that health measures were generally poorer five years post-resettlement, however, those who had contact with nature reported less severe health impacts (Hordyk et al., 2015). The definition of nature used by Hordyk et al. was subjective based upon the respondents' sensory perceptions about what they believed nature in Canada is supposed to be like.

The specific definition of what constitutes a nature exposure of significance is an open question for further study. Some literature suggests that an unobstructed view of nature may be sufficient for beneficial mental health restoration. For instance, hospitalized men with a panoramic view of nature reported better overall mental health status than those without such a view (Raanaas, Patil, & Hartig, 2011). It has also been found that patients with plants or posters of plants in their hospital room reported lower levels of stress than those without and also reported that the rooms with plants or plant posters were visually more attractive (Beukeboom, Langeveld, & Tanja-Dijkstra, 2012). The presence of gardens for residents of nursing home facilities demonstrate therapeutic benefits (Gonzalez & Kirkevold, 2015). These findings have been replicated in the occupational environment where it has been found that connectedness to nature has a significant negative association with lower perceived stress and general health complaints (Largo-Wight, Chen, Dodd, & Weiler, 2011a). The specific nature exposure in each of

these instances, however, were varied and contribute to the school of thought that the specifics of the nature exposure may be less important that an individual's orientation and attitudes toward nature.

In one of the few studies to employ an objective definition of nature and/or greenspace, McEachan et al. (2016) studied the relationship between greenspace, as defined by the NDVI and depression. This index categorized greenspace into five ranked order levels and compared those ordinal data to self-reported depression in 7,547 pregnant women. The women in greener quintiles were 18-23% less likely to report depression than the women in the lowest quintile. Another study using quartiles of the NDVI reviewed 64,705 singleton births between 1999 and 2002 in Vancouver and found an interquartile increase in greenness associated with greater birth weight (20.6 g; 95% *CI* 16.5, 24.7) and other birth outcomes (Hystad et al., 2014). These findings support the concept that exposure to natural settings has a restorative quality for mental health and related health outcomes in accordance with ART and the definition of environmental health.

The benefit of this sort of intervention is not limited to a particular demographic group. A broad review of existing literature supports nature-based restorative therapies having significant value in treating military veterans for a variety of illnesses and injuries including emotional/psychological/cognitive injuries (Hawkins, Townsend, & Garst, 2016). Another study of 98 veterans, a majority of whom (54%) reported physical and/or mental health issues, concluded that group-based nature experiences resulted in improved psychological wellbeing, social functioning, and life outlook (Duvall & Kaplan, 2014).

Focus group conversations with adults have found that restorative outdoor places are generally health promoting and enriching (Hansen-Ketchum, Marck, Reutter, & Halpenny, 2011). And a cross-sectional study of 911 residents of Perth, Australia found that people living near quality public open spaces showed lower odds of psychological stress than those who do not, even if those residents did not actually use the public open space (Francis, Wood, Knuiman, & Giles-Corti, 2012).

There are also data supporting these types of programs for young people. Warber et al. (2015) studied the effect of attending a wilderness adventure camp on the wellbeing of young adults. In this instance, the defined nature exposure was established as presence within this remote camp setting. Statistically significant pre to post camp differences were found positively associated with participant's relationship with nature ($t(33) = -3.94$, $p < 0.001$), increased relaxation ($t(34) = 2.34$, $p = 0.025$), decreased perceived stress ($t(35) = 2.45$, $p = 0.020$), increased positive emotional affect ($t(30) = 4.25$, $p < 0.001$), decreased negative emotional affect ($t(34) = -3.23$, $p = 0.003$), increased sense of wholeness ($t(34) = -2.66$, $p = 0.012$), increased sense of transcendence ($t(34) = -3.36$, $p = 0.002$), and positive relations with others approached significance ($t(34) = -1.90$, $p = 0.066$).

Findings such as these that support the relationship between nature exposures and health, have encouraged educators and school counselors to include curricula in outdoor environments for the purpose of protecting mental health and promoting academic achievement (Flom, Johnson, Hubbard, & Reidt, 2011). It is important to understand the dynamics that form a child's connection to nature if nature-based programming is going

to be successful. The four following factors were found to correlate with connection to nature among Brevard County, Florida children: family values toward nature ($r = .43$, $p < 0.01$), previous experience in nature ($r = .21$, $p < 0.01$), knowledge of the environment ($r = .13$, $p < 0.01$), and having nature near home ($r = .08$, $p < 0.05$) (Cheng & Monroe, 2012).

In 2015, The 30 Days Wild campaign administered by The Wildlife Trust in the UK encouraged approximately 300,000 people to engage in one of 101 suggested activities in nature every day for one month. Although this was not intended to be a public health intervention it did provide useful data. Surveys before the month of activity, immediately afterwards, and again within several months were completed by 126 participants who reported significant ($p < 0.001$) improvements in connection to nature, conservation behaviors, health, and happiness (Richardson, Cormack, McRobert, & Underhill, 2016). While these outcomes did not precisely equate with mental health, the health and happiness outcomes suggest that this program influences wellbeing and emotions linked to mental health. However, a comparative study of the value of physical exercise in urban versus natural settings in a cohort of 75 children aged 11 and 12 years old in the UK found no significant differences in self-esteem (Reed et al., 2013). These seemingly contradictory findings demonstrate the insufficient understanding of the factors and pathways associated with health effects in a meaningful way.

Shanahan et al. (2015) proposed a framework of pathways recognizing relationships between the characteristics of the green space, the function of the particular ecosystem, the effect on people, and the overall health benefit. This framework proposed

that the effect on human health occurs through either autonomic generation of psychophysiological stress reduction, not unlike what ART describes, or through a compelling visual appeal that inspires physical activity. Within this framework, dosage and frequency of the nature exposure factors are important dynamics to consider. When the framework was tested amongst 1,538 residents of Brisbane, Australia, it was found that people who made weekly visits of 30 minutes or more to green spaces reported lower rates of depression and high blood pressure (Shanahan et al., 2016). The authors calculated that if these effects were projected throughout the community, the rate of depression would drop 7% and the rate of hypertension would decrease by 9%. Health care savings associated with this type of population health improvement would be substantial.

As demonstrated, there is a large and growing body of literature supporting the position that exposure to natural environments and nature-based activities is generally beneficial to mental health in humans at multiple life stages and locations. Further study related to the relative value of access, attitudes, and physical activity is warranted.

Obesity

The prevalence of obesity among U.S. adults (39.8%) is a substantial problem that is increasing steadily (CDC, 2017; Flegal, Kruszon-Moran, Carroll, Fryar, & Ogden, 2016). In addition to contributing to many negative health outcomes, medical costs associated with obesity in the United States were approximately $194.4 billion in 2014 (Kim & Basu, 2016). According to statistics from the CDC (2017), childhood obesity rates (ages 2 to 19) have tripled since 1980. Rates of obesity among children between the

age of 6 and 11 years more than doubled (from 7.0 percent to 17.5 percent) and rates of obese teens (ages 12 to 19) quadrupled from 5 percent to 20.5 percent since 1980.

Seventy percent of public health officials believe that obesity is a problem in their home communities (Alberti, Sutton, & Baer, 2014). Although obesity rates may vary between states, the problem is increasing everywhere and is a national problem (CDC, 2017). According to the CDC (2017), obesity affects some groups more than others. Hispanics (47.0%) and non-Hispanic blacks (46.8%) had the highest age-adjusted prevalence of obesity in 2015 and 2016, followed by non-Hispanic whites (37.9%) and non-Hispanic Asians (12.7%). The prevalence of obesity was 35.7% among young adults age 20–39 years, 42.8% among middle-aged adults age 40-59 years, and 41.0% among older adults age 60 and over.

Increased body mass index (BMI) and socio-economic status are associated with poorer academic outcomes and overall health status in children (Carey, Singh, Brown, & Wilkinson, 2015). Data from the Women, Infants, and Children (WIC) program supports the belief that obesity is an issue associated with socio-economic status (Pan et al., 2016). Pan et al. (2016) assessed obesity rates for children aged 2 to 4 years enrolled in the WIC program between 2010 and 2014. Using data provided by the Pediatric Nutrition Surveillance System, they found an obesity rate of 14.5% within this population that is significantly higher than the national obesity prevalence rate of 8.9%.

Disease Burden in Kent County, Michigan

The CHNA survey respondents in Kent County, Michigan, identified obesity as the number two and number three highest priority in the 2014 and 2017 CHNA,

respectively (Healthy Kent, 2014; Kent County Health Department & Healthy Kent, 2017). The trends related to obesity in Kent County are very similar to the national experience. According to data from the 2017 Kent County CHNA, the overall obesity rate for Kent County adults increased from 27.6% in 2014 to 34.1%. Meanwhile, the obesity rate for adults in the United States was 39.8% between 2015 and 2016 (CDC, 2017). These adults also reported a relatively low rate (19.7%) of leisure time physical activity and only 35% indicated that they had participated in 30 or more minutes of physical activity at least five times per week. The 2017 CHNA report also found that obesity is increasing among Kent County youth. In 2014, 9.7% of middle school children and 11.4% of high school students were obese, those rates increased to 11.4% and 12.5% respectively in 2017. The obesity rate for youth aged 2 to 19 years in 2015 and 2016 was 18.5% (CDC, 2017). Data were not readily available to specifically compare youth age groups within the county against state or national averages. It does, however, appear that obesity rates in Kent County are presently less than the national average. Regardless, this issue remains a priority for the community and for public health officials as demonstrated by the 2017 CHNA report conclusions.

Relationships to Nature

There is evidence in the literature that disparate obesity rates may be influenced by access to recreational parks and similar facilities. A cross-sectional study of 42,278 children included in the 2007 National Survey of Children's Health (NSCH) identified a beneficial relationship between access to these recreational resources and prevalence of obesity (Prevalence Ratio [*PR*] = 0.79, 95% *CI* 0.69, 0.91) (Alexander, Huber, Piper, &

Tanner, 2013). Interestingly, the researchers identified race/ethnicity as an effect modifier ($p < 0.0001$). While Non-Hispanic White children (*PR* = 0.89, 95% *CI* 0.64, 1.23) and Hispanic children (*PR* = 0.73, 95% *CI* 0.28, 1.81) did not demonstrate a strong association between access and obesity, Non-Hispanic Black children exhibited a stronger association (*PR* = 0.40, 95% *CI* 0.17, 0.90). The definition of the recreational parks and facilities variable used within the NSCH questionnaire was broadly described in a manner that would include greenspaces and other natural features open to recreational activity. This broad definition also included playgrounds, gymnasiums, and other venues. The breadth of this definition does not allow one to understand the influence that natural areas alone have on obesity prevalence.

Other studies have approached the nature variable as mere proximity to highly vegetated areas. A study of 3,178 Spanish children aged 9-12 years measured rates of overweight/obesity comparatively by quartiles of distance (100 m, 250 m, 500 m, and 1,000 m) from identified green spaces (Dadvand et al., 2014). Green spaces included forests and parks and were described by use of the NDVI, which used satellite-based technology and relied on reflectance of light and spectrum processing (Weier & Herring, 2011). Dadvand et al. (2014) concluded that each interquartile increase in green space proximity corresponded with an 11 to 19% lower prevalence of overweight/obesity. This negative association between proximity to forests and overweight/obesity was significant ($p < 0.05$). Proximity to parks did not demonstrate a significant relationship for overweight/obesity. Perhaps not surprisingly, each interquartile increase in proximity to forests, but not to parks, was also associated with lower rates of screen time.

One of the few longitudinal studies in this field enrolled a cohort of 3,173 Californian children aged 9 or 10 years in 1993 or 1996, collected baseline health and environmental data, and remeasured those variables eight years later (Wolch et al., 2011). Wolch et al. described the nature variable in their study as the number of acres of park land within concentric rings of radii from residential addresses. They found a statistically significant inverse relationship between BMI at age 18 and acres of designated park land within 500 m of the children's homes ($p < 0.05$), however, although still statistically significant the effect was less for females than their male counterparts. Wolch et al. also compared their measure of nature (acres of park land within 500 m), which produced significant health effect association, against the NVDI assessment of the same geographic areas and discovered that the two tools only had a 0.35 correlation. Tree canopy, as measured by an imaging program, was related to better overall health in 7,910 Californian adults (Ulmer et al., 2016). Although these findings suggest proximity to certain types of green space may be important, they do not completely address issues of accessibility, socio-economics, or other social determinants of health. They also do not address the value of attitudes or connectedness to nature, and they often do not consider actual physical activity in the natural environment or engagement in physical activity in those environments.

Proximity, without consideration of other variables, may overlook other geographic and socio-economic variables inhibiting access to nearby green spaces. Improving engagement with natural areas for urban adolescents can be challenging because those children have reported fear of animals, violence, and dislike of weather

extremes as barriers (Blanton et al., 2013). Lagging confidence in the safety of natural areas is another barrier to physical activity (Weimann et al., 2017). Researchers and public health officials may need to recognize these fears as important components affecting the attitude of people toward nature. Other physical obstacles such as fences and highways may relegate mere proximity meaningless. Impediments to access and negative attitudes toward nature and nature-based activities may have associations with health outcomes which proximity alone cannot address.

Attitudes about nature may be powerful factors for consideration within the health and nature relationship. A cross-sectional survey of 2,168 Norwegian adults found that the people who personally support natural areas tend to be more physically active and that childhood experiences in nature are correlated to greater physical activity levels as well (Caloguiri, 2016). Caloguiri also noted a mediational effect associated with feelings about nature and social networks. Caloguiri concludes that it is important to understand how a community feels about nature before assuming that more of it will result in a more active community.

A meta-analysis review of 66 articles assessing associations between greenness nature exposures, expressed as greenness, and a number of health status indicators found substantial support for the beneficial quality of nature exposure (James et al., 2015). The researchers categorized strength of evidence as low, intermediate, or high. They concluded that the strength of evidence for physical activity was high or intermediate, overweight/obesity was intermediate, mental health was intermediate, birth and developmental outcomes was high or intermediate, cardiovascular outcomes was

intermediate or low, and mortality was intermediate. Exposure to green areas and physical activity therein shows promise as a health-promoting factor. Some types of natural environments, such as open countryside and urban parks, may stimulate different types of physical activity and greater energy expenditure on average than other types of natural environments, such as beaches (Elliott, White, Taylor, & Herbert, 2015).

The possible influence of confounding factors, such as socio-economic status, should not be overlooked. A cross-sectional study in England of green space access as defined by public mapping tools, walking frequency, and premature mortality from circulatory diseases concluded that proximity to green space correlated with a 13 to 18% increase in walking in the green space densest areas compared against the least green regions (Lachowycz & Jones, 2014). That same study, however, did not observe a significant difference in mortality in relation to green space density. Deprivation, a measure consisting of socio-economic factors, was a more powerful predictor of premature mortality risk from circulatory diseases (Lachowycz & Jones, 2014).

The dosage and mechanisms through which physical activity benefits health are also subjects of research. Shanahan et al. (2016) used what they titled a *nature-dose framework* for considering linkages between nature-based factors and health status. Their review of 1,538 residents of Brisbane, Australia, found that the health of urban dwellers was significantly linked to nature experiences. Results indicated that 7% of depression cases and 9% of high blood pressure cases could be prevented with increased engagement in natural experiences. Other studies support these findings and suggest that sun exposure

could be relevant in understanding how nature exposures and/or nature-based activities may reduce the burden of obesity (Fleury et al., 2016).

Definitions of Nature and Related Terms

A standard definition and understanding of nature does not appear to exist in the literature. In some instances, researchers have used mapping tools, such as the NDVI, for quantifying the volume of greenspace in proximity to the population (Dadvand et al., 2014; Hystad et al., 2014). This index, as previously discussed, is a geographic information system tool using satellite technology. It may not, however, be readily available, or even essential, for public health decision-making. Another objective tool, the Scania Green Score from Sweden, was only shown to correlate with very mild increases in physical activity (*OR* 1.06, 95% *CI* 1.02, 1.10) and general health (*OR* 1.02, 95% *CI* 1.00, 1.04) and determined that perceptions of safety was a stronger predictor of physical activity in nature (*OR* 1.07, 95% *CI* 1.02, 1.11) (Weimann et al., 2017). There are similarities between greenspace measures that rely on the size of the greenspace to predict mortality and morbidity, however, these types of models are less effective in socioeconomically deprived areas (Mitchell, Astell-Burt, & Richardson, 2011). Acres of park land within specified distance from residence has also been used as the nature variable (Wolch et al., 2011).

The inclusion of descriptors such as serenity may be more powerful than proximity or other objective metrics (van den Bosch et al., 2015). Other studies have found subjective definitions of greenspace quality to be more useful than objective green space percentages or distance to green space for correlating against health measures

(Jonker, et al., 2014). Because of the subjectivity of many of the important factors related to this issue, ethnographic approaches have also been suggested as useful strategies (O'Brien & Varley, 2012).

In Wilson's description of biophilia (1984) and the environmental/evolutionary context in which this human attachment to specific habitats was formed, Wilson described the environs in which the human species developed. The savannas of Africa, Europe, and Asia – grasslands with groves of trees and water features – was most suitable and most commonly populated by humans. It was Wilson's contention that it is a preference for these environmental features that was engrained within our species' profile. The county health department in Kent County, Michigan, elected to use a definition aligned with Wilson's description of the preferred natural habitat for the human species in the Stress and Nature Mini-Survey.

Summary

The findings of the many documents reviewed for this literature review demonstrate that having access to natural areas is important, but so too are attitudes about connectedness to nature, and actual physical activity in nature or engagement in nature-based activities. These findings have been replicated in many places globally and within many populations. This literature review did not identify studies conducted at a county level within a Midwest American state. Assessing the comparative value of these factors has also been studied less well in the research identified through the search strategy and literature review. Additionally, the varied definitions of key terms have complicated macro-analyses of the existing literature.

In this study I sought to advance understanding of the associations between the described nature variables and mental health and obesity status, because, while the positive benefits of nature exposure are documented, the mechanisms and factors empowering this effect are not fully understood. Current literature published in peer reviewed journals includes evidence supporting the importance of access/proximity to green spaces, attitudes about or connectedness to nature, and physical activity in natural areas or in nature-based recreation. I also examined the association between the three nature factors and the two health status variables in Kent County, Michigan. In the following chapter, I will describe the research methods employed to answer this study's research questions.

Chapter 3: Research Method

Introduction

In this quantitative research, I examined the relationships between three independent variable domains and their effect, if any, on the dependent health outcome variables of mental health status and obesity in Kent County, Michigan. I also assessed, to whatever degree possible, the relative benefit of those three independent nature variable domains with the health status variables. The following chapter details the six research questions that were tested to demonstrate if the relationships exist to any significant and consistent degree. The chapter also contains discussion regarding the research design, the statistical methods to be employed, and features of the study population. The proposal for this study and its methodology was reviewed and approved by the institutional review board at Walden University on January 10, 2019 and was issued approval number 01-10-19-0025685.

Research Questions and Hypotheses

RQ #1: Is mental health status in a Michigan county associated with the ability to access nature areas as measured by the county's Stress and Nature Mini-Survey?

$H_0$1: Mental health status in a Michigan county is not associated with the ability to access nature areas as measured by the county's Stress and Nature Mini-Survey.

H_a1: Mental health status in a Michigan county is associated with the ability to access nature areas as measured by the county's Stress and Nature Mini-Survey.

RQ #2: Is mental health status in a Michigan county associated with attitudes about connectedness to nature as measured by the county's Stress and Nature Mini-Survey?

$H_0$2: Mental health status in a Michigan county is not associated with attitudes about connectedness to nature as measured by the county's Stress and Nature Mini-Survey.

H_a2: Mental health status in a Michigan county is associated with attitudes about connectedness to nature as measured by the county's Stress and Nature Mini-Survey.

RQ #3: Is mental health status in a Michigan county associated with physical activity in natural areas or in nature-based activities as measured by the county's Stress and Nature Mini-Survey?

$H_0$3: Mental health status in a Michigan county is not associated with physical activity in natural areas or in nature-based activities as measured by the county's Stress and Nature Mini-Survey.

H_a3: Mental health status in a Michigan county is associated with physical activity in natural areas or in nature-based activities as measured by the county's Stress and Nature Mini-Survey.

RQ #4: Is obesity (as represented by body mass index) in a Michigan county associated with the ability to access nature areas as measured by the county's Stress and Nature Mini-Survey?

H_o4: Obesity in a Michigan county is not associated with the ability to access nature areas as measured by the county's Stress and Nature Mini-Survey.

H_a4: Obesity in a Michigan county is associated with the ability to access nature areas as measured by the county's Stress and Nature Mini-Survey.

RQ #5: Is obesity (as represented by body mass index) in a Michigan county associated with attitudes about connectedness to nature as measured by the county's Stress and Nature Mini-Survey?

H_o5: Obesity in a Michigan county is not associated with attitudes about connectedness to nature as measured by the county's Stress and Nature Mini-Survey?

H_a5: Obesity in a Michigan county is associated with attitudes about connectedness to nature as measured by the county's Stress and Nature Mini-Survey?

RQ #6: Is obesity (as represented by body mass index) in a Michigan county associated with physical activity in natural areas or in nature-based activities as measured by the county's Stress and Nature Mini-Survey?

H_o6: Obesity in a Michigan county is not associated with physical activity in natural areas or in nature-based activities as measured by the county's Stress and Nature Mini-Survey.

H_a6: Obesity in a Michigan county is associated with physical activity in natural areas or in nature-based activities as measured by the county's Stress and Nature Mini-Survey.

Research Design

I used a secondary set of data collected through a survey conducted by the county health department serving Kent County, Michigan. This health department has a history of conducting similar surveys related to the community health needs assessing and risk

factor surveillance survey efforts. This survey was titled the Stress and Nature Mini-Survey. It was designed as a supplement to a larger community survey conducted during the summer of 2017 as part of the CHNA process. Upon analysis of the original CHNA results, the health department recognized that there were additional questions that should be asked related to stress and nature interactions. Stress was a common comment in the CHNA survey in relation to many domains of health. Relationships to nature/parks/greenspaces were also considered subsequent to the CHNA survey. As a result, the health department wanted to gather more information about how the community experiences stress and how or if they interact with nature. Identifying correlations between these variables and CHNA prioritized health issues was the objective of the Stress and Nature Mini-Survey.

The design for this research was cross-sectional. The secondary data set from the county's Stress and Nature Mini-Survey was the product of that agency's effort to gather information about their community during August and early September of 2018. The health department's data collection method was cross-sectional as it intended to gain information from a representative sample of the broad population at a point in time. The survey was announced to the community in a press release in early August. It was subsequently shared via social media multiple times during the survey period. Paper copies of the survey were delivered to partner agencies and clinics throughout the community.

Cross-sectional research is useful for identifying the prevalence of a condition(s) within a population at a particular point in time. This research included the elements of an

analytical cross-sectional design because it was intended to provide some assessment of the comparative relationship between a number of independent variables and the health outcome dependent variables. The greatest weakness of cross-sectional study designs is the temporal limitation of the data. This weakness prevents conclusions of causation and can lead to antecedent-consequent biases. In studies such as this, it is important to recognize that the occurrence of particular levels of access, attitudes about connectedness, and activity at the same time as prevalence, or lack thereof, of poor mental health status or obesity cannot be used to suggest that one preceded or caused the other. Rather, such findings can only be used to demonstrate an association and suggest where further research could be beneficial for deeper understanding.

These data analyses were performed using binary logistic regression, a *z* statistic Wald test, to determine relationships between the nature-exposure statement questions from the survey, which fell within the three domains of interest and mental health and obesity status as self-reported by the survey participants. These three independent variable domains were access to natural areas, attitudes about nature, and actual physical activity in nature or in nature-based activities. As standard with most social research, an alpha level (α) of 0.05 and a power of 0.80 ($1.0 - \beta$) was applied. The accepted probability of Type 1 errors was set at 5% ($\alpha = 0.05$) and Type 2 errors at 20% ($\beta = 0.20$). These assumptions of error are generally acceptable for this type of research and predisposed toward falsely eliminating alternate hypotheses.

It was necessary to have a sufficient sample size to support these data analyses and to communicate effect size in the final assessment. Because this research was

somewhat novel, and effect is difficult to measure with logistic regression, I was interested in measuring effect through the identification of statistically significant odds ratios (*OR*) and pseudo R^2 measures. According to analyses conducted using G*Power Version 3.1.9.2, and information provided by Field (2013), the county's Stress and Nature Mini-Survey should have collected at least 568 responses to be substantial enough to support logistic regression analyses of a one-tailed test with an *OR* of 1.3, an α error probability of 0.05, a β error probability of 0.20, and normal distribution of the variables along the *x* axis. The county's Stress and Nature Mini-Survey collected 713 responses. Each of the respective logistic model analyses contained at least 649 and as many as 653 sufficiently complete surveys. This level of participation was substantially greater than the 568 identified as a minimum sample size and, according to post hoc analysis, produced a satisfactory power of at least .845 ($1 - \beta$ error probability) to avoid Type 2 errors.

The definitions and descriptions constituting nature are varied. Despite the inconsistencies, green spaces may hold similar protective associations for health status (Mitchell et al., 2011). The complicated matter of defining what nature is for the purpose of the county's survey was addressed by referring to the original text of Wilson (1984) and the theory of biophilia that held that humans have affinity for habitats similar to their prehistoric development; areas with open grassy expanses, groves of trees, and surface water features. The county's Stress and Nature Mini-Survey defined nature as large grassy areas with trees, or ponds, lakes, streams, or rivers. The health department also expanded its battery of nature questions from a singular question in their 2017 CHNA

about frequency in greenspaces to a total of seven statement questions in the Stress and Nature Mini-Survey addressing three domains of nature experience: access (three statement questions), attitudes (three statement questions), and physical activity (one statement question).

The battery of questions about access to nature, attitudes about nature, and physical activity in nature were designed with consideration of prior survey tools but did not precisely replicate any earlier roster of questions. The published literature includes support for at least two tested survey tools. The first was the Nature Contact Questionnaire that has shown the sensitivity to detect associations between nature contact and human health in an occupational environment (Largo-Wight et al., 2011b). This questionnaire, with 16 questions, is lengthier than agencies may desire for survey purposes. The other tool supported by the literature was the CNS, which has demonstrated significant reliability and validity (Mayer & Frantz, 2004; Navarro, Olivos, & Fleury-Bahi, 2017). Although the CNS survey tool may have aligned well with the attitudes about nature factor, also known as connectedness, that survey tool, at 14 questions, was also lengthier than desired by the health department for inclusion in the survey. The health department was also concerned that some of the questions included in the CNS survey were written in a way that might offend some portions of the community without gaining meaningful insights. Questions that included language discussing a common life force and humans being no more important than the grass or the birds were considered by the health department to be unnecessary spiritual and possibly offensive or even provocative.

There has also been criticism that the CNS, while reliable, may lack validity because it could be capturing cognitive beliefs instead of emotional connectedness (Perrin & Benassi, 2009). Subsequent analysis of the 14 item CNS found that reducing the scale to seven questions produced a tool that retained reliability according to Cronbach's α (0.866) and correlation with other valid survey tools ($p < 0.01$; Pasca, Aragones, & Coello, 2017). Pasca et al. also suggested that Item 11 of the CNS (*Like a tree can be part of a forest, I feel embedded with the broader natural world*) was the most informative item and may be useful as an independent measure of connectedness to nature. The health department included Item 11 from the CNS as one of the three statement questions within the attitudes about nature domain in the Stress and Nature Mini-Survey.

The Stress and Nature Mini-Survey also collected dichotomous categorical data about mental health status, defined as 14 or more days of poor mental health during the previous 30 days, and obesity, which was calculated by collecting height and weight data and determining BMI and subsequently obesity status (BMI equal to or greater than 30). This approach empowered the health department and other researchers to study relationships between select socioeconomic and exposure factors and the priority health issues of mental health and obesity. Multiple surveying platforms were used by the county health department including the Internet, social media, paper surveys at clinic and partner locations, and also at community convenings.

Study Population

I examined the relationship between the nature variables and health outcomes described within the population of Kent County, Michigan. This county is the fourth most populous in Michigan with 648,594 residents according to the U.S. Census Bureau (2017). The county is located in Southwest Michigan and is composed of 21 townships, five villages, and nine cities. The City of Grand Rapids (population 193,792) is the county seat, the largest city in the county, and the second largest city in the state of Michigan. Kent County is generally considered the economic and manufacturing center of West Michigan. Diverse cultural communities and religious institutions, as well as many venues for enjoying the arts, sports, and entertainment are found in Kent County.

Kent County's population is becoming increasingly more diverse. The racial makeup of the county is 73.9% White/non-Hispanic, 10.6% Hispanic/Latino, 10.5% Black/African American, 3.2% Asian, and the remainder indicated other or multiple races. Blacks/African Americans and Hispanics/Latinos represent 20.9% and 15.6%, respectively, of the population of the city of Grand Rapids. Although racial and ethnic minority populations are more represented in Grand Rapids, the county population is becoming more diverse as minority groups are becoming more dispersed. In 2014, 62% of African Americans and 48% of Hispanics in the county lived within the city limits. These percentages are considerably less than the figures from the 2000 Census that showed 78.7% of the county's African Americans and 64.3% of Hispanics living in Grand Rapids.

Between 2012 and 2016, the estimated median household income in Kent County was $54,673, the per capita income for the county was $28,070, and 12.1% of the population was living below the federal poverty level (United States Census Bureau, 2017). According to the 2017 Census estimate, there were 255,056 housing units with 234,570 households in the county. The home ownership rate is 68.7%.

The 2010 U.S. Census provided the following data for Kent County, Michigan. Among family households, 30.4% had children under the age of 18 years. The average family size was 3.2 members, and the average household size was 2.7. The median age of county residents was 34.9 years, 25.1% of residents are less than 18 years of age, and 12.3% are 65 years of age or older. Among county residents 25 years and over, 89.1% graduated from high school, 21.5% had a bachelor's degree, 12.2% had a graduate or professional degree, and 10.9% are not high school graduates.

Kent County has 26 school districts, five intermediate school districts, 17 charter schools, and numerous nonpublic schools serving diverse religious affiliations. There are at least 12 public and private colleges and universities with campuses in Kent County.

Methodology

I used secondary data collected by the Kent County's cross-sectional Stress and Nature Mini-Survey. That survey was offered to Kent County residents via social media and in paper version at locations throughout the county in August and early September of 2018. Data from that survey were used to assess relationships between the nature exposures stated in the research questions and the health status measures of interest. Whether those exposure variables are significantly correlated to poor mental health and

obesity was determined. The variables were tested to measure effect via *OR* and approximate strength of predictive association through the Nagelkerke R^2. The following section details the specifics of this process.

The health department used the Qualtrics web-based survey platform for collecting the responses. The questions from that survey are publicly available and not protected by copyright by Kent County. Those survey questions are presented in Appendix A. The method of survey distribution was primarily through the Internet via social media distribution. Responses were also collected using paper surveys distributed at various community events and partner organization locations. Data from the paper surveys were inputted into the Qualtrics file by a health department staff person. The health department provided the data file for this completed survey in a SPSS *.sav file (Stress and Nature_September 11, 2018_09.01(1).sav). The survey did not ask for personally identifying information and, therefore, I did not possess any such information at any time during this study. SPSS was used to conduct all statistical analyses.

Binary logistic regression analyses were the most prominently used statistical tool to assess data and were relied upon to answer the six research questions in this quantitative study. Classification tables were calculated and are presented to demonstrate the ability of each equation model to correctly predict dependent variable status. The Hosmer and Lemeshow Test for goodness of fit was useful for determining if the binary logistic regression equations possessed significant predictive ability as supported in literature (Rana, Midi, & Sarkar, 2012). This regression testing was used to interpret the data and identify associations by reporting *OR*, significance levels, coefficient values,

probability values, and presenting R^2 values for approximate strength of effect. While logistic regression findings cannot be truly interpreted with an R^2 product, pseudo R^2 devices including Cox & Snell and Nagelkerke are available and will be presented for approximating the ability of the independent variables to explain the variance of the health factor dependent variables. Nagelkerke R^2 values less than .300 are generally categorized as a weak effect, those from .301 to .600 are generally categorized as a moderate effect, and those from .601 to 1.000 are generally categorized as a strong effect. Those general interpretations have been used throughout this study to categorize the effect of the variables on the variance of the dependent variables. Although Cox & Snell R^2 scores and -2 log likelihood values are presented for informative purposes in model summary tables throughout this paper, I have primarily relied upon the Nagelkerke R^2 within the narrative to describe effect size.

The data from the Stress and Nature Mini Survey were analyzed according to the study method for associations between the independent nature relationship variables and the priority health statuses of poor mental health (described as 14 or more days of poor mental health within the previous 30 days) and obesity (described as body mass index of 30 or greater). The nature relationship variables consisted of seven statement questions on the survey asking respondents to report their level of agreement on a five-point Likert scale (*1 = Strongly disagree, 2 = Disagree, 3 = Neither agree nor disagree, 4 = Agree, 5 = Strongly agree*).

Of the seven statement questions considered as independent variables, three were within the general domain of the subject of accessibility of nature (Statement Questions

23, 24, and 25), three were within the general domain of the subject of attitudes or connectedness to nature (Statement Questions 26, 27 and 28), and one was within the domain of actual physical activity in natural areas or nature-based recreation (Statement Question 29).

The initial analyses were performed in models including all seven independent variable statement questions and the priority health status dependent variable. For the first test, I transformed the five points of Likert scale data into two categories: those who could not agree with the statement question (*1 = Strongly disagree*, *2 = Disagree*, and *3 = Neither agree nor disagree*) were coded as 0, and those who agreed with the statement question (*4 = Agree*, and *5 = Strongly agree*) were coded as 1. This assessment provided a simple perspective into which statement questions were significantly associated and the *OR* differences present within each of these agreement groups.

The testing continued by considering the full range of Likert scale responses to the nature statement questions. All seven of these independent nature statement question variables containing their full range of responses were tested in logistic regression models with the dependent variable health issues, mental health and obesity. This full evaluation allowed for assessing which of the statement questions were significant and their respective *OR*. I subsequently grouped the statement questions into their respective domains (access, attitudes, and physical activity) and tested them in models with the priority health issues. Statement Questions 23, 24, and 25 were within the domain of accessibility to natural areas. The data for each of these questions were individually tested with the mental health and obesity data using regression analyses. The data for the

most powerfully predictive statement question within the accessibility domain were subsequently tested with the mental health and obesity data using regression analyses. Statement Questions 26, 27, and 28 were within the domain of attitudes about nature. In a manner identical to the previous three questions in the accessibility domain, these data were tested individually and then represented by the most powerfully predictive statement question from this domain with the health outcome data. Statement Question #29 was the only inquiry into actual physical activity in nature or nature-based activities. The data from this question were tested with the independent nature factor data as well. These three most powerfully predictive statement questions, one from each domain, were tested together in an additional binary logistic regression model for the intent of identifying significance and relevance against each other. The results of these binary logistic regression models using the full range of responses were used to answer the research questions.

Additional data fields such as age, sex, race/ethnicity, economic status, and religion were included in the survey and were used to assess for confounding. The battery of questions and multiple-choice response options presented in the county's Stress and Nature Mini-Survey are located in Appendix A of this document. This survey battery is publicly available and not protected by copyright. The open-ended questions recorded in the survey were offered along with a narrative box that the respondent could use to enter appropriate responses.

Binary logistic regression was also appropriate for comparing the independent variables' ordinal data that were converted into dichotomous categories of

emotional/mental health status, with the dependent variable ordinal data provided by the survey's Question 10 related to overall mental or emotional health. Question 10 offered the respondents the choice of five ordinal Likert-scaled answers. The findings from this test were used to inform the discussion about the relationship between nature factors and mental health status. The findings from this test were not used to answer the research questions of this study.

The health department's survey also included a narrative box that collected information about barriers to visiting natural areas. Noteworthy comments and patterns are included in the results and discussion portions of this study. These comments may be useful to future researchers and to public health officials and/or other decision-makers attempting to address these priority health issues.

The nature-based statement questions included within the Stress and Nature Mini-Survey are consistent with the framework proposed by Shanahan et al (2015) for understanding how nature exposures influence health outcomes. Step one of that model is to identify a specific, measurable element of nature. This was satisfied through the definition of nature included within the survey: open grassy area with trees, or ponds, lakes, streams, or rivers. Step two of the model is to identify a key characteristic or function of the nature element. The proposed function of the nature area was to facilitate attention restoration as presented through ART. Step three of the model is to identify moderating factors such as physical, social, cultural, or behavioral dynamics. This step was aligned with the purpose of this proposed study: understanding the relationships and associations of the access, attitude, and activity factors with mental health and obesity

outcomes. Steps four through six address identifying the effect(s) on people, moderating factors associated with the health benefit, and the specific health benefits respectively.

I understood that this research must be reliable and valid if it is going to contribute to the knowledge base of the subject. Validity is a measure of how sufficiently a tool or study evaluates what it is supposed to measure. Utilizing ART and the pathways to health benefits from nature framework presented by Shanahan et al. (2015) added validity to the study because these concepts have peer review and demonstrated value for understanding the subject material. Reliability is a measure of whether the findings can be reproduced and were not merely an abnormality. Cronbach's Alpha (α) was designed by Lee Cronbach in 1951 to assess scale reliability (Field, 2013; Tavakol, & Dennick, 2011). This tool randomly splits the responses into two groupings and measures their similarity. The resulting coefficient α values range from 0 to 1. A value of zero represents a perfectly opposed and completely unreliable scale. A value of 1 would represent a perfectly reliable scale. According to Field (2013), a value of .7 is generally interpreted as the minimal value representing acceptable reliability. Cronbach's α values, however, in excess of .8 are more readily recognized as strongly supporting the internal consistency and reliability of the scale. Cronbach's α is one of the most commonly used tools for assessing the reliability of scale measures. The ordinal data scales used in the county's Stress and Nature Mini-Survey are consistent with the type of instruments that can be assessed using Cronbach's α. Cronbach's α was calculated to measure the reliability of the scales used by the health department and is reported in the following chapter.

Summary

This quantitative cross-sectional study used secondary data collected by the local health department in Kent County, Michigan. That survey, entitled the Stress and Nature Mini-Survey, collected at least 649 and as many as 653 complete responses to the necessary statement questions during August and early September of 2018 through Internet-based and paper survey forms. This level of production was more than sufficient to satisfy the power calculations that required at least 568 completed surveys. The questionnaire form, provided in Appendix A, included fields such as: demographics, health status, access to natural areas, attitudes about nature, and physical activity in nature or nature-based recreation.

All data were analyzed using SPSS software. Binary logistic regression analyses were used to assess the associations between the independent variables of access, attitudes, and activity with the dependent variables of mental health status and obesity. The research questions were answered depending upon the results of these binary logistic regression tests. I included additional findings of value to this study, including qualitative comments about obstacles to visiting nature areas and other enlightening observations from the survey analysis in the study results that are used to enrich the discussion of this topic in the final chapter of this document. In the following chapter, I describe the results that were found subsequent to data analyses.

Chapter 4: Results

Introduction

In this chapter, I present the findings from the statistical analyses performed with data provided by the county's Stress and Nature Mini-Survey. The data collection techniques the county used are reported along with the level of community participation they were able to achieve. Descriptive data for the survey participants are provided that demonstrate the diversity of the survey population including gender, age, race, religion, language, education level, and economics. Overall statistical analyses are presented for both of the priority health issues (mental health and obesity). Each research question is addressed and decided individually based on binary logistic regression findings. Classification tables are presented throughout as accuracy devices to present the overall percentage of correctness demonstrated by the regression models. These classification tables are useful for informing the discussion about the overall effectiveness of logistic regression as a tool for identifying relationships between variables. Approximate effect levels, presented as both the Cox & Snell and Nagelkerke's R^2 pseudo measures, are offered as appropriate.

Data Collection

The data for this study were provided by the local health department in Kent County, Michigan. These data were gathered during August and early September of 2018 as part of the Stress and Nature Mini-Survey. The survey was administered via social media and in paper form at various community clinics and public gatherings. The county conducted this survey to supplement the community health needs assessment and to

address questions that arose subsequent to that assessment. The data set did not include personally identifying information and was available upon request to the public. It was provided for this research in the form of a SPSS data file.

Results

A total of 713 individuals responded to the Stress and Nature Mini-Survey. Responses that did not include information about mental health status, height and/or weight, or answers to any nature relationship statement questions were excluded from analysis. Between 649 and 653 sufficiently complete surveys were included in testing after this cleaning. This range of sufficiently complete surveys was because some respondents did not answer every nature relationship statement question. This number of surveys surpasses the 568 required to provide the minimum amount of power needed for this study. Post hoc analyses performed using G*Power Version 3.1.9.2 determined that the survey provided a power ($1 - \beta$ error probability) of at least 0.845 to detect an *OR* of 1.3 with an α error probability of 0.05. This level of power provides an 84.5% likelihood of avoiding Type 2 errors and rejecting the null hypotheses if, in fact, they are false.

Descriptive Statistics

Table 1 presents a demographic description of the 653 survey respondents included in this study. The survey respondents reported female gender at a rate of 83.3%, which is substantially greater than the approximate 50% expected in a large population. The median age of Kent County residents was 34.9 years according to Census Bureau (2010). The 51st percentile of survey respondents reported age in the 35 to 44 years of age category in the Stress and Nature Mini-Survey. This age distribution is similar to the

general population considering that children were not included in the survey. The survey respondents disproportionately reported White race/ethnicity (82.5%) compared to the general population, which according to Census Bureau data (2017), composed 73.9% of the county's population. All other racial and ethnic groups were underrepresented compared to Census Bureau data. All of the survey respondents reported English as their language. The median income for Kent County households was $54,673 according to the Census Bureau (2017). This number is contained with the $50,000 to $74,999 range in the survey that also contained the 50% cumulative percentile of respondents. Educational attainment and religious affiliation, if any, are also reported in Table 1.

Table 1

Description of Survey Respondents

		Frequency	Percent
Gender	Female	544	83.3
	Male	109	16.7
	Total	653	100
Age	18 to 24 years	27	4.1
	25 to 34 years	143	21.9
	35 to 44 years	163	25
	45 to 54 years	148	22.7
	55 to 64 years	120	18.4
	65 to 74 years	44	6.7
	75 years or older	8	1.2
	Total	653	100
Race/Ethnicity	White	539	82.5
	Black or African American	43	6.6
	Multi-Racial	11	1.7
	Hispanic or Latino/a	46	7
	Asian	6	0.9
	American Indian or Alaska Native	2	0.3
	Middle Eastern or North African	2	0.3
	Other	3	0.5
	Total	652	99.8
	Missing	1	0.2
	Total	653	100
Language	English	653	100

(table continues)

		Frequency	Percent
Religion	Christian (Protestant)	310	47.5
	Catholic	119	18.2
	Mormon	2	0.3
	Greek or Russian Orthodox	5	0.8
	Jewish	6	0.9
	Muslim	2	0.3
	Buddhist	5	0.8
	Hindu	2	0.3
	Atheist or agnostic	72	11
	Other	21	3.2
	Nothing in particular	105	16.1
	Total	649	99.4
	Missing	4	0.6
	Total	653	100
Highest Level of Education	Less than high school graduation	3	0.5
	High school diploma or GED	30	4.6
	Some college	92	14.1
	Associate or technical degree	64	9.8
	Bachelor's degree	248	38
	Graduate degree or higher	216	33.1
	Total	653	100
Household Income	Less than $15,000	15	2.3
	$15,000 to $24,999	41	6.3
	$25,000 to $34,999	51	7.8
	$35,000 to $49,999	83	12.7
	$50,000 to $74,999	155	23.7
	$75,000 to $99,999	117	17.9
	$100,000 to $120,000	79	12.1
	More than $120,000	97	14.9
	Total	638	97.7
	Missing	15	2.3
	Total	653	100

Evaluation of Assumptions

The following assumptions must be met for binary logistic regression analyses.

1. The dependent variables consist of binary categorical data.
2. The independent predictor variables consist of continuous data, or categorical/ordinal data that can be treated as continuous, and there are no influential outlying values creating distortion.
3. There is no multicollinearity among the independent predictor variables.
4. There needs to be a linear relationship between the independent predictor variables and the logit transformation of the dependent variable.

The first assumption was satisfied by the construction of the Stress and Nature Mini-Survey that provided the respondents with a dichotomous set of options for mental health status. The obesity status variable also satisfied the first assumption because height and weight data were converted into BMI that was then categorized into a binary variable addressing affirmative or negative obesity status (greater or equal to a BMI of 30). The second assumption was met because all of the independent nature exposure variables were collected as ordinal data from 5-point Likert scales. Those ordinal independent variable data were used both in their ordinal form (representing level of agreement with each statement) and also recoded into categorical data (representing positive agreement or lack thereof). To address the third assumption regarding multicollinearity, I reviewed the variables' regression coefficients in the correlation matrices produced by SPSS and did not find significant correlation among the variables, thereby satisfying this

assumption. The fourth assumption was satisfied by identifying linearity between the value of the independent variable nature statement questions and the logit transformation of the mental health and obesity status dependent variables.

The respondents were given five choices for answering each of the nature statement questions. Those choices were presented as a Likert scale including *Strongly disagree, Disagree, Neither agree nor disagree, Agree,* and *Strongly agree*. Table 2 presents a summary of the frequency of their responses to these nature statement questions.

Table 2

Summary of Nature Statement Question Responses (full Likert Scale Range)

Nature Statement Questions	Level of Agreement	*n*	Marginal Percentage
23. It is easy for me to access a natural area.	Strongly disagree	23	3.5%
	Disagree	32	4.9%
	Neither agree nor disagree	44	6.8%
	Agree	283	43.5%
	Strongly agree	269	41.3%
24. I live close to a natural area.	Strongly disagree	13	2.0%
	Disagree	54	8.3%
	Neither agree nor disagree	60	9.2%
	Agree	281	43.2%
	Strongly agree	243	37.3%
25. I am aware of natural areas that are available for use in my community.	Strongly disagree	16	2.5%
	Disagree	33	5.1%
	Neither agree nor disagree	26	4.0%
	Agree	319	49.0%
	Strongly agree	257	39.5%
26. I feel very connected with nature and/or natural areas.	Strongly disagree	20	3.1%
	Disagree	64	9.8%
	Neither agree nor disagree	129	19.8%
	Agree	240	36.9%
	Strongly agree	198	30.4%
27. It is important for me to spend time in nature or participating in nature-based activities.	Strongly disagree	12	1.8%
	Disagree	44	6.8%
	Neither agree nor disagree	83	12.7%
	Agree	273	41.9%
	Strongly agree	239	36.7%

(table continues)

Nature Statement Questions	Level of Agreement	*n*	Marginal Percentage
28. Like a tree can be part of a forest, I feel embedded within the broader natural world.	Strongly disagree	14	2.2%
	Disagree	88	13.5%
	Neither agree nor disagree	214	32.9%
	Agree	220	33.8%
	Strongly agree	115	17.7%
29. I frequently engage in physical activity in natural areas or in nature-based activities.	Strongly disagree	34	5.2%
	Disagree	178	27.3%
	Neither agree nor disagree	110	16.9%
	Agree	227	34.9%
	Strongly agree	102	15.7%
Valid		651	100%
Missing		2	
Total		653	

The responses to the nature variable statement questions were also recoded into categories of *Not Agreed* for those who responded with answers of 1 through 3 on the Likert scale (*Strongly disagree*, *Disagree,* and *Neither agree nor disagree*) and *Agreed* for those who responded with answers of 4 or 5 (*Agree* and *Strongly agree*). This recoding allowed for additional analyses of association to the priority health issues based on affirmative or negative agreement status. The following tables demonstrate the frequency of responses to each nature variable statement after this recoding.

Table 3

Recoded Statement Question 23 (It is easy for me to access a natural area.)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Agreed	99	15.2	15.2	15.2
	Agreed	554	84.8	84.8	100.0
	Total	653	100.0	100.0	

Table 4

Recoded Statement Question 24 (I live close to a natural area.)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Agreed	127	19.4	19.5	19.5
	Agreed	525	80.4	80.5	100.0
	Total	652	99.8	100.0	
Missing	System	1	.2		
Total		653	100.0		

Table 5

Recoded Statement Question 25 (I am aware of natural areas that are available for use in my community.)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Agreed	75	11.5	11.5	11.5
	Agreed	578	88.5	88.5	100.0
	Total	653	100.0	100.0	

Table 6

Recoded Statement Question 26 (I feel very connected with nature and/or natural areas.)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Agreed	214	32.8	32.8	32.8
	Agreed	438	67.1	67.2	100.0
	Total	652	99.8	100.0	
Missing	System	1	.2		
Total		653	100.0		

Table 7

Recoded Statement Question 27 (It is important for me to spend time in nature or participating in nature-based activities.)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Agreed	139	21.3	21.3	21.3
	Agreed	513	78.6	78.7	100.0
	Total	652	99.8	100.0	
Missing	System	1	.2		
Total		653	100.0		

Table 8

Recoded Statement Question 28 (Like a tree can be part of the forest, I feel embedded within the broader natural world.)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not Agreed	317	48.5	48.6	48.6
	Agreed	335	51.3	51.4	100.0
	Total	652	99.8	100.0	
Missing	System	1	.2		
Total		653	100.0		

Table 9

Recoded Statement Question 29 (I frequently engage in physical activity in natural areas or in nature-based activities.)

	Frequency	Percent	Valid Percent	Cumulative Percent
Not Agreed	323	49.5	49.5	49.5
Agreed	330	50.5	50.5	100.0
Total	653	100.0	100.0	

Statistical Analyses and Findings Related to Mental Health

The reliability of the data set for performing this sort of study was first considered. The Cronbach's α test of internal consistency, recognized as a reliability measure, calculated a value of .823 for the mental health variable and the seven nature statement questions. Cronbach's α values ranging between .700 and .950 are generally considered acceptable for the social sciences (Tavakol & Dennick, 2011).

I found that this first logistic regression model, including all seven nature variable statement questions categorized into two categories of agreement (*Not agreed* and *Agreed*), met the Hosmer and Lemeshow Test for goodness of fit (X^2 (7) = 2.880, p = .896). This model included responses from 649 participants and predicted an overall 86.6% of their responses correctly (Table 10). Overall the model demonstrated a weak effect (.103) on the variation in poor mental health status according to Nagelkerke's R^2 (Table 11).

Table 10

Classification Table of Logistic Regression Model Including All Recoded Nature Statement Questions and the Mental Health Variable

Observed		Predicted: Did you have 14 or more days of poor mental health in the past 30 days? No	Yes	Percentage Correct
Did you have 14 or more days of poor mental health in the past 30 days?	No	562	0	100.0
	Yes	87	0	.0
Overall Percentage				86.6

Note. The cut value for this classification table is .500.

Table 11

Model Summary of Binary Logistic Regression Including All Recoded Nature Statement Questions and the Mental Health Variable

-2 Log likelihood	Cox & Snell R^2	Nagelkerke R^2
473.945[a]	.056	.103

Note. a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Table 12 presents the findings from the logistic regression analyses using all seven nature exposure statement questions coded into the two categories of *Not agreed* and *Agreed* with the statement, and the poor mental health status variable. Agreement with Statement Question 23 (*It is easy for me to access a natural area*) was found to significantly correlate to lower odds of poor mental health ($p < .001$, *OR* .308, 95% *CI*

.160, .592). Those who agreed with this statement were only about 30.8% as likely to report having 14 or more days of poor mental health in the past 30 days as those who did not agree with the statement. Statement Question 29, related to physical activity (*I frequently engage in physical activity in nature or in nature-based activities*), approached significance ($p = .052$). All other statement question responses, when considered as binary *Not agreed* or *Agreed*, were determined to not be significantly associated with poor mental health status.

Table 12

Binary Logistic Regression Analysis of All Recoded Nature Statement Questions and the Mental Health Variable

							95% *CI* for *OR*	
Nature Statement Questions	*B*	*SE*	Wald	*df*	Sig	*OR*	Lower	Upper
23. It is easy for me to access a natural area.	-1.178	.334	12.449	1	<.001	.308	.160	.592
24. I live close to a natural area.	-.256	.324	.623	1	.430	.774	.410	1.462
25. I am aware of natural areas that are available for use in my community.	.183	.369	.245	1	.620	1.200	.583	2.473
26. I feel very connected with nature and/or natural areas.	-.010	.308	.001	1	.973	.990	.541	1.811

(table continues)

Nature Statement Questions	*B*	*SE*	Wald	*df*	Sig	*OR*	95% *CI* for *OR* Lower	Upper
27. It is important for me to spend time in nature or participating in nature-based activities.	-.055	.314	.031	1	.861	.946	.511	1.752
28. Like a tree can be part of the forest, I feel embedded within the broader natural world.	-.172	.286	.361	1	.548	.842	.481	1.475
29. I frequently engage in physical activity in natural areas or in nature-based activities.	-.567	.292	3.780	1	.052	.567	.320	1.005
Constant	-.550	.328	2.809	1	.094	.577		

Note. B = coefficient, *SE* = standard error, *df* = degrees of freedom, Sig = significance, *OR* = odds ratio, *CI* = confidence interval.

The following model, and all subsequent models assessing mental health, were constructed using data including all five Likert responses including *1 = Strongly disagree, 2 = Disagree, 3 = Neither agree nor disagree, 4 = Agree*, and *5 = Strongly agree*. Using this more comprehensive scale of responses provided insight into the relative value of increasing a person's level of agreement by one unit. I found that this model, inclusive of all Likert-scaled nature variables and mental health status, met the Hosmer and Lemeshow Test criteria for goodness of fit (X^2 (8) = 3.185, p = .922). This model included response data from 653 survey participants and correctly predicted 86.7% of their responses (Table 13).

Table 13

Classification Table of Logistic Regression Model Including All Likert-Scaled Nature Statement Questions and the Mental Health Variable

Observed		Predicted: Did you have 14 or more days of poor mental health in the past 30 days? No	Yes	Percentage Correct
Did you have 14 or more days of poor mental health in the past 30 days?	No	560	2	99.6
	Yes	84	3	3.4
Overall Percentage				86.7

Note. The cut value for the classification table is .500.

The Nagelkerke R^2 calculation determined that, taken collectively, these seven Likert-scaled variables presented a weak effect (.103) on the variance in mental health status within this survey population (Table 14). Two of the seven nature-related variable statement questions demonstrated a significant association with the mental health dependent variable in this full model (Table 15). Statement Questions 23 (*It is easy for me to access a natural area*) (p = .002, *OR* .653, 95% *CI* .498, .857) and 29 (*I frequently engage in physical activity in natural areas or in nature-based activities*) (p = .014, *OR* .719, 95% *CI* .553, .935) were independent nature variables that possessed predictive qualities when considering the full five point range of Likert-scaled responses.

Table 14

Model Summary of Binary Logistic Regression Including All Likert-Scaled Nature Statement Questions and the Mental Health Variable

-2 Log likelihood	Cox & Snell R^2	Nagelkerke R^2
473.986[a]	.056	.103

Note. a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Table 15

Binary Logistic Regression Analysis of All Likert-Scaled Nature Statement Questions and the Mental Health Variable

Nature Statement Questions	*B*	*SE*	Wald	*df*	Sig	*OR*	95% *CI* for *OR* Lower	Upper
23. It is easy for me to access a natural area.	-.426	.139	9.456	1	.002	.653	.498	.857
24. I live close to a natural area.	-.025	.160	.024	1	.876	.975	.712	1.336
25. I am aware of natural areas that are available for use in my community.	-.079	.157	.249	1	.618	.924	.679	1.259
26. I feel very connected with nature and/or natural areas.	.006	.158	.001	1	.970	1.006	.737	1.372
27. It is important for me to spend time in nature or participating in nature-based activities.	.119	.153	.598	1	.439	1.126	.834	1.521
28. Like a tree can be part of a forest, I feel embedded within the broader natural world.	-.018	.157	.013	1	.911	.983	.722	1.337
29. I frequently engage in physical activity in natural areas or in nature-based activities.	-.330	.134	6.072	1	.014	.719	.553	.935
Constant	.810	.592	1.872	1	.171	2.248		

Note. *B* = coefficient, *SE* = standard error, *df* = degrees of freedom, Sig = significance, *OR* = odds ratio, *CI* = confidence interval.

To identify the most powerful predictor variables in each of the domains of access to nature, attitudes/connectedness to nature, and physical activity in nature or nature based-activities, I examined the questionnaire statements that addressed these three domains of interest. The statement questions were sorted according to domain area and analyzed in models limited to those similar variables. These analyses allowed me to assess if each domain's model presented goodness of fit and to identify which survey statement question's *OR* associated most powerfully with mental health status.

The Stress and Nature Mini-Survey contained three statement questions (23, 24, & 25) referring to access to nature. For the purpose of this study, these three statement questions were considered to be within the domain of access to nature. The survey data contained information from 650 participants for the statement questions in this model that correctly predicted 86.0% of the mental health responses (Table 16). This model satisfied the Hosmer and Lemeshow Test for goodness of fit (X^2 (5) = 6.489, p = .262) and was found to have a weak effect (Nagelkerke R^2 = .082) on the variation of mental health status (Table 17). Statement Question 23 (*It is easy for me to access a natural area*) was found to be the best and only statistically significant predictor of mental health status from these three access-related statements (p = .001, *OR* .632, 95% *CI* .486, .823). Table 18 demonstrates these three statements and their statistical relationships with the poorer mental health status according to binary logistic regression.

Table 16

Classification Table of Logistic Regression Model Including the Access to Nature Domain Likert-Scaled Nature Statement Questions (23, 24, & 25) and the Mental Health Variable

		Predicted		
		Did you have 14 or more days of poor mental health in the past 30 days?		Percentage
Observed		No	Yes	Correct
Did you have 14 or more days of poor mental health in the past 30 days?	No	557	6	98.9
	Yes	85	2	2.3
Overall Percentage				86.0

Note. The cut value for the classification table is .500.

Table 17

Model Summary of Binary Logistic Regression Including the Access to Nature Domain Likert-Scaled Nature Statement Questions (23, 24, & 25) and the Mental Health Variable

-2 Log likelihood	Cox & Snell R^2	Nagelkerke R^2
482.141[a]	.044	.082

Note. a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Table 18

Binary Logistic Regression Analysis of the Access to Nature Domain Likert-Scaled Nature Statement Questions (23, 24, & 25) and the Mental Health Variable

Nature Statement Questions	*B*	*SE*	Wald	*df*	Sig	*OR*	95% *CI* for *OR* Lower	Upper
23. It is easy for me to access a natural area.	-.458	.135	11.602	1	.001	.632	.486	.823
24. I live close to a natural area.	-.045	.159	.079	1	.779	.956	.701	1.306
25. I am aware of natural areas that are available for use in my community.	-.129	.147	.768	1	.381	.879	.659	1.173
Constant	.633	.500	1.608	1	.205	1.884		

Note. B = coefficient, *SE* = standard error, *df* = degrees of freedom, Sig = significance, *OR* = odds ratio, *CI* = confidence interval.

A similar model was created and tested containing the three independent variable statement questions within the domain of attitudes about nature (26, 27, & 28). A total of 650 surveys contained sufficient data for analyses in this model that correctly predicted 86.5% of the mental health responses (Table 19). The attitudes about nature domain model was found to satisfy the Hosmer and Lemeshow Test for goodness of fit (X^2 (6) = 3.533, p = .740) and demonstrated a weak effect (Nagelkerke R^2 = .043) on the variation in mental health status as shown in Table 20. However, as demonstrated in Table 21, none of the three statements related to attitudes about nature were significantly associated with mental health status. Statement Question 26 (*I feel very connected with nature*

and/or natural areas) approached significantly lower odds of poorer mental health status (p = .067). This variable was, for the purpose of further analyses, included in a subsequent model with the most powerfully predictive variables for the domains of access and activity.

Table 19

Classification Table of Logistic Regression Model Including the Attitudes About Nature Domain Likert-Scaled Nature Statement Questions (26, 27, & 28) and the Mental Health Variable

		Predicted		
		Did you have 14 or more days of poor mental health in the past 30 days?		Percentage
Observed		No	Yes	Correct
Did you have 14 or more days of poor mental health in the past 30 days?	No	562	0	100.0
	Yes	88	0	.0
Overall Percentage				86.5

Note. The cut value for the classification table is .500.

Table 20

Model Summary of Binary Logistic Regression Including the Attitudes About Nature Domain Likert-Scaled Nature Statement Questions (26, 27, & 28) and the Mental Health Variable

-2 Log likelihood	Cox & Snell R^2	Nagelkerke R^2
500.136[a]	.023	.043

Note. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Table 21

Binary Logistic Regression Analysis of the Attitudes About Nature Domain Likert-Scaled Nature Statement Questions (26, 27, & 28) and the Mental Health Variable

Nature Statement Questions	*B*	*SE*	Wald	*df*	Sig	*OR*	95% *CI* for *OR* Lower	Upper
26. I feel very connected with nature and/or natural areas.	-.263	.144	3.352	1	.067	.769	.580	1.019
27. It is important for me to spend time in nature or participating in nature-based activities.	.044	.145	.093	1	.761	1.045	.787	1.389
28. Like a tree can be part of a forest, I feel embedded within the broader natural world.	-.237	.146	2.631	1	.105	.789	.593	1.051
Constant	-.269	.488	.303	1	.582	.764		

Note. B = coefficient, *SE* = standard error, *df* = degrees of freedom, Sig = significance, *OR* = odds ratio, *CI* = confidence interval.

The Stress and Nature Mini-Survey contained only one statement question about physical activity in nature or nature-based recreation. Statement Question 29 (*I frequently engage in physical activity in nature or nature-based activities*) was sufficiently answered by 651 participants. The model containing this one statement question was found to correctly predict 86.5% of the mental health responses (Table 22). The model also satisfied the Hosmer and Lemeshow Test for goodness of fit (X^2 (3) = 4.867, p = .182). Statement Question 29 demonstrated a weak effect (Nagelkerke R^2 = .052) on the

variation in mental health status within the survey population (Table 23). It did, however, significantly predict mental health status in the model ($p < .001$, *OR* .652, 95% *CI* .535, .795) as shown in Table 24. This statement question was thereby considered to have merit for representing the independent variable domain of physical activity in nature compared to the most powerful predictor variables in the domains of access and attitudes/connectedness to nature or natural areas.

Table 22

Classification Table of Logistic Regression Model Including the Physical Activity in Nature Domain Likert-Scaled Nature Statement Question (29) and the Mental Health Variable

		Predicted		
		Did you have 14 or more days of poor mental health in the past 30 days?		Percentage
Observed		No	Yes	Correct
Did you have 14 or more days of poor mental health in the past 30 days?	No	563	0	100.0
	Yes	88	0	.0
Overall Percentage				86.5

Note. The cut value for the classification table is .500.

Table 23

Model Summary of Binary Logistic Regression Including the Physical Activity in Nature Domain Likert-Scaled Statement Question (29) and the Mental Health Variable

-2 Log likelihood	Cox & Snell R^2	Nagelkerke R^2
497.011[a]	.028	.052

Note. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Table 24

Binary Logistic Regression Analysis of *the Physical Activity in Nature Domain Likert-Scaled Nature Statement Question (29) and the Mental Health Variable*

Nature Statement Question	*B*	*SE*	Wald	*df*	Sig	*OR*	95% *CI* for *OR* Lower	Upper
29. I frequently engage in physical activity in natural areas or in nature-based activities.	-.427	.101	17.929	1	<.001	.652	.535	.795
Constant	-.542	.312	3.016	1	.082	.582		

Note. B = coefficient, *SE* = standard error, *df* = degrees of freedom, Sig = significance, *OR* = odds ratio, *CI* = confidence interval.

A third model was tested including the most predictive statement question from each of the domains (access, attitudes, and physical activity). A total of 650 survey participants provided sufficient information for inclusion in this model that correctly predicted 86.8% of the mental health responses (Table 25). This model of the three independent variables satisfied the Hosmer and Lemeshow Test for goodness of fit (X^2 (8) = 3.632, p = .889). Together in this model, the responses to the three statement questions demonstrated a weak effect (Nagelkerke R^2 = .100) on the variance in mental health status within the study population according (Table 26).

Table 25

Classification Table of Logistic Regression Model Including the Most Predictive Likert-Scaled Nature Statement Questions from the Domains of Access (23), Attitudes (26), and Physical Activity (29) and the Mental Health Variable

		Predicted		
		Did you have 14 or more days of poor mental health in the past 30 days?		Percentage
Observed		No	Yes	Correct
Did you have 14 or more days of poor mental health in the past 30 days?	No	560	2	99.6
	Yes	84	4	4.5
Overall Percentage				86.8

Note. The cut value for the classification table is .500.

Table 26

Model Summary of Binary Logistic Regression Including the Most Predictive Likert-Scaled Nature Statement Questions from the Domains of Access (23), Attitudes (26), and Physical Activity (29) and the Mental Health Variable

-2 Log likelihood	Cox & Snell R^2	Nagelkerke R^2
479.027[a]	.054	.100

Note. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Two of the statement question variables demonstrated a statistically significant association with mental health status in this model (Table 27). Statement Questions 23 (*It is easy for me to access a natural area*) ($p < .001$, *OR* .630, 95% *CI* .506, .785) and 29 (*I frequently engage in physical activity in natural areas or in nature-based activities*) ($p = .011$, *OR* .734, 95% *CI* .578, .931) were predictive of mental health status. Statement

Question 26 (*I feel very connected with nature and/or natural areas*) was not found to be significantly associated with mental health status.

Table 27

Binary Logistic Regression Analysis of Most Powerfully Predictive Likert-Scaled Nature Statement Questions from the Domains of Access (23), Attitudes (26), and Physical Activity (29) and the Mental Health Variable

Nature Statement Questions	*B*	*SE.*	Wald	*df*	Sig	*OR*	95% *CI* for *OR* Lower	Upper
23. It is easy for me to access a natural area.	-.462	.112	16.911	1	<.001	.630	.506	.785
26. I feel very connected with nature and/or natural areas.	.019	.132	.020	1	.888	1.019	.786	1.320
29. I frequently engage in physical activity in natural areas or in nature-based activities.	-.310	.122	6.478	1	.011	.734	.578	.931
Constant	.849	.471	3.243	1	.072	2.338		

Note. B = coefficient, *SE* = standard error, *df* = degrees of freedom, Sig = significance, *OR* = odds ratio, *CI* = confidence interval.

The *OR* for the ease of access statement question (.630) was noticeably lower than that for the physical activity statement question (.743) indicating that the odds of inclusion in the poor mental health status group was lowest for those who reported increasing levels of ease of access to natural areas. This suggests that ease of access may be the most powerful predictor of mental health status among the variables studied. It is

important, however, to note that the 95% confidence intervals for these two statement questions overlap. The ease of access variable, as calculated by the Nagelkerke R^2, although still demonstrating a weak effect (.078) explains more of the total variance in mental health status than the physical activity variable (.052). Once again, however, it is important to consider that the Nagelkerke R^2 is a pseudo measure of effect and should not be credited with precise decision-making value. As a result, while ease of access appears to be the most powerful predictor of mental health status, it is not possible to conclusively determine that one is more useful than the other given the data available within this sample.

Binary Logistic Regression Analysis of Survey Question 10

Binary logistic regression was appropriate for comparing the independent variable ordinal data, that was converted into dichotomous categorical data, with the dependent variable ordinal data provided by Question 10 on the survey related to overall mental or emotional health. Question 10 offered the respondents the choice of five ordinal answers and satisfied the assumptions of logistic regression analysis. The findings from this test were only used to help inform the discussion about the relationship between nature factors and mental health status.

Table 28 presents the summary of responses to Question 10. A total of 652 individuals responded to this question. A majority of them, 531 altogether representing 81.4% of the survey population, rated their overall mental or emotional health as *excellent*, *very good*, or *good*. The remainder reported either *fair* (101 for 15.5%) or *poor* (20 for 3.1%) mental or emotional health. For the purpose of this analysis, the response

data for Question 10 was recoded into binary 0 for the 121 who reported *fair* or *poor* mental or emotional health and 1 for the 531 respondents who reported *excellent*, *very good*, or *good* mental or emotional health.

Table 28

Summary of Responses to Question 10

		N	Marginal Percentage
10. In general, how would you rate your overall mental or emotional health?	Excellent	58	8.9%
	Very good	253	38.8%
	Good	220	33.7%
	Fair	101	15.5%
	Poor	20	3.1%

The recoded data for mental or emotional health status was included in a logistic regression analysis with the binary *Not agreed* or *Agreed* status for the seven nature statement questions. This regression model was found to demonstrate goodness of fit (X^2 (7) = 5.195, p = .636) and two of the seven statement questions were significantly correlated with mental or emotional health status in this model. Response status of *Not agreed* with Statement Question 23 (*It is easy for me to access a natural area*) was significantly correlated with *fair* or *poor* mental or emotional health status (p = .011, *OR* 2.195, 95% *CI* 1.198, 4.024). Response status of *Not agreed* with Statement Question 29 (*I frequently engage in physical activity in natural areas or in nature-based activities*) was significantly correlated with *fair* or *poor* mental or emotional health status (p = .018, *OR* 1.842, 95% *CI* 1.112, 3.051). The five other nature statement questions were not found to correlate significantly with the data from this dependent variable.

Consideration of Variables Possibly Confounding the Relationships

Possible confounding variables were also considered within the Stress and Nature Mini-Survey data. A binary logistic regression model was tested including the categories of gender, age, race/ethnicity, religious affiliation, household income, and highest level of education along with the significantly associated variables of the ease of access and frequent activity statement questions and the dependent variable of 14 or more days of poor mental health in the past 30 days. This model included 631 responses and correctly predicted 86.2% of the mental health variable (Table 29). The Hosmer and Lemeshow test for goodness of fit was satisfied (X^2 (8) = 9.100, p = .334). According to the Nagelkerke R^2, this full battery of demographic questions and the significantly associated nature statement question demonstrated a weak effect (Nagelkerke R^2 = .200) on the variation in mental health status within the survey population (Table 30).

Two of the four demographic variables considered in this evaluation of possible confounders were found to have significant relationships to mental health status (Table 31). Gender was found to be a significant predictor of 14 or more days of poor mental health in the prior 30 days (p = .029, OR .381, 95% CI .160, .907). The data for gender was coded with female represented by 0 and male represented by 1. This finding means that males were 38.1% as likely as females to report having 14 or more days of poor mental health in the prior 30 days. Household income was also found to be a significant predictor of 14 days or more of poor mental health in the prior 30 days (p < .006, *OR* .816, 95% *CI* .706, .944). For each increase in income bracket reported, the odds of reporting poor mental health changed at a .816 ratio.

Table 29

Classification Table of Logistic Regression Model Including the Significantly Associated Nature Statement Questions (23 & 29), Demographics of the Survey Population, and the Mental Health Variable

		Predicted		
		Did you have 14 or more days of poor mental health in the past 30 days?		Percentage
Observed		No	Yes	Correct
Did you have 14 or more days of poor mental health in the past 30 days?	No	537	8	98.5
	Yes	79	7	8.1
Overall Percentage				86.2

Note. The cut value for the classification table is .500.

Table 30

Model Summary of Binary Logistic Regression Including the Significantly Associated Nature Statement Questions (23 & 29), Demographics of the Survey Population, and the Mental Health Variable

-2 Log likelihood	Cox & Snell R^2	Nagelkerke R^2
429.045[a]	.110	.200

Note. a. Estimation terminated at iteration number 20 because maximum iterations has been reached. Final solution cannot be found.

Table 31

Binary Logistic Regression Analysis of the Significantly Associated Nature Statement Questions (23 & 29), Demographics of the Survey Population, and the Mental Health Variable

Significant Nature Statement Questions and Demographic Variables	Sig	*OR*	95% *CI* for *OR* Lower	Upper
23. It is easy for me to access a natural area.	<.001	.614	.482	.781
29. I frequently engage in physical activity in natural areas or in nature-based activities.	.047	.792	.629	.997
Gender (Male relative to Female)	.029	.381	.160	.907
Age (per bracket increase)	.132			
Race/Ethnicity				
White	.715			
Black or African American	.999			
Multi-Racial	.999			
Hispanic or Latino/a	.999			
Asian	.999			
American Indian or Alaska Native	1.000			
Middle Eastern or North African	1.000			
Other	1.000			
Household Income (per bracket increase)	.006	.816	.706	.944
Highest Level of Education (per bracket increase)	.271			

(table continues)

Significant Nature Statement Questions and Demographic Variables	Sig	*OR*	95% *CI* for *OR* Lower	Upper
Religious Affiliation				
Christian (Protestant)	1.000			
Catholic	.413			
Mormon	.545			
Greek or Russian Orthodox	.999			
Jewish	.999			
Muslim	.999			
Buddhist	.999			
Hindu	.873			
Atheist or agnostic	1.000			
Other	.853			
Nothing in particular	.636			
Constant	1.000			

Note. Sig = significance, *OR* = odds ratio, *CI* = confidence interval. *OR* and *CI* not shown for non-significant variables.

These findings indicated the odds of self-reported poor mental health decreased both with male gender status and as household income increased within the survey population. It is, however, unlikely that the significant qualities of gender and household income confounded the results of this study primarily because the significant relationships between nature Statement Questions 23 and 29 persisted even when the demographic characteristics were included in the model and also because the correlation of these data to the ease of access and physical activity statement questions was very low. The correlation matrix produced by SPSS analysis demonstrated that the ease of access statement question possessed a .008 rate of correlation with gender status and a -.090

correlation with household income. That same correlation matrix demonstrated that the physical activity statement question had a -.026 rate of correlation with gender status and a .025 correlation with household income.

Research Question #1

Is mental health status in a Michigan county associated with the ability to access nature areas as measured by the county's Stress and Nature Mini-Survey?

$H_0$1 - Mental health status in a Michigan county is not associated with the ability to access nature areas as measured by the county's Department Stress and Nature Mini-Survey.

H_A1 - Mental health status in a Michigan county is associated with the ability to access nature areas as measured by the county's Stress and Nature Mini-Survey.

The domain of access to nature was explored by the following three separate statement questions in the Stress and Nature Mini-Survey.

23. It is easy for me to access a natural area

24. I live close to a natural area

25. I am aware of natural areas that are available for use in my community

The first of these three statement questions (*It is easy for me to access a natural area*) was found to significantly associate with lower probability of poorer mental health status when all seven Likert-scaled nature-related statement questions were considered together in the equation (p = .002, *OR* .653, 95% *CI* .498, .857). This statement question was once again the only access-related item to significantly associate with the mental health variable when the three statements related to access to nature areas were measured

as a group (p = .001, *OR* .632, 95% *CI* .486, .823). This significant statement was framed upon an individual's self-reported ease of access to nature areas and the other two, statistically non-significant, statements were predicated upon proximity to nature areas and awareness of them.

These mixed findings suggested that access to nature areas as a predictor of mental health status is complex. How access is approached – either as ease of access, mere proximity, or awareness of nature area locations – is probably essential for a more accurate understanding of this relationship. Ease of access to nature areas is, however, the most closely aligned with ability to access as stated in this research question. This statement question included 651 responses and when measured independently against the mental health variable correctly predicted an overall 86.5% of the mental health responses (Table 32). This model presented goodness of fit for predicting mental health status (X^2 (1) = 1.217, p = .270). Statement Question 23 demonstrated a weak effect (Nagelkerke R^2 = .078) on the variation of mental health status within the survey population (Table 33). This response to this statement question was also found to have a significant association with the mental health variable (p < .001, *OR* .582, 95% *CI* .479, .707) as shown in Table 34. For each unit increase in self-reported ease of access to natural areas, the odds for 14 or more days of poor mental health in the last 30 days is expected to change by a factor of .582.

Table 32

Classification Table of Logistic Regression Model Including the Select Ease of Access to Nature Likert-Scaled Statement Question (23) and the Mental Health Variable

Observed		Predicted: Did you have 14 or more days of poor mental health in the past 30 days? No	Yes	Percentage Correct
Did you have 14 or more days of poor mental health in the past 30 days?	No	563	0	100.0
	Yes	88	0	.0
Overall Percentage				86.5

Note. The cut value for the classification table is .500.

Table 33

Model Summary of Binary Logistic Regression Including the Select Ease of Access to Nature Likert-Scaled Statement Question (23) and the Mental Health Variable

-2 Log likelihood	Cox & Snell R^2	Nagelkerke R^2
487.523[a]	.042	.078

Note. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Table 34

Binary Logistic Regression Analysis of the Ease of Access to Nature Likert-Scaled Statement Question (23) and the Mental Health Variable

Nature Statement Question	*B*	*SE*	Wald	*df*	Sig	*OR*	95% *CI* for *OR* Lower	Upper
23. It is easy for me to access a natural area.	-.541	.099	29.660	1	<.001	.582	.479	.707
Constant	.279	.391	.509	1	.476	1.322		

Note. B = coefficient, *SE* = standard error, *df* = degrees of freedom, Sig = significance, *OR* = odds ratio, *CI* = confidence interval.

When the responses to this statement question were recoded into the binary categories of *Not agreed* and *Agreed*, a significantly lower *OR* for poor mental health was observed among the respondents who agreed with the statement. Statement Question 23 retained its weak effect (Nagelkerke R^2 = .079) on the variation of mental health status in the study population (Table 35). When considering only this one statement question and mental health status, the probability of respondents who *Agreed* with the statement and reporting 14 or more days of poor mental health within the past 30 day was 23.6% of that for those who could not agree with the statement (p < .001, 95% *CI* .143, .391) (Table 36).

Table 35

Model Summary From Analysis Including the Ease of Access to Nature Recoded Statement Question 23 and the Mental Health Variable

-2 Log likelihood	Cox & Snell R^2	Nagelkerke R^2
486.992[a]	.043	.079

Note. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Table 36

Binary Logistic Regression Analysis of the Ease of Access to Nature Recoded Statement Question (23) and the Mental Health Variable

							95% *CI* for *OR*	
Nature Statement Question	*B*	*SE*	Wald	*df*	Sig	*OR*	Lower	Upper
23. It is easy for me to access a natural area.	-1.442	.257	31.494	1	<.001	.236	.143	.391
Constant	-.739	.215	11.826	1	.001	.478		

Note. B = coefficient, *SE* = standard error, *df* = degrees of freedom, Sig = significance, *OR* = odds ratio, *CI* = confidence interval.

The ability to access nature areas, as predicted by Statement Question 23 was significantly associated with mental health status. This ease of access to natural areas statement question had a weak effect (Nagelkerke R^2 = .078) on the variation in mental health status observed in the survey population when all five Likert scale responses were considered (Table 33) and similarly weak (.079) when the responses were recoded as *Not agreed* and *Agreed* (Table 35). Despite the weakness of this predictive variable, the

relationship was determined to be significant and the null hypothesis was rejected in favor of the alternate.

Research Question #2

RQ #2 - Is mental health status in a Michigan county associated with attitudes about connectedness to nature as measured by the county's Stress and Nature Mini-Survey?

$H_0$2 - Mental health status in a Michigan county is not associated with attitudes about connectedness to nature as measured by the county's Stress and Nature Mini-Survey.

H_A2 - Mental health status in a Michigan county is associated with attitudes about connectedness to nature as measured by the county's Stress and Nature Mini-Survey.

The Stress and Nature Mini-Survey contained three statement questions which I considered to be in the domain of attitudes about connectedness to nature. Those three statement questions, which asked the respondent to report a level of agreement, included the following.

26. I feel very connected with nature and/or natural areas.

27. It is important to me to spend time in nature or participating in nature-based activities.

28. Like a tree can be part of the forest, I feel embedded within the broader natural world.

Binary logistic regression analyses were conducted with both the seven nature exposure variable statement questions in the equation and in a second equation with only

the three above listed statement questions. These analyses were conducted in models including both the full five point Likert scale of agreement levels and with the data recoded into the two categories of *Not agreed* and *Agreed*. The survey data included 650 responses with sufficient information for analyses and the model correctly predicted an overall 86.5% of the mental health variable. Although Statement Question 26 (*I feel very connected with nature and/or natural areas*) approached significance ($p = .067$) when the full scale of responses was considered in a model with only the other two related attitude/connectedness statement questions, none of these independent variables were found to associate significantly with mental health status. The null hypothesis was accepted since mental health status in this Michigan county was not associated with attitudes about, or connectedness to, nature as measured by the Stress and Nature Mini-Survey.

Research Question #3

RQ #3 - Is mental health status in a Michigan county associated with physical activity in natural areas or in nature-based activities as measured by the county's Stress and Nature Mini-Survey?

$H_0$3 - Mental health status in a Michigan county is not associated with physical activity in natural areas or in nature-based activities as measured by the county's Stress and Nature Mini-Survey.

H_A3 - Mental health status in a Michigan county is associated with physical activity in natural areas or in nature-based activities as measured by the county's Stress and Nature Mini-Survey.

The Stress and Nature Mini-Survey contained the one following statement question, which asked respondents to report their level of agreement, related to physical activity in natural areas or nature-based activities.

29. I frequently engage in physical activity in natural areas or in nature-based activities.

A total of 651 survey participants provided sufficient information for analysis of this statement question individually in a model that correctly predicted an overall 86.5% of the mental health variable. This statement question variable significantly associated with lower probability of poorer mental health status when all seven nature-related statements were considered together in the equation (p = .014, *OR* .719, 95% *CI* .553, .935). This statement question, when measured independently against the mental health dependent variable maintained its goodness of fit according to the Hosmer and Lemeshow Test (X^2 (3) = 4.867, p = .182). This predictor variable was responsible for a weak effect (Nagelkerke R^2 = .052) of the variation in mental health status observed in the survey population (Table 37) when the full range of five Likert scales responses were considered. The statement question was significantly associated with mental health status within the survey population (p < .001, *OR* .652, 95% *CI* .535, .795). The *OR* of .652 and *CI* demonstrated in Table 38 indicated that the odds of a survey respondent belonging to the poorer mental health category decreased by that rate with each unit of greater self-reported level of physical activity in nature or in nature-based activities.

Table 37

Model Summary of Binary Logistic Regression Analysis of the Physical Activity in Nature Likert-Scaled Statement Question (29) and the Mental Health Variable

-2 Log likelihood	Cox & Snell R^2	Nagelkerke R^2
497.011[a]	.028	.052

Note. a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Table 38

Logistic Regression Analysis of the Physical Activity in Nature Likert-Scaled Statement Question (29) and the Mental Health Variable

							95% *CI* for *OR*	
Nature Statement Question	*B*	*SE*	Wald	*df*	Sig	*OR*	Lower	Upper
29. I frequently engage in physical activity in natural areas or in nature-based activities.	-.427	.101	17.929	1	<.001	.652	.535	.795
Constant	-.542	.312	3.016	1	.082	.582		

Note. B = coefficient, *SE* = standard error, *df* = degrees of freedom, Sig = significance, *OR* = odds ratio, *CI* = confidence interval.

Statement Question 29 was also analyzed with binary logistic regression and the response data recoded into the two categories of *Not agreed* and *Agreed*. Similar to the model including the Likert-scaled data, the recoded Statement Question 29 presented a weak effect (Nagelkerke R^2 = .041) on the variation of mental health status in the study population (Table 39). This analysis also found significantly lower *OR* for poor mental

health was observed among the respondents who agreed with the statement ($p < .001$, *OR* .403, 95% *CI* .250, .651) (Table 40). Considering only this one statement question and mental health status, the probability of respondents who agreed with the statement and reporting 14 or more days of poor mental health within the past 30 day was 40.3% of that for those who could not agree with the statement.

Table 39

Model Summary of Binary Logistic Regression Analysis of the Physical Activity in Nature Recoded Statement Question (29) and the Mental Health Variable

-2 Log likelihood	Cox & Snell R^2	Nagelkerke R^2
500.964[a]	.022	.041

Note. a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Table 40

Binary Logistic Regression Analysis of the Physical Activity in Nature Recoded Statement Question (29) and the Mental Health Variable

							95% *CI* for *OR*	
Nature Statement Question	*B*	*SE*	Wald	*df*	Sig	*OR*	Lower	Upper
29. I frequently engage in physical activity in natural areas or in nature-based activities.	-.908	.244	13.852	1	.000	.403	.250	.651
Constant	-1.470	.143	105.445	1	.000	.230		

Note. B = coefficient, *SE* = standard error, *df* = degrees of freedom, Sig = significance, *OR* = odds ratio, *CI* = confidence interval.

Physical activity in nature or in nature-based activities, as presented by Statement Question 29, when considered both as a Likert-scaled and recoded affirmative/negative variable, was significantly associated with mental health status. This statement question also presented a weak effect on the variation of mental health status within the survey population. Due to these significant findings, the null hypothesis was rejected in favor of the alternate.

Statistical Analyses and Findings Related to Obesity

The data from the Stress and Nature Mini Survey were analyzed according to the study method for associations between the independent nature relationship variables (Statement Questions 23 through 29) and obesity status, which was described as a body mass index (BMI) of 30 or greater. The nature relationship variables consisted of the seven statements on the survey which respondents were asked to report their level of agreement on a five-point Likert scale. Of these seven statement questions, as previously described, three were within the general domain of the subject of accessibility of nature (23, 24, & 25), three were within the general domain of the subject of attitudes or connectedness to nature (26, 27, & 28), and one was within the domain of actual physical activity in natural areas or nature-based recreation (29).

Hosmer and Lemeshow Tests were performed to measure goodness of fit between the equation of variables. Binary logistic regression analyses were conducted to determine the presence of significant associations between variables. Statement questions significantly associated to the obesity dependent variable were also assessed to measure the *OR* of membership in the obesity group based upon increasing self-reported Likert

scale agreement with the statement questions. Effect size is reported using Nagelkerke's R^2 which, while it is recognized as an imperfect pseudo measure of effect, is useful for approximating the effect of dependent variable variance related to significantly associated nature statement questions.

The Cronbach's α was calculated at .817 for the data for the obesity variable and the seven nature statement questions. This Cronbach's α finding indicated a suitable level of reliability because the value fell between the range of .700 and .950 which is generally considered acceptable for social science (Tavakol & Dennick, 2011).

The first logistic regression analyses of the obesity status data were conducted by recoding the Likert scale responses within the nature statement questions into the categories of *Not agreed* and *Agreed*. I found that this model, including all seven nature variable statement questions, met the Hosmer and Lemeshow Test for goodness of fit (X^2 (6) = 4.222, p = .647). This model included responses from 651 participants and predicted an overall 64.7% of their responses correctly (Table 41). Overall the model demonstrated a weak effect (.059) on the variation in obesity status according to Nagelkerke's R^2 (Table 42).

Table 41

Classification Table of Binary Logistic Regression Model Including All Recoded Nature Statement Questions and Obesity Status

Observed		Predicted BMI of 30 or more		Percentage Correct
		No	Yes	
BMI of 30 or more	No	401	24	94.4
	Yes	206	20	8.8
Overall Percentage				64.7

Note. The cut value for the classification table is .500.

Table 42

Model Summary of Binary Logistic Regression Analysis Including All Recoded Nature Statement Questions and Obesity Status

-2 Log likelihood	Cox & Snell R^2	Nagelkerke R^2
811.967[a]	.043	.059

Note. Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

Table 43 presents the findings from the logistic regression analyses with all seven nature exposure statement questions recoded into the two categories of *Not agreed* and *Agreed* with the statement, and the obesity status variable. Agreement with Statement Question 29 (*I frequently engage in physical activity in nature or in nature-based activities*) was found to significantly correlate to lower odds of obesity ($p < .001$, *OR* .438, 95% *CI* .295, .650). Those who agreed with this statement were only about 43.8% as likely to report a body mass index of 30 or greater as those who did not agree with the statement. All other statement question responses, when considered as binary *Not agreed*

or *Agreed*, were determined to not be significantly associated with obesity within the survey population.

Table 43

Binary Logistic Regression Analysis of All Recoded Nature Statement Questions and Obesity Status

Nature Statement Questions	*B*	*SE*	Wald	*df*	Sig	*OR*	95% *CI* for *OR* Lower	Upper
23. It is easy for me to access a natural area.	-.076	.283	.072	1	.788	.927	.532	1.614
24. I live close to a natural area.	-.112	.250	.199	1	.655	.894	.548	1.460
25. I am aware of natural areas that are available for use in my community.	-.070	.290	.059	1	.808	.932	.528	1.645
26. I feel very connected with nature and/or natural areas.	.281	.228	1.516	1	.218	1.325	.847	2.072
27. It is important for me to spend time in nature or participating in nature-based activities.	-.376	.236	2.547	1	.111	.687	.433	1.090
28. Like a tree can be part of the forest, I feel embedded within the broader natural world.	.075	.200	.142	1	.706	1.078	.729	1.594

(table continues)

Nature Statement Questions	*B*	*SE*	Wald	*df*	Sig	*OR*	95% *CI* for *OR* Lower	Upper
29. I frequently engage in physical activity in natural areas in in nature-based activities.	-.826	.201	16.824	1	<.001	.438	.295	.650
Constant	.041	.286	.021	1	.886	1.042		

Note. B = coefficient, *SE* = standard error, *df* = degrees of freedom, Sig = significance, *OR* = odds ratio, *CI* = confidence interval.

The remaining obesity assessments were binary logistic regression models including the full range of five Likert scale responses to the statement questions. The first of these fuller models included data from all seven independent nature variable statement questions. The survey included 651 responses considered sufficiently complete for this analysis and the model correctly predicted an overall 66.2% of the obesity variable responses (Table 44). I found that this model, inclusive of all nature variables, met the Hosmer and Lemeshow Test criteria for goodness of fit (X^2 (8) = 11.640, p = .168).

Table 44

Classification Table of Binary Logistic Regression Model Including All Likert-Scaled Nature Statement Questions and Obesity Status

		Predicted		
		BMI of 30 or more		Percentage
Observed		No	Yes	Correct
BMI of 30 or more	No	385	40	90.6
	Yes	180	46	20.4
Overall Percentage				66.2

Note. The cut value for the classification table is .500.

The Nagelkerke R^2 calculation found that, taken together, these seven variables have a weak effect (.096) on the variance in obesity status within this survey population (Table 45). Three of the seven nature-related variable statements demonstrated a significant association to the obesity dependent variable in this full model (Table 46). Statement Questions 27 (*It is important for me to spend time in nature or participating in nature-based activities*) (p = .004, *OR* .707, 95% *CI* .560, .892) and 29 (*I frequently engage in physical activity in natural areas or in nature-based activities*) (p < .001, *OR* .666, 95% *CI* .548, .808) were significantly associated with lower *OR* for obesity status. One statement question, number 26 (*I feel very connected with nature and/or natural areas*), was associated with a higher probability for obesity status (p = .028, *OR* 1.312, 95% *CI* 1.029, 1.673).

Table 45

Model Summary of Binary Logistic Regression Analysis Including All Likert-Scaled Nature Statement Questions and Obesity Status

-2 Log likelihood	Cox & Snell R^2	Nagelkerke R^2
793.655[a]	.070	.096

Note. Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

Table 46

Binary Logistic Regression Analysis of All Likert-Scaled Nature Statement Questions and Obesity Status

Nature Statement Questions	*B*	*SE*	Wald	*df*	Sig	*OR*	95% *CI* for *OR* Lower	Upper
23. It is easy for me to access a natural area.	.116	.127	.834	1	.361	1.123	.876	1.440
24. I live close to a natural area.	-.113	.124	.828	1	.363	.893	.701	1.139
25. I am aware of natural areas that are available for use in my community.	-.212	.123	2.985	1	.084	.809	.636	1.029
26. I feel very connected with nature and/or natural areas.	.272	.124	4.806	1	.028	1.312	1.029	1.673
27. It is important for me to spend time in nature or participating in nature-based activities.	-.347	.119	8.523	1	.004	.707	.560	.892
28. Like a tree can be part of a forest, I feel embedded within the broader natural world.	.120	.119	1.014	1	.314	1.128	.892	1.426
29. I frequently engage in physical activity in natural areas or in nature-based activities.	-.407	.099	16.930	1	<.001	.666	.548	.808
Constant	1.469	.490	8.972	1	.003	4.343		

Note. *B* = coefficient, *SE* = standard error, *df* = degrees of freedom, Sig = significance, *OR* = odds ratio, *CI* = confidence interval.

To identify the most powerful predictive variables in each of the domains of access to nature, attitudes about to nature, and physical activity in nature or nature based-activities, I examined the questionnaire statements that address these three domains of interest. The statement questions were sorted according to domain area and analyzed in a model limited to those similar variables. These analyses allowed me to assess if each domain's model was useful for correctly predicting obesity, presented goodness of fit, and identified which survey statement question's *OR* associated most powerfully with obesity status.

The Stress and Nature Mini-Survey contained three statement questions referring to access to nature (23, 24, & 25). A total of 652 survey respondents provided sufficient data for analysis in the model containing the three access statement questions and the obesity status variable data. This model correctly predicted an overall 66.1% of the obesity status (Table 47). The model satisfied the Hosmer and Lemeshow Test for goodness of fit (X^2 (6) = 9.874, p = .130).

Table 47

Classification Table of Logistic Regression Model Including the Access to Nature Domain Likert-Scaled Nature Statement Questions (23, 24, & 25) and Obesity Status

		Predicted		
		BMI of 30 or more		Percentage
Observed		No	Yes	Correct
BMI of 30 or more	No	417	9	97.9
	Yes	212	14	6.2
Overall Percentage				66.1

Note. The cut value for the classification table is .500.

Taken together, the three access to nature statement questions presented a weak effect (Nagelkerke R^2 = .023) on the variation in obesity status amongst the survey population (Table 48).

Table 48

Model Summary of Binary Logistic Regression Analysis Including the Access to Nature Domain Likert-Scaled Statement Questions (23, 24, & 25) and Obesity Status

-2 Log likelihood	Cox & Snell R^2	Nagelkerke R^2
830.634[a]	.017	.023

Note. a. Estimation terminated at iteration number 3 because parameter estimates changed by less than .001.

Table 49 demonstrates these three statements and their statistical relationships with obesity status according to binary logistic regression. Statement Question 25 (*I am aware of natural areas that are available for use in my community*) was found to be the best and only statistically significant predictor of obesity status from these three access-related statements (p = .043, *OR* .793, 95% *CI* .634, .993). This finding indicated that the odds of obesity decreased by a factor of .793 with each ascending level of agreement with the significant statement question.

Table 49

Binary Logistic Regression Analysis of the Access to Nature Domain Likert-Scaled Statement Questions (23, 24, & 25) and Obesity Status

Nature Statement Questions	*B*	*SE*	Wald	*df*	Sig	*OR*	95% *CI* for *OR* Lower	Upper
23. It is easy for me to access a natural area.	.060	.119	.255	1	.613	1.062	.842	1.340
24. I live close to a natural area.	-.129	.120	1.153	1	.283	.879	.695	1.112
25. I am aware of natural areas that are available for use in my community.	-.231	.114	4.099	1	.043	.793	.634	.993
Constant	.598	.419	2.038	1	.153	1.818		

Note. B = coefficient, *SE* = standard error, *df* = degrees of freedom, Sig = significance, *OR* = odds ratio, *CI* = confidence interval.

In a similar manner, the attitudes about nature statement questions were also compared in a model with one another to identify the relative importance of each and which one of them should be selected to measure against the most powerful access-related question and the physical activity question response. A total of 652 survey participants provided sufficient data to be included in this model that correctly predicted 66.3% of the obesity variable (Table 50). The equation containing these three attitudes about nature statement questions met the Hosmer and Lemeshow Test for goodness of fit (X^2 (7) = 12.108, p = .097).

Table 50

Classification Table of Logistic Regression Model lncluding the Attitudes About Nature Domain Likert-Scaled Statement Questions (26, 27, & 28) and Obesity Status

Observed		Predicted BMI of 30 or more No	Yes	Percentage Correct
BMI of 30 or more	No	402	23	94.6
	Yes	197	30	13.2
Overall Percentage				66.3

Note. The cut value for the classification table is .500.

Collectively, the three statement questions in the attitudes/connectedness to nature domain demonstrated a weak effect (Nagelkerke R^2 = .051) on the variance in obesity status (Table 51). Statement Question 27 (*It is important for me to spend time in nature or participating in nature-based activities*) was the only variable in this domain to significantly associate with obesity status (p < .001, *OR* .644, 95% *CI* .514, .806) (Table 52).

Table 51

Model Summary of Binary Logistic Regression Including the Attitudes About Nature Domain Likert-Scaled Nature Statement Questions (26, 27, & 28) and Obesity Status

-2 Log likelihood	Cox & Snell R^2	Nagelkerke R^2
818.379[a]	.037	.051

Note. a. Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

Table 52

Binary Logistic Regression Analysis of the Attitudes About Nature Domain Likert-Scaled Statement Questions (26, 27, & 28) and Obesity Status

Nature Statement Questions	*B*	*SE*	Wald	*df*	Sig	*OR*	95% *CI* for *OR* Lower	Upper
26. I feel very connected with nature and/or natural areas.	.105	.112	.883	1	.348	1.111	.892	1.382
27. It is important for me to spend time in nature or participating in nature-based activities.	-.440	.115	14.718	1	<.001	.644	.514	.806
28. Like a tree can be part of a forest, I feel embedded within the broader natural world.	-.079	.109	.516	1	.472	.924	.746	1.146
Constant	1.011	.379	7.099	1	.008	2.748		

Note. B = coefficient, *SE* = standard error, *df* = degrees of freedom, Sig = significance, *OR* = odds ratio, *CI* = confidence interval.

The Stress and Nature Mini-Survey contained only one statement question about physical activity in nature or nature-based recreation. Statement Question 29 (*I frequently engage in physical activity in nature or nature-based activities*) was sufficiently answered by 651 participants. The model containing this one statement question was found to correctly predict 64.9% of the obesity status (Table 53).

Table 53

Classification Table of Logistic Regression Model Including the Physical Activity in Nature Domain Likert-Scaled Statement Question (29) and Obesity Status

		Predicted		
		BMI of 30 or more		Percentage
Observed		No	Yes	Correct
BMI of 30 or more	No	408	18	95.8
	Yes	211	16	7.0
Overall Percentage				64.9

Note. The cut value for the classification table is .500.

The model also satisfied the Hosmer and Lemeshow Test for goodness of fit (X^2 (3) = 4.418, p = .220). Statement Question 29 demonstrated a weak effect (Nagelkerke R^2 = .052) on the variation in obesity status within the survey population (Table 54). It did, however, significantly predict obesity status in the model (p < .001, *OR* .667, 95% *CI* .578, .769) as shown in Table 55. This statement question was thereby considered to have merit for representing the independent variable domain of physical activity in nature compared to most powerful predictor variables in the domains of access to and attitudes about nature or natural areas.

Table 54

Model Summary of Binary Logistic Regression Including the Physical Activity in Nature Domain Likert-Scaled Statement Question (29) and Obesity Status

-2 Log likelihood	Cox & Snell R^2	Nagelkerke R^2
811.353[a]	.048	.066

Note. Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

Table 55

Binary Logistic Regression Analysis Including the Physical Activity in Nature Domain Likert-Scaled Statement Question (29) and Obesity Status

							95% *CI* for *OR*	
Nature Statement Question	*B*	*SE*	Wald	*df*	Sig	*OR*	Lower	Upper
29. I frequently engage in physical activity in natural areas or in nature-based activities.	-.406	.073	30.868	1	<.001	.667	.578	.769
Constant	.670	.243	7.580	1	.006	1.955		

Note. B = coefficient, *SE* = standard error, *df* = degrees of freedom, Sig = significance, *OR* = odds ratio, *CI* = confidence interval.

A third model was tested that included the most predictive statement question from each of the three domains (access, attitudes, and physical activity). This model possessed data from 652 sufficiently complete survey responses and was found to correctly predict an overall 66.4% of obesity status (Table 56). This model of the three independent variables satisfied the Hosmer and Lemeshow Test for goodness of fit (X^2 (8) = 10.232, p = .249). Together in this model, the responses to the three statement

questions demonstrated a weak effect (Nagelkerke R^2 = .077) on the variance in obesity status within the study population (Table 57).

Table 56

Classification Table of Logistic Regression Model Including the Most Predictive Likert-Scaled Nature Statement Questions from the Domains of Access (23), Attitudes (27), and Physical Activity (29), and Obesity Status

		Predicted		
		BMI of 30 or more		Percentage
Observed		No	Yes	Correct
BMI of 30 or more	No	391	34	92.0
	Yes	185	42	18.5
Overall Percentage				66.4

Note. The cut value for the classification table is .500.

Table 57

Model Summary of Binary Logistic Regression Including the Most Predictive Likert-Scaled Nature Statement Questions from the Domains of Access (23), Attitudes (26), and Physical Activity (29), and Obesity Status

-2 Log likelihood	Cox & Snell R^2	Nagelkerke R^2
805.080[a]	.056	.077

Note. Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

One of the statement question variables demonstrated a statistically significant association with obesity status in this model (Table 58). Statement Question 29 (*I frequently engage in physical activity in natural areas or in nature-based activities*) (p = .001, *OR* .746, 95% *CI* .629, .885) was predictive of obesity status. The other two

statement question variables tested in this equation were not found to be significantly associated with obesity status.

Table 58

Binary Logistic Regression Analysis of the Most Predictive Likert-Scaled Nature Statement Questions from the Domains of Access (23), Attitudes (26), and Physical Activity (29), and Obesity Status

Nature Statement Questions	*B*	*SE*	Wald	*df*	Sig	*OR*	95% *CI* for *OR* Lower	Upper
25. I am aware of natural areas that are available for use in my community.	-.111	.097	1.325	1	.250	.895	.740	1.081
27. It is important for me to spend time in nature or participating in nature-based activities.	-.191	.103	3.422	1	.064	.826	.675	1.011
29. I frequently engage in physical activity in natural areas or in nature-based activities.	-.293	.087	11.286	1	.001	.746	.629	.885
Constant	1.539	.462	11.099	1	.001	4.659		

Note. B = coefficient, *SE* = standard error, *df* = degrees of freedom, Sig = significance, *OR* = odds ratio, *CI* = confidence interval.

Statement Question 29 from the domain area of physical activity (*I frequently engage in physical activity in natural areas or in nature-based activities*) was found to be the most powerful predictor of obesity status among the statement questions tested in these analyses. Further evaluation of the relationship between this variable and obesity status is presented in the discussion of the findings for Research Question #6.

Consideration of Variables Possibly Confounding the Relationships

Possible confounding variables were also considered within the Stress and Nature Mini-Survey data. A binary logistic regression model was tested including the significant nature statement question of frequent activity in nature or in nature-based activities (29) and the co-variate demographic categories of gender, age, race/ethnicity, religious affiliation, household income, and highest level of education related to the dependent variable of obesity defined as a BMI of 30 or greater. The variables of race/ethnicity and religious affiliation were treated as categorical data because of the many possible responses and the lack of ordinal significance available in each of those questions. This model included 633 responses and correctly predicted 66.7% of the obesity variable (Table 59). The Hosmer and Lemeshow test for goodness of fit was satisfied (X^2 (8) = 4.042, p = .853). According to the Nagelkerke R^2, the variables in this model presented a weak effect (.127) on the variation in obesity status within the survey population (Table 60).

Table 59

Classification Table of Logistic Regression Including the Significantly Associated Nature Statement Question (29), Demographics of the Survey Population, and Obesity Status

		Predicted		
		BMI of 30 or more		Percentage
Observed		No	Yes	Correct
BMI of 30 or more	No	365	46	88.8
	Yes	165	57	25.7
Overall Percentage				66.7

Note. The cut value for the classification table is .500.

Table 60

Model Summary of Binary Logistic Regression Including the Significantly Associated Nature Statement Question (29), Demographics of the Survey Population, and Obesity Status

-2 Log likelihood	Cox & Snell R^2	Nagelkerke R^2
759.018[a]	.092	.127

Note. a. Estimation terminated at iteration number 20 because maximum iterations has been reached. Final solution cannot be found.

None of the six demographic variables considered in this evaluation of possible confounding co-variates were found to have significant relationships to obesity status while the physical activity variable maintained a significant relationship in this combined model (Table 61). This analysis supports the conclusion the demographic information collected in the Stress and Nature Mini-Survey did not confound the relationship between the responses to the physical activity statement question and obesity status.

Table 61

Binary Logistic Regression Analysis Including the Significantly Associated Nature Statement Question (29), Demographics of the Survey Population, and Obesity Status

Significant Nature Statement Question and Demographic Variables	Sig	*OR*	95% *CI* for *OR* Lower	Upper
29. I frequently engage in physical activity in natural areas in in nature-based activities.	<.001	.436	.305	.624
Gender	.268			
Age	.053			

(table continues)

Significant Nature Statement Question and Demographic Variables	Sig	*OR*	95% *CI* for *OR* Lower	Upper
Race/Ethnicity (categorical)				
White	.613			
Black or African American	.999			
Multi-Racial	.999			
Hispanic or Latino/a	.999			
Asian	.999			
American Indian or Alaska Native	1.000			
Middle Eastern or North African	.999			
Other	.999			
Household Income	.224			
Highest Level of Education	.052			
Religious Affiliation (categorical)				
Christian (Protestant)	.485			
Catholic	.192			
Mormon	.650			
Greek or Russian Orthodox	.684			
Jewish	.573			
Muslim	.481			
Buddhist	.872			
Hindu	.992			
Atheist or agnostic	1.000			
Other	.180			
Nothing in particular	.456			
Constant	.999			

Note. Sig = significance, *OR* = odds ratio, *CI* = confidence interval. *OR* and *CI* not shown for insignificant variables.

Research Question #4

RQ #4 - Is obesity (as represented by body mass index) in a Michigan county associated with the ability to access to nature areas as measured by the county's Stress and Nature Mini-Survey?

$H_0$4 - Obesity in a Michigan county is not associated with the ability to access nature areas as measured by the county's Stress and Nature Mini-Survey.

H_A4 - Obesity in a Michigan county is associated with the ability to access nature areas as measured by the county's Stress and Nature Mini-Survey.

The domain of access to nature was explored by the following three separate statement questions in the Stress and Nature Mini-Survey.

23. It is easy for me to access a natural area.

24. I live close to a natural area.

25. I am aware of natural areas that are available for use in my community.

These three access to nature statement questions were not found to significantly associate with obesity among the survey population when all seven nature related statements were included in the binary logistic regression equation. Responses to Statement Question 25 (*I am aware of natural areas that are available for use in my community*) was the most proximate to a significant relationship with obesity status (p = .084).

I subsequently analyzed these three access related statement questions (23, 24, & 25) in a binary logistic regression equation without the other statement questions to determine if associations could be identified. This model was created using data from 652

participant respondents determined to be suitable for this analysis and that correctly predicted an overall 66.1% of obesity status. This smaller model equation was found to meet the Hosmer and Lemeshow Test for goodness of fit and had a weak effect on obesity status within the survey population. Statement Question (25) that was previously found to be the most proximate to significance was found to be a significant predictor of obesity within this smaller group model equation (p = .043, *OR* .793, 95% *CI* .634, .993). The other two statement questions (23 & 24), including Statement Question 23 that most closely matched ease of access and was found to be significantly associated with mental health status, remained nonsignificant in relation to obesity status within the survey population. In consideration of the weak statistical support (including the failure of Statement Questions 23, 24, & 25 to demonstrate significant associations to obesity status in the full model equation), the null hypothesis was accepted for Research Question #4.

Of additional note, the relationship of Statement Question 25 (*I am aware of natural areas that are available for use in my community*) was statistically related to obesity in this survey population in two of the three model equations considered; when analyzed with the other two statement questions in the access domain and independently against the obesity dependent variable. The model equations were found to meet the Hosmer and Lemeshow Test for goodness of fit in both instances. When measured independently, once again in a model that satisfied the Hosmer and Lemeshow Test for goodness of fit (X^2 (1) = 2.703, p = .100), Statement Question 25 demonstrated a weak effect (Nagelkerke R^2 = .021) on the variance in obesity status. The association between

this statement question and obesity status was found to be significant (p = .002, *OR* .757, 95% *CI* .636, .902). These findings suggest opportunities for further research.

Research Question #5

RQ #5 – Is obesity (as represented by body mass index) in a Michigan county associated with attitudes about connectedness to nature as measured by the county's Stress and Nature Mini-Survey?

$H_0$5 - Obesity in a Michigan county is not associated with attitudes about connectedness to nature as measured by the county's Stress and Nature Mini-Survey?

H_A5 - Obesity in a Michigan county is associated with attitudes about connectedness to nature as measured by the county's Stress and Nature Mini-Survey?

The Stress and Nature Mini-Survey contained three statement questions which I considered to be in the domain of attitudes about connectedness to nature. Those three statement questions are listed below.

26. I feel very connected with nature and/or natural areas

27. It is important to me to spend time in nature or participating in nature-based activities

28. Like a tree can be part of the forest, I feel embedded within the broader natural world

To answer this question, binary logistic regression analyses were conducted with both the seven nature exposure variable statement questions in the equation and in a

second equation with the three above listed statement questions. The model including the recoded *Not agreed* and *Agreed* data did not identify any significant relationships to obesity status as demonstrated in Table 43. To identify more sensitive associations, the data were reviewed as collected in Likert form. The Likert-scaled logistic regression model included survey data from 651 participants and correctly predicted an overall 66.2% of obesity status and satisfied the Hosmer and Lemeshow Test for goodness of fit (X^2 (8) = 11.640, p = .168). The results from this equation including all seven Likert-scaled nature statement questions are presented in Table 45. Statement Question 26 (*I feel very connected with nature and/or natural areas*) was found to significantly correlate with greater odds for obesity status (p = .028, *OR* 1.312, 95% *CI* 1.029, 1.673). This significant association with higher odds did not, however, hold up when included in an equation with the other two statement questions related to attitudes about nature. Statement Question 27 (*It is important for me to spend time in nature or participating in nature-based activities*) was found to significantly associate with lower odds of belonging to the obesity category (p = .004, *OR* .707, 95% *CI* .560, .892) when included in the equation with all seven statement questions. The third statement question in the attitudes about nature domain (28) did not present a statistically significant relationship with obesity when measured in the equation model with all seven nature related statement questions or in any other model equation.

A binary logistic regression model equation was also calculated including the three Likert-scaled statement questions from the attitudes about nature domain. This model equation included data from 652 survey respondents and correctly predicted an

overall 66.3% of obesity status. The Hosmer and Lemeshow Test for goodness of fit was satisfied (X^2 (7) = 12.108, p = .097). The statistical significance of statement question 27 was sustained when it was included in the equation with just the other two attitude/connectedness statement questions (p < .001, *OR* .644, 95% *CI* .514, .806) as demonstrated in Table 52. Statement Questions 26 and 28 remained insignificant in their relationships to the obesity status variable.

Statement Question 27 was also analyzed independently against the obesity variable to determine if the data met the Hosmer and Lemeshow Test for goodness of fit, maintained a significant association, and to calculate the Nagelkerke R^2. This model equation included information from 652 survey respondents and correctly predicted an overall 65.8% of obesity status (Table 62). This final equation satisfied the Hosmer and Lemeshow Test (X^2 (1) = 5.253, p = .072) and the Nagelkerke R^2 of .049 indicates that this variable had a weak effect on the variation of obesity status within the survey population (Table 63). This statement question maintained significant relationship to obesity status (p < .001, *OR* .663, 95% *CI* .560, .785) as shown in Table 64.

Table 62

Classification Table of Logistic Regression Model Including the Select Attitudes About Nature Likert-Scaled Statement Question (27) and Obesity Status

		Predicted		
		BMI of 30 or more		Percentage
Observed		No	Yes	Correct
BMI of 30 or more	No	399	26	93.9
	Yes	197	30	13.2
Overall Percentage				65.8

Note. The cut value for the classification table is .500.

Table 63

Model Summary of Binary Logistic Regression Analysis Including the Select Attitudes About Nature Likert-Scaled Statement Question (27) and Obesity Status

-2 Log likelihood	Cox & Snell R^2	Nagelkerke R^2
819.401[a]	.035	.049

Note. Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

Table 64

Binary Logistic Regression Analysis Including the Select Attitudes About Nature Likert-Scaled Statement Question (27) and Obesity Status

Nature Statement Question	*B*	*SE*	Wald	*df*	Sig	*OR*	95% *CI* for *OR* Lower	Upper
27. It is important for me to spend time in nature or participating in nature-based activities.	-.410	.086	22.693	1	<.001	.663	.560	.785
Constant	1.015	.352	8.317	1	.004	2.759		

Note. B = coefficient, *SE* = standard error, *df* = degrees of freedom, Sig = significance, *OR* = odds ratio, *CI* = confidence interval.

Statistical analyses of the three statement questions in the domain of attitudes about nature provided conflicting results. None of the statement questions demonstrated significant relationships to obesity status when the data was recoded to binary *Not agreed* and *Agreed* status. When the statement questions were assessed as Likert-scaled data, Statement Question 26 presented significant, but weak, evidence of associating with higher odds of obesity status. This disparity between the findings of the dichotomous *Not agreed*/*Agreed* dependent variable and the Likert-scaled dependent variable suggested improved sensitivity of the model including the latter. Statement Question (27) consistently demonstrated a significant association with lower odds of obesity status. Statement Question (28) did not demonstrate a significant relationship with obesity status in any of the analyses. Each of these three statement questions appear to align equally well with the intent of the language in Research Question #5. Because of these

contradictory findings, the null hypothesis cannot be rejected by this study and it must be concluded that obesity status in this Michigan county is not associated with attitudes about connectedness to nature as measured by the Stress and Nature Mini-Survey. However, the individual significance of Statement Question 27 (*It is important for me to spend time in nature or participating in nature-based activities*) is noteworthy and should be explored in future research.

Research Question #6

RQ #6 - Is obesity (as represented by body mass index) in a Michigan county associated with physical activity in natural areas or in nature-based activities as measured by the county's Stress and Nature Mini-Survey?

H_o6 - Obesity in a Michigan county is not associated with physical activity in natural areas or in nature-based activities as measured by the county's Stress and Nature Mini-Survey.

H_A6 - Obesity in a Michigan county is associated with physical activity in natural areas or in nature-based activities as measured by the county's Stress and Nature Mini-Survey.

The Stress and Nature Mini-Survey included one statement question, as follows, related to physical activity in nature or in nature-based activities.

29. I frequently engage in physical activity in natural areas or in nature-based activities

This statement question was included in the equation with all seven nature related variables and was considered in both in binary form (*Not agreed* and *Agreed*) and in its

original Likert-scaled format. The review of Statement Question 29 in binary form discovered a significant relationship with obesity status ($p < .001$, *OR* .438, 95% *CI* .295, .650). It is noteworthy that this statement question was the only one to demonstrate a significant relationship to obesity status when recoded into binary form. This statement question was also tested in its original Likert-scaled format along with the other six nature statement question variables and obesity status. Sufficient information was available from 651 survey responses for this test which correctly predicted 66.2% of responses. It was found to significantly associate with obesity status ($p < .001$, *OR* .666, 95% *CI* .548, .808). Measured independently against the obesity dependent variable, this statement question maintained its goodness of fit according to the Hosmer and Lemeshow Test (X^2 (3) = 4.418, $p = .220$). As Table 55 demonstrates, this statement question also retained a statistically significant relationship to obesity status and an *OR* similar to the fuller model's measurement ($p < .001$, *OR* .667, 95% *CI* .578, .769). The *OR* of .667 indicated that the odds of a survey respondent belonging to the obesity category changes by that rate with each unit of greater self-reported level of physical activity in nature or in nature-based activities. As a result, the null hypothesis was rejected in favor of the alternate. Physical activity in nature or in nature-based activities, as predicted by the statement question listed above was significantly associated with obesity status. This predictor variable was responsible for a weak effect (Nagelkerke $R^2 = .066$) on the variation in obesity status observed in the survey population (Table 54).

Written Comments Regarding Barriers

The final question in the Stress and Nature Mini-Survey asked respondents if there are obstacles limiting their ability or desire to visit natural areas. The survey tool provided a narrative box that allowed the respondent to answer this open-ended question in their own words. A total of 363 of the 653 surveys included in this study received written responses to this question. Subjective interpretation was required to categorize these responses because of the variety of ways respondents expressed their obstacles. Furthermore, some of the respondents provided one obstacle type with detailed explanation while others listed multiple obstacles and no explanation. Figure 1 demonstrates the number of times each category of obstacle was mentioned by those 363 respondents. These data should be considered for discussion purposes only and not as a proper qualitative measure.

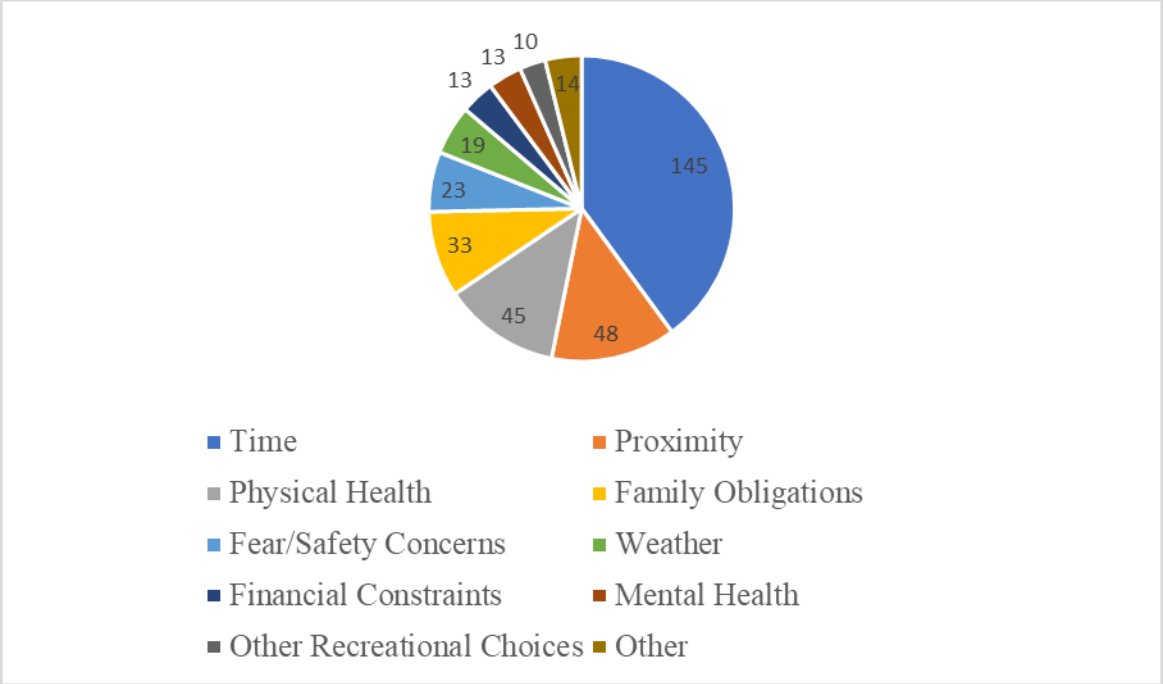

Figure 1. Number of times respondents reported various obstacles limiting their ability or desire to visit natural areas.

Lack of time was reported more frequently (145 times) as an obstacle than anything else. Proximity (48 times) and physical health (45 times) were commonly reported obstacles as well. The physical health category included statements about disabilities, age, and injuries. Family obligations (33 times) were also a common barrier. These statements generally referred to caring for very young children or the elderly and/or disabled relatives. The mention of fear and safety concerns (23 times) included a variety of issues such as dangerous animals (insects, snakes, and dogs), dangerous people, and dangerous plants (poison ivy). Weather was an obstacle of note for 19 respondents primarily referring to conditions being too hot. The references to financial constraints (13 times) generally related to the cost of sporting equipment. There were 13 responses indicating a mental health obstacle such as stress, depression, or anxiety. Ten

individuals noted that they prefer other forms of recreation including exercising at the gym, playing video games, and watching television. A total of 14 other responses were categorized as *other* because they could not be interpreted, were singular in their description, and/or irrelevant to the purpose of the question.

Summary

The Stress and Nature Mini-Survey included 653 sufficiently completed surveys from Kent County, Michigan residents in August and early September of 2018. No fewer than 649 sufficiently completed surveys were available for each analysis conducted in this study. This level of response satisfied the power calculations needed for the research methodology. The demographics of this sample population mismatched the general population in several ways. All the participants reported English as their first language, while the linguistic makeup of Kent County is more diverse. The survey participants were also disproportionately female and of White race than the general population.

I used the responses to the Stress and Nature Mini-Survey to answer this study's six research questions. Binary logistic regression technique was used to compare the seven nature-related statement questions in the survey to the two health status dependent variables of interest. Various model equations were evaluated for testing the statement questions, and all those models satisfied the Hosmer and Lemeshow Test for goodness of fit. A pseudo measure of effect, the Nagelkerke R^2, was also calculated for statistically significant associations to approximate the influence of each nature variable on the health status dependent variable. The Likert scale data for the seven nature statement questions was recoded into binary groupings of *Not agreed* and *Agreed* and assessed alongside

mental health and obesity status. These models found that only Statement Question 23 correlated with significantly lower odds for poor mental health status and that only Statement Question 29 correlated with significantly lower odds for obesity. The data were also evaluated in their original Likert-scaled form. Table 65 summarizes the findings from the statistical analyses and the resolution of the six research questions according to these more sensitive analyses.

Table 65

Summary of Findings Resulting from Analyses of Full Range of Likert-Scaled Responses

	Access to Nature and/or Natural Areas	Attitudes about Nature	Physical Activity in Nature or in Nature-Based Activities
Mental Health Status	$p < .001$ (#25) *OR* .585, (95% *CI* .470, .707) Nagelkerke $R^2 = .078$	Null	$p < .001$ (#31) *OR* .652 (95% *CI* .535, .795) Nagelkerke $R^2 = .052$
Obesity Status	Null	Null (Inconclusive)	$p < .001$ (#31) *OR* .666 (95% *CI* .548, .808) Nagelkerke $R^2 = .066$

Statement Questions 23 and 29 were associated with significantly lower *OR* of reporting poor mental health when the full range of Likert scale responses are considered. The responses to those statement questions were found to have a weak effect (Nagelkerke $R^2 = .078$ and .052 respectively) on the variation in mental health status. The null hypotheses were therefore rejected in favor of the alternate hypotheses for Research Questions #1 and #3. The statement questions related to the domain of attitudes about

nature (26, 27, and 28) did not statistically associate with mental health status and the null hypothesis was accepted for Research Question #2.

Statement Question 29, representing physical activity in nature or in nature-based activities, was the only statement question variable in any of the three domain areas with sufficient evidence to reject the null hypothesis related to association with obesity status. The Likert-scaled responses to the physical activity in nature or nature-based activity statement question were a significant, albeit weak (Nagelkerke $R^2 = .066$), predictor of the variation in obesity status. Research Question #6 was thereby decided in favor of the alternate hypothesis. The null hypotheses were accepted for Research Questions #4 and #5. Research Question #5 did, however, provide some remarkable findings; there was evidence that Statement Question 26 associated with higher odds of obesity, while Statement Question 27 associated with lower odds of obesity, and Statement Question 28 demonstrated no significant associations. These contradictory findings could be further explored in future research. In the following chapter, I discuss these findings in greater detail and their importance for public health practice and positive social change.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

Poor mental health status and obesity are two of the most challenging and epidemic issues facing public health in the 21st century. As demonstrated by 19th century writings of naturalists Humboldt and Thoreau, people have theorized that time in nature has recuperative and calming powers over the human being. A life spent separate from nature is contrary to overall wellness. Fromm, Wilson, and Louv have carried these ideas further and advanced the belief that humans, as part of a greater biological ecosystem, need regular exposure to nature because it is the species' natural habitat and absence thereof is disordered.

There is a robust body of literature supporting the theory that exposure to nature, in general, is associated with more favorable health outcomes related to mental health, obesity, and many other conditions. Lacking, however, is a deeper understanding of what type of particular exposure(s) to nature is significantly associated with health status. The literature contains many different definitions of nature and what an exposure is. For the purpose of this study, nature areas were defined as large, grassy areas with trees, or ponds, lakes, streams or rivers. The exposure variables were categorized into three different domain areas: (a) access to nature and/or natural areas, (b) attitudes about nature or feelings of connectedness to nature, and (c) physical activity in nature in in nature-based activities. There are few studies on the relative influence of these varying types of exposures. In this study, I answered the six research questions about the relationship of the three exposure variable domain areas to the two health outcomes within the survey

population. In this chapter, I discuss those findings and other observations about how the nature exposure variables relate to mental health and obesity status. Additional discussion in this chapter will center on relationships to literature and theory, limitations of the study, recommendations for further research, importance for positive social change, and implications for public health practice.

Interpretation of the Findings

I investigated six research questions related to self-reported relationships to nature and mental health and obesity status as measured by a survey in Kent County, Michigan. Poor mental health status, as defined by the Stress and Nature Mini-Survey, consisted of self-reported 14 or more days of poor mental health in the previous 30 days. This is one measure of mental health status, and the findings of this study should not be overgeneralized to assume that this description is encompassing of the diverse array of mental health illnesses. Obesity status, as determined by this study, was considerably more objective as a calculation of BMI of 30 or greater based on self-reported height and weight.

The data analyses conducted to answer these questions were arranged in a variety of ways. The independent statement question variables were tested as a group of seven, in smaller domain groupings, and independently as appropriate alongside the dependent health status variables. The independent variable data, which were collected as Likert scale data, were tested in their original scale format and again as recoded binary status according to agreement or lack thereof with the statement questions. The responses from two other questions in the survey, one related to mental health status and another

querying information about obstacles to natural areas, were assessed to further illuminate the findings of this study.

The binary logistic regression models used throughout this study were accurate at correctly predicting mental health status. The accuracy of responses correctly predicted by these models consistently ranged around 86%. The binary logistic regression models used for assessing the nature statement questions alongside the obesity status variable were noticeably less accurate. The accuracy of these models were approximately 20 percentage points less than the mental health models. This suggest a greater level of unpredictability and complexity to obesity status that was challenging the ability of the models to predict accurately.

The Nagelkerke R^2 measures presented throughout this study, and the Cox & Snell R^2 values shown in the tables, consistently demonstrated weak effects on the nature statement questions significantly associated with mental health and obesity status. Although these pseudo R^2 values merely approximate effect, the ease of access Statement Question (23) presented a Nagelkerke R^2 of .078 impact on mental health status, and the physical activity statement question (29) presented a Nagelkerke R^2 of .066 impact on obesity status. When considered in the usual manner of standard R^2 values, this suggests that these two variables only explain about 7.8% and 6.6% of the variation in poor mental health and obesity respectively. Although this level of weak impact on two public health issues should not be dismissed, it is essential to recognize the potential of other variables, not considered in this study, to have more substantial relationships to poor mental health and/or obesity status.

Research Question #1 asked whether or not access to nature was related to mental health status. Statement Question 23 (*It is easy for me to access a natural area*), which most closely aligned with the language of the research question, was found to significantly associate with lower odds of poor mental health status in every model. When the Likert-scaled data was recoded in binary *Not agreed* and *Agreed* status, it was found that respondents who agreed with Statement Question 23 were only 30.8% as likely to report poor mental health as though who did not agree. In analysis of the Likert-scaled data for Statement Question 23, I found that ascending levels of agreement correlated with lower odds of reporting poor mental health status. The other two statement questions in access to nature domain (24 and 25) did not demonstrate association to mental health status in any model. These findings are interesting because Statement Question 23 addressed ease of access, while 24 addressed proximity, and 25 addresses awareness of natural areas. I found that improving mental health status by improving ease of access could be a useful strategy for improving public health; however, it is important for planners to understand that there are nuances to improving ease of access that may be more complicated than addressing proximity or improving cognitive awareness of where the natural areas are located. For instance, the narrative responses to the survey question about obstacles limiting their ability or desire to visit natural areas may also be helpful toward interpreting what ease of access means to this survey population. A large plurality of responses (145 out of 363) mentioned limitation of time. The second largest category of limitation reported by the respondents were physical health limitations (48 references). Many respondents may have deemed ease of access as

an issue more complex than the physical accessibility of natural areas. Future researchers could further explore what ease of access means to the population.

Although Research Question #1 was decided in favor of the alternate hypothesis, the overall value of the access to nature domain was further complicated by the lack of statistically significant associations between these three statement questions and obesity status. Research Question #4, which queried the relationship between access to nature and obesity status, was decided in favor of the null hypothesis because Statement Questions 23, 24, and 25 were not associated with obesity status in any of the models tested.

Research Questions #2 and #5 examined the domain of attitudes about nature and asked if these attitudes are associated with mental health and obesity status respectively. In nearly every model tested, the attitudes about nature statement questions did not significantly associate with either poor mental health or obesity status. Statement Question 27 (*It is important for me to spend time in nature or participating in nature-based activities*), when measured only against the other two statement questions in this domain (26 and 28), was found to significantly associate with lower odds for obesity status; however, this association disappeared when considered in a model with the full array of statement questions and also with the most powerfully predictive statement questions from the other domains (23 and 29). This weak evidence supporting the value of Statement Question 27 led to its dismissal when considering Research Question #5. The most surprising finding in this study was the significant relationship between Statement Question 26 (*I feel very connected with nature and/or the natural world*) with

higher odds of obesity (1.312, 95% *CI* 1.029, 1.673) when considered in a model with all seven nature statement questions. I found that as the people in this survey population reported higher levels of agreement with Statement Question 26, their odds of being obese increased. This was, however, a singular finding that was not replicated when this variable was considered in other logistic regression models. Also noteworthy was the lack of support for the relationship of Statement Question 28 (*Like a tree can be part of a forest, I feel embedded within the broader nature world*) to either mental health or obesity. This statement question was noted in a previous study to be a singularly useful measure (Pasca et al., 2017). Both of these Research Questions (#2 and #5) were decided in favor of the null hypotheses. The findings of this study do not support the thought advanced by Lin et al. (2014) that personal attitudes may be more important factors than issues of access. Future studies measuring the value of this variable domain should weigh the design of the questions to ensure that they are capturing emotional connectedness and not cognitive beliefs.

Research Questions #3 and #6 examined the relationship between physical activity in nature or nature-based activities and mental health and obesity status respectively. In both cases, the nature statement question directly asking this question was found to significantly associate with lower odds for poor mental health (.652) and obesity status (.666) with ascending levels of agreement with the statement question. These findings were approximately replicated in every model including this statement question and the health outcome variables. Furthermore, when the Likert-scaled data were recoded in binary *Not agreed* and *Agreed* status, I found that respondents who

agreed with Statement Question 29 were only 43.8% as likely to report obesity as though who did not agree. As a result of these findings, the alternate hypothesis was accepted for both research questions. Although the statistical analyses of this study supports the association of the independent variable with the dependent variables, it is important to consider that there may remain some ambiguity of understanding related to physical activity in nature or in a nature-based activity.

When the relative impact of the three domains areas were compared, it was observed that ease of access (Statement Question 23) and physical activity (Statement Question 29) were the only independent variables significantly related to poor mental health status with *OR* of .630 and .734 respectively. Although the overall effect on mental health status was deemed weak by their relatively low Nagelkerke R^2 values, ease of access to nature and physical activity in nature or in nature-based activities were similarly useful predictors of mental health status within this survey population. When considering obesity status, physical activity (Statement Question 29) was the only independent variable to consistently and significantly associate with obesity status. When compared against the most powerful predictors from the domains of access and attitudes, physical activity as represented by Statement Question 29 demonstrated an *OR* of .746 for inclusion in the obesity status group with each ascending level of agreement with the statement question. The attitudes about nature domain of statement question did not generate any consistently significant associations with either poor mental health or obesity status.

The Stress and Nature Mini Survey also contained an additional Likert-scaled mental health status question (*10. In general, how would you rate your overall mental or emotional health?*). This question was not used to answer the research questions; however, its findings also support the value of nature Statement Questions 23 and 29 as they relate to mental health status. Binary logistic regression analysis of this question's data alongside of the recoded binary *Not agreed* and *Agreed* status for the seven nature statement questions. I found that respondents with *Not agreed* status with Statement Questions 23 and 29 were significantly more probable to report *fair* or *poor* mental health status.

These findings indicated that physical activity in nature or in nature-based activities was the most important domain when considering poor mental health and obesity together. Ease of access to nature was the second most important domain as it was associated with mental health status, but not obesity. The attitudes about nature domain, that did not consistently demonstrate any significant associations, was considered to be the least important of the three studied domains as it relates to the survey population profiled in the Stress and Nature Mini-Survey in Kent County, Michigan.

The survey also collected open-ended narrative answers to respondents about obstacles limiting their ability or desire to visit natural areas. The responses to that question pointed to barriers of time being the most common response, however, a broad array of obstacles were reported aligning generally with the findings of other studies including references to fear (Blanton et al., 2013; Hansen-Ketchum, Marck, Reutter, & Halpenny, 2011). Some of the responses also represented choices on the part of the

respondents to prioritize other forms of recreation. These choices of people in modern society to opt for recreation outside of nature is consistent with the problem statement proposed by Louv (2005 and 2011). This may represent an opportunity for public health officials to promote activity in nature or nature-based recreation as a beneficial choice by communicating the healthful benefits. There may be a disparity between the motivations and/or obstacles that people have related to nature and their understanding of the potential benefits to their health (Irvine et al., 2013). Bridging these discrepancies could increase willingness and desire to be active in nature.

Relationship to Literature

The literature I reviewed in Chapter 2 of this study presented an array of articles supporting the positive relationship that exposure to nature has with a variety of health outcomes including the issues of interest to this paper: mental health and obesity. The reviewed body of literature did not include research from Kent County, Michigan or similar county-level locales. Furthermore, the literature reviewed for this study examined many parameters of the nature-health relationship, however, a gap in the literature existed concerning the relative contributions and/or values of different types of nature exposures. I examined this gap with data provided by Kent County's Stress and Nature Mini-Survey, as limited as it was, and concluded that the exposure domain of physical activity in nature or in nature-based activities had predictive value for mental health and obesity status within the survey population. Ease of access to nature was predictive of mental health status. No predictive value was found in the domain of attitudes about nature contrary to the conclusions of numerous articles discussed in the literature review. These findings

contribute to the understanding of nature exposures to mental health and obesity status and should provide insight for future research.

Findings and the Theoretical Framework

This study was grounded in the theories of biophilia as presented by Fromm (1964) and Wilson (1984), ART as described by Kaplan and Kaplan (1989), and NDD as presented by Louv (2005 and 2011). Biophilia proposes that the human species has evolved to thrive in the natural environment over eons of time and that separation from this ideal environment is disordered. ART posits that exposure to nature has recuperative qualities for persons who are mentally stressed and fatigued. NDD is Louv's explanation for growing rates of physical and developmental illness. This study also considered several additional frameworks of understanding such as environmental health, the social determinants of health, and the pathways to health benefits from nature framework presented by Shanahan and colleagues (2015). The definition of environmental health claims that illness, injury, and wellbeing are affected by exposures to nearby agents and/or conditions (National Environmental Health Association, 2013). The framework of the social determinants of health claims that human wellness is strongly influenced by many socio-economic factors (Solar & Irwin, 2010). The pathways to health benefits from nature framework presented by Shanahan et al. (2015) provides a six step structure for assessing nature exposure variables.

The findings from this study largely support these theories and frameworks in at least a weak manner. The associations between ease of access to nature with mental health and physical activity with mental health and obesity provides further support to the

theories of biophilia, NDD, and possibly ART. Assessing the relationship to ART is more complicated because the data studied in this research did not measure whether or not the respondents nature exposure caused attention restoration and subsequently a change in mental health or obesity status. There is, however, nothing in these findings which contradict ART. The National Environmental Health Association's understanding of environmental health is supported by the relationship between physical activity in the natural environment as an exposure to a healthful setting for and possibly by the ease of access variable as well. The ability to access nature and the ability/resources to be physically active in nature or in nature-based activities are factors that should rightfully be considered as social determinants of health consistent with the framework described by Solar and Irwin (2010). The findings that female gender and lower household income were associated with higher odds for poor mental health status further supports the idea that social determinants of health are powerfully linked to health status. The pathways to health effects from nature framework proposed by Shanahan et al. (2015) was incorporated into the design of this study. Together, this study and its findings provide limited support for the described theories and conceptual frameworks.

Limitations of the Study

This study contained limitations worth describing. The first grouping of those limitations is within the category of demographic response to the survey. While the volume of response to the Stress and Nature Survey was sufficient to satisfy the power calculations, it was apparent that female gender, White race, and English language speakers were overrepresented in the sample population. The method of the survey

distribution, primarily via the Internet, may have also caused disproportionate participation based on access to technology and literacy level. Also, while the post hoc power calculations satisfied the needs of this study, it is important to recognize that the 84.5% ability to avoid Type 2 errors does not exclude the possibility altogether.

Secondly, it is important to note that the Stress and Nature Mini Survey was conducted during the months of August and early September. The weather in Michigan during that time of year is generally warm and considered enjoyable by most people. Michigan, not unlike other geographic locations, has a climate that includes extremes in temperature and seasonal variety. It is possible that survey respondents would answer the nature statement questions differently during other parts of the year. The timing of the survey therefore presented a temporal and meteorological/seasonal limitation.

Additionally, questions remain about the definitions of nature and many of the other terms used in this study. The domain of attitudes about nature may have been the most affected by this problem. Further study and clarification about how to best present the statement questions could help future studies. The concepts and understandings related to attitudes and connectedness to nature may be the most difficult domain area to properly measure. This challenge may have contributed to the inability of this study to detect significant associations. Furthermore, there is no indication that the survey questions were constructed with any test for validation. These self-reported data provided through the question responses could also have been subject to biases further compromising the integrity of the data.

Finally, the cross-sectional design of this study was inherently limited when attempting to perform analytics. The design cannot be used to determine causation and is therefore prone to mistakes of antecedent-consequent bias. It is not possible in cross-sectional studies to conclude that the independent variables caused the status of the dependent variables. It is, in fact, possible that causation could happen in reverse of these biases.

Recommendations

The following subsections present recommendations regarding how the findings from this research can be utilized to advance further research, positive social change, and public health practice.

Further Research

The relationship between nature exposure variables and human health measures is complex as this study and previous research has found. Further research should be intentional about gathering input from a truly representative and diverse sample of the population. Data collected throughout the year, or over a period of years, could be beneficial in providing insight to the role of weather and season in relation to the study variables. This sort of longitudinal analysis would align with the recommendations of other researchers as well (Pearce et al., 2016). It is also important for future researchers to further refine and clarify the definition of nature and related terms such as those used in the Stress and Nature Mini-Survey's statement questions.

Positive Social Change

Advancing positive social change is a core value for Walden University. The purpose of public health and epidemiology is also focused on positive social change through the process of assessing human health challenges, developing interventions, and evaluation. The research I reported in this study is consistent with the commitments to positive social change held by Walden University and the field of public health. Understanding the relationship(s) between nature exposures – whether they be access, attitudes, or physical activity – and human health outcomes is useful for advancing positive social change. Additionally, limited public resources further underscore the importance of wise expenditures into public health and community planning.

The findings of this study can aid positive social change in Kent County, Michigan, and similar counties by empowering decision-makers with the information that this analysis of data available in the Stress and Nature Mini-Survey presents. Namely, that physical activity in nature or in nature-based activities was associated with lower odds for poor mental health and obesity, also, that ease of access to natural areas was associated with lower odds for poor mental health. Reducing the occurrence of poor mental health and obesity equates to positive social change for that community.

Public Health Practice

The findings from this study suggest that some exposures to nature are significant factors associated with mental health and obesity in Kent County, Michigan as reported by the participants of the Stress and Nature Mini-Survey. Their responses can help to inform public health practitioners and other community leaders with information useful

for decision-making about investments in public policy and programming. Environmental health practitioners in particular should contemplate how the findings of this study, and others like it, could be used to improve public health through a broader understanding of their field of discipline as described by Briggs (2008).

I found that higher self-reported frequency of physical activity in nature and/or in nature-based activities associated with decreasing odds for both poor mental health and obesity. While none of the nature exposure variables were found to have more than weak effects on the variance for either health outcome measure, the physical activity variable assessed in Research Questions #3 and #6 was found to be a significant factor ($p < .05$) associated with reduced odds of poor mental health and obesity. The physical activity statement question responses weakly effected (Nagelkerke $R^2 < .300$) both the mental health and obesity variance. The statistically significant association with better health in both community health priority areas suggests that promoting physical activity in nature areas and/or nature-based activities could be useful, albeit incomplete, strategies for advancing public health in this community. These limited findings support a public health practice strategy for addressing these priority health issues in Kent County, Michigan, in the following order.

1. Promote and invest in increasing physical activity in natural areas and/or nature-based activities. This increased activity was associated with lower odds of poor mental health and obesity.

2. Advance policies and planning that ensures ample access to nature areas. Increasing levels of reported ease of access to natural areas was associated with lower odds of poor mental health.
3. Promoting initiatives to build positive attitudes and connectedness to nature may be impactful but had non-significant and/or inconclusive associations to mental health and obesity in this study. Further research is recommended within this domain to better understand its relevance to health status.

Conclusion

The primary purpose of this study was to identify if exposures to the natural environment were associated with two community health priority issues in Kent County, Michigan: poor mental health and obesity status. The nature exposures were categorized into three domain areas representing access, attitudes, and physical activity. Secondary data available in the county's Stress and Nature Mini-Survey, and gathered from 653 county residents in August to early September of 2018, were used to answer this study's six research questions. The data analyses found that ease of access to natural areas was significantly associated with lower odds for poor mental health while no association was found to odds for obesity. Physical activity was significantly associated with lower odds for both poor mental health and obesity. No significant associations were consistently found between the domain of attitudes about nature and poor mental health or obesity. These findings were limited by a number of factors, however, they do support the need for additional research and suggest that access to nature areas, as defined in this study, and the promotion of physical activity in nature or in nature-based activities are

beneficial for the community's health. This conclusion is useful for informing better public health policy and positive social change.

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Appendix A: County Health Department Stress and Nature Mini-Survey

1. *What is your gender?*

Male *Female*

2. *What is your age?*

18 to 24 *55 to 64*

25 to 34 *65 to 74*

35 to 44 *75 or older*

45 to 54

3. *Which race/ethnicity best describes you? (Please choose only one.)*

American Indian or Alaskan Native

Asian

Black or African American

Hispanic or Latino/a

White

Middle Eastern or North African

Multi-Racial

Native Hawaiian or Pacific Islander

Other

4. *What is your approximate average household income?*

Less than $15,000 *$50,000-$74,999*

$15,000-$24,999 *$75,000-$99,999*

$25,000-$34,999 *$100,000-$120,000*

$35,000-$49,999 *More than $120,000*

5. In what ZIP code is your home located? (Enter 5-digit ZIP Code, e.g. 49505)

6. What is the highest level of education you have completed?

Less than high school graduation

High school diploma or GED

Some college

Associate or technical degree

Bachelor's degree

Graduate school degree or higher

7. What is your current religion, if any?

Christian/Protestant/Methodist/Lutheran/

Baptist

Catholic *Buddhist*

Mormon *Hindu*

Greek or Russian Orthodox *Atheist or agnostic*

Jewish *Nothing in particular*

Muslim *Other*

8. What is your height in feet and inches?

9. What is your current weight in pounds?

10. In general, how would you rate your overall mental or emotional health?

Excellent *Fair*

Very good *Poor*

Good

11. Did you have 14 or more days of poor mental health in the past 30 days?

Yes *No*

12. In the last month, how often have you been upset because of something that happened unexpectedly?

Very often *Almost never*

Fairly often *Never*

Sometimes

13. In the last month, how often have you felt that you were unable to control the important things in your life?

Very often *Almost never*

Fairly often *Never*

Sometimes

14. In the last month, how often have you felt nervous and "stressed"?

Very often *Almost never*

Fairly often *Never*

Sometimes

15. In the last month, how often have you felt confident about your ability to handle your personal problems?

Very often *Almost never*

Fairly often *Never*

Sometimes

16. In the last month, how often have you felt that things were going your way?

Very often *Almost never*

Fairly often *Never*

Sometimes

17. In the last month, how often have you found that you could not cope with all the things that you had to do?

Very often *Almost never*

Fairly often *Never*

Sometimes

18. In the last month, how often have you been able to control irritations in your life?

Very often *Almost never*

Fairly often *Never*

Sometimes

19. In the last month, how often have you felt that you were on top of things?

Very often *Almost never*

Fairly often *Never*

Sometimes

20. In the last month, how often have you been angered because of things that were outside of your control?

Very often *Almost never*

Fairly often *Never*

Sometimes

21. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?

Very often *Almost never*

Fairly often *Never*

Sometimes

22. Please tell us what you believe are the root causes of your stress:

For the following questions, a "natural area" is defined as a large, grassy area with trees, or ponds, lakes, streams or rivers.

Please rate your level of agreement with the following statements:

23. It is easy for me to access a natural area.

Strongly disagree *Agree*

Disagree *Strongly agree*

Neither agree nor disagree

24. I live close to a natural area.

Strongly disagree *Agree*

Disagree *Strongly agree*

Neither agree nor disagree

25. I am aware of natural areas that are available for use in my community.

Strongly disagree *Agree*

Disagree *Strongly agree*

Neither agree nor disagree

26. I feel very connected with nature and/or natural areas.

Strongly disagree *Agree*

Disagree *Strongly agree*

Neither agree nor disagree

27. It is important for me to spend time in nature or participating in nature-based activities.

Strongly disagree *Agree*

Disagree *Strongly agree*

Neither agree nor disagree

28. Like a tree can be part of a forest, I feel embedded within the broader natural world.

Strongly disagree *Agree*

Disagree *Strongly agree*

Neither agree nor disagree

29. I frequently engage in physical activity in natural areas or in nature-based activities.

Strongly disagree *Agree*

Disagree *Strongly agree*

Neither agree nor disagree

30. Are there obstacles which limit your ability or desire to visit natural areas? If so, what are those obstacles?