THE ROLE OF THE CAMPUS OUTDOOR ENVIRONMENT ON UNIVERSITY STUDENT MENTAL HEALTH: A STUDY FOCUSING ON THE MICHIGAN STATE UNIVERSITY CAMPUS

By

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ABSTRACT

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The mental health and wellness of university students has been a pressing concern in recent years in the US and is becoming an even larger issue due to the COVID-19 Pandemic. The main purpose of this study is to investigate the correlations between university student mental health and their campus's outdoor environment. To gather data for this research, an online survey was designed based on literature review and distributed to students at Michigan State University. Students were asked questions about their overall mental well-being, as well as questions about their environmental perceptions, outdoor activity, views to nature through windows and safety concerns regarding their outdoor campus environment. Among 161 survey respondents, the major findings of this study indicate a significant difference in mental health scores for windows in living quarters, where students with living quarter windows had better mental health scores (MHS) than students without living quarter windows. This study also found a marginally significant difference in the MHS for students with classroom windows, where students with classroom windows had better mental health than students without classroom windows. These results also indicated a stronger need for windows in living quarters than on campus. Other results of this study include a significant difference in MHS for students' perception of safety on campus, outdoor work time, and perception of greenspace on campus. Future landscape designers, university planners, and student counselors will be able to use this study to determine what kinds of outdoor spaces should be created and used to improve the well-being of students.

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CHAPTER 1. INTRODUCTION

Mental health has become a rising concern in recent years, especially among young adults and university students (Hunt and Eisenberg, 2010; Mahmoud et al., 2012; Roberts et al., 1999; Saleh et al., 2017; Stallman, 2010: Stowell et al., 2021). Of the diseases that plague young adults, mental health disorders account for one-half (Hunt and Eisenberg, 2010). Due to the unique characteristics of university education lifestyles, many students experience relatively high stress levels, and in turn are at higher risks for mental disorders such as anxiety and depression (Stowell et al., 2021). Causes of higher stress levels among college students could be attributed to the unique university lifestyle with factors such as exam anxiety, the selection of degrees, living alone for the first time, and freedom of schedule organization (Saleh et al., 2017). In one study, online surveys were given to students of Australian universities to assess psychological distress in students. Results showed that 83.9% of students reported elevated stress levels while only 29% of the Australian general public reported elevated stress levels during the same time period (Stallman, 2010). This issue continues to be even more alarming during the COVID-19 Pandemic. According to the CDC, the percentage of people aged 18-29 experiencing symptoms of anxiety has more than doubled since the beginning of the Pandemic. Considering this risk of mental health issues among university students, more research needs to be focused on this population to increase awareness and better understand the extent of the issue (Vahratian et al., 2021).

With this rising concern of mental health issues, researchers are investigating possible solutions. The outdoor environment can have a tremendous impact on an individual's physical and mental health. The idea that natural environments are beneficial to human health and wellbeing has been carefully considered and studied for many years (Bowler et al, 2010). Many

studies suggest that outdoor environments with more natural settings can have a positive impact on cognitive abilities and mental health (Greco et al., 2021; Kaplan, 1995; Li and Sullivan, 2016; Maes, et al. 2021; Moran, 2019; Peen et al., 2010; Ulrich et al., 1991). Previous studies have also been conducted to determine what factors of the natural environment are contributing to this influence on mental and physical health, with diverse research settings such as prisoner's exposure to natural settings (Moran, 2019), windows in classrooms with views of natural settings (Li and Sullivan, 2016), and cognitive function of adolescents with exposure to woodland areas (Maes et al., 2021). The effects of the natural environment on physical health have been studied by looking at neighborhood landscape spatial patterns and obesity and mental health in children (Kim, et al., 2014), and gestational diabetes mellitus associated with residential greenness (Qu, et al., 2020). All of these studies suggest a positive relationship between exposure to natural settings and good mental and physical health. In one study conducted by Sugiyama et. al. (2008), researchers set out to determine the possible beneficial factors of nature by studying the association between residents' perceptions of neighborhood greenness and their perceptions of mental health. Results of this study indicated a strong positive relationship of high perceptions of greenness, outdoor walking, and social factors with good physical and mental health (Sugiyama et al., 2008). In another study, human responses to different vegetation were measured, indicating that visual encounters with vegetation can have great benefits to individuals experiencing stress or anxiety (Ulrich, 1986). These articles indicate that some factors of natural environments that could contribute to mental health include perceptions of greenery, walking, social interaction, and views to nature.

However, although many previous studies suggest that natural environments are beneficial to physical and mental health, the correlations between greenery and university students mental health conditions have not been yet fully investigated. University students may not be able to spend a substantial amount of time in completely natural areas to alleviate their stress. Considering this, the current study aims to assess how campus outdoor environments could impact student mental health by investigating students' activities, views, and perceptions of their outdoor campus environment, and their relationships with student mental health. By having a better understanding of how outdoor campus environments could be related to better mental health of students, campus master planners will be able to consider these needs and create designs that will promote healthier lifestyles for students.

CHAPTER 2. LITERATURE REVIEW

The safety and wellbeing of people should be always considered when planners and designers create a new space. Thus, much research has been done to investigate how these spaces can impact the wellbeing of people. More specifically, many previous studies have examined the effects of highly urbanized areas on mental health (Baggaley, 2019). Some researchers studied how psychiatric disorders correlate with highly urbanized communities (Peen et al., 2010), while others studied how spending time outdoors may positively impact the mental health of people living in urban areas (Payne et al., 2020). The environmental effect on mental health is a subject that has been highly investigated in recent years. Mental health status has been paid more attention over the past years due to the recent increase in mental health issues amongst the younger population. However, there is still some existing gap to investigate university students' mental health in relation to their campus outdoor environments. This study will evaluate many different aspects of outdoor campus environments and how they may affect mental health in university students. The importance of this investigation can be highlighted when taking into consideration that a positive increase in mental health and quality of life which may lead to an increase in students' success and graduation rates for universities.

2.1 Beneficial Effects of Natural Environment on Mental and Physical Health

There are two widely referenced theories when discussing the restoration of stress in the outdoor environment. The stress reduction theory (SRT), developed by Roger Ulrich, states that since human evolution primarily occurred in natural environments, humans adapt more easily to sudden stress-causing changes in a natural environment rather than an urban environment (Ulrich et al., 1991). SRT states that individuals can recover from stress faster and more completely by

spending time in natural environments. In his 1991 study, Ulrich conducted an experiment with 120 subjects who viewed a stressful movie, followed by videos of urban and natural settings. Participants' stress levels were measured using self-reported surveys as well as various cardiovascular measurements such as heart period. Results indicated that recovery was faster when subjects viewed natural rather than urban settings, thus further justifying the SRT (Ulrich et al., 1991). Many other researchers have referenced his research while studying other population groups such as university students (Payne et al., 2020), ICU patients in hospitals (Ulrich et al., 2020), and high school students in their classrooms (Li and Sullivan, 2016). The second theory, the Attention Restoration Theory (ART), developed by Rachel Kaplan and Stephen Kaplan, states that spending time in nature can provide rest and help restore attention and mental fatigue in humans (Kaplan, 1995). ART has also been a widely referenced theory that helps explain why nature is beneficial to psychological health. In comparison to the SRT, the ART states that a person's ability to focus is improved when exposed to natural environments. Kaplan states that "Experience in natural environments can not only help mitigate stress; it can also prevent it through aiding in the recovery of this essential resource." (Kaplan, 1995). The "essential resource" he is referencing is directed attention and an individual's ability to have and maintain it for long periods of time. Kaplan theorizes that a lack of attention and focus can often lead to mental fatigue and therefore stress. So, unlike SRT which states that nature can mitigate stress, the ART states that nature can also prevent it from happening in the first place. This theory is also referenced in a number of previous studies in various research settings including prisoners' exposure to nature (Moran, 2019), and walking in natural and non-natural environments (Crossan and Salmoni, 2021). Taking into consideration both of these main theories, this study will be able to better conclude and respond to its findings.

As mentioned briefly in the introduction, numerous studies have been conducted to investigate the relationship between natural environments and general human health. The natural environment's impact on cognitive function, obesity, physical activity, and mental fatigue have all been investigated in previous studies, with evidence supporting that the natural environment is overall beneficial to human health (Guite et al., 2006; Kim, et al., 2016; Li and Sullivan, 2016; Maes, et al. 2021; Peen et al., 2010; Qu, et al., 2020).

There is strong evidence that supports how natural environments can be good for physical health (Kim, et al., 2014; 2016; Qu, et al., 2020). In one study conducted by Kim et al. (2016), the relationship of landscape spatial patterns, childhood obesity and mental health were examined by measuring children's health-related quality of life. The results of this study showed that children who live near superior landscape special patterns and more natural environments would likely be less obese and have better health conditions (Kim, et al., 2016). In another study conducted by Qu et al. (2020), other physical health benefits of greenspace were identified: type 2 diabetes mellitus and gestational diabetes mellitus. In this study, 5,237 pregnant women were analyzed from 2004 to 2016, focusing on each individuals' diagnosis of gestational diabetes and their residential greenspace. Associations between greenness (measured by the Normalized Difference Vegetation Index (NDVI)) and the 157 participants that were diagnosed were evaluated with risk for the disease decreasing as NDVI increased. These results indicate that greenspace may minimize gestational diabetes.

Highly urbanized areas can also have potential disadvantages on the mental health of their residents. In one meta-analysis study conducted by Peen et al. (2010), 20 previous studies regarding mental health disorders in urban cities were compared and analyzed. The purpose of their study was to compare the differences in reported mental health disorders in urban vs rural

communities in developed countries. A few variables were evaluated in order to look at overall mental health and wellbeing, which include but are not limited to mood disorders, anxiety disorders, severe depression, and alcohol and drug abuse. Using "The Review Manager" software program, the authors were able to compare the different countries' rural and urban areas for mental health disorders. Researchers concluded that three main variables showed a higher prevalence rate of mental illness disorders in urban areas than in rural areas. All combined disorders reported from studies in urban areas had a 38% higher prevalence rate, 39% higher for mood disorders, and 21% higher for anxiety disorders (Peen et al., 2010). Another study conducted by Guite (2006), set out to investigate the association between physical and social factors of the built environment and mental health. Respondents (n=1,012) in Greenwich, London participated in a survey which included questions regarding multiple factors of the built environment including design and maintenance, noise, and crowding, as well as questions regarding the respondents' mental health. The study found neighborhood noise, feeling overcrowded, and limited access to greenspace were associated with lower levels of mental health and vitality (Guite et al., 2006). These results indicated a confirmation of the negative association between the physical aspects of the built environment and mental health.

It is well known that mental health can be benefited by natural environments, and extensive research has been conducted studying multiple variables. In one experimental study, Li and Sullivan (2016) investigated how classroom windows with views to greenspace impact recovery from stress and mental fatigue by conducting an experiment with 94 students from 5 different high schools. In this study, participants were randomly assigned to classrooms with no windows, windows only letting in light, and windows with views of greenspace. With a series of tests measuring the level of students' attention and stress, the main results of this study indicated

that participants in the windows with greenspace group recovered from these tests significantly better than the other two groups (Li and Sullivan, 2016). This study illustrates how viewing greenspace can have a positive impact on improving psychological health, or more specifically, attention in association with stress. In another study conducted by Maes et al. (2021), cognitive function of adolescents was investigated with exposure to natural areas. In this longitudinal study, the cognitive abilities and mental health of 3,568 adolescents were studied in association with natural environments. The natural environments that were studied were greenspace, bluespace, grasslands, and woodlands. Results indicated that cognitive function was improved most with exposure to woodland areas (Maes, et al. 2021). In both studies, significant evidence supported the benefits of natural environments on psychological health. They indicate that not only being physically exposed to nature is beneficial to mental health, but also just having a view to nature is also beneficial. The restoration of mental fatigue and stress was improved by viewing greenspace in schools through a window, and the cognitive function of adolescents was improved with exposure to woodland areas. These findings provide a rationale for further studies investigating the psychological health benefits of natural environments. However little research has been done to investigate how other outdoor environments, such as campus environments, may impact mental health, specifically anxiety and depression disorders of university students.

2.2 Mental Health Disorders Amongst Teens and University Students

The mental health of college-aged individuals has been paid attention by previous researchers, and in the recent global COVID-19 Pandemic, rates of mental health disorders are increasing even more rapidly. According to the national center for health statistics conducted in 2020, of people ages 18-29, 40.2% experienced symptoms of anxiety, compared to the same time

period in 2019, only 10.9% of people over 18 experienced symptoms of anxiety disorders (CDC, 2020). The uncertainty and morbidity of the pandemic is likely the cause of this dramatic increase in mental health issues, therefore it is imperative that researchers investigate the problem.

Several surveys and studies have been conducted to try and grasp just how serious this problem is. In their 2010 report, Hunt and Eisenberg introduced several different studies and illustrated important differences in mental health among males and females, college and non-college students, and other variables. Among males and females, this study found that men were more likely to commit suicide, but females were more likely to have major depression and anxiety disorders. College and non-college students of the same age did not have a statistically significant difference in mental health disorders, but both these numbers were increasing for this age group. Hunt referenced the 2008 National College Health Association which reported that more than 33% of students felt almost too depressed to function within the past year. This study also documented that 6% of graduate and 4% of undergraduate students had contemplated suicide in a 2006 study (Hunt and Eisenberg, 2010).

Similar studies have been conducted to study how and why students may be experiencing more mental health issues. In one study, Roberts et al. (1999), investigated the general health and wellbeing of 260 British university students and possible contributing factors. Results of this study indicated that students' economic circumstances were strongly related to their mental and physical health, with poorer students having worse mental health. Students who had larger debts, and students who are required to work longer hours in order to budget properly were both more likely to have poorer mental health. Students who had poor mental health also were more likely to report worse physical health, and habits of smoking and drinking (Roberts et al., 1999). This

study not only describes the mental health risks for students, but also illustrates the idea that mental health and physical health are connected. In another study conducted by Mahmoud et al. (2012), researchers focused on the increase in mental health problems among university students. They recruited 508 university students, their coping styles and symptoms of depression, stress, and anxiety. Results of this study found that maladaptive coping was a main predictor of depression anxiety and stress (Mahmoud et al., 2012).

This information provides good reasoning to further investigate the situation. Of the above literature, all mention elevated levels of mental health symptoms or disorders among this population, with some investigating different contributing factors of the university lifestyle. However, very few studies investigated the physical outdoor campus environment as a contributing factor. This study will draw attention to the existing and growing problems in mental health issues among young adults and will investigate more environmental factors that may contribute to poor mental health within this population group.

2.3 Outdoor Environment and Mental Health

The campus outdoor environment plays a significant role in impacting mental health, particularly for students. However, there are limited studies investigating the health effects of living in a campus environment when compared to the number of studies investigating other environments like natural or urban environments. Of the few previous studies that have been conducted, many conclude that natural aspects of campus environments have a positive impact. Few studies investigate how education campuses' natural environments impact mental health (Li and Sullivan, 2016; Lau and Yang, 2009), while other studies focus on other environments such as prison and nursing home environments (Moran, 2019; Potter et al., 2018).

In one study conducted by Lau (2009), the presence of healing gardens and greenspaces in a compact college campus was studied to investigate the potential benefits of these green spaces. The University of Hong Kong (HKU) was used as a case study in this investigation due to its compact urban environment and limited greenspace. Surveys were given out to students on campus questioning their preferences and uses of the greenspace on HKU's campus. Results indicated that a vast majority of students (97%) preferred to view nature from a window (Lau, 2009).

Other studies focus on different types of campus environments, such as prison environments and assisted living environments. In 2019, Moran investigated the unique custodial environment of prisons, evaluating their exposure and views to outdoor environments. Results of this study indicated that there are potential restorative benefits of nature and that different aspects of nature such as greenspace and green views had varying effects on prisoners' ability to feel calm and ability to reflect (Moran, 2019). In another study, Potter et. al. investigated the impact of the physical environment on depressive symptoms of nursing home residents. Nursing homes can have higher rates of depression amongst residents when compared to other populations. After controlling for multiple variables, it was not found that the physical environment did not predict depressive symptoms. However, it was found that access to outdoor space within nursing homes was the only predicting variable for decreasing depressive symptoms (Potter et al., 2018). This illustrates the importance of outdoor spaces and their accessibility to different types of population groups' mental wellbeing. These articles are good examples of unique population groups and environments being used to study how nature affects mental health, and both contain valuable results that promote further studies in this area.

2.4 Measuring Mental Health

Mental health can be measured in many different ways and there are many factors that can contribute to overall mental health conditions. Symptoms of mental illness include excessive tiredness, excessive fear or worries, feeling sad or depressed, etc. (Mayo Clinic, 2019). However, since constructs such as fear, worry, or sadness are not directly observable, they can be difficult to measure definitively to indicate overall mental health. Theoretical constructs like these instead need to be inferred by measuring other observable variables such as heart rate or self-reports (Foa and Cahill, 2001). When investigating mental health, studies typically use participant-response questionnaires to measure these symptoms and find a general idea of an individual's overall mental health (Breedvelt et al., 2020; Foa and Cahill, 2001).

Stress is a physiological and psychological reaction that a person has to a certain difficult or threatening event and can have a substantial impact on overall health. It is also one of the major contributors to mental health disorders (Ulrich et al., 1991). Stress can also be displayed in behavioral reactions or changes, such as excessive drinking, and evasion of tasks. This also causes reactions in bodily systems like cardiovascular, skeletomuscular, and neuroendocrine which usually lead to fatigue (Ulrich et al., 1991). Stress along with anxiety takes a large toll on a person, especially when ignored and allowed to continue over a long period of time. The aftereffects of stress can be detrimental to a person's well-being and ability to complete future tasks (Thoits, 2010).

Mental health and stress levels have been measured in a number of ways. One example is through the use of heart rate monitors to measure heart rate variability and the sympathetic nervous system. These were good indicators of how stress affects the body, (Kim, et al., 2018). Another way to measure stress in individuals is using a survey like the Perceived Stress Scale

(Cohen et al., 1983). One of the measuring tools for evaluating a person's stress level is the Perceived Stress Scale (PSS). The PSS scale, designed by Sheldon Cohen in 1983, evaluates the degree of the stressfulness of situations and events in a person's life. There are 10 questions in the PSS survey that are all designed to question how uncontrollable, unpredictable, or overwhelming a person feels their current condition is. The questions are also constructed to be unbiased to any subpopulation group and easy to follow and answer (Cohen et al., 1983). This measurement tool can be useful in evaluating the stress levels of many different individuals but does not measure other aspects of mental health.

Another measurement for assessing stress levels that has been widely accepted is the Kessler Psychological Distress Scale (K10). This tool was developed to assess non-specific psychological distress symptoms such as depression, anxiety, worry, and fatigue. Creators of this questionnaire also ensured that it would be relevant to unique population groups such as adolescents, ethnic minority groups, and rural populations (Andrews and Slade, 2007). The K10 has been evaluated and concluded to be consistent with rates of mental disorders, as well as with other widely used questionnaires such as the General Health Questionnaire (GHQ), thus supporting the validity of the K10. This questionnaire is a 10-item, point scale ranging from 1-5 (1 being none of the time and 5 being all of the time) (Kessler et al., 2002). Apart from the PSS, the K10 takes into consideration of anxiety and symptoms of depression as well as stress. Several previous studies have adopted the K10 tool to evaluate psychological distress and mental health (Hides et al., 2007; Stallman, 2010).

CHAPTER 3. METHODOLOGIES

Existing evidence shows the importance of evaluating mental health, especially among university students, and the different ways the outdoor environment can have an impact on it (Hunt and Eisenberg, 2010, Kaplan, 1995; Ulrich et. al., 1991). The purpose of this research is to investigate the student population at Michigan State University, by examining their mental health and how it may be correlated to MSU's outdoor campus. This section will introduce research methods, data collection and analysis, and the tools used to collect this data.

3.1 Study Area and Sample

In order to evaluate the mental health of university students and its relationship to the campus outdoor environment, students at Michigan State University (MSU) in East Lansing at Michigan, USA were recruited to participate in this study. Between September 30th, 2021, and October 31st, 2021, an online survey was sent out via email to various departments at MSU including, the School of Planning, Design, and Construction, Environmental Geography, Natural Science, Biology, Arts and Humanities, and Community Sustainability. These departments were chosen by convenience sampling based on faculty cooperation. Among 1,642 students recruited for this study, 161 students responded to this survey, creating a response rate of approximately 9.8%. Participants were asked to complete the online survey that questioned them on their mental health, environmental perceptions, safety concerns, outdoor physical activity, and demographic information including residency. This study has been approved by the MSU Human Protection Program's IRB review (STUDY00006418).

3.2 Survey Design

The online survey of this research consisted of 9 sections with a total of 57 questions. Section one (environmental perceptions) contained 14 questions, section 2 (safety concerns) contained 5 questions, section 3-1, 3-2, 3-3, and 3-4 (transportation method, outdoor physical activity, outdoor relaxation, and outdoor work) each contained 4 questions, section 4 (viewing time) contained 5 questions, section 5 (mental health evaluation with K10) contained 10 questions, and section 6 (demographics) contained 7 questions.

Sections 1 and 2 of the survey are 5-point Likert scale responses ranging from "strongly disagree" to "strongly agree" and an option for "don't know" in section 1 and ranging from "none of the time" to "all of the time" and an option for "don't know" in section 2. Sections 3-1, 3-2, 3-3, and 3-4 all contain 4 multiple choice questions, asking respondents how often they spend time outdoors doing various activities. Responses to these questions include 0 days per week, 1-2 days per week, 3-5 days per week, and 5+ days per week, or 1-10 minutes per day, 11-20 minutes per day, 21-30 minutes per day, and 30+ minutes per day. Section 4 contains 3 multiple choice questions, and one fill-in-the-blank, asking respondents about their windows in living quarters and classrooms at MSU. Responses to these questions include yes or no, as well as 1-2 windows, 3-4 windows, and 5+ windows. Section 5 is the K10 questionnaire, a 10-question, 5-point Likert scale questionnaire designed to evaluate an individual's psychological distress. The last section of the online survey has 7 questions asking respondents about their demographic information including gender, age, ethnicity, academic classification, residency, major, and nationality.

For the purpose of this research, the Kessler Psychological Distress Scale (K10) was adopted to measure university student mental health. The K10 scale is a 10-item, 5-point Likert

scale questionnaire which is meant to evaluate an individual's mental state by determining a quantifiable measurement of psychological distress of individuals. This is a self-reported questionnaire in which questions are designed to measure distress based on anxiety or depressive symptoms experienced in the past 30 days. The 10 questions are scored from 1-5 (1 being none of the time, 5 being all of the time), totaling to a composite score of 10-50. Based on population data, scores ranging from 30-50 indicate probable serious mental disorder(s), 16-29 indicate probable mild mental disorder, and 10-15 were classified as probable no mental disorders (Stallman, 2010). For the purpose of this research, scores from the K10 were inversed in order to have higher scores indicate good mental health, and low scores indicate poor mental health. This was done to ensure the data analysis was easily understandable.

3.3 Research Hypothesis

According to the literature review, there is a need for further investigation of university students' mental wellbeing and how it is influenced specifically by their outdoor campus environment. There are many sources that describe how mental health disorders have become a pressing concern, (Hunt and Eisenberg, 2010; Mahmoud et al., 2012; Roberts et al., 1999; Saleh et al., 2017; Stallman, 2010: Stowell et al., 2021), and many sources that investigate the potential beneficial health factors of the outdoor natural environment (Kaplan, 1995; Sugiyama et. al., 2008; Ulrich, 1986). The gap in the existing literature, however is that little has been done to investigate how different factors of a campus environment can impact student mental health. This study investigates the multiple factors of the outdoor campus environment. These factors include students' perception of their campus environment, safety concerns, outdoor physical activity, outdoor relaxation, outdoor work, views to nature, and demographic information (Table

1). Based on the literature review, we hypothesize that positive environmental perceptions (scores above 3.0), more time spent outdoors, more views to nature on campus, and more views to nature in living quarters will correlate with higher mental health scores. We also hypothesize that the variables "Students' perception of accessibility to greenspace" and "Presence of windows in residences that view nature" will have the strongest statistically significant difference in mental health scores. A significant correlation between mental health and these two variables would be consistent with previous studies that suggest more greenspace, and more windows can have a positive impact on mental health.

3.4 Data Analysis

The data analysis focuses on examining the correlation between the independent variables and the dependent variable of mental health (evaluated by the K10 measurement) listed in Table 1. The research had four major steps of data analysis. First, descriptive statistics were performed to understand the respondents' environmental perceptions, safety concerns, outdoor physical activity, views to nature, location of residency, and demographic characteristics. Then the standard diagnostic testing was conducted to determine key variables and outliers. Second, bivariate analyses were performed to understand any associations between independent variables and a dependent variable using t-test or one-way ANOVA test. The correlations among environmental perceptions, safety concerns, outdoor activities, views to nature through windows, demographic variables, and mental health scores were evaluated. Third, a series of single regression models were tested to predict student mental health using the independent variables. Finally, a multiple regression model was estimated to predict the influence of the campus outdoor environment, physical activity, and residency conditions on student mental health.

 Table 1 Research Construct and Variables

Construct	Variables	Measurement	Data Source
Dependent Variables			
Mental Health	Mental Health Score (MHS)	Continuous	Kessler Psychological Distress Scale (K10)
Independent Variables			
Environmental	- Students' perception of plantings on	Ordinal	Survey Q1.1 &
Perceptions	campus		Q1.2
	- Students' perception of overall campus	Ordinal	Survey Q1.3
	appearance - Students perception of accessibility to	Ordinal	Survey Q1.4, Q1.5
	greenspace	0.151	& Q1.7
	- Students' perception of outdoor seating - Students' perception of landscape	Ordinal Ordinal	Survey Q1.6 Survey Q1.8
	maintenance	Ofullial	Survey Q1.8
	- Student's perception of cleanliness of outdoor space	Ordinal	Survey Q1.9
	- Students' perception of snow plow and overall maintenance	Ordinal	Survey Q1.10 & Q1.11
	- Students' perception of daytime,	Ordinal	Survey Q1.12,
	nighttime and overall safety on campus		Q1.13 & Q1.15
	- Students' perception of outdoor lighting	Ordinal	Survey Q1.14
Safety Concerns	- How often a student has been injured on campus	Ordinal	Survey Q2.1
	- How often a student has witnessed an injury on campus	Ordinal	Survey Q2.2
	- How often a student has witnessed litter/trash on campus	Ordinal	Survey Q2.3
	- How often a student has witnessed vandalism on campus	Ordinal	Survey Q2.4
	- How often a student has witnessed other crimes on campus	Ordinal	Survey Q2.5
Outdoor Physical Activity	- Days per week / minutes per day walking/biking to class in summer, spring, or fall	Ordinal	Survey Q3.1.1 & Q3.1.2
	- Days per week / minutes per day walking/biking to class in winter	Ordinal	Survey Q3.1.3 & Q3.1.4
	- Days per week / minutes per day doing physical activity outdoors in summer, spring, or fall	Ordinal	Survey Q3.2.1 & Q3.2.2
	- Days per week / minutes per day doing physical activity outdoors in winter	Ordinal	Survey Q3.2.3 & Q3.2.4
Outdoor Relaxation	- Days per week / minutes per day relaxing outdoors in summer, spring, or	Ordinal	Survey Q3.3.1 & Q3.3.2
	fall - Days per week / minutes per day relaxing outdoors in winter	Ordinal	Survey Q3.3.3 & Q3.3.4

Table 1. (cont'd)

	1	1
- Days per week / minutes per day	Ordinal	Survey Q3.4.1 &
working outdoors in summer, spring, or		Q3.4.2
fall		~
	Ordinal	Survey Q3.4.3 &
- Days per week / minutes per day		Q3.4.4
working outdoors in winter		
- Presence of windows in MSU classes	Ordinal	Survey Q4.1
that view nature		
- Number of classrooms with window	Ordinal	Survey Q4.2
views to nature		
- Presence of windows in residences that	Ordinal	Survey Q4.3
view nature		
- Number of windows in residency with	Ordinal	Survey Q4.4
views to nature		
- Hours per day spent viewing a digital	Ordinal	Survey Q4.5
screen		
- Gender - Academic Standing		Survey Q6.1 –
		Q6.7
		`
	fall - Days per week / minutes per day working outdoors in winter - Presence of windows in MSU classes that view nature - Number of classrooms with window views to nature - Presence of windows in residences that view nature - Number of windows in residency with views to nature - Hours per day spent viewing a digital screen	working outdoors in summer, spring, or fall - Days per week / minutes per day working outdoors in winter - Presence of windows in MSU classes that view nature - Number of classrooms with window views to nature - Presence of windows in residences that view nature - Number of windows in residency with view nature - Number of windows in residency with views to nature - Hours per day spent viewing a digital screen - Gender - Academic Standing - Age - Residency - Ethnicity - Nationality

CHAPTER 4. RESULTS

4.1 Characteristics of Respondents

Of the 161 participants in the survey 154 respondents completed the survey.

Majority of respondents were 21 or older (32.47%), female (55.84%), and white (78.57%).

According to residency status, majority of students reported living on-campus (51.95%), while 43.45% reported living off-campus, and majority were domestic (84.42%), as opposed to international students (6.49%). Participants were also from various academic backgrounds including engineering, planning, design and construction, geography, agriculture and natural resources, and others. Academic classification was somewhat evenly distributed with a slight majority that were freshman (27.27%). Table 2 shows the frequency of responses to demographic information.

 Table 2 Demographic Characteristics of Respondents

Variables	Full Sample (N=154)
	Freq. (%)
Age	
18	36 (23.38%)
19	32 (20.78%)
20	24 (15.58%)
21+	50 (32.47%)
Prefer not to Answer	12 (7.79%)
Gender	
Male	54 (35.06%)
Female	86 (55.84%)
Other	5 (3.25%)
Prefer not to Answer	9 (5.84%)
Ethnicity	
White/Caucasian	121 (78.57%)
Asian	10 (6.49%)
Hispanic	3 (1.95%)
Black/African American	4 (2.60%)
Other	7 (4.55%)
Prefer not to Answer	9 (5.84%)

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Table 2. (cont d)	
Residency	
Off-Campus	63 (40.91%)
On-Campus	80 (51.95%)
Other	11 (7.14%)
Nationality	
Domestic	130 (84.42%)
International	10 (6.49%)
Prefer not to answer	14 (9.09%)
Academic Classification	
Freshman	42 (27.27%)
Sophomore	31 (20.13%)
Junior	20 (12.99%)
Senior	23 (14.94%)
5th year +	11 (7.14%)
Graduate Student	15 (9.74%)
Prefer not to answer	12 (7.79%)
Major	
Engineering	31 (20.13%)
Planning Design and Construction	39 (25.32%)
Geography, Environment and Spatial	8 (5.19%)
Sciences	
Agriculture and Natural Resources	33 (21.43%)
Psychology	3 (1.95%)
Exploratory	1 (0.65%)
Lyman Briggs	7 (4.55%)
Natural Science & Pre-Health	5 (3.25%)
Other	6 (3.90%)
Prefer not to answer	21 (13.64%)

The average mental health scores were calculated for different groups. Lower mental health scores (10 being worst) indicate poor mental health, while high scores (50 being best) indicate good mental health. Of the gender category, the average mental health score for male students was higher than female students (μ =37.9 compared to μ =34.3). Ethnicity also had a difference in mental health scores with white/Caucasian individuals (μ =35.9) being slightly higher than non-white individuals (μ =35.5). On-campus participants also had a slightly higher (μ =36.2) mental health score than off-campus individuals (μ =35.0), while academic classification had a fairly even distribution of psychological distress scores. Table 3 includes the

mean and standard deviation of K10 psychological distress scores grouped by various demographic groups.

Table 3 Mental Health Scores by Demographic Group

VARIABLE	MEAN	SD
Mental Health Score Reported	35.5	8.88
Gender		_
MHS (Male)	37.9	8.75
MHS (Female)	34.3	8.80
MHS (Other)	29.0	4.97
Ethnicity		
MHS (white)	35.9	8.32
MHS (non-white)	35.5	10.5
Academic Classification		
MHS (Freshman)	36.6	7.64
MHS (Sophomore)	33.9	10.20
MHS (Junior)	36.2	9.93
MHS (Senior)	35.1	6.94
MHS (5th year+)	38.1	7.63
MHS (Graduate)	35.9	10.20
Residency		
MHS (On-Campus)	36.2	8.91
MHS (Off-Campus)	35.0	8.47

4.2 Environmental Perceptions and Safety Concerns of Respondents

For environmental perception questions, many respondents indicated higher mean scores (greater than 3.00 out of a 5-point Likert Scale), indicating positive perceptions of students' outdoor campus environment. Questions regarding quality of greenery all had very high means (4.65, 4.54, and 4.62). Respondents reported higher mean scores to questions about greenspace accessibility (μ =4.35), snowplow maintenance (μ =4.92), and plant maintenance (μ =4.64), indicating students had generally positive perceptions of these characteristics. Students answered positively to questions about outdoor seating opportunities (μ =3.48) and nighttime safety (μ =3.49), but the mean scores were relatively lower than the other variables. According to the

survey, majority of students had an overall positive perception of the quality of MSU's outdoor campus (Table 4).

Table 4 Environmental Perceptions

Variables			Ctuonaly	Diagram	Neither	Agras	Ctuonaly	Dan?4
Variables	Mean	SD	Strongly disagree (1)	Disagree (2)	(3)	Agree (4)	Strongly agree (5)	Don't know (6)
There are many planting materials on MSU's outdoor campus (e.g. trees, shrubs, flowers).	4.65	0.56	0 (0.0%)	(0.6%)	3 (1.9%)	45 (29.2%)	104 (67.5%)	0 (0.0%)
There are many green spaces on MSU's campus that I can view (e.g. open fields, wooded areas).	4.54	.66	0 (0.0%)	3 (1.9%)	5 (3.2%)	52 (33.8%)	94 (61.0%)	0 (0.0%)
I enjoy the overall appearance of my outdoor campus environment.	4.62	0.67	(0.0%)	(1.3%)	10 (6.5%)	32 (20.8%)	109 (70.8%)	(0.0%)
There are many green spaces on MSU's campus that I can access.	4.38	0.82	(0.0%)	(5.8%)	(3.9%)	54 (35.1%)	(53.2%)	(0.0%)
I live a short distance from green space on MSU.	4.06	1.18	4 (2.6%)	19 (12.3%)	17 (11.0%)	32 (20.8%)	76 (49.4%)	0 (0.0%)
There is adequate amount of seating opportunities on the MSU campus.	3.48	1.19	7 (4.5%)	35 (22.7%)	20 (13.0%)	58 (37.7%)	32 (20.8%)	0 (0.0%)
Overall, I can easily access the green space where I want to go on the MSU campus.	4.35	0.91	3 (1.9%)	5 (3.2%)	12 (7.8%)	48 (31.2%)	84 (54.5)	(0.0%)
The MSU campus's trees, shrubs, and lawns are well maintained.	4.64	0.69	(0.6%)	(1.3%)	(1.9%)	43 (27.9%)	100 (64.9%)	4 (2.6%)
The MSU campus's sidewalks and streets are kept clean.	4.29	0.95	(1.3%)	11 (7.1%)	7 (4.5%)	55 (35.7%)	77 (50.0%)	(0.6%)
The MSU campus maintains consistently snow-plowed sidewalks.	4.92	1.20	(0.6%)	(3.9%)	(7.1%)	38 (24.7%)	28 (18.2%)	69 (44.8%)
Overall, MSU's outdoor campus is well-maintained.	4.59	0.63	(0.6%)	0 (0.0%)	5 (3.2%)	50 (32.5%)	96 (62.3%)	(0.6%)
The MSU campus is safe during the day.	4.53	0.77	(0.6%)	(2.6%)	7 (4.5%)	43 (27.9%)	97 (63.0%)	(0.6%)
The MSU campus is safe at night.	3.49	1.36	(3.9%)	(24.0%)	36 (23.4%)	36 (23.4%)	23 (14.9%)	(9.1%)
Overall, I feel safe on MSU's outdoor campus.	4.22	0.81	(0.6%)	(3.2%)	16 (10.4%)	68 (44.2%)	63 (40.9%)	(0.0%)

For students' safety concerns, respondents reported lower mean scores to all questions, meaning students did not often have negative experiences on MSU's outdoor campus. These 5 questions were also based on a 5-point Likert scale ranging from never (1) to always (5). The

mean scores for how often students were injured (μ =1.23) or saw someone else injured on MSU's campus were low (μ =1.64). Mean scores for how often students experienced crime (μ =1.30) or vandalism on campus were also low (μ =1.54), meaning students did not often have these experiences. The highest average score for safety concerns was how often students see trash/litter on campus (μ =2.50). Table 5 shows the distribution of responses to safety concern questions as well as the mean and standard deviation values.

Table 5 Safety Concerns

Variables	Mean	SD	(1) Never	(2) Somewhat Often	(3) Often	(4) Very Often	(5) Always	(6) Don't know
How often have you fallen/gotten injured on MSU's outdoor campus?	1.23	0.48	119 (77.3%)	30 (19.5%)	(0.6%)	(0.6%)	(0.0%)	(0.0%)
How often do have you seen someone fall/get injured on MSU's outdoor campus?	1.64	0.71	69 (44.8%)	71 (46.1%)	8 (5.2%)	(1.3%)	(0.6%)	(0.0%)
How often do you see trash/litter on MSU's outdoor campus?	2.50	0.96	13 (8.4%)	82 (53.2%)	34 (22.1%)	17 (11.0%)	7 (4.5%)	(0.0%)
How often do you see vandalism on MSU's outdoor campus?	1.54	0.64	80 (51.9%)	63 (40.9%)	(3.9%)	(1.3%)	(0.0%)	(0.0%)
How often do you see crime on MSU's outdoor campus?	1.30	0.55	108 (70.1%)	32 (20.8%)	4 (2.6%)	(0.6%)	(0.0%)	(0.0%)

4.3 Respondents' Outdoor Activity Patterns

For outdoor physical activity on MSU's campus, participating students were questioned about their time spent walking/biking, doing physical activities, relaxing outdoors, and working outdoors. These questions were asked to students considering seasonal climate differences in Michigan (e.g. time spent in the spring, summer and fall, vs time spent during the winter). For all questions, mean scores for time spent outdoors during the winter were lower than time spent outdoors during the spring, summer, and fall. These questions were then repeated to inquire average day per week outdoors as well as minutes per day, doing each activity. Of all activities,

students reported spending more days per week walking/biking to class (μ =3.10 for spring summer and fall and μ =2.54 for winter) in all seasons than any other activity. The activity that had the lowest average days per week was working outside in both spring, summer, and fall (μ =1.91) as well as during the winter (μ =1.20).

This trend was also consistent with minutes per day spent doing each activity. The average score for minutes per day walking/biking to class was higher than any other activity with during the spring, summer, and fall (μ =3.03), and in the winter (μ =2.54). The activity that had the lowest average minutes per day spent outdoors during spring summer and fall was outdoor working (μ =2.26). For the winter season, minutes per day spent relaxing outdoors was lower than working outdoors (μ =1.16 compared to μ =1.27) (Table 6).

Table 6 Outdoor Activity Patterns

Variables	Mean	SD	(1) 0 days	(2) 1-2 days	(3) 3-4 days	(4) 5+ days
On average, how many days per week do you walk or bike to class during spring, summer, and fall?	3.10	0.92	12 (7.8%)	22 (14.3%)	58 (37.7%)	62 (40.3%)
On average, how many days per week do you walk or bike to class during winter?	2.54	1.03	28 (18.2%)	45 (29.2%)	46 (29.9%)	32 (20.8%)
On average, how many days per week do you do physical activity outdoors on campus during the spring, summer, or fall?	2.20	0.91	34 (22.1%)	72 (46.8%)	30 (19.5%)	17 (11.0%)
On average, how many days per week do you do you spend physical activity outdoors on campus during the winter?	1.56	0.71	83 (53.9%)	49 (31.8%)	16 (10.4%)	(0.6%)
On average, how many days per week do you spend sitting or relaxing outdoors on campus during the spring, summer, or fall?	2.08	0.77	34 (22.1%)	76 (49.4%)	36 (23.4%)	5 (3.2%)
On average, how many days per week do you spend sitting or relaxing outdoors on campus during the winter?	1.20	0.44	120 (77.9%)	26 (16.9%)	(1.3%)	(0.0%)
On average, how many days per week do you spend outdoors to do work during the spring, summer, or fall?	1.91	1.06	70 (45.5%)	42 (27.3%)	16 (10.4%)	20 (13.0%)
On average, how many days per week do you spend outdoors to do work during the winter?	1.20	0.58	125 (81.2%)	12 (7.8%)	4 (2.6%)	3 (1.9%)
Variables	Mean	SD	(1) 0-10 mins/day	(2) 11-20 mins/day	(3) 21-30 mins/day	(4) 30+ mins/day

Table 6. (cont'd)

On average, how many minutes per day do you walk or bike to class during spring, summer, and fall?	3.03	1.03	18 (11.7%)	24 (15.6%)	47 (30.5%)	65 (42.2%)
On average, how many minutes per day do you walk or bike to class during winter?	2.54	1.17	40 (26.0%)	32 (20.8%)	36 (23.4%)	43 (27.9%)
On average, how many minutes per day do you do physical activity outdoors on campus during the spring, summer, or fall?	2.60	1.19	42 (27.3%)	25 (16.2%)	38 (24.7%)	48 (31.2%)
On average, how many minutes per day do you do physical activity outdoors on campus during the winter?	1.74	1.06	91 (59.1%)	26 (16.9%)	16 (10.4%)	18 (11.7%)
On average, how many minutes per day do you spend sitting or relaxing outdoors on campus during the spring, summer, or fall?	2.41	1.12	44 (28.6%)	33 (21.4%)	42 (27.3%)	32 (20.8%)
On average, how many minutes per day do you spend sitting or relaxing outdoors on campus during the winter?	1.16	0.42	127 (82.5%)	17 (11.0%)	(1.9%)	0 (0.0%)
On average, how many minutes per day do you spend outdoors to do work during the spring, summer, or fall?	2.26	1.36	74 (48.1%)	9 (5.8%)	18 (11.7%)	47 (30.5%)
On average, how many minutes per day do you spend outdoors to do work during the winter?	1.27	0.80	128 (83.1%)	(1.3%)	5 (3.2%)	9 (5.8%)

4.4 Respondents' View to Nature

Students were asked if they had windows in their classrooms at MSU or at their living quarters, and if so, the number of windows they had. Majority of students reported having windows with a view to nature in their MSU classes (61.0%), as well as in their living quarters (85.7%). Of the students that have windows, the majority only had 2-3 windows in their classrooms (29.9%) while in living quarters, the majority had 1-2 windows (51.3%) (Table 7).

Table 7 Views to Nature

Variables	Yes		No		Mean	SD
In your classes at MSU, do you have a view to the outdoor environment through a window?	94 54 (61.0%) (35.1%)		1.36	0.48		
In your living quarters, do you have a view to the outdoor environment through a window?	132 (85.7%)		14 (9.1%)	1.10	0.30	
Variables	(1) 1-2 Windows	(2) 3 Wind		(3) 5+ Windows	Mean	SD
How many of your classes have views of the outdoor environment through a window?	42 (27.3%)	(46 29.9%)	5 (3.2%)	1.60	0.59

Table 7. (cont'd)

How many windows do you have in your	79	32	21	1.56	0.75
living quarters?	(51.3%)	(20.8%)	(13.6%)		

4.5 Bivariate Analyses between Student Mental Health and Different Student Groups

For this research, a series of independent samples t-tests were conducted with different groups of the demographic variables listed in Table 1. According to an independent samples t-test conducted to compare mental health scores between genders, there was a significant difference in the scores for males (M=37.93, SD=8.75) and females (M=34.33, SD=8.804) on mental health scores; t(138) = 2.36, p = 0.020. This result suggests that the difference in student mental health scores between males and females is significant, with males reporting higher mental health scores than females.

Another independent samples t-test was conducted to compare student mental health scores with and without windows in their MSU classes. There was a marginally significant difference in the scores for students *with* classroom windows (M=36.44, SD=8.06) and students *without* classroom windows (M=33.91, SD=9.99) conditions; t(143) =1.67, p = 0.097. The result suggests that the difference in mental health scores between students with and without classroom windows was significant, and students with classroom windows reported higher mental health scores.

Similarly, an independent samples t-test was conducted to compare student mental health scores with and without windows in their living quarters. There was a significant difference in the scores for students *with* windows in their living quarters (M=36.20, SD=8.22) and students *without* windows in their living quarters (M=29.62, SD=12.28) conditions; t(142) = 2.62, p = 0.010. This result suggests that the difference in mental health scores between students with living quarter windows and without living quarters windows was significant, and students with

living quarter windows reported higher mental health scores. Table 8 contains all significant independent t-test results. In addition, an ANOVA test was conducted to compare the effect of residency on student mental health. The result showed that there was a marginally significant difference between students' residency status (living off-campus versus living on campus), F(2,152) = 2.91, p=.058 (Table 9).

Table 8 T-test Results with Different Independent Groups

Comparison	Male (n=54)	Female (n=86)	
Group 1:			t
Mean	37.93	34.33	t = .020**
SD	8.75	8.80	
Comparison	Classroom Window	No Classroom Window	
Group 21:	(n=91)	(n=54)	
Mean	36.44	33.91	t = .097*
SD	8.06	9.99	
C			
Comparison	Living Quarters	Living Quarters without	
Group 31:	Living Quarters Windows (n=131)	Living Quarters without Windows (n=13)	
-	0 -		t = .010**

^{*}p<0.10; **p<0.05; ***p<0.01

 Table 9 Correlations between Student Mental Health and Residency Status

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	446.424	2	223.212	2.907	.058
Within Groups	10903.824	152	76.787		
Total	11350.248	154			

4.6 Linear Regression Analysis

To examine the correlation between students' mental health scores and the independent variables, this study ran a multiple linear regression analysis. Mental health score was a dependent variable, while 15 independent variables from environmental perceptions, outdoor physical activity, and views to nature, and two demographic variables were selected as

confounding variables, after considering multicollinearity and correlations among independent variables. For regression analysis, this study conducted a stepwise method with use probability criteria of F (entry .1 / removal .15) and took an Exclude Cases Likewise method for treating missing values. This model was statistically significant according to the ANOVA test (P<.001), and the r-square value of the model was .159. Of the 15 selected independent variables and 2 confounding variables, 4 variables significantly predicted mental health scores. Higher perceptions of safety and greenspace were both positively related to higher mental health scores. Student perceptions of safety was the most significant predictor in the model. Longer work minutes spent outdoors during the winter was negatively related to mental health scores. Gender, as a confounding variable also had a significant difference in mental health where males had higher mental health scores (Table 10).

Table 10 Final Linear Regression Model of Student Mental Health

	Unstandardized		Standardized		
	Coefficients		Coefficients		
Variables	В	Std. Error	Beta	t	sig
(Constant)	24.056	7.309		3.291	.001
Perception of Safety	2.219	.970	.208	2.287	.024
Gender	-3.304	1.529	196	-2.161	.033
Mins per day – winter work	-1.884	.916	182	-2.057	.042
Perception of Greenspace	2.286	1.169	.172	1.956	.053
Daytime Safety	-2.193	1.322	179	-1.659	.100
Dayperweek_Walk_Summer	-1.861	1.164	207	-1.599	.113
Dayperweek_Walk_Winter	1.571	1.016	.193	1.546	.125
Nighttime Safety	.801	.752	.127	1.065	.290
Residency	-1.681	1.861	101	903	.369
Living_Window_Quantity	1.000	1.139	.091	.878	.382
Overall Appearance	437	1.432	032	305	.761

CHAPTER 5. DISCUSSION AND CONCLUSIONS

Evidence from the CDC of recent dramatic increases in mental health issues among college-aged individuals illustrates the need for further investigation of possible solutions for mental health issues on campus. The results of previous studies also support the hypothesis that natural environments are beneficial to mental health and therefore support the reasoning behind the current study. According to previous studies, many variables of the natural environment have been found to have an impact on improving mental health such as perceptions of greenery (Ulrich, 1986), accessibility to greenspace (Sugiyama et al., 2008), views to nature (Li and Sullivan, 2016), and safety (Guite et al., 2006). As has been noted in previous sections, the goal of the current study is to investigate the correlations between student mental health and campus outdoor environment using the Michigan State University campus. The results of this study were consistent with the previous findings.

The results of this study reported that gender and location of student residency were the demographic variables that had significant differences in mental health scores. According to the independent samples t-test, the difference in mental health scores between males and females was significant, with males having higher (better) mental health scores. This is also consistent with other findings, where males typically have better mental health or are less likely to have psychiatric disorders (Guite et al., 2006; Hunt and Eisenberg, 2010; Stowell et al., 2021). Location of residency of students also had a significant difference in mental health scores, where students living on-campus had higher (better) mental health scores. MSU has a great quality of outdoor environments with a number of mature trees. In addition to the many large trees, the campus also contains a large number of gardens including the W.J. Beal Botanical Garden, 4 large MSU Horticulture Gardens, and many more that all act as both areas for relaxation and

opportunities for education. The campus was also certified as the most beautiful campus from the American Society of Landscape Architects (ASLA) in 1999. Based on rich natural environments in MSU, the result of student residency could indicate that an on-campus living environment with well-established natural environments may be more beneficial for enhancing students' mental health.

This study also found that there was a significant difference in the existence of windows in student classrooms and living quarters, where the presence of windows in both classrooms and living quarters had higher mental health scores. This study also found that the presence of windows in living quarters had a more significant effect on mental health than in classrooms. This is also consistent with other previous literature (Li and Sullivan, 2016), and strengthens the importance of having windows with a view to nature, especially in student living quarters. However, this study found that the quantity of windows did not have a significant relationship to student mental health, indicating that only the presence of at least one window in classrooms and living quarters is still significant.

Another major finding of this study includes the significant difference in mental health scores of the perceptions of greenspace and perceptions of campus safety. Both a greater amount of greenspace and safer campus environments were positively related to higher mental health scores. Other perceptions of the campus environment such as accessibility to greenspace and overall campus appearance had no significant effect on student mental health.

This research also found that more time spent outdoors working in the cold winter season had a negative relationship with mental health scores. This could mean that working longer hours in the winter outside has a negative effect on mental health. The Michigan climate in the winter can be quite harsh, having an average low temperature of 17 degrees Fahrenheit in January, and

an average 31-day snowfall of 5.7 inches in January in East Lansing (Cedar Lake Ventures, 2022). These harsh winter seasons could contribute to the lower mental health of students who are required to work outdoors during these months.

This research is also subject to some limitations. These include the accuracy of survey responses, due to the nature of self-reported survey design. Due to funding limitations and other factors, information was only gathered from Michigan State University students' self-reported responses to the survey and the K10 questionnaire. Students may have been less likely to report their honest answers about their mental health status with some bias in responses which may not accurately illustrate the true state of an individual's mental health. Also, responses to questions from the survey such as "I enjoy the overall appearance of my outdoor campus environment", may be skewed positively, because all participants are MSU students. As aforementioned, Michigan State University is known for having a beautiful outdoor campus with many greenspaces, and this is often a factor in how students choose their schools. This may account for most students in this study reporting higher environmental perception values. To better evaluate mental health among individuals, future investigations on this subject may consider objective measurements such as heart monitors and blood pressure monitors to quantify participants' mental health. Lastly, to better evaluate campus appearance, future investigations may consider a comparison research design with multiple college campuses with different natural environment settings.

Overall, this study contributes to a better design guideline for campus planners and designers and provides information on how to create a stress-mitigating campus environment.

Results of this study indicate a need for more windows to nature, safety, and greenspace. These aspects of the outdoor campus environment have a positive impact on mental health and

designers will be able to emphasize these factors in their future designs. From the results of this study, university designers need to ensure the presence of windows with a view to nature in both classrooms and especially living quarters. Designers also need to ensure there is an adequate amount of open greenspace for students to access on campus. By utilizing this information and implementing it into their designs, campus architects and landscape architects can help improve student mental health. University faculty will also be able to utilize the information gathered from this experiment to help inform students on how they can improve their mental health. Student advisors and counselors will be able to identify areas on their campuses that may have a positive impact on students' mental health and encourage students to access these spaces. By enhancing campus outdoor environments and helping university students improve their mental health, universities may also see an increase in graduation rates and an overall improvement in the quality of life of students.

APPENDICES

Appendix I. Survey

5/7/2021

Qualtrics Survey Software

Section 1: MSU Campus Outdoor Environment

The questions below are asking your personal environmental perceptions of MSU's outdoor campus.

Please choose the answer that best applies to your perceptions. (Check Only One)

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree	Don't Know
There are many planting materials on MSU's outdoor campus (e.g. trees, shrubs, flowers)	0	0	0	0	Ο	0
There are many green spaces on MSU's campus that I can view (e.g. open fields, wooded areas)	0	0	0	0	0	0
I enjoy the overall appearance of my outdoor campus environment.	0	Ο	0	Ο	0	0
There are many green spaces on MSU's campus that I can access (e.g., open fields, wooded areas)	0	0	0	0	0	0
I live a short distance from green space on MSU (e.g. open fields, wooded areas)	0	0	0	0	0	0
There is adequate amount of seating opportunities on the MSU campus	0	Ο	0	Ο	0	0

 $https://msu.co1.qualtrics.com/Q/EditSection/Blocks/Ajax/GetSurveyPrintPreview?ContextSurveyID=SV_0GGSSd45cvMWuIm\&ContextLibraryID=UR_14ACdj3Z... 1/13$

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree	Don't Know
	uisagiee	uisagree	uisagree	agree	agree	KIIOW
Overall, I can easily access the green space where I want to go on the MSU campus	0	0	0	Ο	Ο	0
The MSU campus's trees, shrubs, and lawns are well maintained	0	0	0	0	0	0
The MSU campus's sidewalks and streets are kept clean	0	0	0	0	Ο	0
The MSU campus maintains consistently snow-plowed sidewalks	0	Ο	0	0	Ο	0
Overall, MSU's outdoor campus is well-maintained	0	Ο	0	0	Ο	0
The MSU campus is safe during the day	0	0	0	0	0	0
The MSU campus is safe at night	0	0	0	0	0	0
There is adequate and lighting on MSU's campus (e.g. street and sidewalk lights)	0	0	0	0	Ο	0
Overall, MSU has a safe outdoor campus	0	Ο	0	0	0	0

Section 2

The questions below are asking about your personal experiences on MSU's outdoor campus.

Please choose the answer that best applies to your experiences. (Check only one)

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	Never	Somewhat Often	Often	Very Often	Always	Don't Know
How often have you fallen/gotten injured on MSU's outdoor campus?	0	0	0	0	0	0
How often do have you seen someone fall/get injured on MSU's outdoor campus?	0	0	0	0	0	0
How often do you see trash/litter on MSU's outdoor campus?	0	0	0	0	Ο	0
How often do you see vandalism on MSU's outdoor campus?	0	0	0	0	0	0
How often do you see crime on MSU's outdoor campus?	0	0	0	0	0	0

Section 3-1 - Transportation Method

The questions below are asking your **Transportation Method** - do not consider the current COVID 19 restrictions. - questions are asking in normal conditions.

On average, how many *days per week* do you walk or bike to class during spring, summer, and fall?

O 0 Days

O 1-2 Days

O 3-4 Days

O 5+ Days

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On average, how many <i>minutes per day</i> do you walk or bike to class during spring, summer, and fall?
○ 1-10 Minutes○ 11-20 Minutes○ 21-30 Minutes○ 31+ Minutes
On average, how many <i>days per week</i> do you walk or bike to class during winter? O Days 1-2 Days 3-4 Days 5+ Days
On average, how many <i>minutes per day</i> do you walk or bike to class during winter? O 0-10 Minutes O 11-20 Minutes O 21-30 Minutes O 31+ Minutes

Section 3-2 - Outdoor Physical Activity

The questions below are asking your **Physical Activity** outdoors on MSU's Campus - do not consider the current COVID 19 restrictions. - questions are asking in normal conditions.

(According to the CDC, leisure-time physical activity is described as "Exercise, sports, and physically active hobbies done in one's leisure time")

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On average, how many days per week do you do physical activity outdoors on campus during the spring, summer, or fall?
O 0 Days
O 1-2 Days
O 3-4 Days
O 5+ Days
On average, how many <i>minutes per day</i> do you do physical activity outdoors on campus during the spring, summer, or fall?
O 0-10 Minutes
O 11-20 Minutes
O 21-30 Minutes
O 31+ Minutes
On average, how many <i>days per week</i> do you do you spend physical activity outdoors on campus during the winter?
O 0 Days
O 1-2 Days
O 3-4 Days
O 5+ Days
On average, how many <i>minutes per day</i> do you do physical activity outdoors on campus during the winter?
O 0-10 Minutes
O 11-20 Minutes
O 21-30 Minutes
O 31+ Minutes

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Section 3-3 - Outdoor Relaxing Time

The questions below are asking about your **relaxation** time spent outdoors on MSU's Campus - do not consider the current COVID 19 restrictions. - questions are asking in normal conditions.

On average, how many days per week do you spend sitting or relaxing outdoors on campus during the spring, summer, or fall? O 0 Days O 1-2 Days O 3-4 Days O 5+ Days On average, how many minutes per day do you spend sitting or relaxing outdoors on campus during the spring, summer, or fall? O 0-10 Minutes O 11-20 Minutes 21-30 Minutes O 30+ Minutes On average, how many days per week do you spend sitting or relaxing outdoors on campus during the winter? O 0 Days O 1-2 Days O 3-4 Days O 5+ Days

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the winter?

On average, how many <i>minutes per day</i> do you spend sitting or relaxing outdoors on campus during the winter?
O 0-10 Minutes O 11-20 Minutes O 21-30 Minutes O 30+ Minutes
Section 3-4 - Outdoor Work Time
The questions below are asking about your time spent working outdoors.
On average, how many <i>days per week</i> do you spend outdoors to do work during the spring, summer, or fall?
O 0 Days
O 1-2 Days
O 3-4 Days
O 5+ Days
On average, how many <i>minutes per day</i> do you spend outdoors to do work during the spring, summer, or fall?
O 0-10 Minutes
O 11-20 Minutes
O 21-30 Minutes
O 30+ Minutes
On average, how many days per week do you spend outdoors to do work during

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	O 0 Days
	O 1-2 Days
	O 3-4 Days
	O 5+ Days
	On average, how many <i>minutes per day</i> do you spend outdoors to do work during the winter?
	O 0-10 Minutes
	O 11-20 Minutes
	O 21-30 Minutes
	O 30+ Minutes
	Section 4 - Viewing Time
	The questions below are asking about your visual exposure to MSU's outdoor campus and electronics.
	In your classes at MSU, do you have a view to the outdoor environment through a window?
	O Yes
	○ No
	How many of your classes have views of the outdoor environment through a window?
	O 1-2 Classes with windows
	O 3-4 Classes with windows
	O 5+ Classes with windows

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reason?

feel nervous?

During the last 30 days, about how often did you

In your living quarters, do window?	you have a	view to the	outdoor en	vironment t	hrough a
O Yes O No					
How many windows do yo	ou have in yo	our living qu	arters?		
O 1-2 O 3-4					
O 5+					
On average, how many ho phone, tablet, laptop)	urs per day	do you spe	nd looking	at a screen	? (e.g.
Section 5 - Mental Healtl	n Evaluatio	n			
The following questions ar	e asking ab	out your em	notional and	d mental we	ell-being.
	None of the Time	A Little of the Time	Some of the Time	Most of the Time	All of the Time
During the last 30 days, about how often did you feel tired out for no good	0	0	0	0	0

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	None of the Time	A Little of the Time	Some of the Time	Most of the Time	All of the Time
During the last 30 days, about how often did you feel so nervous that nothing could calm you down?	0	0	0	0	0
During the last 30 days, about how often did you feel hopeless?	0	Ο	Ο	0	0
During the last 30 days, about how often did you feel restless or fidgety?	0	Ο	Ο	0	0
During the last 30 days, about how often did you feel so restless you could not sit still?	0	Ο	0	0	0
During the last 30 days, about how often did you feel depressed?	0	0	0	0	0
During the last 30 days, about how often did you feel that everything was an effort?	0	Ο	0	0	0
During the last 30 days, about how often did you feel so sad that nothing could cheer you up?	0	Ο	Ο	0	0
During the last 30 days, about how often did you feel worthless?	0	Ο	Ο	0	0

Section 6 - Demographics

vvnat	IS	your	Gender?

O Male

O Female

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5/	O Prefer not to answer	ualtrics Survey Software
	O Troid her to allower	
	What is your age?	
	O Under 17	
	O 17-18	
	O 19-20	
	O 21+	
	O Prefer not to answer	
	What is your ethnicity?	
	O Black/African American	
	O White/Caucasian	
	O Asian	
	O Hispanic	
	Other Prefer not to answer	
	O Prefer hot to answer	
	What year are you in your university edu	cation?
	O Freshman	
	O Sophomore	
	O Junior	
	O Senior	
	O 5th year +	
	Graduate student Prefer not to answer	
	O Freier not to answer	

When attending classes, where do you live?

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5/7/2021	Qualtrics Survey Software
On campus	
Off campus	
O Prefer not to answer	
What is your Major?	
What is your nationality?	
O Domestic	
O International	
O Prefer not to answer	
	and the same of the same
	Contact Information Privacy Statement Site Accessibility Call MSU: (517) 355-1855 Visit: msu.edu
	MSU is an affirmative-action, equal-opportunity employer. Notice of Nondiscrimination SPARTANS whome bediable கொல்லால்

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Consent to Participate in Research

Thank you for your interest in participating in this research study.

This research focuses on the correlation between the Michigan State University (MSU) outdoor campus environments, and students' mental health. Your feedback will help us develop a guiding document which aims to maintain or develop future campus outdoor environments to improve students' mental health. This research may also be used in future planning of campus environments to create safer and healthier outdoor spaces.

The following survey will take about 5-10 minutes to complete. The purpose of this research is to gather information on MSU students' perception to the MSU campus environment, and study how these relationships may impact their mental health. The following survey will question your opinions, experiences, and daily usage of the MSU outdoor campus environment, as well as your mental health. While you will be asked to share some demographic information, all information gathered will be completely confidential and kept anonymous. Your participation in this research is voluntary, and you will not be penalized or lose benefits if you refuse to participate or decide to stop.

If you have concerns or questions about this study, please contact to Mallory Koning (koningma@msu.edu), or Dr. Jun-Hyun Kim (junhkim@msu.edu).

If you have questions or concerns about your role and rights as a research participant, would like to obtain information or offer input, or would like to register a complaint about this study, you may contact, anonymously if you wish, the Michigan State University's Human Research Protection Program at 517-355-2180, Fax 517-432-4503, or e-mail irb@msu.edu or regular mail at 4000 Collins Rd, Suite 136, Lansing, MI 48910.

By clicking on the button below, you indicate your voluntary agreement to participate in this online survey.

MICHIGAN STATE

EXEMPT DETERMINATION Revised Common Rule

July 7, 2021

To: Jun Hyun Kim

Re: MSU Study ID: STUDY00006418

Principal Investigator: Jun Hyun Kim

Category: Exempt 2(i)

Exempt Determination Date: 7/7/2021 Limited IRB Review: Not Required.

Title: Outdoor Campus Environments and Mental Health of MSU Students

This study has been determined to be exempt under 45 CFR 46.104(d) 2(i).

Principal Investigator (PI) Responsibilities: The PI assumes the responsibilities for the protection of human subjects in this study as outlined in Human Research Protection Program (HRPP) Manual Section 8-1, Exemptions.



Office of Regulatory Affairs Human Research Protection Program

> 4000 Collins Road Suite 136 Lansing, MI 48910

517-355-2180 Fax: 517-432-4503 Email: <u>irb@msu.edu</u> www.hrpp.msu.edu Continuing Review: Exempt studies do not need to be renewed.

Modifications: In general, investigators are not required to submit changes to the Michigan State University (MSU) Institutional Review Board (IRB) once a research study is designated as exempt as long as those changes do not affect the exempt category or criteria for exempt determination (changing from exempt status to expedited or full review, changing exempt category) or that may substantially change the focus of the research study such as a change in hypothesis or study design. See HRPP Manual Section 8-1, Exemptions, for examples. If the study is modified to add additional sites for the research, please note that you may not begin the research at those sites until you receive the appropriate approvals/permissions from the sites.

Please contact the HRPP office if you have any questions about whether a change must be submitted for IRB review and approval.

New Funding: If new external funding is obtained for an active study that had been determined exempt, a new initial IRB submission will be required, with limited exceptions. If you are unsure if a new initial IRB submission is required, contact the HRPP office. IRB review of the new submission must be completed before new funds can be spent on human research activities, as the new funding source may have additional or different requirements.

Reportable Events: If issues should arise during the conduct of the research, such as unanticipated problems that may involve risks to subjects or others, or any

MSU is an affirmative-action,

problem that may increase the risk to the human subjects and change the category of review, notify the IRB office promptly. Any complaints from participants that may change the level of review from exempt to expedited or full review must be reported to the IRB. Please report new information through the study's workspace and contact the IRB office with any urgent events. Please visit the Human Research Protection Program (HRPP) website to obtain more information, including reporting timelines.

Personnel Changes: After determination of the exempt status, the PI is responsible for maintaining records of personnel changes and appropriate training. The PI is not required to notify the IRB of personnel changes on exempt research. However, he or she may wish to submit personnel changes to the IRB for recordkeeping purposes (e.g. communication with the Graduate School) and may submit such requests by submitting a Modification request. If there is a change in PI, the new PI must confirm acceptance of the PI Assurance form and the previous PI must submit the Supplemental Form to Change the Principal Investigator with the Modification request (available at hrpp.msu.edu).

Closure: Investigators are not required to notify the IRB when the research study can be closed. However, the PI can choose to notify the IRB when the study can be closed and is especially recommended when the PI leaves the university. Closure indicates that research activities with human subjects are no longer ongoing, have stopped, and are complete. Human research activities are complete when investigators are no longer obtaining information or biospecimens about a living person through interaction or intervention with the individual, obtaining identifiable private information or identifiable biospecimens about a living person, and/or using, studying, analyzing, or generating identifiable private information or identifiable biospecimens about a living person.

For More Information: See HRPP Manual, including Section 8-1, Exemptions (available at hrpp.msu.edu).

Contact Information: If we can be of further assistance or if you have questions, please contact us at 517-355-2180 or via email at IRB@msu.edu. Please visit hrpp.msu.edu to access the HRPP Manual, templates, etc.

Exemption Category. The full regulatory text from 45 CFR 46.104(d) for the exempt research categories is included below. ¹²³⁴

Exempt 1. Research, conducted in established or commonly accepted educational settings, that specifically involves normal educational practices that are not likely to adversely impact students' opportunity to learn required educational content or the assessment of educators who provide instruction. This includes most research on regular and special education instructional strategies, and research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

Exempt 2. Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview

procedures, or observation of public behavior (including visual or auditory recording) if at least one of the following criteria is met:

- (i) The information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects;
- (ii) Any disclosure of the human subjects' responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation; or
- (iii) The information obtained is recorded by the investigator in such a manner that the identity of the human subjects can readily be ascertained, directly or through identifiers linked to the subjects, and an IRB conducts a limited IRB review to make the determination required by 45 CFR 46.111(a)(7).
- **Exempt 3.** (i) Research involving benign behavioral interventions in conjunction with the collection of information from an adult subject through verbal or written responses (including data entry) or audiovisual recording if the subject prospectively agrees to the intervention and information collection and at least one of the following criteria is met:
 - (A) The information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects;
 - (B) Any disclosure of the human subjects' responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation; or
 - (C) The information obtained is recorded by the investigator in such a manner that the identity of the human subjects can readily be ascertained, directly or through identifiers linked to the subjects, and an IRB conducts a limited IRB review to make the determination required by 45 CFR 46.111(a)(7).
 - (ii) For the purpose of this provision, benign behavioral interventions are brief in duration, harmless, painless, not physically invasive, not likely to have a significant adverse lasting impact on the subjects, and the investigator has no reason to think the subjects will find the interventions offensive or embarrassing. Provided all such criteria are met, examples of such benign behavioral interventions would include having the subjects play an online game, having them solve puzzles under various noise conditions, or having them decide how to allocate a nominal amount of received cash between themselves and someone else.

(iii) If the research involves deceiving the subjects regarding the nature or purposes of the research, this exemption is not applicable unless the subject authorizes the deception through a prospective agreement to participate in research in circumstances in which the subject is informed that he or she will be unaware of or misled regarding the nature or purposes of the research.

Exempt 4. Secondary research for which consent is not required: Secondary research uses of identifiable private information or identifiable biospecimens, if at least one of the following criteria is met:

- (i) The identifiable private information or identifiable biospecimens are publicly available;
- (ii) Information, which may include information about biospecimens, is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained directly or through identifiers linked to the subjects, the investigator does not contact the subjects, and the investigator will not re-identify subjects;
- (iii) The research involves only information collection and analysis involving the investigator's use of identifiable health information when that use is regulated under 45 CFR parts 160 and 164, subparts A and E, for the purposes of ``health care operations" or ``research" as those terms are defined at 45 CFR 164.501 or for ``public health activities and purposes" as described under 45 CFR 164.512(b); or
- (iv) The research is conducted by, or on behalf of, a Federal department or agency using government-generated or government-collected information obtained for nonresearch activities, if the research generates identifiable private information that is or will be maintained on information technology that is subject to and in compliance with section 208(b) of the E-Government Act of 2002, 44 U.S.C. 3501 note, if all of the identifiable private information collected, used, or generated as part of the activity will be maintained in systems of records subject to the Privacy Act of 1974, 5 U.S.C. 552a, and, if applicable, the information used in the research was collected subject to the Paperwork Reduction Act of 1995, 44 U.S.C. 3501 et seq.

Exempt 5. Research and demonstration projects that are conducted or supported by a Federal department or agency, or otherwise subject to the approval of department or agency heads (or the approval of the heads of bureaus or other subordinate agencies that have been delegated authority to conduct the research and demonstration projects), and that are designed to study, evaluate, improve, or otherwise examine public benefit or service programs, including procedures for obtaining benefits or services under those programs, possible changes in or alternatives to those programs or procedures, or possible changes in methods or levels of payment for benefits or services under those programs. Such projects include, but are not limited to, internal studies by Federal employees, and studies under contracts or consulting arrangements, cooperative agreements, or grants. Exempt projects also include waivers of otherwise mandatory requirements using

authorities such as sections 1115 and 1115A of the Social Security Act, as amended. (i) Each Federal department or agency conducting or supporting the research and demonstration projects must establish, on a publicly accessible Federal Web site or in such other manner as the department or agency head may determine, a list of the research and demonstration projects that the Federal department or agency conducts or supports under this provision. The research or demonstration project must be published on this list prior to commencing the research involving human subjects.

Exempt 6. Taste and food quality evaluation and consumer acceptance studies: (i) If wholesome foods without additives are consumed, or (ii) If a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the Food and Drug Administration or approved by the Environmental Protection Agency or the Food Safety and Inspection Service of the U.S. Department of Agriculture.

Exempt 7. Storage or maintenance for secondary research for which broad consent is required: Storage or maintenance of identifiable private information or identifiable biospecimens for potential secondary research use if an IRB conducts a limited IRB review and makes the determinations required by 45 CFR 46.111(a)(8).

Exempt 8. Secondary research for which broad consent is required: Research involving the use of identifiable private information or identifiable biospecimens for secondary research use, if the following criteria are met:

- (i) Broad consent for the storage, maintenance, and secondary research use of the identifiable private information or identifiable biospecimens was obtained in accordance with 45 CFR 46.116(a)(1) through (4), (a)(6), and (d);
- (ii) Documentation of informed consent or waiver of documentation of consent was obtained in accordance with 45 CFR 46.117:
- (iii) An IRB conducts a limited IRB review and makes the determination required by 45 CFR 46.111(a)(7) and makes the determination that the research to be conducted is within the scope of the broad consent referenced in paragraph (d)(8)(i) of this section; and
- (iv) The investigator does not include returning individual research results to subjects as part of the study plan. This provision does not prevent an investigator from abiding by any legal requirements to return individual research results.

¹Exempt categories (1), (2), (3), (4), (5), (7), and (8) cannot be applied to activities that are FDA-regulated.

² Each of the exemptions at this section may be applied to research subject to subpart B (Additional Protections for Pregnant Women, Human Fetuses and Neonates Involved in Research) if the conditions of the exemption are met.

³ The exemptions at this section do not apply to research subject to subpart C (Additional Protections for Research Involving Prisoners), except for research aimed at involving a broader subject population that only incidentally includes prisoners.

⁴ Exemptions (1), (4), (5), (6), (7), and (8) of this section may be applied to research subject to subpart D (Additional Protections for Children Involved as Subjects in Research) if the conditions of the exemption are met. Exempt (2)(i) and (ii) only may apply to research subject to subpart D involving educational tests or the observation of public behavior when the investigator(s) do not participate in the activities being observed. Exempt (2)(iii) may not be applied to research subject to subpart D.

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