A Randomized Controlled Trial of Virtual Forest Bathing on Depression, Anxiety, Stress, Heart Rate and Blood Pressure in an Elderly Population



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A Randomized Controlled Trial of Virtual Forest Bathing on Depression, Anxiety, Stress, Heart Rate and Blood Pressure in an Elderly Population

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Abstract

Forest bathing, a tradition of Japanese culture also known as *Shinrin-yoku*, involes leisurely walking through a natural setting in which an individual remains calm and attentive to the environment around them (Li et al., 2016, Li et al., 2007). Forest bathing has demonstrated a wide variety of beneficial health effects (Detweiler et al., 2008; Lee et al., 2011;Li et al., 2016), and elderly individuals, especially those living in assisted living facilities, are less likely to be able to access outdoor environments. This study aimed to investigate the potential benefits virtual forest bathing may have on resting cardiovascular activity and symptoms of depression, anxiety, and stress. Participants were randomized to either the Forest Condition or Urban Condition and blood pressure, heart rate, and Depression, Anxiety, and Stress (DASS) scores were taken at both Time 1 and Time 2. As evaluated by six 2 (Condition: Forest or Urban) X 2 (Time: Time 1 or Time 2) mixed model ANOVAs, the study's findings did not support the main hypothesis that the Forest Condition would experience greater reductions in blood pressure, heart rate, and DASS scores. Unexpectedly, the Urban Condition displayed a 12 mmHg systolic blood pressure decrease. Although the study was limited, the results indicated virtual reality may be of benefit to those unable to access outdoor environments.

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Nature plays a much larger role in human health than previously appreciated; immersion in nature can help develop feelings of connection to the natural world (Stevens, 2010) which is increasingly lacking (Howell et al., 2010; Logan et al., 2012). The field of ecopsychology, which studies the beneficial relationship between humans and the natural world, introduces an idea known as the *biophilia hypothesis* (Hartig et al., 2011). This hypothesis proposes the idea that human beings have an innate physiological and psychological drive to connect with nature (Hartig et al., 2011; Stevens, 2010). Therefore, in order for individuals to achieve higher levels of happiness and improved health they must look to the natural world to do so (Hartig et al., 2011; Grinde and Patil, 2009).

Shrinin-yoku, a Japanese tradition also known as forest bathing, incorporates the *biophilia hypothesis* into Japan's foundation of preventive medicine (Hansen et al., 2017;Li et al., 2016). Forest bathing involves leisurely walking through natural settings while mindfully using the five senses (Hansen et al., 2017). Forest bathing has exhibited a number of health benefits on the cardiovascular system (Hansen et al., 2017) such as reduction of blood pressure (Li et al., 2016; Park et al., 2010; Tsunetsugu et al., 2007) and reduced pulse rate (Lee et al., 2011; Li et al., 2016; Park et al., 2010; Tsunetsugu et al., 2007). Forest bathing has also shown improvement of mood (Hansen et al., 2017) including increases of self-esteem (Bedard et al., 2003) and positive feelings (Lee et al., 2011) such as "comfortable" (Tsunetsugu et al., 2007), "calm" (Tsunetsugu et al., 2007), "refreshed" (Tsunetsugu et al., 2007) and "vigor" (Li et al., 2016), as well as decreased negative feelings (Lee et al., 2011) such as depressive symptoms (Li

et al., 2016; Maas et al., 2009), fatigue (Li et al., 2016), anxiety (Bratman et al., 2015; Li et al., 2016; Maas et al., 2009), confusion (Li et al., 2016), and stress (Tyrvainen et al., 2013; Yamaguchi et al., 2006). Natural environments have also led to lower mortality rates in whole populations (Mitchell and Popham, 2008) as well as the elderly (Kabish et al., 2017). Therefore increasing access to green environments has potential to improve individual's overall health outcomes (Mitchell and Popham, 2008).

Elderly individuals, especially those who find themselves in nursing care facilities due to age-related decline, often experience a decrease in their quality of life (QOL) (Barnes, 2006; Clare et al., 2013; Figueira et al., 2008; Motteran et al., 2016). QOL is a multidimensional concept used to capture well-being by assessment of physical, mental, social, and psychological health (CDC 2016), and a higher QOL is associated with a greater feeling of happiness (Susniene and Jurkauskas, 2009). QOL can be affected by varying states of stress (Colović et al., 2009), depression (Moore et al., 2005), and anxiety (Mogotsi et al., 2000) as well as medical conditions such as rheumatoid (Sokoll and Helliwell, 2001), obesity (Schwimmer et al., 2003), cancer (Littlewood et al., 2011), and coronary heart disease (Thompson and Yu, 2003). One major structural brain change that occurs during aging is overall reduced brain volume (Bishop et al., 2010) and increased ventricle size (Bishop et al., 2010) which contributes to a decrease in myelinated fibers that connect different cortical regions leading to less communication between brain areas and ultimately resulting in less higher-order cognitive function (Bishop et al., 2010). In addition, aging adults have an increase in gene expression involved in the stress-response pathway which can disrupt hypothalamic regulation (Bishop et al., 2010). Newly admitted residents often experience the onset or worsening of depression (Beekman et al., 2000; Kramer et

al., 2009; Ulbricht et al., 2016), anxiety (Beekman et al., 2000; Ulbricht et al., 2016), and pain (Ulbricht et al., 2016) due to the life changes they are facing (Ulbricht et al., 2016).

Consequently, forest bathing appears to be a potential solution. However, the idea lacks practicality as elderly individuals may not be able to practice forest bathing due to reduced muscle strength (Keller and Engelhardt, 2013; Milanovic et al., 2013), body-fat percentage (Milanovic et al., 2013; St-Onge and Gallagher, 2010), flexibility (Milanovic et al., 2013), agility (Milanovic et al., 2013), and endurance levels (Milanovic et al., 2013).

According to the United States 2010 Census, the percentage of individuals 65 years and older experienced an increase of 15.1% since the last census, almost double the percentage the overall population increased (Brandon, 20120). The elderly currently make up 13% of the population, which is the largest percentage this age group has ever represented in the overall population (Brandon, 2012). The increasing number of older individuals raises concerns involving the availability and efficiency of long-term care resources (Knickman and Snell, 2002). A crucial aspect of caring for the elderly will be looking for new and effective ways to keep them as healthy as possible (Knickman and Snell, 2002). The present study aims to explore the potential of natural virtual reality to demonstrate health benefits similar to natural environments.

Literature Review

Nature as a Solution

An increasing amount of literature supporting the *biophilia hypothesis* exists (Li et al., 2016; Park et al., 2010; Tsunetsugu et al., 2007). Regardless of demographic characteristics, nature helps individuals feel better emotionally and physically (Li et al., 2016; Park et al., 2010; Tsunetsugu et al., 2007). Performance benefits include increased concentration after walking in the park (Taylor and Kuo, 2009), decreased ADHD symptoms after completing after school activities outside instead of inside (Taylor and Kuo, 2004), increased interpersonal skills (Bedard et al. 2003), and increased memory (Bratman et al., 2015). Biological changes include increases in parasympathetic activity (Lee et al., 2011; Park et al., 2010; Tsunetsugu et al., 2007) and decreases in sympathetic nerve activity (Lee et al., 2011; Park et al., 2010; Tsunetsugu et al., 2007). Specifically, reduction of pulse rate (Lee et al., 2011; Li et al., 2016; Park et al., 2010; Tsunetsugu et al., 2007), reduction of blood pressure (Park et al., 2010; Tsunetsugu et al., 2007), decreased urinary adrenaline (Li et al. 2016), decreased urinary dopamine (Li et al., 2016), decrease in blood glucose levels (Ohtsuka et al., 2008), increases in serum adiponectin (Li et al., 2016), increased natural killer cell activity (Li et al., 2007), increases in telomere length (Woo et al., 2009), more constant salivary amylase activity (Yamaguchi et al., 2006), and lower salivary cortisol levels (Lee et al., 2011; Park et al., 2007; Park et al. 2010; Tsunetsugu et al., 2007).

Depression

Although it is common to feel sadness in response to an event, prolonged states of feeling worthlessness and guilt can be diagnosed as depression (Bear et al., 2016). Depressive symptoms include disturbance of mood, loss of interest, sleeping disturbances, difficulty concentrating, and

change in appetite (Bear et al., 2016; Singh and Gotlib, 2014). Disruption of the hypothalamic-pituitary-adrenal (HPA) axis is associated with depression (Bear et al., 2016). Cortisol typically activates hippocampal glucocorticoid receptors which leads to inhibition of the HPA axis (Bear et al., 2016). However, individuals who experience depressive symptoms experience a disruption of this feedback process due to fewer present glucocorticoid receptors (Bear et al., 2016). The increased activation of the HPA axis leads to increased blood cortisol levels (Bear et al., 2016). Functional brain imaging has also led to the understanding that individuals suffering from depression also have increased anterior cingulate cortex activity (Bear et al., 2016; Sacher et al., 2012) as well as under activation of frontal brain areas (Singh and Gotlib 2014). Depression is also associated with physical changes in the brain. Abnormalities most consistently refer to reduced volume of the hippocampus (Cole et al., 2011, McKinnon et al., 2009; Norbury et al., 2013; Singh and Gotlib, 2014; Suzuki et al., 2013). Decreases in gray matter of the amygdala (Kerestes et al., 2013; Sacher et al., 2012; Singh and Gotlib, 2014) have also been observed but are not consistent when examining patients also taking medications for anxiety disorder (Singh and Gotlib, 2014).

Forest bathing has shown to combat depressive symptoms (Chun et al., 2017; Lee et al., 2016; Li et al., 2016; Shin et al., 2012). A group of middle-aged men who walked for 80 minutes in the Akasawa Natural Recreation Forest displayed lower scores of depression on a Japanese version of the Profile of Mood States (POMS) the morning after the walk (Li et al., 2016). Another group of participants randomized to stay overnight at a forest site or a urban hotel also displayed benefits from the natural environment (Chun et al., 2017). In fact, while participants who stayed at the forest site scored lower on the Beck Depression Inventory, Hamilton Depression Rating Scale, and State-Trait Anxiety Inventory, participants who stayed at the urban

hotel actually scored higher on the State-Trait Anxiety Inventory (Chun et al., 2017). Participants suffering from alcoholism who participated in a 9-day forest therapy program also scored lower on the Beck Depression Inventory (Shin et al., 2012). The use of only forest sounds has also shown to lower depressive symptoms (Lee et al., 2016); the brain waves of individuals who self-reported depression were compared to individuals who did not exhibit symptoms of depression and listening to forest sounds, specifically birds chirping, moved brain waves to high bandwidth by 47.5% (Lee et al., 2016). Chun et al., 2017 believes forest therapy may be a viable option for individuals suffering from major depression that have not been responsive to other pharmacological and electroconvulsive therapies.

Anxiety

Although fear is a normal momentary response to stressors, fear that is not adaptive or appropriate is categorized as anxiety (Bear et al., 2016; National Institute of Mental Health, 2016). Anxiety stems from hyperactivity of the amygdala (Bear et al., 2016), decreased activity of the hippocampus (Bear et al., 2016) and increased prefrontal cortex activity (Bear et al., 2016; Morey et al., 2008). Stronger feelings of connection to nature was correlated with lower levels of anxiety (Martyn and Brymer, 2016) and forest bathing has also been found to alleviate anxiety-related symptoms (Li et al., 2016). Participants who walked for 80 minutes in the Akasawa Natural Recreation Forest and had lower depression scores after the walk, also had lower anxiety scores on the POMS (Li et al., 2016). Guan et al., 2017 studied if tree type had an effect on the alleviation of anxiety symptoms by having participants walk through either a birch, maple, and oak forest. Interestingly enough, participant weight was correlated with anxiety scores, and those with larger body weights were found to experience more alleviation of anxiety symptoms (Guan

et al., 2017). Furthermore, females were found to have the biggest decrease in anxiety when walking in the oak forest (Guan et al., 2017). These results are important considering little has been explored about what specific aspects of the forest are beneficial.

Stress

Stress is defined as an experience of biochemical, physiological, and behavioral changes that occur in the body in response to a situation and is more commonly known as the feeling a person experiences when a demand exceeds their resources, whether real or perceived (Baum, 1990; Holmes and Rahe, 1967). Although stress is accompanied by uneasy emotions and physiological responses, stress can be beneficial as acute stress can function as motivation. In animals, stress can lead to increased hippocampal neurogenesis by simulating astrocytes to release additional levels of fibroblast growth factor 2 (Kirby et al., 2013); this growth factor was not previously known to act as a contributor to neuron growth but seems to assist with nerve cell proliferation and reduced levels have been found in individuals with depression (Sanders, 2013). Chronic stress, however, reduces neuron production by secreting glucocorticoid stress hormones (Sanders, 2013).

Chronic stress has a wide range of negative effects on the human body, affecting the musculoskeletal (Barzideh et al., 2012), cardiovascular (Cohen et al., 2007), endocrine (Ranabir and Reetu1, 2011), both male and female reproductive systems (Sharma et al., 2013) and the nervous system (American Psychological Association, 2012). In the body, the stress response is mediated by the HPA axis, which regulates cortisol secretion from the adrenal cortex (Bear et al., 2016). Chronic stress leads to continuous disregulated activation of the HPA axis (Harvard Health, 2011) and cortisol build up can lead to a variety of disorders such as anxiety due to an

increased spine density of amygdala neurons and overall greater amygdala volume (Radley et al., 2015) as well as an inhibited feedback loop of the HPA axis that contributes to depression (Radley et al., 2015). In addition, hippocampal neuronal function may be disrupted after years of chronic stress that disconnects the communication between the hippocampus and hypothalamus (Bishop et al., 2010).

Forest bathing can also lead to stress reduction (Jung et al., 2015; Morita et al., 2007). Participants who spent 1 day in a forest environment and 1 day in a control environment exhibited lower State-Trait Anxiety Inventory scores when in the forest environment (Morita et al., 2007), and health care workers who spent 3 days and 3 nights at a Forest Therapy camp scored lower on both the Maslach Burnout Inventory-General Survey and Worker's Stress Response Inventory than those who stayed at the control camp.

Cardiovascular Health

Blood pressure is a physiological measurement of the force that blood flow exerts on the arteries as the heart pumps (National Heart, Lung, and Blood Institute, 2015). The measurement is expressed by two units: systolic pressure, which is the pressure exerted while the heart is contracted and diastolic pressure, which is the pressure exerted by the blood while the heart is at rest (National Heart, Lung, and Blood Institute, 2015). The Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure-8 (JNC-8) has established guidelines for ideal blood pressure such that goal systolic blood pressure ≥140–159 mmHg and diastolic blood pressure ≥90–99 mmHg as high blood pressure is associated with hypertension, the leading cause of cardiovascular morbidity and mortality (Makridakis & DiNicolantonio, 2014). Heart rate, measured as the number of times the heart beats per minute,

has also been associated with cardiovascular risk as raised resting heart rate (>70bpm) is a primary risk factor for coronary artery disease and chronic heart failure (Böhm et al., 2010).

Forest bathing has also demonstrated beneficial effects on blood pressure, which is important to explore because a positive correlation exists between hypertension and cognitive decline (Novak and Hajjar, 2010) and blood pressure variability may further lead to cognitive decline (Behnam et al., 2013). In a study aimed to explore the relationship between forest bathing and stress, participants walked in two different settings, either a forest setting or urban setting, for 30 minutes for 7 consecutive days (Grazuleviciene et al., 2015). After the intervention was completed, individuals who walked in the forest environment displayed a 2.4 mmHg decrease in diastolic blood pressure (Grazuleviciene et al., 2015). A similar study looked at the influence of proximity to a park and found that participants' blood pressure increased by 9% every 300m away from the park (Grazuleviciene et al., 2014). Views of natural environments have also displayed cardiovascular benefits, as participants who sat in a room with a view of trees displayed larger diastolic blood pressure reductions that those who sat in a room with no view (Hartig et al., 2003)

Proposed Explanations

Although a large amount of research surrounding the benefits of forest bathing exists, it remains poorly understood exactly why or how forest bathing works. The Attention-Restoration Theory (ART) proposes that urban environments, which are built with high levels of arousal-increasing properties, lead to fatigue due to too much directed attention (Felston, 2008). Neural inhibitory mechanisms tire due competing stimuli (Felston, 2008). In comparison, natural environments, which include lower levels of intensity, can lead to better concentration (Taylor and Kuo, 2008).

Several neurophysiological changes may also be responsible for the healing power of forest bathing. Forest bathing mimics two types of meditation: focused attention meditation (FAM) and open monitoring meditation (OM) (Lippelt et al., 2014). FAM (Lippelt et al., 2014) involves sustaining attention on a specific mental or sensory object, such as the breath or a candle flame or in the case of forest bathing, the trees or running water or the sound of shoes against the forest floor. The focus on only the desired stimulus can inhibit the mind from wandering. It has been demonstrated to heighten attentional control, increase meta-awareness, improve sensory clarity, and improve an individual's ability to regulate thoughts (Raffone & Srinivasan, 2009; Vago and Silbersweig, 2012; Dahl et al., 2016). OM (Lippelt et al., 2014) encourages the practitioner to be aware of the surrounding environment, sensations, and feelings, but not to attentively focus on a specific item or sensation. OM should be a continuous acceptance of new stimulus that is passed through the mind but does not linger (Lippelt et al., 2014). One observes the stimulus, but does so non-judgmentally. This ongoing consumption of stimulus trains the practitioners to be more efficient at distributing their attentional focus, have increased conflict monitoring, and reduced attentional blink (Raffone and Srinivasan, 2010). These results suggest that this mindfulness meditation practice can help individuals to more efficiently process stimuli (Lippelt et al., 2014) around them and better allocate their attentional resources (Lippelt et al., 2014).

Mind-wandering, engaging in thoughts that are irrelevant to current task goals and otherwise known as daydreaming, has been associated with increased activity of the Default Mode Network (DMN) in the brain (Mittner et al. 2016). A 2010 study on 2250 adults' found that regardless of the task they were engaged in participants reported mind-wandering 46.9% of the time (Killingsworth and Gilbert, 2010). When compared with mood, participants were less happy

when they were daydreaming, even if they were having pleasant thoughts (Killingsworth and Gilbert, 2010). Rumination, focusing on negative thoughts, also leads to negative emotions (Bratman et al., 2015). Walking in a forest environment for as short as 90 minutes has been associated with decreases in rumination by decreasing subgenual prefrontal cortex activity (sgPFC) (Bratman et al., 2015). Higher levels of activation in this area are associated with mental illnesses such as anxiety (Bratman et al., 2015) and depression (Bratman et al., 2015). Reduced activation in this area could be associated with improved mood and decrease in depressive symptoms of those who spend more time in nature settings (Bratman et al., 2011). Increased sgPFC activity has also been associated with DMN activity in patients suffering with major depressive disorder (Hamilton et al., 2015), suggesting that nature environments decrease depressive symptoms by reducing both DMN and sgPFC activity.

Individuals practicing forms of meditation have also displayed beneficial neurological structural changes such as reduction of right basolateral amygdala gray matter density (Hozel et al., 2009) and reduced amygdala activity (Taren et al., 2015). Meditation has also led to reduced levels of proinflammatory cytokine interleukin 6 (IL-6) (Creswell et al., 2016), which can decrease risk for depression (Kiecolt-Glaser and Glaser, 2012). Therefore, it is possible that forest bathing leads to health benefits because much like meditation it has the capability to make structural and functional changes in the brain.

In order to further explore what regions of the brain were involved in natural scene recognition, individuals were shown a series of images including beaches, forests, highways, industries, and mountains at varying levels of resolution (Walther et al., 2009). There was increased activity of the Parahippocampal Place Area (PPA), although the right PPA was more active than the left PPA (Walther et al., 2009). There was also increased activity of the Lateral

Occipital Complex (LOC), which has been shown to activate during moments of identifying other objects (Walther et al., 2009). The Retrosplenial Cortex (RSC) was most active when determining scenes rather than individual objects (Walther et al., 2009). Overall, this study suggests that communication between the PPA, LOC, and RSC play a role in detecting nature scenes and provides neurophysiological evidence for the *biophilia hypothesis*.

Nature as a Virtual Reality Intervention

Images of natural scenes and objects can elicit health benefits similar to forest bathing (Igarashi et al., 2015; Laumann et al., 2002). A group of females were shown either a real plant or a picture of a plant and both groups of participants indicated increased feelings of comfort and relaxation (Igarashi et al., 2015). After viewing a video of either a natural or urban environment, participants who viewed the natural environment had a lower heart rate than those who viewed the urban video (Laumann et al., 2002). Muscular tension, pulse, skin temperature, and fear also decreased when participants were shown videos of natural environments (Felsten, 2009; Louv, 2008)

In 2008 a group of 92 students from Oberlin College participated in a study designed to assess whether virtual forest settings would have the same benefits as real nature settings on positive affect and ability to reflect on life problems (Mayer et al., 2008). Participants reported feeling more positive in the forest group than the urban group (Mayer et al., 2008). Although these results suggest that a virtual forest may have as many benefits as a real forest, the results from a study conducted in 2014 challenge that idea. Groups of men and women were shown 6 minute 3-D videos of walking through forests with different tree densities in order to explore the dose-response curve of stress and nature (Jiang et al., 2014). Women displayed no significant

relationship between stress reduction and tree density but men did (Jiang et al., 2014). Men in environments with 0%-24% tree density experienced an increase in stress reduction and no change in stress once reaching a tree density of 34% (Jiang et al., 2014).

Whether or not the benefits of nature can be reciprocated in a virtual environment remains poorly understood. This idea is important especially considering the need for new interventions for the elderly population in a nursing care environment (Knickman and Snell, 2002) and elderly treated with antihypertensive drugs have displayed greater progression in cognitive decline (Mossello et al., 2015). Therefore, even if the virtual reality forest did not have as great of an improvement as real nature settings, any improvement of mood or decrease in blood pressure would be beneficial. In addition, Li et al., 2016 reported no difference between the urban and forest settings in terms of blood pressure, but the lack of difference was attributed to the differences in temperature: lower in the forest setting and higher in the urban setting.

Research based on virtual reality interventions has begun over the past 10 years and poses no threat to the participant's; virtual reality studies have helped soldiers with symptoms of PTSD (Rizzo, 2014), amputee’s phantom pain (Ortiz-Catalan et al., 2014), and other psychological disorders (North and North, 2016). Overall, the present study aimed to investigate the potential benefits a virtual forest bathing condition may have on resting cardiovascular activity and symptoms of depression, anxiety, and stress in an elderly population of residents of assisted living and community members.

Hypotheses

I. Prior to the virtual reality, there would be no difference between DASS scores, heart rate, and blood pressure of participants randomly assigned to either the Forest Bathing Condition or the Urban Condition at Time 1.

II.There would be a reduction at Time 2 of the Forest Bathing Condition and Urban Condition DASS scores, heart rate, and blood pressure from Time 1.

III. The reduction of the DASS scores, heart rate, and blood pressure would be greater in the group randomly assigned to the Forest Bathing Condition than the Urban Condition.

Methods

Design

This study was a randomized controlled trial and was approved by the Allegheny College Institutional Review Board on December 5, 2017.

Recruitment

Assisted living facilities in north western Pennsylvania were contacted by the researcher. Administrators expressing interest in the study were followed up with the study's methods and those choosing to participate were given approval forms (Appendix A). Community members also residing in north western Pennsylvania were recruited verbally.

Participant Criteria

The Director of Nursing at each facility ensured eligible residents exhibited no signs of severe cognitive impairment (e.g. Severe Dementia or diagnosed Alzheimer's Disease). Additional criteria included being a full-time resident of the facility and Power of Attorney consent (Appendix B). Both residents and community members possessed the ability to provide informed consent as well as complete questionnaires independently.

Confidentiality

Participant data was kept confidential by using identification numbers instead of names. Only the student researcher and faculty advisor had access to the data. Individual participant data was not discussed with administration, employees, or any other residents of the facility. In addition, only averages were reported in the final paper.

Virtual Reality Conditions

Participants were randomized to one of two conditions; the Forest Bathing Condition acted as the experimental condition, and the Urban Condition acted as the control condition. Participants randomized to the Forest Bathing Condition watched a virtual reality video that simulated walking through the Schenley Park Trail in Pittsburgh, Pennsylvania (Appendix C). Participants randomized to the Urban Condition watched a virtual reality video that simulated walking through the streets of Pittsburgh, Pennsylvania (Appendix D). The Forest Bathing Condition and Urban Condition virtual reality videos were recorded on two days, October 8th 2017 and October 10th 2017, that exhibited similar mostly sunny weather conditions. Both conditions were recorded between the hours of 10 A.M. and 12 P.M. in order to maintain

consistent lighting. The researcher attempted to exclude as many pedestrians in the videos as possible in order to omit the variable of social interaction.

The Forest Bathing and Urban Conditions were both recorded using a Canon Powershot SX30 IS. The recorded footage was uploaded to iMovie and edited to play as a split screen view, meaning the same video played through both the left and right visual lenses. The final versions were uploaded to YouTube in order to be accessed from any smartphone device.

The participants watched the conditions on a Google Cardboard Viewer (Appendix E), a virtual reality platform made of cardboard with a back flap that straps any smartphone into the viewer; the smartphone can access any split screen video to begin the virtual reality immersion. The viewer has two lenses and two side flaps that concentrate the participants' field of vision on the video playing as well as an adjustable velcro strap to hold the viewer on the participant's head.

Experimental Procedure

At Time 1, residents (Appendix F) and community members (Appendix G) were asked to sign a consent form and fill out 2 different questionnaires: either a demographic questionnaire for residents (Appendix H) or a demographic questionnaire for community members (Appendix I) and the Depression, Anxiety, and Stress Scale (DASS) (Psychology Foundation of Australia 2014) (Appendix J). Filling out the questionnaires took no more than 10 minutes per participant. After completion of the questionnaires the participant was asked to sit still for 1-2 minutes in order to record their initial blood pressure. Their blood pressure was recorded with an Omron BP742N 5 Series Upper Arm Blood Pressure Monitor and their systolic and diastolic measurements were recorded in an Google Drive Excel Sheet on the researcher's computer. After

the recording the resident was asked to sit in a relaxed position and watch a 5 minute video of the randomly assigned Condition.

At Time 2, one day after time 1, participants used the Google Cardboard viewer to watch 10 minutes of the same condition they watched at Time 1. After the video was completed, the participant's final blood pressure was taken and they were asked to fill out 2 final questionnaires: the DASS (Appendix K) and an exit questionnaire (Appendix L). At the completion of the study the participant was given a debriefing form (Appendix M), which was also made available for the Power of Attorneys. All participants were given an opportunity to choose from a basket of items including fuzzy socks and candy.

Measurements

Assessment of Resting Cardiovascular Activity.

In order to observe the potential effects of the Conditions on resting cardiovascular activity, blood pressure was measured at Time 1 and Time 2 using an auscultatory technique. An Omron BP742N 5 Series Upper Arm Blood Pressure Monitor was chosen because upper arm monitors give more reliable systolic and diastolic readings than the oscillatory method of using wrist monitors due to wrist anatomy and inability to efficiently occlude the artery (Parati et al., 2002), especially in patients 65 years and older (Landgraf et al., 2010).

Assessment of Depression, Anxiety, and Stress

The Depression, Anxiety, and Stress Scale (DASS) is a 21 item questionnaire that quantifies symptoms of depression, anxiety, and stress. There are 7 questions for each scale and 2-5 of those questions include repeated material. Participants were asked to respond to each

question by choosing a number from 0-3 that applied to them during the past two days and their final score was by finding the total of each category and multiplying by 2 (Appendix N). Levels of severe depression, anxiety, and stress exist in ranges of 21-27, 15-19, and 36-33, respectively (Psychology Foundation of Australia, 2014). The DASS-21 has been utilized in several studies and has been found to be reliable as well as a valid assessment of depression, anxiety, and stress in elderly participants (Clara et al., 2001; Henry and Crawford, 2005; Wood et al., 2010).

Statistical Analysis

All statistics were run on JMP Pro 12 (JMP®, Version *Pro 12*. SAS Institute Inc., Cary, NC, 1989-2007). Before testing the hypotheses, data were analyzed to verify the assumptions of the analysis of variance (ANOVA): randomness, independence, normality, and homogeneity of variance. Further, in order to observe if either the Forest Condition or Urban Condition led to a decrease in depression, anxiety, or stress, participants with Time 1 scores of 0 for depression (N=7), anxiety (N=3), and stress (N=3) were removed from further analysis. Samples were random and independent because participants were chosen at random and assigned to a condition by a random number generator. Shapiro-Wilk tests were run to test for normality (Appendix O). All attempts to transform non-normal data were made, including taking the ln [y+1] for data equal to 0. F-tests were run to test for homogeneity of variance (Appendix P), although mixed model ANOVAs are robust for violating homogeneity when samples sizes are similar (Erceh-Hurn and Mirosevich, 2008).

Results

Demographic information, facility duration, mobility status, and nature exposure of participants is shown in Table 1. In order to test the first hypothesis that there was no difference between Conditions for DASS scores, heart rate, and blood pressure at Time 1, six unpaired *t*-tests were conducted (Table 2). As can be seen, means for depression, stress, heart rate, systolic blood pressure and diastolic blood pressure at Time 1 were not different between Conditions. However, anxiety scores at Time 1 were significantly higher in the Forest Condition.

To test the second hypothesis that condition means for DASS scores, heart rate, and blood pressure would decline from Time 1 to Time 2, and the third hypothesis that participants in the Forest Bathing Condition would show greater reductions in DASS scores, heart rate, and blood pressure from Time 1 to Time 2, six 2 (Condition: Forest or Urban) X 2 (Time: Time 1 or Time 2) mixed model ANOVAs were run; the between subjects factor was Condition and the within subjects factor was Time.

As expected, main effects of Time were found for all DASS scores: depression (Table 3), anxiety (Table 4), and stress (Table 5), demonstrating that Time 2 scores for the whole sample were lower than Time 1 (Table 6). A main effect of condition was only found for anxiety, and Urban Condition means were lower than the Forest Condition. However, considering Forest Condition anxiety means started higher at Time 1 this was somewhat expected.

No main effects or interactions were observed for Heart Rate (Table 7) and a significant Condition X Time interaction was found for Diastolic Blood Pressure, however post-hoc testing revealed no statistical significance (Table 8).

No main effects of Time or Condition were found for Systolic Blood Pressure (Table 9). However, a significant crossover Condition X Time interaction was found (Figure 1). The Urban

Condition means for systolic blood pressure were unexpectedly lower at Time 2 than Time 1 thereby not supporting the *biophilia hypothesis* that the Forest Condition would improve mood and reduce resting heart rate and blood pressure.

The Urban Condition served as the control group for the study, but since it surprisingly lowered systolic blood pressure the exit survey results were further explored. An unpaired *t*-test ($t(22)=4.91$, $p<0.0001$) suggested participants randomized to the Urban Condition ($M=4.64$, $SD=0.25$) enjoyed it significantly more than those randomized to the Forest Bathing Condition ($M=3.00$, $SD=0.23$). A chi-square test ($x^2(1)=0.04$, $P=0.498$) further suggested those randomized to the Urban Condition had a higher probability to answer 'yes' to using the google cardboard virtual reality viewer in their daily life than those randomized to the Forest Condition.

Discussion

Interpretation of Findings

The primary goal of this study was to explore if the demonstrated health benefits of natural environments would be similarly observed in natural virtual reality among older individuals less likely to readily access outdoor natural environments. Relevant literature was explored and helped inform the study's hypotheses that there would no difference between the Forest Bathing Condition and Urban Condition DASS scores, heart rate, and blood pressure at Time 1, there would be a reduction at Time 2 in the Forest Bathing Condition and Urban Condition DASS scores, heart rate, and blood pressure from Time 1, and the reduction of the DASS scores, heart rate, and blood pressure would be greater in the Forest Bathing Condition than the Urban Condition.

As expected, a main effect of time was observed for all DASS scores, showing that the Whole Sample's anxiety scores decreased from mild to normal. Unexpectedly, the results failed to support the main hypothesis as the Urban Condition, which served as the control group, lowered the Whole Sample's systolic blood pressure.

Considering the Urban Condition displayed a decrease in systolic blood pressure but not the Forest Condition, an alternative mechanism such as the brain-behavioral system may have affected vascular activity. Individuals have varying levels of brain-behavioral systems to regulate behavior (Alillo et al., 2010; Farshid et al., 2015; Fayazi and Hasani, 2017; Sadeghi et al., 2013). The behavioral activation system (BAS) activates in the presence of reward and the behavioral inhibition system (BIS) activates in the presence of aversive stimuli (Fayazi and Hasani, 2017; Simons et al., 2009). The brain areas associated with BAS activation are the mesolimbic and mesocortical dopamine projections (Fayazi and Hasani, 2017) and the BIS activation is associated with the connection between the hippocampus and the amygdala (Fayazi and Hasani, 2017). Due to environmental factors and life experience, an individual's BAS or BIS can be more likely to respond to a situation (Fayazi and Hasani, 2017; Hundt et al., 2006; Simons et al., 2009). Individuals with a more active BIS often experience anxiety (Farshid et al., 2015; Fayazi and Hasani, 2017; Gray and McNaughton, 2000) and are hypersensitive to fear and sadness (Gray and McNaughton, 2000). When hypertensive individuals with a more active BAS were shown a series of stressor and pleasant pictures, they displayed lower systolic blood pressure when shown the pleasant pictures than the hypertensive individuals with a more active BIS (Sadeghi et al., 2013). Participants in the current study were not evaluated for BAS/BIS but it is possible those randomized to the Urban Condition were more likely to experience a decrease in systolic blood pressure from Time 1 to Time 2 because they had a more dominant BAS. In addition, although

not statistically different, those in the forest condition experienced a systolic blood pressure increase of 12 mmHg from Time 1 to Time 2, suggesting they may have had a more dominant BIS as those with more BIS activation experience higher blood pressure and heart rates (Sadeghi et al., 2013).

In addition it is not without possibility that participants simply enjoyed the Urban Condition more than the Forest Bathing Condition. Engaging in relatively enjoyable activities has shown to lower blood pressure (Jeon et al., 2009; Taubert et al., 2003) and increase brain activity (Abujelala et al., 2016; Hurless et al., 2013). For example, elderly participants consumed 100g of dark chocolate per day over a 14-day period which led to a 5 mmHg decrease systolic in blood pressure (Taubert et al., 2003), and elderly women listening to music twice a week for two weeks displayed a 7.5 mmHg decrease of diastolic blood pressure (Jeon et al., 2009). In addition, participants listening to their preferred genre of music displayed a 0.6 μV increase of alpha wave amplitude (Hurless et al., 2013) and participants playing their preferred video game displayed increased frontal theta activity ($t(13774) = 62.69$, $p < .001$) (Abujelala et al., 2016). Participants enjoyed the Urban Condition, which involved surrounding activity such as crossing through traffic, moving cars, construction zones, and passing an array of buildings, more than the Forest Bathing Condition, which displayed walking on a continuous path with a similar view of trees and foliage for the duration of the video. The researcher also noted participants in the Urban Condition verbally reacted in a more positive way during the virtual reality viewing more so than the Forest Bathing Condition in which several participants asked when the video would be over. Future research should aim to capture data related to the hedonic value or ratings by participants to better understand how enjoyment influences physiology.

Furthermore, although attempts were made to exclude as many pedestrians as possible from both virtual reality conditions, there were still several individuals that appeared in the Urban Condition. The increased social interaction may have contributed the Urban Condition decrease in systolic blood pressure since positive social interaction has documented benefits on multiple domains of health (Chung, 2013; Eisenberger and Cole, 2012; Kawachi and Berkman, 2001; Newman and Roberts, 2013; Nielson et al., 2014; Umberson and Montez, 2010). The human body interprets social disconnection as a potential threat, and the central nucleus of the amygdala responds innately by increasing SNS activity (Eisenberger and Cole, 2012) and blood pressure (Eisenberger and Cole, 2012). Elderly participants who reported feeling higher levels of loneliness (Hawkley et al., 2006) and lower amounts of social interaction (Sneed and Cohen, 2014; Yang et al. 2014) were both found to have increased systolic blood pressure. Hawkley et al., 2006 found a positive correlation between loneliness and systolic blood pressure; participants who scored high on the UCLA Loneliness Scale exhibited systolic blood pressures ranging from 160-200 mmHg (Hawkley et al., 2006) in comparison to participants with low loneliness scores who had systolic blood pressures around 120-130 mmHg (Hawkley et al., 2006). A neuroendocrine effect may be responsible for the increase in blood pressure, as those with higher levels of loneliness in older adults has been associated with higher levels of epinephrine (Hawkley et al., 2006). Epinephrine binds to alpha receptors on the endothelium and contributes to vasoconstriction which can lead to increases systolic blood pressure (Hawkley and Cacioppo, 2007). In addition, elderly individuals experiencing loneliness have also been found to have higher levels of of overnight epinephrine levels further indicating loneliness may increase SNS activity (Hawkley et al., 2006).

Likewise to cardiovascular health, social interaction has additional health benefits for an older population. For example, a sample of 823 older participants were followed for 4 years and those with more social interaction were less likely to develop Alzheimer's disease (Wilson et al., 2007) as well as have better cognitive function (Wilson et al., 2007), and a separate sample of 131 elderly participants who self-reported loneliness showed less depressive symptoms (Heikkinen and Kauppinen, 2004). Therefore, it is possible that personal enjoyment as well as the social aspect of the Urban Condition could have contributed to the decrease in systolic blood pressure and perhaps a more engaging Forest Bathing Condition could have also displayed a decrease in blood pressure. Future research should continue to examine these phenomena given both the increasing prevalence of hypertension (CDC, 2017) and loneliness (Beutel et al., 2017) among Americans, which has been described as having more potential negative effects than smoking (Holt-Lunstad et al., 2015).

Although the effect size of the decrease in systolic blood pressure was small (η_p^2=0.03) this decrease could be important in a clinical setting. Some of the most common medications used to lower blood pressure include ACE inhibitors (Morgan et al., 2011), calcium blocking inhibitors (Morgan et al., 2011), diuretics (Chen et al., 2009; Musini et al., 2015; Morgan et al., 2011) and beta blockers (Morgan et al., 2011) which lower systolic blood pressures on average by 8mmHg, 15mmHg, 13mmHg, and 5mmHg, respectively (Morgan et al., 2011). The Urban Condition led to a decrease in systolic blood pressure of 12mmHg which exceeds both ACE inhibitors and beta blockers. Since no participants reported negative effects such as nausea or dizziness, urban virtual reality could evolve as a new method to decrease hypertension and improve aspects of well-being in elderly.

Limitations

The current study is not without limitations. The sample size of this study included *N*=25 participants which may be considered relatively small. Although a number of studies also surrounding forest bathing included similar samples sizes of *N*=12 (Li et al. 2006) and *N*=19 (Li et al. 2016), a larger samples size would reduce the impact of individual participant's responses on the group mean scores. In addition, previous studies on forest bathing were done on largely male populations (Lee et al., 2010; Li et al., 2006; Li et al., 2016) and 82% of participants in the present study were female. The relationship between cardiovascular health and age remains inconclusive as elderly women have shown to have both lower rates (Daughtery et al., 2011) and higher rates (Chu et al., 2015) of hypertension control, but a sample with more balanced gender would have been a better representation of the larger population.

The design of the study included the Depression, Stress, and Anxiety Scale (DASS) which is a 21-item questionnaire answered on a scale from 0-3. Upon completion of the surveys, the researcher noted a large majority of the participants struggled with understanding how to rate their feelings. A more appropriate questionnaire may have incorporated yes or no responses instead of a likert scale. In addition, participants also had a difficult time reflecting on the past week or two day time period when answering the questions. Participants often vocally spoke about specific situations in their lifetime or other various occurrences that affected all of their answers.

Furthermore, upon scoring the questionnaires the researcher noticed a disproportionate number of participants answered “3” for item number 2 which related to dryness of mouth at both Time 1 and Time 2. The demographic and exit survey did not collect information related to medications, and considering dryness of mouth is a common side effect of age (Leal et al., 2010) ,

anti-inflammatory medications (Ohara et al., 2011), pain relief medications (Ohara et al., 20101), antidepressants (Scully and Felix, 2005) and antihypertensives (Scully and Felix, 2005) as well as dementia medications (Leal et al., 2010), this could have influenced the increased Time 2 anxiety score. In addition, the demographic and exit survey also did not collect current diagnoses of the participants. In a study similar to the present study, participants with diagnosed Coronary Artery Disease were randomized to either walking in a park or city for 30 minutes for 7 days (Grazuleviciene et al., 2015). Those randomized to the park experienced 2.4 mmHg decrease in diastolic blood pressure compared to those randomized to the city who experienced a 4 mmHg increase in blood pressure (Grazuleviciene et al., 2015). It is possible that the participants of the current study had not developed coronary heart disease and therefore an improvement was not able to take place.

Limitations may also include the method in which blood pressure was measured. Although the researcher made attempts to increase reliability (Landgraf et., al 2010; Parati et al., 2002) by using an arm cuff (Omron BP742N 5 Series Upper Arm Blood Pressure Monitor) instead of a wrist monitor, multiple measurements were not obtained. Elderly, especially those with declining cognitive ability, often exhibit higher blood pressure variability throughout the day (Behnam et al., 2013; Brickman et al., 2010; Oishi et al., 2017), therefore multiple pressures taken over several days before and after the experiment may have been a more accurate representation. Finapress measures continuous blood pressure (Birch, 2007) and would also improve understanding of the relationship between virtual reality and blood pressure. In addition, the researcher did not account for the possibility of the white coat effect, which is when individuals display a higher blood pressure in a medical setting in comparison to a home setting (Manios et al., 2008; Thomas et al., 2016). A more accurate blood pressure may have been recorded by

involvement of the nursing staff at the assisted living facilities, and self-report of the community participants. Since the nursing staff at assisted living facilities often take the residents' blood pressure for their own medical records the resident's may have displayed a more accurate blood pressure than with the researcher.

Further limitations may also include the selected sample of participants. Participants had a difficult time sitting back and refraining from talking during the video about various thoughts and ideas they were having. Perhaps the Forest Condition could still be beneficial to particiapants who were more able to direct their attention to the task at hand. However, Detweiler et al., 2008 did find that the addition of a wander garden to a dementia facility led to an improved quality of life for the residents.

Limitations may also include the duration of the experiment. Due to time constraints this study was an acute intervention and a long term repeated exposure may have been able to display other benefits. However, other studies conducted on forest bathing also utilized acute interventions (Lee et al., 2010;Li et al., 2006;Li et al., 2016).

Finally, the study looked at group mean averages in order to assess whether the forest bathing or urban condition had a statistically relevant effect. However, in a clinical setting not all individuals find benefit from the same medications and treatments. Analyzing individual participants' DASS scores, heart rates, and blood pressures may have given the researcher the opportunity to see if particular individual benefitted from one condition over the other.

Future Work

Despite the limitations and lack of support for the study's main hypothesis, the results found are supporting factors for the *biophilia hypothesis* because virtual reality was unable to

recreate the benefits of nature. A very recent study published March 2018 aimed to explore if a virtual nature experience could reduce anxiety and agitation in individuals with dementia and found that the nature exposed group displayed reductions but they were not significant (Reynolds et al. 2018). A similar study found that nature scenes did not significantly improve dementia patient's behavioral aspects, including hitting, yelling, screaming, cursing, and throwing oneself onto the floor (Chung et al. 2016). Therefore, the present study suggests virtual nature settings are not beneficial for older populations. Additional studies on the topic of virtual reality must be continued in order to better assess the role of virtual nature and health. Directions for future work could include the possibility of developing an interactive virtual reality system in which the participating were fully immersed in settings with hedonic value to participants. Participants could wear headphones to maximize immersion and direct attention to the condition.

References

Abujelala, M. Abellanoza, C., Sharma, A. Makedon, F. (2016). Brain-EE: Brain Enjoyment Evaluation using Commercial EEG Headband. In Proceedings of the 9th ACM International Conference on PErvasive Technologies Related to Assistive Environments (PETRA '16). ACM, New York, NY, USA, Article 33, 5 pages. DOI: https://doi-org.ezproxy1.allegheny.edu/10.1145/2910674.2910691

Aliloo, M., Bayrami, M., Sogolotappeh, F. (2010). Relationship between Behavioral Inhibition and Activation Systems and Personality Disorders with Coronary Heart Disease. *Medical Journal of Tabriz University of Medical Sciences,* 32(4), 20.

American Medical Association. (2012). Stress in America: Our Health at Risk. Retrieved from https://www.apa.org/news/press/releases/stress/2011/final-2011.pdf

Barnes, S. (2006). Space, Choice and Control, and Quality of Life in Care Settings for Older People. *Environment and Behavior,* 38(5), 589–604.

Barzideh, M., Choobineh, A., Tabatabaee, H. (2012). Job stress dimensions and their relationship to musculoskeletal disorders in Iranian nurses. *Work*, 47, 423–429.

Baum, A. (1990). Stress, intrusive imagery, and chronic distress. *Health Psychology*, 9(6):653-75.

Bear, M., Connors, B., Paradiso, M. (2016). Neuroscience: Exploring the Brain - 4th Edition. China: Wolters Kluwer

Bedard, R., Rosen, L., Vacha-Haase, T. (2003). Wilderness therapy programmes for juvenile delinquents: a meta-analysis. *Journal of Therapeutic Wilderness Camping*, 3, 7-13.

Beekman, A., Beurs, E., van Balkom, A., Deeg, D., van Dyck, R., Tilburg, W. (2000). Anxiety and Depression in Later Life: Co-Occurrence and Communality of Risk Factors. *The American Journal of Psychiatry,* 157(1), 89-95

Behnam, S.,Wijsman, L., Foster-Dingley, J., Stott, D., Ford, I., Bucklet, B., Sattar, N., Jukema, J., Osch, M., van der Grond, J., van Buchem, M., Westendorp, R., de Craen, A., Mooijaart, S. (2013). Association of visit-to-visit variability in blood pressure with cognitive function in old age: prospective cohort study. *British Medical Journal,* 347, 1-11.

Beutel, M., Klein, E., Brahler, E., Reiner, I., Junger, C., Michal, M., Wiltink, J., Wild., P., Munzel, T., Lackner, K., Tibubos. (2017). Loneliness in the general population: prevalence, determinants and relations to mental health. *BMC Psychiatry*, 17, 97

Birch, T. (2007). Continuous non-invasive blood pressure measurements. Retrieved from http://www.maths-in-medicine.org/uk/2007/blood-pressure/

Bishop, N., Lu, T., Yanker, B. (2010). Neural mechanisms of ageing and cognitive decline. *Nature, 464(7288), 529-535.*

Brandon, E. (2012). 65-and-Older Population Soars. *U.S. News and World Report*. Retrieved from https://money.usnews.com/money/retirement/articles/2012/01/09/65-and-older-population-soars

Bratman, G., Daily, G., Levy, B., Gross, J. (2015). The benefits of nature experience: Improved affect and cognition. *Landscape and Urban Planning,* 138, 41-50

Bratman, G., Hamilton, P., /hahn, K., Daily, G., Gross, J. (2015) Nature experience reduces rumination and subgenual prefrontal cortex activation.

Brickman, A., Reitz, C., Luchsinger, J., Manly, M., Schpuf, N., Muraskin, J., DeCarli, Brown, T., Mayeux, R. (2010). Long-term Blood Pressure Fluctuation and Cerebrovascular Disease in an Elderly Cohort, *Journal of American Medical Association*, 67(5), 564-569.

Böhm, M., Swedberg, K., Komajda, M., Borer, J. S., Ford, I., Dubost-Brama, A., & Tavazzi, L. (2010). Heart rate as a risk factor in chronic heart failure (SHIFT): The association between heart rate and outcomes in a randomised placebo-controlled trial. *The Lancet, 376*(9744), 886-94.

Cella, D. (1994). Quality of life: Concepts and definition. *Journal of Pain and Symptom Management*, (9)3, 186-192.

Center for Disease Control and Prevention. (2013). Long-Term Care Services in the United States: 2013 Overview. Retrieved from https://www.cdc.gov/nchs/data/nsltcp/long_term_care_services_2013.pdf

Center for Disease Control and Prevention. (2016). Health-Related Quality of Life. Retrieved from https://www.cdc.gov/hrqol/concept.htm

Center for Disease Control and Prevention. (2017). High Blood Pressure. Retrieved from https://www.cdc.gov/bloodpressure/index.htm

Chen, J., Heran, B., Wright, J. (2009) Blood pressure lowering efficacy of diuretics as secondline therapy for primary hypertension. *Cochrane Database of Systematic Reviews*, 4.

Chiba, S., Numakawa, T., Ninomiya, M., Richards, M., Wakabayashi, Kunuhi, H. (2012). Chronic restraint stress causes anxiety- and depression-like behaviors, downregulates glucocorticoid receptor expression, and attenuates glutamate release induced by brain-derived neurotrophic factor in the prefrontal cortex. *Progress in Neuro-Psychopharmacology and Biological Psychiatry,* 39(1), 112-119.

Chu, S., Baek, J., Kim, E., Stefani, K., Lee, W., Park, Y., Youm, Y., Kim, H. (2015). Gender Differences in Hypertension Control Among Older Korean Adults: Korean Social Life, Health, and Aging Project. Journal of Preventive Medicine and Public Health, 48(1), 38–47.

Chun, M., chang, M., Lee, S. (2017). The effects of forest therapy on depression and anxiety in patients with chronic stroke. *International Journal of Neuroscience*, 127(3). 199-203.

Chung, J. (2013). Social Networking in Online Support Groups for Health: How Online Social Networking Benefits Patients. *Journal of Health Communication*, 19:6, 639-659.

Chung, J., Choi, S., Kim, J. (2016). Experience of media presentations for the alleviation of agitation and emotional distress among dementia patients in a long-term nursing facility. *Dementia*, 15(5), 1021-1033.

Clara, I., Cox, B., Enns, M. (2001). Confirmatory factor analysis of the Depression-Anxiety-Stress Scales in depressed and anxious patients. Journal of *Psychopathology and Behavioral Assessment*, 23, 61-67.

Clare, L., Whitaker, R., Woods, T., Quinn, C., Jelley, H., Hoare, Z., Woods, J., Downs, M., Wilson, B. (2013). AwareCare: a pilot randomized controlled trial of an awareness-based staff training intervention to improve quality of life for residents with severe dementia in long-term care settings. *International Psychogeriatrics,* 25(1), 128-39.

Cohen, S., Janicki-Deverts, D., Miller, G. (2007). Psychological Stress and Disease. *Journal of the American Medical Association,* 298(14), 1685–1687.

Cole, J., Costafreda, S., McGuffin, P., Fu, C. (2011). Hippocampal atrophy in first episode depression: a meta-analysis of magnetic resonance imaging studies. Journal of affective disorders, 134, 483–487.

Colović, O., Lecić-Tosevski D, Mandić V, Tosković O. (2009). The impact of stress related disorders on quality of life. *Psychiatria Danubina,* 21(2), 199-205.

Creswell, J., Taren, A., Lindsay, E., Greco, C., Gianaros, P., Fairgrieve, A., Marsland, A., Brown, K., Way, B., Rosen, R., Ferris, J. (2016). Alterations in Resting-State Functional Connectivity Link Mindfulness Meditation With Reduced Interleukin-6: A Randomized Controlled Trial. *Society of Biological Psychiatry,* 80, 53-61.

Dahl, C. J., Lutz, A., & Davidson, R. J. (2015). Reconstructing and deconstructing the self: cognitive mechanisms in meditation practice. *Trends in Cognitive Sciences, 19*(9), 15-523.

Eisenberger, N. and Cole, S. (2012). Social neuroscience and health: neurophysiological mechanisms linking social ties with physical health. *Nature Neuroscience,* 15(5), 669-674.

Erceh-Hurn, D. and Mirosevich, V. (2008). Modern Robust Statistical Methods. *American Psychologist,* 63(7), 591-601.

Farshid, A., Jarfar, H., Vida, O., Saber, S. (2015). Brain-Behavioral Systems and Psychological Distress in Patients with Diabetes Mellitus; A Comparative Study. *Caspian Journal of Neurological Sciences*, 1(2): 20-29.

Fayazi, M. and Hasani, J. (2017). Structural relations between brain-behavioral systems, social anxiety, depression and internet addiction: With regard to revised Reinforcement Sensitivity Theory (r-RST). *Computers in Human Behavior*, 72, 441-448

Felston, G. (2008). Where to take a study break on the college campus: An attentional restoration theory perspective. *Jounral of Environmental Psychology*, 29, 160-167.

Figueira, H., Figueira, J., Mello, D., Dantas, E. (2008). Quality of life throughout aging. *Acta Medica Lituanica*, 15(3), 169-172.

Grazuleviciene, R., Vencloviene, J., Kubilius, R., Grizas, V., Dedele, A., Grazulevicius, T., Ceponiene, I., Tamuleviciute-Prasciene, E., Nieuwenhuijsen, M., Jones, M., Gidlow, C. (2015). The Effect of Park and Urban Environments on Coronary Artery Disease Patients: A Randomized Trial. *BioMedical Research International*, 2015, 1-9.

Grazuleviciene, R., Dedele, A., Danilevicjute, A., Vencoviene, J., Grazulevicius, T., Andrusaityte, S., Uzdanaviciute, I., Nieuwenhuijsen, M. (2014). The Influence of Proximity to City Parks on Blood Pressure in Early Pregnancy. *International Journal of Environmental Research and Public Health,* 11(3), 2958-2972.

Gray, J. and McNaughton, N. (2000). *The neuropsychology of anxiety*. New York: Oxford University Press.

Grinde, B. and Patil, G. (2009). Biophilia: Does Visual Contact with Nature Impact on Health and Well-Being? *International Journal of Environmental Research and Public Health,* 6(9), 2332-2343

Guan, H., Hongxu, W., Zingyuan, H., Ren, Z., An, B. (2017). The tree-species-specific effect of forest bating on perceived anxiety alleviation of young-adults in urban forests. *Annals of Forest Research*, 60(2). 327-341.

Hamilton, J., Farmer, M., Fogelman, P., Gotlib, I. (2015). Depressive Rumination, the Default-Mode Network, and the Dark Matter of Clinical Neuroscience. *Biological Psychiatry,* 78(4), 224-230

Hansen, M., Jones, R., Tocchini, K. (2017). Shinrin-Yoku (Forest Bathing) and Nature Therapy: A State-of-the-Art Review. *International Journal of Environmental Research and Public Health,* 14(8), 851.

Hartig, T., Evans, G., Jamner, L., Davis, D., Garling, T. (2003). Tracking restoration in natural and urban field settings. *Journal of Environmental Psychology,* 23(2), 109-123.

Hartig, T., van den Berg, A., Hagerhall, C., Tomalak, M., Bauer, N., Hansmann, R., Ojala, A., Syngollitou, E., Carrus, G. (2011). Health benefits of Nature Experience: Psychological, Social and Cultural Processes. In Nilsson, K., Sangster, M., Gallis, C., Hartig, T., De Vries, S., Seeland, K. and Schipperijn, J. (2010). *Forest, trees and human health*. (pp. 127-168). Houten, Netherlands: Springer

Hawkley, L., Masi, M., Berry, D., and Cacioppo, J. (2006). Loneliness is a unique predictor of age-related differences in systolic blood pressure.Psychology and Aging, 21(1), 152-164.

Hawkley, L. and Cacioppo, J. (2007). Aging and Loneliness: Downhill Quickly? *Current Directions in Psychological Science*, 16(4), 187-191.

Henry, J., and Crawford, J. (2005). The short-form version of the Depression Anxiety Stress Scales (DASS-21): Construct validity and normative data in a large non-clinical sample. *British Journal of Clinical Psychology*, 44, 227-239.

Holt-Lunstad, J., Smith, T., Baker, M., Harris, T., Stephenson, D. (2015). Loneliness and Social Isolation as Risk Factors for Mortality: A Meta-Analytic Review. *Perspectives on Psychological Science*, 10(2), 227 - 237.

Holmes T., Rahe, R. (1967). The social readjustment rating scale. *Journal of Psychosomatic Research*, 11(2), 213-218.

Hölzel, B., Carmody, J., Evans, K., Hoge, E., Dusek, J., Morgan, L., Pitman, R., Lazar, S. (2009). Stress reduction correlated with structural changes in the amygdala. *Social Cognitive and Affective Neuroscience,* 5, 11-17.

Hölzel, B. K., Lazar, S. W., Gard, T., Schuman-Olivier, Z., Vago, D. R., & Ott, U. (2011). How Does Mindfulness Meditation Work? Proposing Mechanisms of Action From a Conceptual and Neural Perspective. Perspective Psychological Sciences, 6(6), 537-539.

Howell, A., Dopko, R., Passmore, H., and Buro, K. (2011). Nature connectedness: Associations with bell-being and mindfulness. *Personality and Individual Differences*, 51, 166-171.

Hundt, N., Nelson-Gray, R., Kimbrel, N., Mitchell, J., Kwapil, T. (2007). The interaction of reinforcement sensitivity and life events in the prediction of anhedonic depression and mixed anxiety-depression symptoms . *Personality and Individual Differences*, 43, 1001-1012.

Ijarashi, M., Song, C., Ikei, H., Miyazaki. (2015). Effect of Stimulation by Foliage Plant Display Images on Prefrontal Cortex Activity: A Comparison with Stimulation sing Actual Foliage

Plants. *Journal of Neuroimaging*, 25(1), 127-130.

Jeon, E., Kim, S., Yoon, H. (2009). Effects of Music Therapy and Rhythmic Exercise on Quality of Life, Blood Pressure and Upper Extremity Muscle Strength in Institution-Dwelling Elderly Women. *Journal of Korean Academy of Nursing*, 39(6), 829-839.

Jiang, B., Chang, C., Sullivan, W. (2014). A dose of nature: Tree cover, stress reduction, and gender differences. *Landscape and Urban Planning*, 132, 26-36.

Jung, W., Woo, J. Ryu, J. (2015). Effect of a forest therapy program and the forest environment on female workers' stress. *Urban Forestry & Urban Greening,* 14(2), 274-281.

Kabish, N., van ben Bosh, M., Lafortezza, R. (2017).The health benefits of nature-based solutions to urbanization challenges for children and the elderly – A systematic review. *Environmental Research*, 159, 362-373.

Kawachi, I. and Berkman, L. (2001). Social ties and mental health. *Journal of Urban Health*, 78(3). 458-467.

Keller, K. and Engelhardt, M. (2013). Strength and muscle mass loss with aging process: age and strength loss. *Muscles, Ligaments, and Tendons Journal*, 3(4), 346-350.

Kerestes, R., Davet, C., Stephanou, K., Whittle, S., Harrison, B. (2013). Functional brain imaging studies of youth depression: A systematic review. *NeuroImage clinical*, 209-231.

Killingsworth, M. A., & Gilbert, D. T. (2010). A Wandering Mind Is an Unhappy Mind. *Science,* 330, 932.

Kirby, E., Muroy, S., Sun, W., Covarrubias, D., Leong, M., Barchas, L., Kaufer, D. (2013). Acute stress enhances adult rat hippocampal neurogenesis and activation of newborn neurons via secreted astrocytic FGF2. *eLife*

Knickman, J. and Snell, E. (2002). The 2030 Problem: Caring for Aging Baby Boomers. *Health Services Research,* 37(4), 849-884.

Kramer, D., Allgaier, A., Fejtkova, S., Mergl, R., Hegerl, U. (2009). Depression in nursing homes: prevalence, recognition, and treatment. *International Journal of Psychiatry in Medicine , 39(4), 345-358.*

Landgraf, J., Wishner, S., Kloner, R. (2010). Comparison of Automated Oscillometric Versus Auscultatory Blood Pressure Measurement. *The American Journal of Cardiology*, 106(3), 386-388.

Laumann, K., Garling, T., and Stormark, K. (2002). Selective attention and heart rate responses to natural and urban environments. *Journal of Environmental Psychology*, 23, 125-134.

Leal, S., Bittar, J., Portuga, A., Palaco, D., Faber, J., Zanotta, P. (2010). Medication in elderly people: its influence on salivary pattern, signs and symptoms of dry mouth. *Gerodontology*, 27, 129-133.

Lee, A. and Maheswaran, R. (2011) The health benefits of urban green spaces: a review of the evidence. *Journal of Public Health,* 33(2), 212-222.

Lee, J., Park, B. J., Tsunetsugu, Y., Ohira, T., Kagawa, T., & Miyazaki, Y. (2011). Effect of forest bathing on physiological and psychological responses in young japanese male subjects. *Public Health*, 125(2), 93-100.

Lee, W., Kim, M., Bae, M. (2016). On the Use of Forest Sounds for Relieving Depression Focusing on Characteristics of Human Brainwaves. *International Information Institute Information,* 19(9), 3725-3730.

Li, Q., Morimoto, K., Nakadai, A., Inagaki, H., Katsumata, M., Shimizu, T., . . . Kawada, T. (2007). Forest bathing enhances human natural killer activity and expression of anti-cancer proteins. *International Journal of Immunopathology and Pharmacology*, 20(2), 3-8.

Li Q., Kobayashi, M., Kumeda, S., Ochiai, T., Miura, T., Kagawa, T., Imai, M., Wang, Z., Otuska, T., Kawada, T. (2016). Effects of forest bathing on cardiovascular and metabolic parameters in middle aged males. *Evidence-based Complementary and Alternative Medicine,* 2016*,* 1-7.

Littlewood, T., Bajetta, E., Nortier, J, Vercammen, E., Rapoport, B. (2001). Effects of Epoetin Alfa on Hematologic Parameters and Quality of Life in Cancer Patients Receiving Nonplatinum Chemotherapy: Results of a Randomized, Double-Blind, Placebo-Controlled Trial. *Journal of Clinical Oncology,* 19(11), 2865-2874.

Logan, A. and Selhub, E. (2012). Does nature minister to the mind? *BioPsychoSocial Medicine,* 6, 1-10.

Makridakis, S., & DiNicolantonio, J. J. (2014). Hypertension: Empirical evidence and implications in 2014. *Open Heart, 1*(1).

Manios, E., Koroboki, E., Tsivgoulis, G., Spengos, K., Spiliopoulou, I., Brodie, F., Zakopoulos, N. A. (2008). Factors influencing white-coat effect. *American Journal of Hypertension*, 21(2), 153-8.

Maas, J., Verheij, R., de Vries, S., Spreeuwenberg, P., Schellevis, F., Groenewegen, P. (2009). Morbidity is related to a green living environment. *Journal of Epidemiology and Community Health*, 63, 967-973.

Martyn, P. and Brymer, E. (2016). The relationship between nature relatedness and anxiety. *Journal of Health Psychology,* 21(7), 1436-1445

Mayer, F. S., Frantz, C. M., Bruehlman-Senecal, E., & Dolliver, K. (2008). Why Is Nature Beneficial?: The Role of Connectedness to Nature. *Environment and Behavior*, 41(5), 607-643.

McKinnon, M., Yucel, K., Nazarov, A., MacQueen, G. (2009). A meta-analysis examining clinical predictors of hippocampal volume in patients with major depressive disorder. *Journal of Psychiatry and Neuroscience*, 34, 41-45

Mitchell, R. and Popham, F. (2008). Effect of exposure to natural environment on health inequalities: an observational population study. *The Lancet,* 372, 1655-1660

Milanovic, Z., Pantelic, S., Trajkovic, N., Sporis, G., Kostic,R., James, N. (2013) Age-related decrease in physical activity and functional fitness among elderly men and women. *Clinical Interventions in Aging,* 8, 549-556.

Mittner, M., Hawkins, G. E., Boekel, W., & Forstmann, B. U. (2016). A Neural Model of Mind Wandering. *Trends in Cognitive Sciences*.

Mogotsi, M., Kaminer, D., Stein, D. (2000). Quality of life in the anxiety disorders. *Harvard Review of Psychiatry,* 8(6), 273-282.

Moore, M., Hofer, S., McGee, H., Ring, L. (2005). Can the concepts of depression and quality of life be integrated using a time perspective? *Health and Quality of Life Outcomes, 3(1).*

Morey, R., Petty, C., Cooper, D., Labar, K., McCarthy, G. (2008). Neural systems for executive and emotional processing are modulated by symptoms of posttraumatic stress disorder in Iraq War veterans. *Psychiatry Research,* 161(1), 59-72.

Morgan, T., Anderson, A., MacInnis, R. (2001). Ace inhibitors, beta-blockers, calcium blockers, and diuretics for the control of systolic hypertension. American Journal of Hypertension, 14(3), 241-247.

Morita, E., Fukua, S., Nagano, ., Hamajima, N., Yamamoyo, H., Iqai, Y., Nakashima, T., Ohira, H., Shirakawa. (2007). Psychological effects of forest environments on healthy adults: Shinrin-yoku (forest-air bathing, walking) as a possible method of stress reduction. *Public Health,* 121(1), 54-63.

Mossello, R., Pieraccioli, M., Nesti, N. (2015). Effects of Low Blood Pressure in Cognitively Impaired Elderly Patients Treated With Antihypertensive Drugs. *Journal of the American Medical Association*, 175(4), 578-585.

Motteran, A., Trifiletti, E., Pedrazza, M. (2016). Well-being and Lack of Well-bring among Nursing Home Residents. *Ageing International*, 41(2). 150-166.

Musini, V., Rezapour, P., Wright, J., Bassett, K., Jauca, C. (2015). Blood pressure-lowering efficacy of loop diuretics for primary hypertension. *Cochrane Database of Systematic Reviews*, 5.

National Heart, Lung, & Blood Institute. (2015). *Description of High Blood Pressure.* Retrieved from https://www.nhlbi.nih.gov/health/health-topics/topics/hbp

National Institute of Mental Health. (2016). *Anxiety Disorders*. Retrieved from https://www.nimh.nih.gov/health/topics/anxiety-disorders/index.shtml

Newman, M. and Roberts, N. (2013). *Health and social relationships : the good, the bad, and the complicated.* Washington, DC: American Psychological Association.

Norbury, R., Godlewska, B., Cowen, P. (2013) When less is more: a functional magnetic resonance imaging study of verbal working memory in remitted depressed patients. *Psychological Medicine*, 1-7.

Novak, V. and Hajjar, I. (2010). The relationship between blood pressure and cardiovascular function. *Nature Reviews Cardiology,* 7(12), 686-698.

Ohara, Y., Hirano, Hl, Yoshida, H., Suzuki, T. (2011). Ratio and associated factors of dry mouth among community-dwelling elderly Japanese women. *Geriatrics and Gerontology*, 11, 83-89.

Ohtsuka, Y., Yabunaka, .,Takayama, S. (1998). Shinrin-yoku (forest-air bathing and walking) effectively decreases blood glucose levels in diabetic patients. *International Journal of Biometeorology*, 41(3), 125-127.

Oishi, E., Ohara, T., Sakata, S., Fukuhara, M., Hata, J., Yoshida, D., Shibata, M., Ohtsubo, T., Kitazono, T., Kiyohara, Y., Ninomiya, T. (2017). Day-to-Day Blood Pressure Variability and Risk of Dementia in a General Japanese Elderly Population: The Hisayama Study. *Circulation,* 136, 516-525.

Parati, G., Asmar, R., Stergiou, G. (2002). Self blood pressure monitoring at home by wrist devices: a reliable approach? *Journal of Hypertension*, 20(4), 573-578

Park, B., Tsunetsugu, Y., Kasetani, T., Hirano, H., Kagawa, T., Sato, M., & Miyazaki, Y. (2007). Physiological effects of shinrin-yoku (taking in the atmosphere of the forest)--using salivary cortisol and cerebral activity as indicators. *Journal of Physiological Anthropology, 26*(2), 123-128.

Park, B., Tsunetsugu, Y., Kasetani, T., Kagawa, T., & Miyazaki, Y. (2010). The physiological effects of shinrin-yoku (taking in the forest atmosphere or forest bathing): Evidence from field experiments in 24 forests across japan. *Environmental Health and Preventive Medicine, 15*(1), 18.

Psychology Foundation of Australia. (2014). Depression, Anxiety, and Stress Scale. Retrieved from http://www2.psy.unsw.edu.au/dass/

Radley, J., Morilak, D., Viau, V., Campeau, S. (2015). Chronic stress and brain plasticity: Mechanisms underlying adaptive and maladaptive changes and implications for stress-related CNS disorders. *Neuroscience and Biobehavioral Reviews,* 58, 79–91.

Raffone, A. and Srinivasan, N. (2010). The exploration of meditation in the neuroscience of attention and consciousness. *Cognitive Processing, 11*(1), 1-7.

Ranabir, S., and Reetu, K. (2011). Stress and hormones. *Indian Journal of Endocrinology and Metabolism*, 15(1), 18–22.

Reddy, M. and Chandrashekhar C. (1998) Prevalence of Mental and behavioral disorders in India: a meta- analysis. *Indian Journal of Psychiatry*. 40, 149–157.

Reynolds, L., Rodiek, S., Lininger, M., McCulley, A. (2018). Can a Virtual Nature Experience Reduce Anxiety and Agitation in People With Dementia? *Journal of Housing for the Elderly*, 1-18

Sacher, J., Neumann, J., Fünfstück, T., Soliman, A., Villringer, A., Schroeter, M. (2012). Mapping the depressed brain: a meta-analysis of structural and functional alterations in major depressive disorder. *Journal of Affective Disorders*. 140, 142–148.

Sadeghi, M., Namdar, H., Vahedi, S., Aslanabadi, N., Ezzati, D., Sadeghi, B. (2013). Effects of Emotional Stimuli on Cardiovascular Responses in Patients with Essential Hypertension Based on Brain/Behavioral Systems. *Journal of Cardiovascular and Thoracic Research*, 5(4), 167-171. doi:10.5681/jcvtr.2013.036

Sanders, R. (2013). Researchers find out why some stress is good for you. *Berkley News.* Retrieved from http://news.berkeley.edu/2013/04/16/researchers-find-out-why-some-stress-is-good-for-you/

Schwimmer, J., Burwinkle, T., Varni, J. (2003). Health-Related Quality of Life of Severely Obese Children and Adolescents. *Journal of American Medical Association,* 289(14), 1813-1819.

Scully, C. and Felix, D. (2005) Oral Medicine — Update for the dental practitioner: Dry mouth and disorders of salivation, *British Dental Journal*, 199, 423-427.

Sharma, R., Biedenharn, K., Fedor, J., Agarwal, A. (2013). Lifestyle factors and reproductive health: taking control of your fertility. *Reproductive Biology and Endocrinology,* 11(66), 1-15.

Shin, W., Shin, C., Yeon, P. (2012). The influence of forest therapy camp on depression in alcoholics. *Environmental Health and Preventive Medicine,* 17(1), 73-76.

Simons, J., Dvorak, R., Lau-Barraco, C. (2009). Behavioral Inhibition and Activation Systems: Differences in Substance Use Expectancy Organization and Activation in Memory. *Psychology of Addictive Behaviors,* (23)2, 315-328.

Singh, M., Gotlib, I. (2014).The Neuroscience of Depression: Implications for Assessment and Intervention. *Behavior Research and Therapy,* 622, 60-73.

Sneed, R. and Cohen, S. (2014). Negative Social Interactions and Incident Hypertension Among Older Adults. *Health Psychology*, 33(6), 554-565.

Sokoll, K., and Helliwell, P. (2001). Comparison of disability and quality of life in rheumatoid and psoriatic arthritis. *The Journal of Rheumatology*, 28(8), 1842-1846;

Stevens, P. (2010). Embedment in the environment: A new paradigm for well-being? *Perspectives in Public Health*, 130(6), 265-269.

St-Onge, M. and Gallagher, D. (2010). Body composition changes with aging: The cause or the result of alterations in metabolic rate and macronutrient oxidation? *Nutrition*, 26(2), 153-155.

Susniene, D. and Jurkauskas, A. (2009). The Concepts of Quality of Life and Happiness - Correlation and Differences. *Inzinerine Ekonomika-Engineering Economics*, 3, 58-66.

Suzuki, H., botteron, K., Luby, J., Belden, A., Gaffrey, M., Babb, C., Barch, D. (2013). Structural-functional correlations between hippocampal volume and cortico limbic emotional responses in depressed children. *Cognitive, Affective and Behavioral Neuroscience, 13, 131-151.*

Taren, A., Gianaros, P., Greco, C., Lindsay, E., Fairgrieve, A., Brown, K., Rosen, R., Ferrie, J., Julson, E., Marsland, A., Bursley,J., Ramsburg, J., Creswell, J. (2015). Mindfulness meditation training alters stress-related amygdala resting state functional connectivity: a randomized control trial. *Social and Cognitive Affective Disorder*, 1758-1768

Taubert, D., Berkels, R., Roesen, R., Klaus, W. (2003). Chocolate and Blood Pressure in Elderly Individuals With Isolated Systolic Hypertension. *The Journal of the American Medical Association*, 290(8), 1029-1030.

Taylor, A. and Kuo, E. (2004). A Potential Treatment for Attention-Deficit/Hyperactivity Disorder: Evidence from a National Study. *Journal of Attention Disorders*, 94(9), 1580-1586.

Taylor, A. and Kuo, E. (2009). Children with attention deficits concentrate better after walk in the park. *Journal of Attention Disorders*, 12(5), 402-409.

The World Health Organization. (1998). The World Health Organization Quality of Life Assessment: Development and psychometric properties. *Social Science and Medicine,* 46, 1569-1585.

Thomas, O., Shipman, K., Day, K., Thomas, M., Martin, U., Dasgupta, I. (2016). Prevalence and determinants of white coat effect in a large UK hypertension clinic population. *Journal of Human Hypertension*, 30(6), 386-391.

Thompson, D. and Yu, C. (2003). Quality of life in patients with coronary heart disease. *Health Quality of Life Outcomes*, 1-42.

Tsunetsugu, Y., Park, B., Ishii, H., Hirano, H., Kagawa, T., & Miyazaki, Y. (2007). Physiological effects of shinrin-yoku (taking in the atmosphere of the forest) in an old-growth broadleaf forest in yamagata prefecture, japan. *Journal of Physiological Anthropology, 26*(2), 135-142.

Tyrvainen, L., Ojala, A., Korpela, K., Lanki, T., Tsunetsuga, Y., Kagawa, T. (2013). The influence of urban green environments on stress relief measures: a field experiment. *Journal of Environmental Psychology,* 38, 1-9

Ulbricht, C., Hunnicutt, J., Lapane, K. (2016). Triad of Suffering: Pain, Depression, and Anxiety among Newly Admitted Nursing Homes Residents. *The American Journal of Geriatric Psychiatry,* 24(3), S124.

Umberson, D. and Montez, J. (2010). Social Relationships and Health: A Flashpoint for Health Policy. *Journal of Health and Social Behavior*, 51(1), 54-66.

Vago, D. R., & Silbersweig, D. A. (2012). Self-awareness, self-regulation, and self-transcendence (S-ART): a framework for understanding the neurobiological mechanisms of mindfulness. *Frontiers in Human Neuroscience*, 6(296), 1-30.

Walther, D., Caddigan, E., Fei-Fei, L., Beck, D. (2009). Natural Scene Categories Revealed in Distributed Patterns of Activity in the Human Brain. *Journal of Neuroscience*, 29(34), 10573-10581.

Wilson, R., Kreuger, K., Arnold, S., Schneider, J., Kelly, J., Barnes, L., Tang, Y., Bennett. (2007). Loneliness and Risk of Alzheimer Disease. *Archives of General Psychiatry,* 64, 234-240.

Woo, J., Tang, N., Suen, E. Leung, J., Wong, M. (2009). Green space, psychological restoration and telomere length. The Lancet, 373, 299-300.

Wood, B., Nicholas, M., Blyth, F., Asghari, A., Gibson, S. (2010). The Utility of the Short Version of the Depression Anxiety Stress Scales (DASS-21) in Elderly Patients with Persistent Pain: Does Age Make a Difference? *Pain Medicine*, 11(12), 1780-1790.

World Health Organization. (2017). *Cardiovascular diseases (CVDs).* Retrieved from http://www.who.int/mediacentre/factsheets/fs317/en/

Yamaguchi, M., Deguchi, M., Miyazaki, Y. (2006). The Effects of Exercise in Forest and Urban Environments on Sympathetic Nervous Activity of Normal Young Adults. *Journal of International Medical Research*, 34(2), 152-159.

Yang, Y. and Boen, C. (2014). Social Relationships and Hypertension in Late Life: Evidence From a Nationally Representative Longitudinal Study of Older Adults. *Journal of Aging and Health*, 27(3), 403-431.

Tables

Table 1:
Demographic Information, Facility Duration, Mobility Status, and Nature Exposure for the Whole Sample and by Virtual Reality Condition

	Whole Sample (*N*=25)	Forest (*N*=13)	Urban (*N*=12)
Gender[a]	88%	92.3%	83.3%
Age	81.2 (8.5)	82.8 (7.7)	79.4 (9.2)
Living			
Resident	56%	61.5%	50%
Community	44%	38.5%	50%
Months at Facility			
N/A[b]	44%	38.5%	50%
1 year +	20%	10.8%	8.3%
< 1 year	15%	15.3%	16.7%
< 6 months	16%	7.7%	25%
< 3 months	4%	7.7%	0%
Mobility			
Mobile	44%	38.4%	50%
Walker	24%	30.8%	16.7%
Wheelchair	32%	30.8%	33.3%
Nature Exposure[c]			
Yes	64%	30.8%	41.7%
No	36%	69.2%	58.3%

Notes: All data are reported as percent except for age which is reported as years. [a]Gender represents percent female, [b]N/A represents community members not living in a facility, [c]Nature Exposure represents visiting an outdoor environment within the past month

Table 2:
Comparing Forest and Urban Condition Group Average Means at Time 1

	Forest M(SD)	Urban M(SD)	*df*	*t*-value	*P*-value
SBP[a]	134.38 (5.18)	146.91 (5.18)	23	1.94	0.06*
DBP[b]	73.15 (2.26)	79.50 (2.35)	23	1.67	0.11*
HR[c]	66.08 (3.53)	69.33 (3.67)	23	0.64	0.53*
DS[d]	2.25 (0.26)	1.68 (0.29)	16	-1.45	0.08*
AS[e]	10.09 (1.25)	5.18 (1.25)	20	- 2.77	0.01
SS[f]	2.17 (0.18)	2.12 (0.19)	19	-0.15	0.89*

*Notes: *p>0.05* indicates statistically equal means, [a]SBP=Systolic Blood Pressure, [b]DBP=Diastolic Blood Pressure, [c]HR=Heart Rate, [d]DS=Depression Score, [e]AS=Anxiety Score, [f]SS=Stress Score

Table 3:

Condition and Time on Depression Score (*2x2 Mixed-Model ANOVA)*

Source	*dfNum*	*dfDen*	*F*-Value	*P*-value	η_p^2
Between Subjects					
Condition	1	16.3	1.89	0.19	0.09
Within Subjects					
Time	1	15.6	20.56	0.00*	0.18
Interaction	1	15.6	0.03	0.87	0.00
Condition x Time					

*Notes: *p*<0.05

Table 4:

Condition and Time on Anxiety Score (*2x2 Mixed-Model ANOVA)*

Source	*dfNum*	*dfDen*	*F*-Value	*P*-value	η_p^2
Between Subjects Condition	1	23.1	5.08	0.03*	0.14
Within Subjects Time	1	22.6	25.02	<0.0001*	0.19
Interaction Condition x Time	1	22.6	0.55	0.47	0.01

*Notes:***p*<0.05

Table 5:

Condition and Time on Stress Score (*2x2 Mixed-Model ANOVA)*

Source	*dfNum*	*dfDen*	*F*-Value	*P*-value	η_p^2
Between Subjects Condition	1	19.0	0.13	0.73	0.005
Within Subjects Time	1	19.0	27.54	<0.000*	0.29
Interaction Condition x Time	1	19.0	0.14	0.72	0.002

*Notes:***p*<0.05

Table 6:

Post-hoc Main Effect Mean Comparisons

	Forest M(SD)	Urban M(SD)	Time 1 M(SD)	Time 2 M(SD)
DS[a]			1.96 (0.22)	1.14 (0.21)
AS[b]	6.34 (0.98)	3.12 (1.03)	6.64 (0.80)	2.28 (0.82)
SS[b]			2.14 (0.17)	1.16 (0.17)

Notes: [a]DS=Depression Score, [b]AS=Anxiety Score, [c]SS=Stress Score

Table 7:

Condition and Time on Heart Rate (*2x2 Mixed-Model ANOVA)*

Source	*dfNum*	*dfDen*	*F*-Value	*P*-value	η_p^2
Between Subjects					
Condition	1	23.2	0.05	0.83	0.000
Within Subjects					
Time	1	22.4	0.01	0.98	0.00
Interaction					
Condition x Time	1	22.4	1.78	0.20	0.01

Table 8:
Condition and Time on Diastolic Blood Pressure (*2x2 Mixed-Model ANOVA)*

Source	*dfNum*	*dfDen*	*F*-Value	*P*-value	η_p^2
Between Subjects					
Condition	1	23.0	0.89	0.35	0.04
Within Subjects					
Time	1	22.4	0.16	0.69	0.00
Interaction					
Condition x Time	1	22.4	7.03	0.014*	0.05

Notes: *p<0.05

Table 9:
Condition and Time on Systolic Blood Pressure (*2x2 Mixed-Model ANOVA)*

Source	*dfNum*	*dfDen*	*F*-Value	*P*-value	η_p^2
Between Subjects					
Condition	1	23.2	0.80	0.38	0.03
Within Subjects					
Time	1	22.5	2.95	0.10	0.16
Interaction					
Condition x Time	1	22.5	5.57	0.03*	0.03

Notes: *p<0.05

Figures

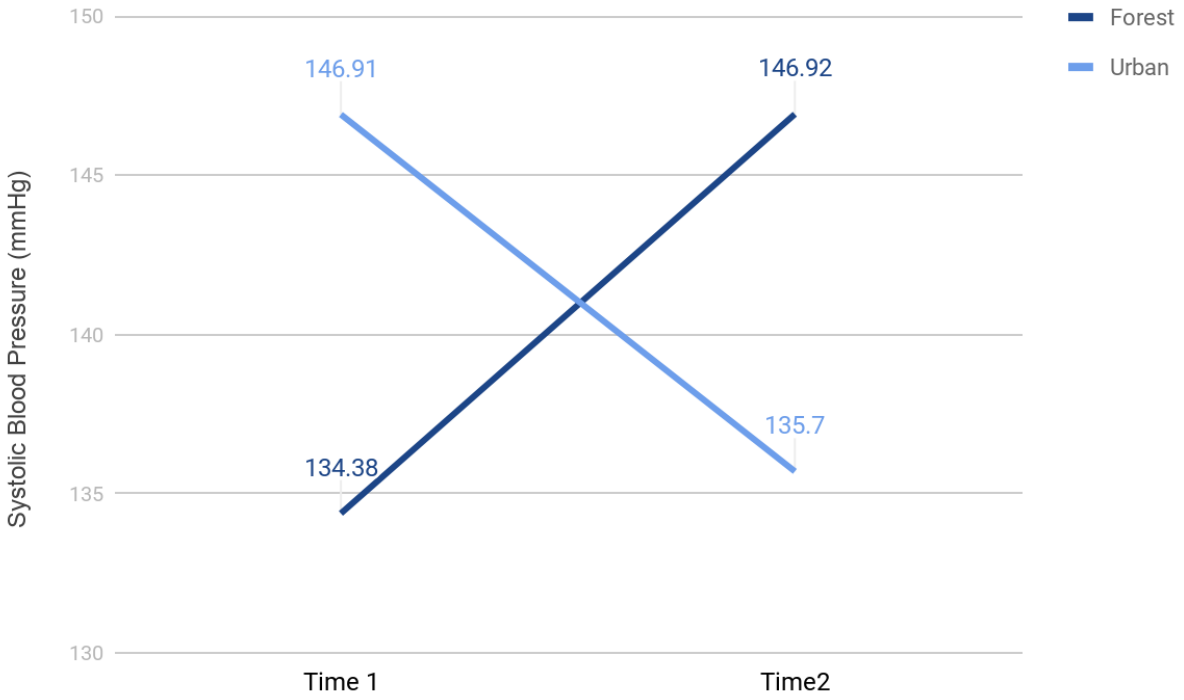

Figure 1: Comparison of Forest and Urban Systolic Blood Pressure Means at Time 1 and Time 2.

Appendices

Appendix A - Signed Approval Forms

Locust Grove Personal Care and Memory Care

4043 Irene Street, West Mifflin, PA 15122

Approval Form

As an administrator of Locust Grove Personal Care and Memory Care, I give permission for Madalyn Clark, an undergraduate neuroscience major at Allegheny College, to collect data for her senior thesis at this facility on residents who are interesting and willing to volunteer to participate. I have read through the documentation she will be providing both participating residents as well as their family members. I am aware of both the rationale and methods for this study and understand that there is zero to minimal risk for residents participating. She will have participants wear a virtual reality headset where participants will see either a city or forest landscape. I understand that all data collected from residents will be confidential and will not be connected to their name or this facility. My signature authorizes that any residents interested in participating will make that decision on their own and will not be given incentives or coerced to participate.

Administrator Printed Name Christine Panepinto

Administrator Signature Christine Panepinto

Title ADMINISTRATOR

Date 11-20-17

Juniper Village

455 Chestnut Street, Meadville, PA 16335

Approval Form

As an administrator of Juniper Village, I give permission for Madalyn Clark, an undergraduate neuroscience major at Allegheny College, to collect data for her senior thesis at this facility on residents who are interesting and willing to volunteer to participate. I have read through the documentation she will be providing both participating residents as well as their family members. I am aware of both the rationale and methods for this study and understand that there is zero to minimal risk for residents participating. She will have participants wear a virtual reality headset where participants will see either a city or forest landscape. I understand that all data collected from residents will be confidential and will not be connected to their name or this facility. My signature authorizes that any residents interested in participating will make that decision on their own and will not be given incentives or coerced to participate.

Administrator Printed Name Tami L Williams

Administrator Signature Tami L Williams

Title DOW

Date 11/21/17

Appendix B

Informed Consent - Power of Attorney

Virtual Reality Simulation - Allegheny College

Introduction to Research: Forest bathing, a tradition of Japanese culture also known as *Shinrin-yoku*, is referred to as a leisurely walk through a nature setting in which the individual remains calm and attentive to the environment around them and has demonstrated several health benefits. Forest bathing in a virtual reality setting has not yet been explored, but other forms of virtual reality have been used in research before.

Participation: I understand that my signature verifies that I am the Power of Attorney of the participant at Locust Grove Personal Care and Memory Care. I understand that their participation in this research is completely voluntary and they chose to participate based on their own desire. If they feel uncomfortable at any point during the study they may withdraw immediately with no consequence.

Procedure: I understand that on the first day of the study the participant will fill out two separate questionnaires as well as have their blood pressure taken. After the questionnaires are filled out they will be given an opportunity to become acclimated to the virtual reality system which is a cardboard box that holds an iPhone, which they wear in front of their eyes (see Image 1). They will be able to try on the virtual reality box and watch a 5 minute video. Participants will be randomly assigned to view one of two different videos. On the second day of the study, they will watch a 10 minute video on the virtual reality box. After the completion of the video they will fill out two additional questionnaires as well as have their blood pressure taken. The questionnaires on both days should take no more than 10 minutes.

Potential Risk: I understand that participating in the study involves minimal risk to the participant's health and safety. Potential, but unlikely, risks could include feelings of dizziness or nausea as well as feeling uncomfortable answering questions about emotions. If at any point during the study the participant becomes nauseous or dizzy they will let the researcher know and immediately remove the virtual reality box or if they feel upset they may immediately stop completing the survey.

Confidentiality: I understand the participant's responses and blood pressure data will be kept completely confidential between the researcher who will be scoring my questionnaires and the research advisor. I understand that written responses may be directly quoted within internal documents and only group averaged data may be published but the participant's name or living facility will not be attached.

Compensation: Upon completion of the experiment the participant will be able to choose one item from a basket including candy, fuzzy socks, and lotions.

Contact Information: If at any point during or after questions arise I may contact the researcher Madalyn Clark at clarkm@allegheny.edu. If additional questions arise I may contact the research

project advisor Dr. Sarah Conklin at sconklin@allegheny.edu or the IRB Committee Chair Dr. Ryan Van Horn at ryanhorn@allegheny.edu.

Power of Attorney Printed Name _____

Power of Attorney Signature_____

Participants Name_____

Date_____

I would like to receive the results of this study: Yes No

Image 1:



Appendix C

Forest Bathing Condition



Appendix D

Urban Condition



Appendix E

Google Cardboard Viewer



Appendix F

Informed Consent - Resident

Virtual Reality Simulation - Allegheny College

Introduction to Research: Forest bathing, a tradition of Japanese culture also known as Shinrin-yoku, is referred to as a leisurely walk through a nature setting in which the individual remains calm and attentive to the environment around them and has demonstrated several health benefits. Forest bathing in a virtual reality setting has not yet been explored, but other forms of virtual reality have been used in research before.

Participation: I understand that my signature verifies that I am above 18 years old and am a resident of Locust Grove Personal Care and Memory Care/Juniper Village. I understand that my participation in this research is completely voluntary and I chose to participate based on my own desire. I feel uncomfortable at any point during the study I may withdraw immediately with no consequence. I understand that my responses to the questionnaires will be based on my personal thoughts and not based on my relationship with the researcher.

Procedure: I understand that on the first day of the study I will fill out two separate questionnaires as well as have my blood pressure taken. After the questionnaires are filled out I will be given an opportunity to become acclimated to the virtual reality system, which the researcher will show me before I sign this form. I will be able to try on the virtual reality box and watch a 5 minute randomly assigned video. On the second day of the study, I will watch a 10 minute video on the virtual reality box and. After I will fill out an additional two additional questionnaires as well as have my blood pressure taken. The questionnaires on both days should take no more than 10 minutes.

Potential Risk: I understand that participating in the study involves minimal risk to my health and safety. Potential, but unlikely, risk includes feelings of dizziness or nausea as well as feeling uncomfortable answering questions about my emotions. If at any point during the study I become nauseous or dizzy I will let the researcher know and immediately remove the virtual reality box or if I feel upset I may immediately stop completing the survey.

Confidentiality: I understand that my responses and blood pressure data will be kept completely confidential between the researcher who will be scoring my questionnaires and the research advisor. I understand that my written responses may be directly quoted within internal documents and only group averaged data may be published but my name or living facility will not be attached.

Compensation: Upon completion of the experiment I will be able to choose one item from a basket including candy, fuzzy socks, and lotions.

Contact Information: If at any point during or after the study I have questions I may contact the researcher Madalyn Clark at clarkm@allegheny.edu. If additional questions arise I may contact

the research project advisor Dr. Sarah Conklin at sconklin@allegheny.edu or the IRB Committee Chair Dr. Ryan Van Horn at ryanhorn@allegheny.edu.

Participant Printed Name _____

Participant Signature_____

Date_____

I would like to receive the results of this study: yes no

Appendix G

Informed Consent - Community

Virtual Reality Simulation - Allegheny College

Introduction to Research: Forest bathing, a tradition of Japanese culture also known as Shinrin-yoku, is referred to as a leisurely walk through a nature setting in which the individual remains calm and attentive to the environment around them and has demonstrated several health benefits. Forest bathing in a virtual reality setting has not yet been explored, but other forms of virtual reality have been used in research before.

Participation: I understand that my signature verifies that I am above 18 years. I understand that my participation in this research is completely voluntary and I chose to participate based on my own desire. I feel uncomfortable at any point during the study I may withdraw immediately with no consequence. I understand that my responses to the questionnaires will be based on my personal thoughts and not based on my relationship with the researcher.

Procedure: I understand that on the first day of the study I will fill out two separate questionnaires as well as have my blood pressure taken. After the questionnaires are filled out I will be given an opportunity to become acclimated to the virtual reality system, which the researcher will show me before I sign this form. I will be able to try on the virtual reality box and watch a 5 minute randomly assigned video. On the second day of the study, I will watch a 10 minute video on the virtual reality box and. After I will fill out an additional two additional questionnaires as well as have my blood pressure taken. The questionnaires on both days should take no more than 10 minutes.

Potential Risk: I understand that participating in the study involves minimal risk to my health and safety. Potential, but unlikely, risk includes feelings of dizziness or nausea as well as feeling uncomfortable answering questions about my emotions. If at any point during the study I become nauseous or dizzy I will let the researcher know and immediately remove the virtual reality box or if I feel upset I may immediately stop completing the survey.

Confidentiality: I understand that my responses and blood pressure data will be kept completely confidential between the researcher who will be scoring my questionnaires and the research advisor. I understand that my written responses may be directly quoted within internal documents and only group averaged data may be published but my name will not be attached.

Compensation: Upon completion of the experiment I will be able to choose one item from a basket including candy, fuzzy socks, and lotions.

Contact Information: If at any point during or after the study I have questions I may contact the researcher Madalyn Clark at clarkm@allegheny.edu. If additional questions arise I may contact the research project advisor Dr. Sarah Conklin at sconklin@allegheny.edu or the IRB Committee Chair Dr. Ryan Van Horn at ryanhorn@allegheny.edu.

Participant Printed Name _____

Participant Signature_____

Date_____

I would like to receive the results of this study: yes no

Appendix H

Demographic Survey - Resident

1. What is your age? _____
2. What is your gender? _____
3. Approximately how long have you lived at this assisted living facility?

less than 1 month less than 3 months less than 6 months less than 1 year 1 year +

4. Have you visited a park or outdoor environment in the past month? yes no

Appendix I

Demographic Survey - Community

1. What is your age? _____
2. What is your gender? _____
3. Have you visited a park or outdoor environment in the past month? yes no

Appendix J

DASS-2, Time 1

Please read each statement and circle a number 0, 1, 2 or 3 which indicates how much the statement applied to you *over the past week*. There are no right or wrong answers. Do not spend too much time on any statement.

The rating scale is as follows:

0 Did not apply to me at all

1 Applied to me to some degree, or some of the time

2 Applied to me a considerable degree, or a good part of time

3 Applied or me very much, or most of the time

---

1. I found it hard to wind down	0	1	2	3
2. I was aware of dryness of my mouth.	0	1	2	3
3. I couldn't seem to experience any positive feeling at all	0	1	2	3
4. I experienced breathing difficulty (eg, excessively rapid breathing, breathlessness in the absence of physical exertion)	0	1	2	3
5. I found it difficult to work up the initiative to do things	0	1	2	3
6. I tended to overreact to situations	0	1	2	3
7. I experienced trembling (eg, in the hands)	0	1	2	3
8. I felt that I was using a lot of nervous energy	0	1	2	3
9. I was worried about situations in which I might panic and make a fool of myself	0	1	2	3
10. I felt that I had nothing to look forward to	0	1	2	3
11. I found myself getting agitated	0	1	2	3
12. I found it difficult to relax	0	1	2	3
13. I felt down-hearted and blue	0	1	2	3
14. I was intolerant of anything that kept me from getting on with what I was doing	0	1	2	3

15. I felt I was close to panic	0	1	2	3
16. I was unable to become enthusiastic about anything	0	1	2	3
17. I felt I wasn't worth much as a person	0	1	2	3
18. I felt that I was very touchy	0	1	2	3
19. I was aware of the action of my heart in the absence of physical exertion (eg, sense of heart rate increase, heart missing a beat)	0	1	2	3
20. I felt scared without good reason	0	1	2	3
21. I felt that life was meaningless	0	1	2	3

Appendix K

DASS-21, Time 2

Please read each statement and circle a number 0, 1, 2 or 3 which indicates how much the statement applied to you *over the past two days*. There are no right or wrong answers. Do not spend too much time on any statement.

The rating scale is as follows:

0 Did not apply to me at all

1 Applied to me to some degree, or some of the time

2 Applied to me a considerable degree, or a good part of time

3 Applied or me very much, or most of the time

---

1. I found it hard to wind down	0	1	2	3
2. I was aware of dryness of my mouth.	0	1	2	3
3. I couldn't seem to experience any positive feeling at all	0	1	2	3
4. I experienced breathing difficulty (eg, excessively rapid breathing, breathlessness in the absence of physical exertion)	0	1	2	3
5. I found it difficult to work up the initiative to do things	0	1	2	3
6. I tended to overreact to situations	0	1	2	3
7. I experienced trembling (eg, in the hands)	0	1	2	3
8. I felt that I was using a lot of nervous energy	0	1	2	3
9. I was worried about situations in which I might panic and make a fool of myself	0	1	2	3
10. I felt that I had nothing to look forward to	0	1	2	3
11. I found myself getting agitated	0	1	2	3
12. I found it difficult to relax	0	1	2	3
13. I felt down-hearted and blue	0	1	2	3
14. I was intolerant of anything that kept me from getting on with what I was doing	0	1	2	3

15. I felt I was close to panic	0	1	2	3
16. I was unable to become enthusiastic about anything	0	1	2	3
17. I felt I wasn't worth much as a person	0	1	2	3
18. I felt that I was very touchy	0	1	2	3
19. I was aware of the action of my heart in the absence of physical exertion (eg, sense of heart rate increase, heart missing a beat)	0	1	2	3
20. I felt scared without good reason	0	1	2	3
21. I felt that life was meaningless	0	1	2	3

Appendix L

Exit Survey

1. Please circle a number corresponding to your enjoyment in participating in the study

(Extremely Disliked) (Extremely Liked)

0 1 2 3 4 5

If you disliked the study, what could have made it better?

2. Did you experience any adverse effects during this experiment (eg, nausea or dizziness) yes no

3. Do you see yourself using this virtual reality system in your daily life? yes no

Appendix M

Debriefing Form

A Randomized Controlled Trial of Virtual Forest Bathing on Depression, Anxiety, Stress, Heart Rate and Blood Pressure in an Elderly Population

Purpose of Research: The purpose of this study was to examine the potential benefits a virtual reality forest or urban environment may on cardiovascular health, depression, anxiety and stress. The researcher was interested to see if the virtual reality forest led to higher reductions in blood pressure and heart rate as well as scored levels of depression, anxiety, and stress assessed by the Depression, Anxiety, and Stress Scale (DASS) than the urban environment.

Confidentiality: Please remember that all data collected during this study will remain confidential and your name will not be attached in any way.

Contact Information: If at any point during or after the study I or my family members may contact the researcher Madalyn Clark at clarkm@allegheny.edu. If additional questions arise I may contact the research project advisor Dr. Sarah Conklin at sconklin@allegheny.edu or the IRB Committee Chair Dr. Ryan Van Horn at ryanhorn@allegheny.edu.

If you would like to read more about this topic please take a look at the following sources:

Detweiler, M., Murphy, P., Myers, L., Kim, K. (2008). Does a wander garden influence inappropriate behaviors in dementia residents? *American Journal of Alzheimer's Disease and Other Dementias*, 23(1), 31-45.

Lee, J., Park, B. J., Tsunetsugu, Y., Ohira, T., Kagawa, T., & Miyazaki, Y. (2011). Effect of forest
bathing on physiological and psychological responses in young japanese male subjects. Public Health, 125(2), 93-100. doi:10.1016/j.puhe.2010.09.005

Li Q., Kobayashi, M., Kumeda, S., Ochiai, T., Miura, T., Kagawa, T., Imai, M., Wang, Z., Otuska, T., Kawada, T. (2016). Effects of forest bathing on cardiovascular and metabolic parameters in middle aged males. Evidence-based Complementary and Alternative Medicine, 2016, 1-7.

Appendix N

DASS Scoring

1.

(Stress) = Q1, 6, 8, 11, 12, 14, 18

A (Anxiety) = Q2, 4, 7, 9, 15, 19, 20

D (Depression) = Q3, 5, 10, 13, 16, 17, 21

2.

S X 2 = Stress Score

A X 2 = Anxiety Score

D X 2 = Depression Score

Ranges:

Stress	Anxiety	Depression
Normal: 0-10	Normal: 0-6	Normal: 0-9
Mild: 11-18	Mild: 7-9	Mild: 10-12
Moderate: 19-26	Moderate: 10-14	Moderate: 13-20
Severe: 27-34	Severe: 15-19	Severe: 21-27
Extremely severe: 35-42	Extremely severe: 20-42	Extremely severe: 28-42

Appendix O

Testing for Normality (Shapiro-Wilk Tests)

	Forest Condition		Urban Condition	
	Time 1	Time 2	Time 1	Time 2
SBP[1]	0.70*	0.93*	0.92*	0.49*
DBP[2]	0.76*	0.95*	0.53*	0.39*
HR[3]	0.84*	0.44*	0.90*	0.79*
DS[4]	0.18*	0.41*	0.47*	0.06*
AS[5]	0.37*	0.37*	0.13*	0.16*
SS[6]	0.08*	0.08*	0.28*	0.61*

Notes:
*$p > 0.05$ indicates normal distribution of data
[1]SBP=Systolic Blood Pressure
[2]DBP=Diastolic Blood Pressure
[3]HR=Heart Rate
[4]DS=Depression Score
[5]AS=Anxiety Score
[6]SS=Stress Score

Appendix P

Testing for Homogeneity of Variance

		F Ratio	DFNum	DFDen	Prob>F[a]
SBP[a]	T1	2.01	11	12	0.25*
	T2	2.31	10	12	0.17*
DBP[b]	T1	1.87	11	12	0.30*
	T2	2.21	10	12	0.19*
HR[c]	T1	1.15	11	12	0.81*
	T2	1.61	12	12	0.45*
DS[d]	T1	1.32	7	9	0.68*
	T2	1.12	9	6	0.93*
AS[e]	T1	4.62	10	10	0.04
	T2	5.55	10	9	0.02
SS[f]	T1	1.10	9	10	0.87*
	T2	1.78	10	9	0.40*

Notes:
**p*>0.05 indicates homogeneity of variance
[a]SBP=Systolic Blood Pressure
[b]DBP=Diastolic Blood Pressure
[c]HR=Heart Rate
[d]DS=Depression Score
[e]AS=Anxiety Score
[f]SS=Stress Score