Green Exercise for Older Adults:
Scoping Review, Implementation, and Perceived Restorativeness

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Abstract

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Green exercise, or exercise performed in a natural environment, has additional health benefits than exercise alone (Barton, Bragg, Wood, & Pretty, 2016). However, older adults may experience barriers to getting outside including distance from natural spaces (Murayama, Yoshie, Sugawara, Wakui, & Arami, 2012; Stride, Cranney, Scott, & Hua, 2017). Therefore, urban parks and forests provide older adults an opportunity to engage in accessible green exercise. Guided by the Attention Restoration Theory and using scoping review and walking interview methods, this dissertation provides evidence for: (1) a gap in existing green exercise intervention studies with exclusively older adult samples, (2) acceptability and appropriateness of Seattle Parks and Recreation walking groups among older adults in Seattle, Washington, United States of America, and (3) the need to critically evaluate theories and measures prior to use with older adults. Multiple perceived benefits were identified among older adults to their physical, mental, social, and spiritual health from green exercise program participation.

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Chapter 1 – Introduction

Physical activity plays an important role in healthy aging, maintaining function, and preventing chronic disease (King & Guralnik, 2010). The Physical Activity Guidelines Advisory Committee Report recommends 150 to 300 minutes per week of moderate intensity activities for older adults aged 65 years and older (Physical Activity Guidelines Advisory Committee, 2018). However, the suggested amount of exercise is often not met (Hupin et al., 2015). Approximately 35% of adults aged 65-74 are inactive and that rate steadily increases with age up to the point that 64%of adults aged 85 years and older are inactive (U.S. Department of Health and Human Services, 2015). Research has shown that even low doses of moderate-to-vigorous physical activity can reduce mortality by 22% in adults aged 60 years and above (Hupin et al., 2015).

Walking is a versatile and accessible form of exercise. It does not require special skills, does not require special equipment to perform, and is able to be performed in both indoor and outdoor settings (Barton, Bragg, Wood & Pretty, 2016; Piercy et al., 2018). Walking is also the preferred form of exercise for older adults (Finlay, Franke, McKay, & Sims-Gould, 2015). Due to reduced exercise capacity through the normal aging process, walking can more easily qualify as moderate intensity exercise in older adults due to higher relative intensity (how intense an exercise is in comparison to a person's total capacity) (Piercy et al., 2018).

Green exercise, or exercise that is performed in a natural environment has been shown to have overall better health outcomes than exercise performed in an indoor or outdoor urban environment (Barton, Bragg, Wood, & Pretty, 2016). Walking outside as opposed to inside has also been shown to increase enjoyment and intention to continue walking (Foucht, 2009). The mental health benefits of adding greenspace exposure, or performing exercise while in the presence of nature, can be perceived immediately for all age groups, both genders, within

multiple types of green environments, and for participants who are healthy or have mental illnesses (Barton & Pretty, 2010).

Underpinning the additional health benefits of green exercise, the Attention Restoration Theory (ART) provides a mechanism for which natural environments create health benefits that combined with exercise, compounds the benefits of each. ART identifies nature as a restorative environment, which replenishes directed attention fatigue by providing the mind engaging stimuli to focus on, but that does not require significant mental effort, so that it may rest. Directed attention's role is executive functioning, the ability to concentrate on a task, situation, or behavior while fending off competing stimulation, leading to successful completion of the task at hand (Kaplan & Kaplan, 1989; Kaplan, 1995; Staats, 2012). Directed attention fatigue occurs after prolonged mental effort. In urban, modern society, intense stimuli are constantly present. These can be loud noises, bright lights, or even the presence of other people (Staats, 2012). Natural, restorative environments can improve attention, reduce stress, lessen agitation, and when combined with exercise, can increase intention to continue the physical activity (Murayama, Yoshie, Sugawara, Wakui, & Arami, 2012; Rantakokko et al., 2009).

As green exercise benefits are increasingly being recognized recommendations of green exercise have begun to be included in patient-centered, holistic healthcare plans alongside biomedical treatments (Wessel, 2017; Christiana, James, & Battista, 2017). In Japan, a particular form of green exercise called Shinrin-yoku, or forest bathing, has sites that include medical facilities with professionals on-site adjacent to the recreational areas where they can carry out a prescription of Shinrin-yoku (Li, 2018). New Zealand has begun adopting "green prescriptions" (Marques, McIntosh, & Popoola, 2018). Here in the United States, the "National park Prescription Initiative (ParkRx)" has been rolled out and is recommended in the National

prevention strategy for healthy aging (National Park Service & Golden Gate National Parks Conservancy, 2018; National Prevention Council, 2016).

However, older adults may experience one or more barriers to getting outside. These may include physical limitations, fall risk, and neighborhood design (Murayama, Yoshie, Sugawara, Wakui, & Arami, 2012; Rantakokko et al., 2009; Michael, Green, & Farquhar, 2006). Furthermore, distance from a natural space affects use by older adults (Stride, Cranney, Scott, & Hua, 2017). Parks within walking distance of home are associated with increased physical activity (Mowen, Orsega-Smith, Payne, Ainsworth, & Godbey, 2007). Therefore, urban parks and greenspaces provide an excellent opportunity for older adults to engage in accessible green exercise programming.

This Dissertation Project

The project reported on here, in partial fulfillment of the degree requirements for Alexa R. Meins, contributes three components to the furthering of the green exercise scientific literature: (1) a scoping review of green exercise interventional studies that include older adult participants, (2) an evaluation of the implementation of an existing green exercise walking program for older adults offered by Seattle Parks and Recreation's Lifelong Recreation Program (Sound Steps), and (3) a critical appraisal of the validity of the Perceived Restorativeness Scale - 11 and appropriateness of ART as a framework for the underlying mechanism of green exercise health benefits among older adults.

Scoping Review – Chapter 2

Most of what is known regarding the health benefits of green exercise come from studies that have children or young adult samples. Therefore, the goals of the scoping review reported on here were 1) to identify the scope and trends of the body of green exercise literature that includes

older adult (65 years and older) participants and 2) provide recommendations for future research for older adult green exercise interventions. This scoping review followed the Levac, Colquhoun, and O'Brien (2010) strategy and included database searches of PubMed, CINAHL Complete, PsycINFO, Embase, and Environment Complete from 2003-2019. Studies that included a green exercise intervention and subsequent health benefits were included. Twenty-nine studies were included in this review. Attributes of included studies reported here are descriptive trends, types of green exercise interventions investigated, the health outcomes captured and the resulting impact of the green exercise interventions, and age trends of study samples.

Implementation Evaluation – Chapter 3

Implementation is the translation of research into evidence-based and sustainable interventions for a specific population and setting (Eccles & Mittman, 2006; Lobb & Colditz, 2013; Nilsen, 2015; Proctor, Powell, & McMillen, 2013). In this study, an implementation evaluation of a green exercise walking group, called Sounds Steps, offered for older adults in the City of Seattle was completed (Seattle Parks and Recreation, n.d.). The implementation outcomes of acceptability and appropriateness according to Proctor et al.'s framework (2011) were investigated. Two established walking groups that meet weekly in urban forests were observed and a sample of older adult participants were interviewed about their walking experience in this environment. Fourteen walkers were interviewed while walking along established walking group routes. Acceptability was established through investigation into the group structure of the program, program frequency, and the urban forest physical features. Appropriateness was evaluated for the targeted older adult population and whether health benefits were perceived by program participants.

Measurement and Theory Insights – Chapter 4

The Attention Restoration Theory (ART) posits that nature is a restorative environment due to the presence of factors that allow directed attention to recover (Kaplan & Kaplan, 1989; Kaplan, 1995). Validated measures of perceived restorativeness allow for the presence of these factors to be measured (Hartig, Korpela, Evans & Garling, 1997; Pasini, Berto, Brondino, Hall, & Ortner, 2014). This paper explored whether administration of a perceived restorativeness scale was feasible and whether the domains of ART were appropriate for older adults. Cognitive interviewing was used to test the ART-based Perceived Restorativeness Scale - 11 and identify where and how it fails to provide valid assessments of the restorative environment constructs (Blair & Piccinino, 2005). This strategy evaluates for measurement error, assessing whether respondents consistently comprehend and respond to a question, and respond as the researcher intended (Collins, 2003). To understand potential sources of measurement error, the traditional model of cognitive testing was used, specifically focusing on the component comprehension (Campanelli, 1997; Tourangeau, 1984). Think-aloud processing during walking interviews with older adults in Sound Steps locations provided evidence of measurement error in comprehension. These inconsistencies across participants and perceived restorativeness factors call into question the feasibility of the survey and appropriateness of ART domains for older adults.

The three components of this dissertation aim to establish state of the science for existing green exercise literature and provide insights for future green exercise interventions for older adults by evaluating an established community program. A critical examination of the underlying theory that posits a mechanism for the added health benefits of green exercise and its associated measurement tool can provide insights into with an older adult population. Findings from this

study can be used to inform researchers and community partners of considerations when developing green exercise interventions or programming that are appealing to older adults.

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Chapter 2 – Green Exercise Studies Including Older Adults: A Scoping Review

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Abstract

A scoping review of green exercise studies that reported health outcomes and included older adult participants from 2003-2019 in PubMed, CINAHL Complete, PsycINFO, Embase, and Environment Complete was conducted. Twenty-nine studies were included. Most studies included were published since 2009 and represent a range of disciplines (determined through first author affiliation) and geographic regions. Physical, mental, and social health of participants was improved in most studies. Recommendations for future research include consistent use of the term "green exercise," reducing the number of components in interventions, additional studies with samples of only older adult participants, and use of an implementation science approach to the study of green exercise interventions for older adults.

Keywords

Green Exercise, Nature-based Activities, Older Adults, Scoping Review, General Health

Introduction

The Attention Restoration Theory (ART) posits that nature is restorative and therapeutic with the ability to promote well-being and functioning (Kaplan & Kaplan, 1989; Kaplan, 1995). It theorizes that living in modern, urban environments provides constant stimuli and stressors, such as intense light and sound, that wear down the executive functioning capabilities of directed attention. Directed attention is the ability to concentrate on a task, situation, or behavior while fending off competing stimulation, leading to successful completion of the task at hand (Staats, 2012). Directed attention requires effort and is a finite resource (Kaplan & Berman, 2010). Furthermore, in late adulthood, the frontal lobe, responsible for executive and social functioning, including directed attention per ART, atrophies causing decreased capacities in older adults (Von Hippel, 2007). Exposure to restorative environments that provide the mind an opportunity to engage in involuntary or effortless attention (otherwise known as fascination) instead, allows the mind to rest and directed attention to be replenished (Kaplan & Kaplan, 1989; Kaplan, 1995; Kaplan & Berman, 2010). 'Nature' can be perceived as restorative across a range of populations has been expanded to include other areas with natural vegetation such as urban parks, public open spaces, and street vegetation (Bossen, 2010; Twohig-Bennett & Jones, 2018). There are gentle, or soft fascinations (low-intensity, effortless attention) in nature that immerse someone enough to hold effortless attention and release directed attention. To be restorative, the environment must also be free of tasks or new stressors that re-engage directed attention (Kaplan, 1995; Kaplan & Berman, 2010).

Regular physical activity is important for maintaining mobility and independence through aging. Physical activity alone provides physical and mental health benefits (McPhee, French, Jackson, Nazroo, Pendleton, & Degens, 2016). However, when physical activity is combined

with exposure to natural restorative environments, their collective benefits can be greater than either one alone and exceed those of exercise that occurs in indoor or built urban outdoor environments such as neighborhood streets (Shanahan, Franco, Lin, Gaston, & Fuller, 2016). This concept, green exercise, or physical activity that is performed while directly exposed to nature, was first introduced in 2003 by Jules Pretty and colleagues (Pretty, Griffin, Sellens, & Pretty, 2003). For older adults, health benefits can include improved attention, reduced stress, lessened agitation, and increased intention to continue the physical activity (Murayama, Yoshie, Sugawara, Wakui, & Arami, 2012; Rantakokko et al., 2012).

Most of what is known regarding the health benefits of green exercise come from studies that have children or young adult samples (Coon et al., 2011). Additionally, green exercise research has been gaining attention by researchers worldwide and across disciplines, so there are likely more studies investigating green exercise than those that specifically use the term "green exercise" in their study description. Therefore, the goals of this scoping review were 1) to identify the scope and trends of the body of green exercise literature that includes older adult (65 years and older) participants; and 2) provide recommendations for future research for older adult green exercise interventions. A scoping review is more appropriate than a systematic review in this instance because the proposed review is exploratory in nature – clarifying concepts and establishing state of science- as opposed to synthesizing the evidence for a specific outcome across multiple studies (Munn, Peters, Stern, Tufanaru, McArthur, & Aromataris, 2018).

Related Reviews and Current Contributions

Four other related reviews have been recently published: Twohig-Bennet and Jones (2018), Mygind et al. (2019), Lahart et al. (2019), Gagliardi and Piccinini (2019). The current review differs from the prior reviews in distinct ways that contributes new information to the

field. Specifically, this review focuses on studies that investigate the health benefits of direct exposure green exercise interventions and those that include older adults in their sample.

Twohig-Bennet and Jones (2018) conducted a systematic review and meta-analysis that focused on studies that tested the relationship between exposure to greenspace and health outcomes. The Twohig-Bennet and Jones review included all ages and health outcomes, excluding studies that focused on mental health, communicable diseases, and weight status. The current review differs from Twohig-Bennett and Jones in that it includes only those studies in which physical activity occurred in the greenspace not just exposure to the greenspace, age was restricted to only those studies that included participants 65 and older, and had no health outcome restriction.

Mygind et al. (2019)'s review of controlled studies included immersive greenspace experiences, both sedentary and active in five languages and captured health outcomes that were mental (e.g., positive and negative affect, stress), physical (e.g., blood pressure, immune function), or social (e.g., collective efficacy, sense of community). Though the current review and Mygind et al. both include non-randomized trials and have no quality of study parameters, the current study restricts interventions to only active interventions in direct exposure to natural environments, has a population characteristic restriction of age, and was restricted to English-language articles.

Lahart et al. (2019) published a systematic review of green exercise studies that compare outdoor or virtual exercise interventions with indoor exercise. Physical and mental health outcomes reported were included in eligibility criteria as were studies that used a comparative or crossover design. The current review differs from Lahart et al.'s in that virtual exposure to greenspace was not included, though social health benefits and all study designs were.

Furthermore, an age restriction to only those studies that included older adult participants as a part of the study sample was applied to the current study, whereas Lahart et al. included studies with adult participants of age 18 and above without any further restrictions.

Gagliardi and Piccinini (2019) conducted an integrative literature review of nature-assisted therapies for older adults. For their review, a range of therapies including green exercise were eligible, as were both qualitative and quantitative, experimental and descriptive studies. The current study differs from Gagliardi and Piccinini's in that it focuses exclusively on green exercise therapies and has an age definition for older adults of aged 65 and above. Though Gagliardi and Piccinini focused exclusively on older adult samples, the current study opened the inclusion criteria to also accept studies with younger adults plus older adults to maintain a robust review selection.

Methods

This scoping review followed the Levac, Colquhoun, and O'Brien (2010) strategy. This strategy consists of six steps: (1) identifying the research question, (2) identifying relevant studies, (3) study selection, (4) charting the data, (5) collating, summarizing, and reporting results, and (6) consultation. Consultation occurred with a multidisciplinary committee of experts who provided input on the review process and drafts of the manuscript.

Identifying the Research Question

The focus of this scoping review was the exploration of green exercise interventional studies that included older adults aged 65 and above in the sample. In order to identify the scope and trends of currently published literature, the following research questions were posed:

1. To what extent have green exercise studies included older adults internationally?

2. What are the age distributions of the included samples and how many include exclusively older adult samples?
3. How many studies have used the term ‘green exercise’ to describe the intervention and is the term used consistently?
4. What types of physical activity exercises and natural environments were included as green exercise interventions?
5. Which health outcomes were used to capture the effects of green exercise interventions?

Identifying Relevant Studies

Databases were chosen for this review to represent source material across multiple health disciplines and built environment research. Those selected were PubMed, CINAHL Complete, PsycINFO, Embase, and Environment Complete. The database search occurred in August 2019. Furthermore, reference lists of related reviews were hand searched for additional articles that meet inclusion criteria (Gagliardi & Piccinini, 2019; Lahart et al., 2019; Mygind et al., 2019; Twohig-Bennet & Jones, 2018).

To capture studies that investigated green exercise interventions by its definition, but may not have used the term ‘green exercise’ in the report of their findings, a search strategy was constructed to capture the variations in terms used to describe the physical activity and natural environment within which that physical activity occurred. Table 1 specifies the strategy used. An experienced health sciences librarian was consulted during development of the aforementioned strategy for identifying relevant studies to include in this review.

Table 1. Search Strategy for PubMed (adapted for other databases)

Known terms – search strategy
Green exercis* [TIAB]
Outdoor recreation [TIAB]
Adventure therapy [TIAB]

Forest therapy [TIAB]	
Forest bathing [TIAB]	
Outdoor adventure [TIAB]	
Descriptors - terms	
#1	outdoor*[TI] OR outside[TI]
#2	park[TI] OR greenspace*[TI] OR green space*[TI] OR natural environment[TI] OR natur*[TI]
#3	garden[TI]
#4	wilderness[TI] OR forest[TI]
#A	exercis*[TI] OR physical activit*[TI] OR walk*[TI] OR physical fit*[TI]
#B	therapy[TI]
#C	health[TI]
Descriptors – search strategy	
#1 & #A	
#1 & #B	
#1 & #C	
#2 & #A	
#2 & #B	
#2 & #C	
#3 & #A	
#3 & #B	
#3 & #C	
#4 & #A	
#4 & #B	
#4 & #C	

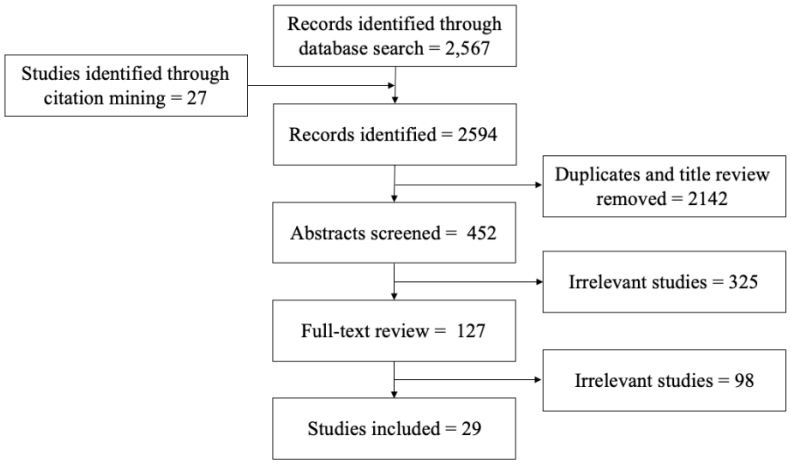
[TIAB] = search restricted to title or abstract
[TI] = search restricted to title

Study Selection

Inclusion criteria included studies that were published in 2003 or later (the first year the term ‘green space’ was used in academic research), written in the English language, had participant(s) that were over the age of 65 included in the sample, and investigated a green exercise intervention (where participants completed a green exercise program) and subsequently measured at least one physical, mental, and/or social health outcome. Studies were excluded if they included participant(s) under the age of 18, were reviews or meta-analyses, were letters or opinions, investigated only green space exposure and not a physical activity occurring in that

space, included physical activity as an outcome but not as the intervention, did not collect data on a specific health outcome, or were validating a measure. Search results underwent title review for relevancy and duplicates were deleted. Abstracts were reviewed and researchers (ARM and YS) conducted a full text review for final selection. The web application Rayyan was used to allow for a double blinding in the screening process (Ouzzani, Hammady, Fedorowicz, & Elmagarmid, 2016). Discrepancy were resolved by meeting to discuss and arrive at consensus and if needed, consultation with an additional reviewer. Figure 1 specifies the study selection process.

Figure 1. Selection of Sources of Evidence



Charting the Data

Abstraction was completed by the same researchers (ARM and YS) who completed the study selection. Seven abstractions were completed by both researchers independently and after establishing concurrence, the remaining 22 abstractions were divided equally for the researchers to complete individually. Abstraction items included year, first author field of study, country where data collection occurred, study purpose, study results, sample characteristics, participant ages, study design, data collection method(s), data collection timing, analysis plan, green exercise language use and definition, physical activity component of intervention, environment

in which physical activity occurred, health outcome(s), change in health outcome, study limitations, recommendation for future studies, and funding source. See Appendix 1 for data abstraction tool.

Collating, Summarizing, and Reporting Results

All abstraction data was collected and managed using REDCap electronic data capture tools hosted at University of Washington (Harris et al., 2009, 2019). REDCap (Research Electronic Data Capture) is a secure, web-based software platform designed to support data capture for research studies, providing 1) an intuitive interface for validated data capture; 2) audit trails for tracking data manipulation and export procedures; 3) automated export procedures for seamless data downloads to common statistical packages; and 4) procedures for data integration and interoperability with external sources. REDCap was also used to document study inclusion decisions during abstraction. Results reporting was guided by the PRISMA Extension for Scoping Reviews (Tricco et al., 2018).

Consultation

Consultation occurred with a multidisciplinary committee of experts who provided input on the review process and drafts of the manuscript.

Results

The database search and subsequent citation mining of related studies resulted in 2594 studies for consideration (Gagliardi & Piccinini, 2019; Lahart et al., 2019; Mygind et al., 2019; Twohig-Bennet & Jones, 2018). Following title, abstract, and full-text review, 29 studies were included (see figure 1). Two studies included (Grazuleviciene et al., 2015; Grazuleviciene et al., 2016) reported on different health outcomes, but using the same sample. The most common reasons for exclusion were that exercise was an outcome of greenspace exposure as opposed to

an intervention element (n = 95), no green exercise intervention (n = 55), no greenspace exposure for an exercise intervention (n = 47), no health outcome reported (n = 42), and only young adult participants (n = 32).

The time frame included in this review was 2003-2019. The year 2003 was selected to align with the first instance of the term green exercise that appeared in the literature. However, all except two of the studies included in this review were published in the last decade, from 2009 on, showing a more recent trend to include an older adult population. When looking at the different disciplines from which this body of research is being produced (determined by the department of the first author), there is very little overlap across the included studies, with exception of medicine from which seven of 29 (24%) studies were reported. See Table 2 for a descriptive summary of included studies.

To what extent have green exercise studies included older adults internationally?

The location from which participants were sampled from spread over many countries and continents. Eleven studies were from European countries (United Kingdom-5, Austria-2, Lithuania-2, Finland-1, Ireland-1); ten studies were from Asian countries (Japan-5, China-2, Korea-2, Taiwan-1); six studies were from North America (United States of America-6); and two studies were from Australasian countries (Australia-1, New Zealand-1). Figure 2 shows the distribution of studies regionally by year, both showing the international interest in green exercise research and increased focus on green exercise interventional studies since 2009.

Figure 2. Number of studies published by year and continent

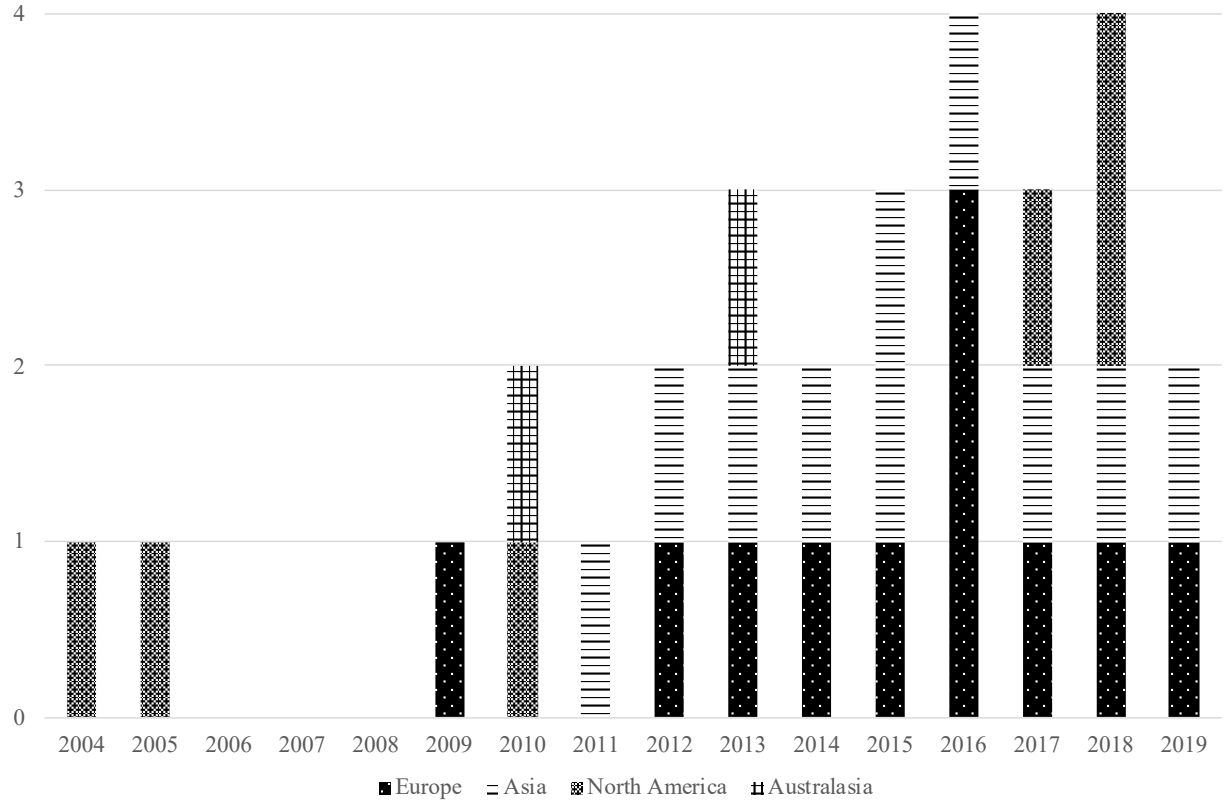


Table 2. Description of the Studies included in the Scoping Review (listed alphabetically by last name of the first author)

First author (year)	Country of First Author	Discipline	Sample Size	Design	Purpose
Barton (2009)	United Kingdom	Biological Sciences	n = 132	Between subject, 2 level, cross-sectional	Evaluate changes in self-esteem and mood after walking in four different National Trust sites of natural and heritage value in the East of England.
Barton (2012)	United Kingdom	Biological Sciences	n = 53	Non-randomized control trial	Evaluate two existing group-based health promotion initiatives and compare these to a new green exercise program (weekly countryside and urban park walks).
Boyes (2013)	New Zealand	Physical Education	n = 80	Observational, cross-sectional Mixed methods	Explore how outdoor adventure activities in a New Zealand community-based program are experienced and understood as successful ageing strategies.
Crust (2013)	United Kingdom	Sport and Exercise Science	n = 83	Non-randomized control trial	Evaluate the effects of short walks in two different green exercise environments on important markers of psychological health in mid- to older-aged adults.
Detweiler (2005)	United States of America	Medicine	n = 20	Case study	Report a case in which a dementia wander garden in a long-term treatment facility was used as an active modality in a post-stroke restorative therapy program to resolve treatment resistance and to achieve the treatment goals.
Grazuleviciene (2015)	Lithuania	Environmental Science	n = 20	Randomized control trial	Test the hypothesis that walking in a park has a greater positive effect on coronary artery disease patients' hemodynamic parameters than walking in an urban environment.
Grazuleviciene (2016)	Lithuania	Environmental Science	n = 20	Randomized control trial	Investigate whether walking in a park has a greater positive effect on coronary artery disease patients' stress parameters and cardiac function than walking in an urban environment.
Huber (2019)	Austria	Ecomedicine	n = 80	Randomized control trial	Test whether green exercise (moderate mountain hiking) combined with Mg-Ca-SO4 thermal balneotherapy is an effective and economic nature therapy to reduce symptoms and improve wellbeing of patients with non-specific lower back pain.
Iwata (2016)	Ireland	Agriculture and Food Science	n = 15	Pre-post Observational, cross-sectional	Investigate the effects of a group forest walk program (Woodland for Health) for the treatment of significant mental ill-health, specifically related to short-term self-rated psychological effects, symptoms of mental disorder, perceived effects on participants, elements of forests that are responsible for the effects.

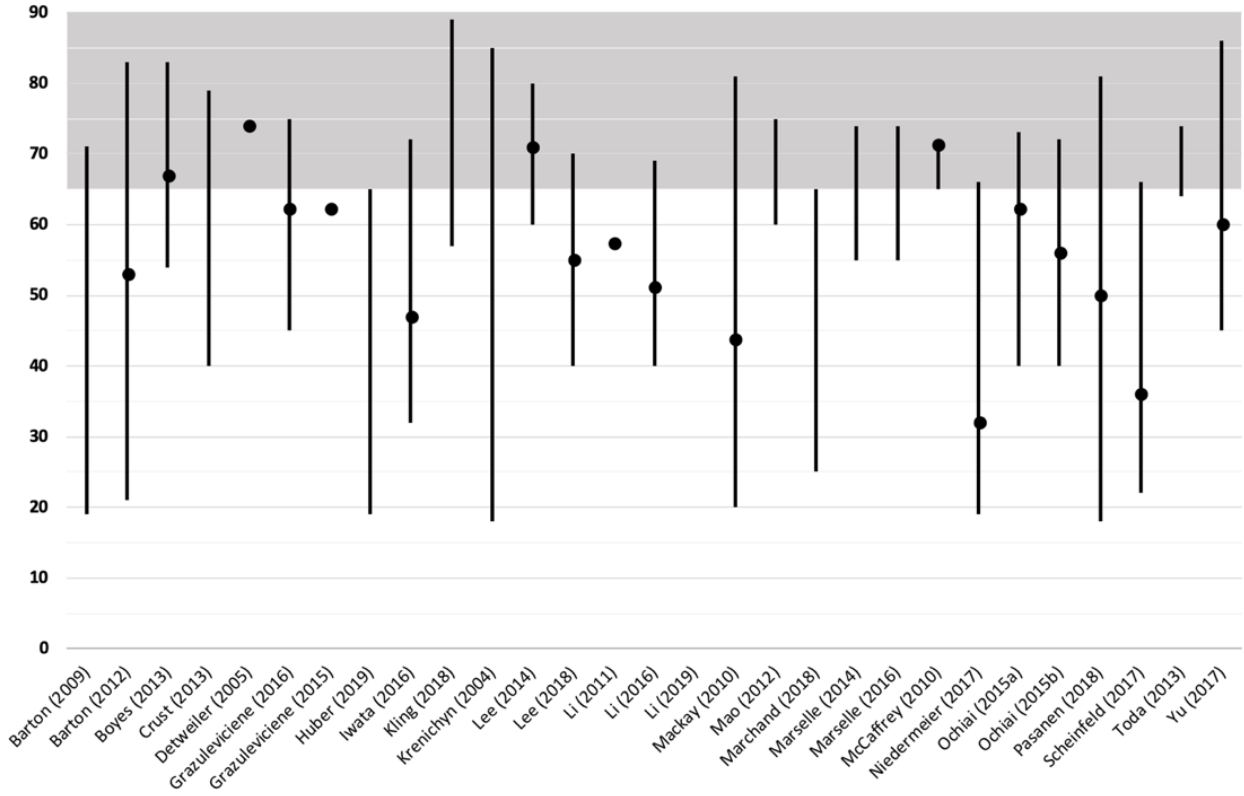
Kling (2018)	United States of America	Medicine	n = 106	Pre-post Observational, cohort	Examine cardiovascular, strength, and mobility outcomes after participation in 21 weeks of a community park-based physical activity program and explain differences in fitness outcomes across racial/ethnic groups.
Krenichyn (2004)	United States of America	Environmental Psychology	n = 41	Observational, cross-sectional	Explore themes of relationships and caring in interviews with women who did physical activities in Prospect Park in Brooklyn.
Lee (2014)	Korea	Medicine	n = 70	Randomized control trial	Investigate the acute effects of forest walking on arterial stiffness and pulmonary function in Korean elderly women.
Lee (2018)	Korea	Medicine	n = 71	Non-randomized control trial	Examine the biophysical and psychological effects of two different types of forests on women with metabolic syndrome.
Li (2011)	Japan	Public Health	n = 16	Within-subject	Investigate the effects of walking under forest environments on cardiovascular and metabolic parameters.
Li (2016)	Japan	Public Health	n = 19	Pre-post	Investigate the effects of walking in a forest park on cardiovascular and metabolic parameters in middle-aged males.
Li (2019)	China	Landscape Architecture and Urban Planning	n = 200	Observational, cross-sectional	Investigate adults' activity patterns in parks, especially the duration of activity in different park zones and self-reported psychological benefits.
Mackay (2010)	Australia	Psychology	n = 101	Non-randomized control trial	Explore the short-term effects of green exercise on state anxiety and examine the influence of exercise type, intensity, duration, and degree of greenness.
Mao (2012)	China	Medicine	n = 24	Randomized control trial	Provide scientific evidence supporting the efficacy of forest bathing as a natural therapy for human hypertension.
Marchand (2018)	United States of America	Veterans Affairs Medical Center	n = 22	Pre-post	Evaluate the short-term psychological impact of the SAT by determining if any increases in short-term anxiety and/or negative effect occurred.
Marselle (2014)	United Kingdom	Psychology	n = 127	Randomized control trial	Explore the health benefits of Nature beyond a "green" environment and investigate the effect of environment type and indicators of perceived environmental quality on emotional well-being following an outdoor group walk. Investigate whether perceived restorative quality of an environment moderates the effect of perceived environment

					type or perceived environmental quality on emotional well-being.
Marselle (2016)	United Kingdom	Arts and Media	n = 127	Pre-post	Examine whether perceived restorative quality would mediate the effect of perceived environmental quality and walk characteristics on emotional well-being following an outdoor group walk.
McCaffrey (2010)	United States of America	Nursing	n = 40	Pre-post Phenomenology Mixed Methods	Examine a combination of walking and reflective writing to determine the effects of this combined strategy to reduce depression and improve mood.
Niedermeier (2017)	Austria	Sport Science	n = 42	Randomized cross-over	Analyze the acute effects of a three-hour green exercise intervention (mountain hiking) on stress-related physiological responses.
Ochiai (2015a)	Japan	Medicine	n = 17	Pre-post	Assess the physiological and psychological effects of a forest therapy program on middle-aged females.
Ochiai (2015b)	Japan	Plastic and Reconstructive Surgery	n = 9	Pre-post	Measure the physiological and psychological effects of forest therapy on middle-aged males with high-normal blood pressure.
Pasanen (2018)	Finland	Psychology	n = 128 n = 121	Non-randomized control trial	Study the restorative effects of instructed interaction with the environment, through two field experiments of walking along a nature trail, either with or without psychological tasks
Scheinfeld (2017)	United States of America	Medicine	n = 242	Non-randomized control trial	Examine male U.S. military veterans' change in overall mental health symptoms after Outward Bound for Veterans course.
Toda (2013)	Japan	Pharmacology	n = 20	Pre-post	Investigate the effect of walking through woodland on salivary endocrinological stress markers, cortisol and chromogranin A.
Yu (2017)	Taiwan	Forestry and Resource Conservation	n = 128	Pre-post	Investigate changes in autonomic nervous system activity and emotions after a short forest bathing program in the Xitou Nature Education Area, Taiwan.

What are the age distributions of the included samples and how many include exclusively older adult samples?

This review focused on studies that included older adults, aged 65 or older per MeSH age category delineations, in their samples. However, restricting studies that only included older adult participants did not produce enough studies for a robust review. Therefore, studies were selected as long as they sampled all adults and included older adult participants. Participant ages across studies ranged from 18-89 years. See Figure 3 for sample ages. When looking at the studies included only older adult participants, only two studies would be included, both reporting on samples from the United States (Detweiler, 2005; McCaffrey, 2010). Some studies defined older adults or elderly as 60 years and above (example: Lee, 2014), but even with this alternative definition of older adults, only an additional four studies would be included and all studies were from Asian countries (Lee, 2014; Li, 2019; Mao, 2012; Toda, 2013).

Figure 3. Age Distribution of Study Participants Among Studies Included in Scoping Review



| = Age range of study sample; • = Average age of study sample, if reported

How many studies have used the term 'green exercise' to describe the intervention and is the term used consistently?

In anticipation of studies fulfilling the definition requirements of 'green exercise' but not all using the term to describe their intervention, the search parameters were developed to capture interventions in various types of natural environments and performing different types of exercises. Of the 29 studies that were included in this review, nine (31%) of them explicitly used the term 'green exercise' to describe the activity investigated. Of the nine studies that did use the term, three did not provide a definition of the green exercise. The six studies that did include a definition of green exercise (21% of all studies included), all included the two elements of a

physical activity and a natural environment, though used varying language to describe each element, see Table 3. Four of the definitions also included an example of one or both elements. This would indicate lack of outside contribution to further concept development of 'green exercise' over time. In most cases where the definition of green exercise is cited (n=3), the work of contributor Jules Pretty is exclusively reference with little variation on the actual definition used (Pretty, Griffin, Sellens, & Pretty, 2003; Pretty et al., 2005; Pretty, Hine, & Peacock, 2006; Barton & Pretty, 2010).

Table 3. Definitions of Green Exercise

Authors (Year)	Provided Definition(s) of Green Exercise	Definition Citation
Pretty, Griffin, Sellens, & Pretty, 2003	"physical activities whilst at the same time being directly exposed to nature." (p. 7)	Seminal definition
Barton (2009)	"participating in physical activities in outdoor greenspaces… (walking, running, cycling, gardening, horse riding, etc.)" (p. 26)	Pretty, Griffin, Sellens, & Pretty, 2003 Pretty, Hine, & Peacock, 2006
Barton (2012)	"any activity in a green space in the presence of nature" (p. 2)	N/A
Crust (2013)	"exercise or physical activity that occurs in the presence of nature such as cycling in the countryside or walking in an urban park" (p. 161)	Barton & Pretty, 2010
Huber (2019)	"active therapy combined with experience of nature" (p.2) "Physical activity in natural environments such as meadow, forests or alpine pastures" (p. 2)	N/A
Mackay (2010)	"exercise performed in (relatively) natural environments such as parks" (p. 238) "physical activities undertaken whilst exposed to natural environments." (p. 239)	Pretty et al., 2005

Niedermeier (2017)	"physical activity in natural environments" (p. 1) "physical activity and exposure to natural environments" (p. 2)	N/A

What types of physical activity exercises and natural environments were included as green exercise interventions?

For all studies included, whether the term 'green exercise' was included or not, both elements of the definition – a physical activity and a natural environment in which the activity took place – were present. There was great heterogeneity as to how the definition of green exercise (the specific activity and environment of the intervention) was fulfilled, demonstrating the need for a search strategy that includes applications of the green exercise definition past the use of the term itself.

The types of exercise that were investigated varied. Walking was the most prevalent form of exercise investigated with 24 (83%) studies including it as an element. Four studies (14%) investigated hiking (including backpacking and mountaineering), four studies (14%) investigated water sports (including kayaking/canoeing/rafting), four studies (14%) investigated undefined general exercise/recreation, three studies (10%) investigated cycling (including mountain and road cycling), three studies (10%) investigated unspecified games, two studies (7%) investigated running/jogging, and two studies (7%) investigated sailing. Other interventions included with only one study each were orienteering (sport of navigation), strength training, rock climbing, skiing, snowshoeing, dog sledding, stretching, boxercise, and rollerblading.

Investigations varied in the amount of interventional exercise elements. Twenty studies (69%) included only one type of exercise in their intervention. Walking (n=17), hiking (n=2), and sailing (n=1) were the three exercises that were investigated as a single exercise intervention.

Eight of the 29 studies (28%) (Barton et al., 2009; Boyes et al., 2013; Iwata et al., 2016; Kling et al., 2018; Krenichyn et al., 2004; Lee et al., 2018; Mackay et al., 2010; Scheinfeld et al., 2017) investigated more than one form of exercise. These eight studies introduced most of the variety in types of exercises investigated across all included studies.

Furthermore, the duration of the exercise varied from one study to another, including how much of the total intervention time was dedicated to green exercise versus another intervention element included. The average time spent actively performing green exercise per session was 99.7 minutes with an average number of sessions being 4.8. Eleven studies (38%) included an element beyond green exercise as a part of the intervention. Most commonly were meditation (n=3), rest (n=3), or looking at the scenery/wildlife (n=3). The next most common additional elements with two studies (7%) each were deep breathing, lecture, and reflection.

Table 4. Exercise Type, Duration, and Additional Intervention Elements

First author (year)	Exercise Type	Exercise Duration	Additional Element(s)
Barton (2009)	Walking, general exercise, playing games, recreation	15-240 mins	Enjoying fresh air, looking at scenery, watching wildlife, visiting heritage or history, meeting family or friends
Barton (2012)	Walking	6 walks of 45 mins	None
Boyes (2013)	Walking, cycling	mean years of engagement with program = 4.8	None
Crust (2013)	Walking	60-90 mins	None
Detweiler (2005)	Walking	45-60 mins/day for 90 days	None
Grazuleviciene (2015)	Walking	30 min/day for 7 days	None
Grazuleviciene (2016)	Walking	30 mins/day for 7 days	None
Huber (2019)	Hiking	5 hours/day for 6 days	Baths in thermal water (balneotherapy), relaxation
Iwata (2016)	Walking, warm-up exercises	70-100 mins/week for 7-8 weeks	Refreshments/socializing

Kling (2018)	cardiovascular exercise, strengthening exercise, stretching, balancing	1 hours, 2-3 times/week	Meditation
Krenichyn (2004)	Walking, cycling, jogging/running, hiking, roller blade, pick-up sports	Not specified	None
Lee (2014)	Walking	1 hour, <10km	None
Lee (2018)	Walking, playing folk games	2 hours	Five-sense feeling, meditation
Li (2011)	Walking	2 hours, 6km twice/day	None
Li (2016)	Walking	80 mins, 2.6km	None
Li (2019)	Walking, other	21-68 minutes	None
Mackay (2010)	Walking, mountain running, orienteering, cross-country running, boxercise, kayaking, road and mountain biking	20 mins (running), >60 mins (other)	None
Mao (2012)	Walking	1 week	None
Marchand (2018)	Sailing	3 hours, 1-2 sessions	Lecture, discussion and reflection
Marselle (2014)	Walking	1-32 walks over 13 week period	None
Marselle (2016)	Walking	10-90 mins for 13 weeks	None
McCaffrey (2010)	Walking	2 hours/week for 12 weeks	Reflective writing
Niedermeier (2017)	Hiking	3 hours, 6km	None
Ochiai (2015a)	Walking	94 mins	Deep breathing, lie down, lecture, chat, rest
Ochiai (2015b)	Walking	109 mins	Deep breathing, lie down, rest, ride on the “forest train”
Pasanen (2018)	Walking	44-97 mins	None
Scheinfeld (2017)	Backpacking, rock climbing, canoeing, white water rafting, mountaineering, sailing, sea kayaking, skiing, snow shoeing, dog sledding	6 days	Therapeutic group facilitation, winter camping

Toda (2013)	Walking	45 mins, 1km	None
Yu (2017)	Walking	2 hours, 2.5km	Stimulation of four senses

The natural environments in which these exercises took place also varied, as well as the level of descriptive detail given that would allow comparisons on the quality of greenness from one study to another. The way in which most studies described the greenspace used for the natural setting of the exercise was by name of the forest, city, etc. and then species of tree, size, and amenities were the next most common ways to describe the greenspace. "Forest," used 12 times (41%), was the most common descriptor used, followed by "urban park" used by seven studies (24%), and "mountains" used by four studies (14%). Other greenspace descriptors used included "coastline", "river valley," "marshland," "countryside," "bushland," "lake," "country park," "nature reserve," "garden," and "farmland." Two studies provided only vague descriptors of the space- Marselle et al. (2016) simply used the descriptor "nature" and Boyes et al. (2013) simply called the space "wilderness."

Which health outcomes were used to capture the effects of green exercise interventions?

Studies investigated the effect of green exercise interventions on a range of physical, mental, and social health outcomes, see Table 4. In total, 49 unique health outcomes were captured, with the majority of the outcomes (n=46, 94%) having evidence of improvement. Only one outcome, fatigue had evidence of worsening, however this outcome had mixed results with other studies reporting improvement or no change.

Although there were more physical health outcomes studied compared to mental or social outcomes, there were a few that had supporting evidence from multiple studies. Blood pressure, pulse rate, and stress/cortisol were the three physical health outcomes reported most frequently, each reporting outcome improvement or no change. Of studies that reported blood pressure

outcomes as a result of green exercise, four (67%) reported outcome improvement that was significant. Similarly, three studies (50%) reported improved pulse rate outcomes and two studies (40%) reported improved perceived and biologic measures of stress outcomes.

Mental health outcomes were most consistently reported across studies and often used the same measures to capture the green exercise effects. With the exceptions of fatigue, quality of life, and negative affect which had mixed results across studies, all other mental health outcomes reported trends of improvement (see Table 4).

Social health outcomes had the least robust support across the health outcomes categories. Not only were there fewer individual outcomes reported on, but all outcomes were captured through qualitative and observational methods, there were no controlled studies that captured social health outcomes. However, all the social health outcomes that were captured showed improvement due to participation in green exercise activities.

Table 4. Reported Changes in Health Outcomes

Outcome	Studies that Reported Improved Outcome	Studies that Reported Worsened Outcome	Studies that Reported No Change to Outcome
Physical Health			
Activities of daily living	Detweiler, 2005	-	-
Adiponectin	Li, 2016*	-	-
Adrenaline	Li, 2016	-	-
Aerobic capacity	Grazuleviciene, 2015	-	-
Aphasia	Detweiler, 2005	-	-
Arterial stiffness	Lee, 2014*	-	-
Back performance scale	-	-	Huber, 2019
Blood pressure	Grazuleviciene, 2016* Kling, 2018 Lee, 2014* Mao, 2012* Yu, 2017*	-	Li, 2016
BMI	Kling, 2018	-	-
Chromogranin A (CgA)	Toda, 2013*	-	-
Dopamine	Li, 2016*	-	-
Fitness	Grazuleviciene, 2015 Kling, 2018	-	-

Functional disability	Huber, 2019*	-	-
Insulin Regulation	Lee, 2018	-	-
Nervous system activity	Grazuleviciene, 2015	-	Yu, 2017
Noradrenaline	-	-	Li, 2016
Pain	Huber, 2019*	-	-
Pain related disability	-	-	Huber, 2019
Physical well-being	Boyes, 2013	-	-
Pulmonary function	Lee, 2014*	-	-
Pulse rate	Grazuleviciene, 2015 Kling, 2018 Li, 2016* Ochiai, 2015* Yu, 2017*	-	Grazuleviciene, 2016
Pulse rate recovery	Grazuleviciene, 2015	-	-
Spine check score	Huber, 2019*	-	-
Stress/cortisol	Grazuleviciene, 2016 Lee, 2018* Ochiai, 2015* Toda, 2013	-	Toda, 2013
Trunk rotation	Huber, 2019*	-	-
Mental Health			
Affect, negative	Crust, 2013* Marselle, 2016* Ochiai, 2015*	-	Grazuleviciene, 2016 Iwata, 2016
Affect, positive	Crust, 2013* Grazuleviciene, 2016 Iwata, 2016* Marselle, 2016* Ochiai, 2015*	-	-
Anger	Barton, 2009* Yu, 2017*	-	-
Anxiety	Li, 2016* Mackay, 2010* McCaffrey, 2010 Ochiai, 2015* Yu, 2017*	-	Lee, 2018
Confusion	Barton, 2009* Li, 2016* Yu, 2017*	-	-
Depression	Barton, 2009* Huber, 2019* Iwata, 2016 Li, 2016* McCaffrey, 2010* Yu, 2017*	-	Lee, 2018
Enjoyment	Crust, 2013*	-	-

	McCaffrey, 2010		
Fatigue	Barton, 2009 Li, 2016* Yu, 2017*	Toda, 2013	Ochiai, 2015
Gratitude	McCaffrey, 2010	-	-
Happiness	Marselle, 2016*	-	-
Mood disturbance	Barton, 2009* Barton, 2012* Li, 2016* Mao, 2012* Ochiai, 2015* Toda,2013 Yu, 2017*	-	Lee, 2018
Psychological well-being	Boyes, 2013 Huber, 2019* Schienfeld, 2017*	-	-
Quality of life	Detweiler, 2005	-	Huber, 2019
Restoration	Pasanen, 2018	-	-
Self-esteem	Barton, 2009* Barton, 2012* Crust, 2013* Detweiler, 2005	-	-
Sustained attention	Pasanen, 2018	-	-
Tension	Barton, 2009*	-	-
Vigor	Barton, 2009* Li, 2016* Ochiai, 2015* Yu, 2017*	-	-
Social Health			
Companionship	Krenichyn, 2004	-	-
Emotional support	Krenichyn, 2004	-	-
Familiarity	Krenichyn, 2004	-	-
Family bonding	Krenichyn, 2004	-	-
Social well-being	Boyes, 2013	-	-
Speech	Detweiler, 2005	-	-

* = statistically significant change in outcome

Discussion

This is the first scoping review of studies that investigated the health benefits of green exercise and that included older adult participants in their sample. The review identified multiple trends that can inform future directions of green exercise research for older adults. Particularly important to note are using samples that are made up of exclusively older adults, encouraging

further development of the concept definition of 'green exercise' and consistent use of the term for ease of identifying related studies, reducing the number of intervention elements to better understand the mechanisms leading to the health benefits received, investigating the implementation of green exercise in spaces that are accessible and accommodating of older adult participants.

All of the studies included have older adult participants in their study sample, however the lack of studies that focus exclusively on participants 65 years of age and above is a large gap in existing research. This is important because of the potential for compounded strain on directed attention that comes from living in modern society and aging-related atrophy of the frontal lobe in older adults (Kaplan, 1995; Kaplan & Bergman, 2010). In this review, it was not possible to further restrict the age parameters to focus on only older adults as there were too few studies to produce a robust review. The health outcomes received from the various green exercise interventions was a summary across a range of ages, so future research will be needed to verify these results in the subpopulation of older adults. Furthermore, an emphasis on social health outcomes when developing and testing green exercise interventions for older adults is warranted as another impact of age-related frontal lobe atrophy and changing sociodemographic status can affect social functioning and well-being (Kaplan & Berman, 2010; Kosteli, Williams, & Cummings, 2016).

Although the term "green exercise" appeared in the literature in 2003, it is not used with regularity (Pretty, Griffin, Sellens, & Pretty, 2003). This makes it difficult to search for related studies and therefore track the progress of the green exercise body of research because similar language is not being used. In this review, the search parameters were designed to capture studies that meet the definition criteria, even if not self-identified as green exercise and it was

found that less than a third of studies used the green exercise language. Positively, when the term 'green exercise' was used, consistent definitions demonstrates cited suggest established understanding. However, it also indicates a need further concept analysis of green exercise by other contributors than the one, nearly universally accepted definition.

Similar alignment will be needed as we continue to develop studies exclusive for older adults. This includes not only decisions in study design and outcomes, but also in the details shared in the write-up so that better cross-study comparisons and meta analyses are possible. Multiple studies were excluded during the screening process due to the lack of age information and those studies that were included, had inconsistent standards for the way in which age was reported.

The type of greenspace included in the parameters of the search included urban parks and gardens that have varying degrees of greenspace exposure and human modification. It is difficult to identify how immersive the experience is, a possible contributing factor to the amount of benefits the greenspace contributes. As urbanization continues to increase in communities worldwide, the more necessary it will be to protect and build accessible greenspace, even if it is more modified and controlled by human development than naturally occurring greenspace. Additionally, as adults progress through the aging process, more modifications may be necessary for a greenspace to be appealing and safe to recreate in. As the example of Detweiler (2005) shows, the diagnosis of dementia can require a highly modified wander garden to be created within a controlled environment. Research is underway to discover the 'dose' of greenness necessary to receive the health benefits of greenspace exposure (Barton & Pretty, 2010), though further studies are necessary with older adult populations and the addition of an exercise

component to determine how modified a greenspace can be to still receive the health benefits of green exercise.

This review has shown that green exercise can be beneficial for physical, mental, and social health outcomes. The majority of studies provided evidence of improved outcomes. A consideration for future research is to simplify the elements included in the intervention being tested. In the studies included in this review, green exercise interventions often included different types of natural environments, types of exercise, added intervention elements, duration of intervention as well as the range of geographical locations. Although this demonstrates a range of implementation strategies for green exercise, it also adds complexity to discovering and testing mechanisms and ideal dose for receiving positive health benefits. Greater standardization in green exercise interventions could also increase reliability, allowing for testing across multiple contexts and populations. Particularly when intervention elements that are not strictly green exercise are included, such as lectures, reflective writing, or meditation, correlational links between green exercise and health outcomes becomes more difficult to determine. Therefore, future research that includes fewer types of exercises and that remove non-exercise elements will allow for factors such as exercise duration, level of greenness or immersion necessary to receive benefits, and impact of green exercise duration to be explored.

A limitation of this review was the need to include studies with adult participants outside of the target age range of 65 and above in the sample. This was necessary to create a robust appraisal of types of green exercise interventions and health benefits studies have investigated thus far. Another limitation of this review is the lack of evaluation for study rigor, as it was outside the scope of this scoping review. Furthermore, the variability in dose of the intervention in regard to type, duration, and intensity of the physical activity as well as greenness of the

natural environment contributed a limitation to this review. Though this variability may affect the ability to consolidate health outcome findings across studies, the goal of a scoping review in determining state of the science and opportunities for future research is fulfilled.

Older adults may face one or more barriers to getting outside (Murayama, Yoshie, Sugawara, Wakui, & Arami, 2012; Rantakokko et al., 2009) though continuing regular exercise is important for maintaining mobility and independence (McPhee, French, Jackson, Nazroo, Pendleton, & Degens, 2016). Exercise preferences and needs of outdoor recreational areas that are appropriate and acceptable for older adults may differ from younger populations. Further investigations are warranted to both explore the implementation of current green exercise interventions for older adult populations and to determine whether the positive health benefits received are maintained.

Conclusion

This scoping review revealed 29 green exercise studies that included older adult participants in the sample. Though studies published 2003 and later were included, most were published 2009 and later, thus intervention studies that include older adults have been increasing over the last decade. Additionally, first author affiliations show a range of disciplines investigating the health benefits of green exercise, with the largest portion coming from medicine. Tracking the progress of this body of research can be difficult in that consistent green exercise language is not currently being utilized to identify similar investigations. More widespread use of the term green exercise for future studies will help advance the science as a single body of literature.

The particular elements of green exercise interventions varied greatly across studies. This includes the type of physical activity, natural environment in which they took place, and the

duration of the intervention. That being said, the majority of health outcomes reported showed benefits for the physical, mental, and social health of participants. Simplifying interventions to include limited elements in future research will allow for more rigorous investigation into mechanism and correlations of green exercise features and consequential health effects.

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Appendix 1. Data Abstraction Tool (using REDCap)

Confidential

Scoping Review Abstraction

Record ID	_____
Reviewer Name	◯ AM ◯ YS
ARTICLE Please select the article name that matches the PDF file name. You can start typing the PDF file name in the box to search the drop-down options.	◯ Barton-2009-The-health-benefits-of-walking-in-g ◯ Barton-2012-Exercise--nature--and-socially-inte ◯ Boyes-2013-Outdoor-adventure-and-successful-ag ◯ Crust-2013-The-acute-effects-of-urban-green ◯ Detweiler-2005-Dementia-wander-garden ◯ uleviciene-2015-The-effect-of-park-and-urban-enviro ◯ uleviciene-2016-Tracking-restoration-of-park-and-ur ◯ Huber-2019-Green-exercise-and-mg-ca-so-thermal ◯ Iwata-2016-Benefits-of-group-walking ◯ Kling-2018-The-effect-of-a-park-based-physical ◯ Krenichyn-2004-Women-and-physical-activity-in-an-u ◯ Lee-2014-Cardiac-and-pulmonary-benefits-of-f ◯ Lee-2018-Acute-biophysical-responses ◯ Li-2011-Acute-effects-of-walking-in-forest- ◯ Li-2016-Effects-of-forest-bathing-on-cardio ◯ Li-2019-Subtypes-of-park-use-and-self-repor ◯ Mackay-2010-The-effect-of-green-exercise ◯ Mao-2012-Therapeutic-effect-of-forest-bathin ◯ Marchand-2018-Safety-and-psychological-impact-of- ◯ Marselle-2014-Moving-beyond-green-exploring-the-r ◯ Marselle-2016-Does-perceived-restorativeness-medi ◯ McCaffrey-2010-Garden-walking-for-depression ◯ iedermeier-2017-A-randomized-crossover-trial-on-acu ◯ ai-2015-Physiological-and-psychological-eff-FEMALES ◯ hiai-2015-Physiological-and-psychological-eff-MALES ◯ Pasanen-2018-Can-nature-walks-with ◯ Scheinfeld-2017-The-impact-of-outward-bound ◯ Toda-2013-Effects-of-woodland-walks ◯ Yu-2017-Effects-of-short-forest-bathing

CONFIRMATION OF INCLUSION Please verify that the study meets inclusion criteria. - No children included (< 18) - Participants aged 45+ (age range can include ages 18-44, as long as participants aged 45+ are included as well) - English Language (body of text) - Physical activity component in intervention (must include at least light physical activity of any nature - cannot be only exposure that occurs in a greenspace setting) - Natural space exposure in intervention (Natural space can include greenspace, parks, water, desert, or other environments that have had minimal modifications by humans - no only indoor or outdoor urban environments) - Physical, Mental/emotional, Social, or Spiritual Health outcome reported (outcome may be collected via medical testing, survey, or self-report including interview or story telling) - Original Research Report (quant, qual, mixed methods; experimental, quasi-experimental ok; case study ok) - Published between 2003-2019	◯ Include ◯ Exclude
EXCLUSION REASON Please include which inclusion criteria was not met by the current study and rationale for exclusion.	_____
FIELD OF STUDY Select the department affiliation of first author.	◯ Nursing ◯ Medicine ◯ Public Health ◯ Psychology ◯ Physiology ◯ Sports Medicine ◯ Health Promotion ◯ Environmental Science ◯ Urban Planning ◯ Other
Please specify "Other":	_____
COUNTRY Select the country in which data collection occurred.	◯ Australia ◯ Austria ◯ Denmark ◯ Finland ◯ Ireland ◯ Japan ◯ Netherlands ◯ Poland ◯ Scotland ◯ Switzerland ◯ Taiwan ◯ United Kingdom ◯ United States of America ◯ Other
Please specify "Other":	_____

PURPOSE Please copy the stated purpose of the study according to author, including page number.	_____
RESULTS Please copy and past in the "results" section of the abstract into the provided box.	_____
SAMPLE Please provide sample size and any descriptive information about the sample provided (i.e. gender)	_____
PARTICIPANT AGES Please provide age range and/or mean age provided by author to describe study sample.	_____

STUDY DESIGN Mark the study design as specified in the "Methods" section. More than one design may be selected. Randomized control trial = intervention and control groups, randomized at recruitment Non-randomized control trial = intervention and control groups, assigned groups by staff or choice Pre-post = single group, assessment-intervention-assessment Observational, cohort = 2 groups, 1 time point-assessed based on exposure to green exercise or not Observational, case-control = 2 groups matched on outcome, 1 time point Observational, cross-sectional = single time point Other Quantitative = survey-based study not captured by other options, please specify Case Study = single test subject Ethnography = systematic study of people and cultures Grounded Theory = creation of theory based on systematic collection of data Phenomenology =study of the lived experience of a phenomenon Other Qualitative = interview-based study not captured by other options, please specify Mixed Methods = more than one design employed Text box option = if you would like to further describe the study design	☐ Randomized control trial ☐ Non-randomized control trial ☐ Pre-post ☐ Observational, cohort ☐ Observational, case-control ☐ Observational, cross-sectional ☐ Other Quantitative ☐ Case Study ☐ Ethnography ☐ Grounded Theory ☐ Phenomenology ☐ Other Qualitative ☐ Mixed Methods ☐ Not Specified ☐ Text box option (optional)
Please specify "Other Quantitative":	_____
Please specify "Other Qualitative":	_____
Please provide more information.	

DATA COLLECTION Mark all that apply to how data was collected in this study. Observation = researchers generated knowledge without asking participants Interview = participants were asked open-ended questions Survey = participants were asked questions with pre-determined answer options Mixed Methods = used more than one of above. Please mark all that apply from list. Biological sample = sample taken from participants for lab testing In person = face-to-face interaction, researcher and participant in same location Over the phone = researcher interacted with the participant via phone calls, or other live electronic communication (i.e. via Skype, FaceTime) Internet = questions were delivered and received via electronic text or form communication (i.e. email, internet survey, etc.) Other = none of the above applies Text box option = if you would like to further describe the study design	☐ Observation ☐ Interview ☐ Survey ☐ Mixed Methods ☐ biological sample ☐ In person ☐ Over the phone ☐ Internet ☐ Other ☐ Not Specified ☐ Text box option (optional)
Please specify "Other":	_____
Please provide more information.	_____
DATA COLLECTION TIMING Please specify at what time points related to the Green Exercise Intervention data was collected. EX: T1 = 2 days prior to green exercise T2 = 4 days into 7 day green exercise program T3 = 1 day post green exercise completion If unclear, please provide what information is provided, ok to copy and paste from publication.	_____

ANALYSIS Select all that apply for methods used to analyze data. Statistics = statistical method applied to numerical data, please specify model if given Content/Thematic Analysis = interview data, theme/thought is unit of analysis Discourse Analysis = interview data, word is unit of analysis Grounded Theory/Constant Comparative Method = interview data, incidence/social unit is unit of analysis Phenomenological/Hermetical Analysis =interview data, incidence/experience is unit of analysis Other = none of the above applies OR open text box to specify further on format listed above.	☐ Statistics ☐ Content/Thematic Analysis ☐ Discourse Analysis ☐ Grounded Theory/Constant Comparative Method ☐ Phenomenological/Hermetical Analysis ☐ Other ☐ Not Specified
Please specify "Statistics" by providing the model used, if provided:	_____
Please specify "Other":	_____
GREEN EXERCISE LANGUAGE Did the author use the term "Green Exercise" to describe the intervention?	◯ Yes ◯ No
GREEN EXERCISE DEFINITION Please copy and paste green exercise definition (including citation Author, Year), if provided. If not defined, please write, "no definition specified."	_____
PHYSICAL ACTIVITY Physical activity/form of exercise that was performed in a natural environment	☐ Walking ☐ Hiking ☐ Cycling ☐ Tai-Chi ☐ Swimming ☐ Sailing ☐ Gardening ☐ Other ☐ Not specified
Please specify "Other":	_____
OTHER INTERVENTION ELEMENTS Did the intervention include elements other than exercise/physical activity?	◯ Yes ◯ No
Please describe the other elements of the intervention beyond the exercise/physical activity component.	_____

EXERCISE DURATION
Please specify the duration/distance of exercise performed by subjects.

If the intervention included other elements, please also include the overall duration.

_____

GREENSPACE DESCRIPTION
Please provide a description of the greenspace/natural environment the exercise was performed in, including any facilities/elements of the greenspace description provided by authors.

_____

HEALTH OUTCOME(S)
Specify the health outcome that was measured/reported on as a result of participating in green exercise.
Mark all that apply.

Stress/cortisol = a state of mental or emotional strain or tension resulting from adverse or very demanding circumstances

Fatigue = extreme tiredness resulting from mental or physical exertion or illness

Fitness = the condition of being physically fit and healthy, the quality of being suitable to fulfill a particular role or task

Other Physical = biological outcome related to bodily functioning, not captured in other options

Anxiety = feeling of worry, nervousness, or unease, typically about an imminent event or something with an uncertain outcome

Depression = feelings of severe despondency and dejection

Mood = temporary state of mind or feeling, frame of mind

Other Mental/Emotional = outcome related to mental or emotional well-being not captured by other options

Loneliness = sadness or isolation because one has no friends or company

Other Social = outcome related to social health, communication, ability to relate/engage with others in community

Text box option = if you would like to further describe the health outcomes included

- ☐ Stress/Cortisol
- ☐ Blood pressure
- ☐ Cholesterol
- ☐ Diabetes
- ☐ Fatigue
- ☐ Fitness
- ☐ Other Physical/physiological
- ☐ Anxiety
- ☐ Depression
- ☐ Mood
- ☐ Other Mental/Emotional
- ☐ Loneliness
- ☐ Other social
- ☐ Text box option (optional)

Please specify "Other Physical":

_____

Please specify "Other Mental/Emotional":

_____

Please specify "Other Social":	_____
Please provide more information.	_____
CHANGE IN HEALTH OUTCOME Was there a change in the health outcome(s) as a result of participating in green exercise? What direction? How much? Please list for each health outcome measured/reported on.	_____
STUDY LIMITATIONS Please copy and paste study limitations as quoted by author (including page number) If no study limitations included, please write "not specified" in text box.	_____
FUTURE STUDIES Please copy and paste in what the author identifies as opportunities for future research. If no future directions included, please write "not specified" in text box.	_____
FUNDING SOURCE Using the "Acknowledgement" section, write funding source(s). Grant numbers are not necessary. If no funding source is acknowledged, please write "not specified" in text box.	_____

Chapter 3 – Acceptability and Appropriateness of an Urban Green Exercise Program for Older Adults: A Pilot Study

Co-authors

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Abstract

Green exercise, or physical activity that occurs in a natural environment, can provide added health benefits as compared to indoor exercise. In order to assess the uptake of green exercise programming for older adults, this pilot study evaluated the implementation of an ongoing urban forest walking program for adults aged 50 years and above in Seattle, Washington, United States of America. Semi-structured walking interviews with 14 program participants were analyzed using thematic content analysis and applied to an implementation framework for program evaluation. The program's group structure, program frequency, and the physical elements of the urban forest environment were found to have high levels of acceptability. Additionally, appropriateness was supported by tailoring to an older population and their health needs. Insights provided by this study can inform the development of future green exercise interventions for older adults that can be rigorously investigated for the health benefits participants receive.

Keywords

Green Exercise, Older Adults, Urban Green Space, Implementation, General Health

Introduction

Walking is both a preferred and highly beneficial form of exercise for older adults (Finlay, Franke, McKay, & Sims-Gould, 2015). When walking occurs outside and in a natural environment, additional health benefits beyond just those received by exercise have been reported (Barton, Bragg, Wood, & Pretty, 2016). In this study, an existing urban park walking program, Sound Steps, offered free of charge to participants by Seattle Parks and Recreation in Washington, USA, is evaluated for acceptability and appropriateness as an outdoor walking program targeting an older adult population.

Older Adults and Physical Activity

Regular physical activity is important for maintaining and improving physical and mental health outcomes for older adults. A lifestyle that includes regular physical activity helps maintain mobility and independence (McPhee et al., 2016). Walking is a versatile and accessible form of exercise. It does not require special skills or equipment to perform and is the preferred exercise of older adults (Barton, Bragg, Wood & Pretty, 2016; Finlay, Franke, McKay, & Sims-Gould, 2015; Piercy et al., 2018). Due to reduced exercise capacity through the normal aging process, walking can more easily qualify as moderate intensity exercise in older adults due to higher relative intensity (how intense an exercise is in comparison to a person's total capacity) (Piercy et al., 2018).

Green Exercise for Older Adults

Green exercise is physical activity or exercise that occurs in natural environments (Pretty, Peacock, Sellens, & Griffin, 2005). People who exercise in natural as opposed to built environments, whether indoor or outdoor, enjoy added physical, mental, and social health benefits (Lahart et al., 2019). Studies have shown that when walking outside versus inside,

participants report more enjoyment and intention to continue walking (Foucht, 2009). Additionally, exercising in natural settings can improve attention, reduce stress, lessen agitation, reduce pain, and lessen the need for medications (Detweiler et al., 2011).

Older adults may experience one or more barriers to getting outside and into natural settings necessary for green exercise. These may include physical limitations, fall risk, neighborhood design, weather, and decreased perception of socializing opportunities (Hug, Hartig, Hansmann, Seeland, & Hornung, 2009; Murayama, Yoshie, Sugawara, Wakui, & Arami, 2012; Rantakokko et al., 2009). Distance from a natural space also affects use by older adults; parks within walking distance of home are associated with increased physical activity (Mowen, Orsega-Smith, Payne, Ainsworth, & Godbey, 2007). Thus, urban parks are ideal for access to nature near to home in order to engage in green exercise for those older adults living in metropolitan areas.

Understanding Implementation of Green Exercise Interventions for Older Adults

Implementation science translates research into practice by examining how interventions are implemented in real-world settings. It applies evidence-based interventions, discovering what works, what doesn't, and why with the goal of improving population health and well-being (Eccles & Mittman, 2006; Lobb & Colditz, 2013; Nilsen, 2015). Guided by implementation frameworks, evaluation of interventions allows researchers to ask how to adopt and sustain an intervention (Proctor, Powell, & McMillen, 2013).

Such uptake of previous green exercise research can be seen through initiatives both in the United States and internationally. In the US, the "National Park Prescription Initiative" or ParkRX launched in 2013 and New Zealand has begun adopting "green prescriptions" as a part

of a holistic, patient-centered practice (Marques, McIntosh, & Popoola, 2018; National Park Service & Golden Gate National Parks Conservancy, 2018).

The green exercise research that has guided current uptake of these programs have been based primarily on samples of children and young adults. We therefore lack a clear understanding of how these programs are implemented among older adult populations. The purpose of this pilot study is to assess the acceptability and appropriateness of an urban forest walking program for adults aged 50 years and above.

Materials and Methods

Setting

Sound Steps is volunteer-lead group walking program free of charge to participants, adults aged 50 years and above. The program is offered by the Seattle Parks and Recreation Lifelong Recreation program in Seattle, Washington, USA. The program is designed to encourage regular exercise and promote a healthy lifestyle. Weekly Sound Steps walks are offered in 10-15 walk locations around the City of Seattle each quarter (Seattle Parks and Recreation, n.d.).

This pilot study sampled program participants from two Sound Steps walking groups that take place in urban forests in the northern Seattle neighborhood of Broadview – Carkeek Park and Llandover Woods Greenspace. Participants of both programs walk at a moderate pace for 5 kilometers (km) along natural surface forest trails with some hills. Carkeek Park is as 87-hectare (ha.) park that consists of lush forest, meadows, wetlands, creeks, and beach located 14.5 km from downtown Seattle. Llandover Woods Greenspace is a three-ha. park that consists of dense northwest forest located 16 km from downtown Seattle.

Participants

Participants (n= 14) were identified via convenience sampling of existing Sound Steps attendees. Inclusion criteria for participants included Sound Steps registration, English language fluency, aged 50 years and older, able to talk while walking at a moderate pace for up to 45 minutes, and willingness to be audio recorded.

Data Collection

Recruitment of participants occurred in-person using fliers and pre-walk announcements. A single interviewer conducted all walking interviews during Fall 2019. The semi-structured interviews were conducted while walking along established program routes and lasted between 15-56 minutes (average 27.5 minutes). All participants provided informed consent before being interviewed and received a monetary incentive for their participation. Questions covered background on program participation, perceived health benefits, perceived restorativeness, and perceptions of walking program structure and environmental features of the selected parks, see Appendix 1.

During the walking interviews, the interviewer and participant walked through the normal route of the Sound Steps program. The participant set the pace and was able to take any necessary rest breaks. Using this method, participants are able to be asked about their experiences while being immersed in the environment being investigated as opposed to being separated from it as in a traditional sit-down interview (Harris, 2016). Additionally, the interviewer was able to observe how the participants interacted with their surroundings, enriching the responses with field notes directly related to responses (Finlay, Franke, McKay, Sims-Gould, 2015; Carpiano, 2009; Ståhl, Carlsson, Hovbrandt, & Iwarsson, 2008).

This study was approved by the Institutional Review Board of the University of Washington (STUDY00008013). All approved study protocols were followed during the recruitment and interview stages of data collection. Approval for this study was also granted by program leadership at Seattle Parks and Recreation.

Data Analysis

All interviews were audio-recorded and transcribed verbatim using a professional transcription service. Interview transcripts were entered into data management software Dedoose Version 8.3.19 for analysis (SocioCultural Research Consultants, LLC, Los Angeles, CA). For the first stage of analysis, thematic content analysis was employed to delineate participant feedback into distinct themes through inductive analysis coding (Graneheim & Lundman, 2004; Sandelowski, 2000; Thomas, 2006). Themes are text that represents an important concept about participants' experiences or opinion in relation to the research questions and communicated through passages or whole responses (Braun & Clarke, 2006; DeSantis & Ugarriza, 2000). Five interviews were randomly selected using a random number generator and used to develop the initial codebook, which was reviewed by two investigators (ARM and SCC) to ensure coding rigor (Barbour, 2001). After consensus was reached, the edited codebook was used to code the remaining interviews by a single investigator (Thomas & Magilvy, 2011).

The second stage of analysis used the framework established by Proctor et al. (2011) for implementation evaluation. The codebook created through content analysis was applied to the implementation outcomes by the same two investigators (ARM and SCC) individually and then brought together to discuss and negotiate any inconsistencies.

Implementation Evaluation Framework

To guide evaluation of the Sounds Steps walking program, Proctor and colleagues implementation framework was employed. This framework identifies eight implementation outcomes, two of which assess on the level of the individual – acceptability and appropriateness (Proctor et al., 2011) (see Table 1).

Table 1. Taxonomy of selected implementation outcomes (from Proctor et al., 2011)

Implementation outcome	Level of analysis	Other terms in literature	Available measurement
Acceptability	Individual provider Individual consumer	Satisfaction with various aspects of the innovation (e.g. content, complexity, comfort, delivery, and credibility)	Survey Qualitative or semi-structured interviews Administrative data
Appropriateness	Individual provider Organization or setting	Perceived fit; relevance; compatibility; suitability; usefulness; practicability	Survey Qualitative or semi-structured interviews Focus group

Acceptability is the perception of program participants that the given treatment is agreeable, palatable, or satisfactory within the treatment setting in which the treatment occurs. Acceptability may be dynamic as it is based on a participant's direct experience with the treatment (Proctor et al., 2011). Though questionnaires are used to evaluate aspects of the treatment such as its content, complexity, or comfort, semi-structured interviews are also a common method of assessment (Proctor et al., 2011). In the current evaluation, acceptability examined group structure, program frequency, and physical elements of urban forest locations.

Appropriateness, conceptually similar to acceptability, is the perceived fit, relevance, or compatibility of the treatment. It can also be the perceived fit of the treatment to address an issue or problem (Proctor et al., 2011). Appropriateness differs from acceptability in that it focuses on

the application of the treatment to a specific population or outcome (Proctor et al., 2011). Appropriateness of Sound Steps was evaluated for the target population of older adults and for its target outcome of improving the physical, mental, and social wellbeing of participants.

Results

Fourteen participants, seven from each walk program site, were interviewed for this study, see Table 2 for demographics.

Table 2. Participant Demographics (n=14)

	Overall	Carkeek Park (CP)	Llandover Woods Greenspace (LW)
n	14	7	7
Age	Average 73.7 years Range 68-83 years	Average 73 years Range 68-78 years	Average 74.4 years Range 68-83 years
Gender	Female 10 (71%) Male 4 (29%)	Female 4 Male 3	Female 6 Male 1
Race/Ethnicity	Caucasian 11 (79%) Asian 2 (14%) Unknown 1 (7%)	Caucasian 5 Asian 1 Unknown 1	Caucasian 6 Asian 1

Acceptability of Group-based Structure

The group-based structure of Sound Steps was a particular draw for participants to this program. Groups were guided by volunteer walk leader and consisted of the same about 15-30 participants weekly. First of all, the walking through the park with other people gave participants a feeling of safety. Concerns of injury were prevalent, given reduced stability and injury recovery associated with the aging process. Being a part of the volunteer-led group meant that participants were walking with those who knew the area and the terrain of the park and therefore able to identify upcoming changes to trail conditions or potential hazards. One participant who rotates in as a volunteer walk leader regularly describes, "*We have to pick the route, where we're going, where the restroom stops are, where we stop. And first and foremost, we have to go out*

and examine our routes; make sure they're safe" (LW1). Additionally, participants felt more at ease walking through the forest setting with the knowledge that if an injury were to occur, they would have others around able to help. LW7 says, "*I would hesitate to do this alone because I just think walking alone is not safe. Something could happen to you, and you might not be able to tell anybody*."

The group structure of the walking program also contributed to feelings of safety from other park goers. Multiple participants expressed feeling uncomfortable when passing others on the trail as they did not know the intention of the other person. They felt that as an older adult, they may be the target of attack. LW5 explains, "*there were people that were congregating. And I'm not sure what kind of things they were doing. Things that maybe they shouldn't be doing. And I suppose I would now probably have somebody walk with me as opposed to walk by myself like I did before, which is probably a good idea no matter what to have a partner with you as you get older just in case*." Participants in both urban forests identified that the homeless encampments contribute to the parks feeling unsafe to be walking through alone. Homeless encampments are informal makeshift dwellings where those that are unable to afford or maintain permanent residences seek shelter (Sparks, 2017). As one participant says, "*Sadly I have to be safer when we're walking where there are homeless camps…I would never walk there alone because of the encampment… I just feel safer walking with somebody else not by myself*" (LW6).

Being a part of the Sound Steps group provided participants a support network for accountability. When asked what they get from program participation that they would not get otherwise, CP3 responded, "*Accountability maybe. I mean [the group] notices if you don't come for a few weeks. So it's partly the structure."* Volunteer walk leaders took attendance at the beginning of each walk, and absentees were noted by both the leader and other group members.

If someone missed multiple walk sessions, that individual was contacted out of concern by members of the group. Though attendance in Sound Steps programs are completely voluntary, the friendships among the group members fostered a sense of neighborly concern for the wellbeing of other participants. This created an accountability system that participants credited in part for encouraging regular attendance of the program.

Walking with the Sound Steps group also pushed participants to move more vigorously, a key element of beneficial physical activity and successful ageing (Hupin et al., 2015; Menai et al., 2017). Though volunteer walk leaders ensured no one fell behind, participants expressed a conscious effort to keep up with the group or challenged themselves to be at the front of the pack. One participant, CP4, had a moment of competitiveness while we were talking, "*walking in the forest, in Seattle and all around - hey, they're passing us - I think it's changed much of my attitudes*." Additionally, when the grade got steeper, such as a hill, participants used other group members to push through the uncomfortableness. This provided motivation to walk up the hill as well as made the reported experience easier for participants. CP5 explains, "*Well, we're going uphill [laughter]. I can feel that [laughter]. It's a little harder to breathe. My body's going, 'No. Here come the stairs.' But I'm still energized and enthusiastic*."

Acceptability of Program Frequency

The walk program occurring on a weekly basis was an important element that contributed to the Sound Steps participants. Nearly all participants committed to attending the program every week unless a conflict arose. Having the program occur at the same time, at the same place, every week allowed participants to create a routine around the walk. This was identified as one of the primary draws of participating in the program. As LW4 describes, "*I think the best thing I'd have to say is discipline. Because we do certain things on certain days. So if I wasn't, I*

probably would be sleeping in late and getting up and just being lazy." Additionally, the regularity of the program allows for the group to develop deeper social bonds with each other. As CP2 describes, "*I guess it's easy to make acquaintances, right? But making close friends is more difficult. So, I guess you need more time to be able to meet people. And this is a good opportunity to, I guess deepen the friendship you get*."

Acceptability of Urban Forest Physical Features

The greenness and natural beauty of the Sound Steps urban forest locations were discussed frequently by program participants. Both urban parks allowed immersion in lush Pacific Northwest green space with tall evergreen trees, water streams, and various other plant and animal life. Participants felt a connectedness to nature in these spaces, able to disconnect from metropolitan surroundings. As LW6 notes, "*I like being in a natural environment. It's uplifting and really makes me smile. And being away from the sounds of the city is really important."* Participants felt as though they received fresher air than in their neighborhoods where car exhaust is more prevalent. CP5 explains, "*I just like to be in nature. I like the green, I like trails. I don't like walking on the street, necessarily. There's traffic and pollution-- you can tell the air is fresher here*." And watching the park go through seasonal changes continued to make the walks engaging despite visiting the same location week after week. LW5 shares, "*There's always something different when we do this trail from winter to spring the summer the fall. It just changes so much. There's always something different to look at*."

The urban forest trail in both park locations was desirable for Sound Steps participants. The trail was made of primarily dirt or gravel, with some areas of cement. Those areas that were dirt or gravel were deemed more appealing by walk participants. The dirt or gravel caused reduced impact and pain on the joints, which has become more noticeable through the aging

process. As CP5 explains, "*It's easier to walk on dirt and gravel than pavement. It's just harder on the body*."

The grade of the trail, how much the trail either inclined or declined, was the element of the urban forest environment that had the most mixed opinions between walk participants. Though participants of the Sound Steps walks were physically able to walk in variable terrain as both parks required hills to get to meeting locations, their preferences and attitudes varied from preferring flatter to preferring more hilly terrain. Most of the disagreement stemmed from amount of physical exertion required- those that preferred the flatter terrain wanted to have the walk be easier like CP7 who says "*But if I was by myself, I'd probably more go on a flat surface*." Others felt like they got a sufficient workout in when it was hillier. As CP3 explains, "*when we walk, I try to get hills so you get enough cardio benefit to make it worthwhile. This is fun like this*."

Facilities provided by the park space were important to program participants. In particular, bathrooms and parking were the facilities most used and important to walk participants. An element of natural aging recognized by multiple participants was the need to use the restroom frequently, so having a bathroom available at the park and a break at the bathrooms during the walk was important to participants. As LW1 describes, "*we identify on the map where the restrooms are. So you can plan it ahead of time because that's a really important feature for any seniors over 60*." Almost all participants drove to the walk locations, and therefore utilized parking at the meeting location where walks began and ended.

Appropriateness for Older Adults

Sound Steps provides participants a challenging, yet approachable green exercise program. LW3 shares "*it depends on the terrain because some of it is really quite challenging for*

people our age but that's great." LW5 expands on this thought when they say, "*And maybe in the geriatric field can push some envelopes a little bit. We're not out and gone just because we're a little bit older. We're a generation that has a lot to give, so don't count us out*."

Participants perceived Sound Steps as a positive program that gives attendees benefits, beyond exercise alone, through the social network that it creates. As LW4 describes, "*I feel good. I don't know how else to explain, but I feel good. And being with people your own age helps*." It is important for participants of this walking group to have opportunities to meet new people, and people who are like them. Though not asked specifically, participants often talked about being retired, and in some cases also widowed. CP1 shares, "*It helps me with my social skills. I'm a very shy person and meeting with new people used to be a real struggle for me. But with groups like this, everyone is so accepting of one another*."

Appropriateness for Health Outcomes

Sound Steps programming provided a wide range of self-reported health benefits among participants. Physical wellbeing benefits attributed to the walking component of the program included increased physical fitness, cardiovascular health, and digestive health. Participants recognized the need for exercise to be a part of part of regular health maintenance. CP6 explains, "*physical activity helps your body not age as quickly… you use it or lose it. And this is one way to be using your facilities*." Joint health was particularly emphasized – the regular exercise allows participants' joints to remain limber and maintain their level of mobility and activity. LW2 shares, "*I'm here to take a deep breath, keep moving, making sure that I'm still walking a year from now*."

Sound Steps also contributed to participants' mental wellbeing. LW4 explains, "*I was here three years, miserable in Seattle, and [my son] saw this ad for Sound Steps, forwarded that*

to me, and the rest is history. I just love it." It is difficult, however, to determine if any one component of the walk group contributed more to these mental health lifts, as exercise, the greenery, and the group structure have all been identified as contributors. For instance, CP4 calls out exercise and nature together when they say, "*After [my husband] died, I feel lonely. I feel sadness, and I don't want to live. And then I see that when I'm walking… I don't know how, but I feel better. And I feel that I'm looking to the sky. Looking to the little trees that grow up. And every time, I see a new-- a leaf in the tree, and it makes it better… It's pills against depression."*

Benefits to participants' social wellbeing is evident by their testimonies. Both Sound Steps programs fostered close social ties between participants, creating connections and friendships. LW4 says, "*I figured this is for older people like myself to participate in. So I joined and I made good friends, we have fun walking together*." Even those less inclined to be social received this benefit, such as CP7 who explains, "*the camaraderie with other people is good, although I tend to be a little bit of a loner, but it's breaking me out of that, which is a good thing."*

Another benefit captured through interview testimonies was that of the spiritual wellbeing of participants. When asked about the benefits received from program participation, CP5 responded, "*physically, and emotionally, spiritually, you got all those things still at work*." In one interview, this spiritual benefit was expressed through a comparison to religion, such as LW2 who said, "*how can I say this? I'm not a churchgoing person. The outdoors, that's my spiritual home.*" Another talked about the effect on their soul such as CP4 who said, "*I like very, very much the green in my eyes. And I really mean it. It's makes my soul feel like she is a free soul*."

Discussion

Sound Steps program was found to be both an acceptable and appropriate green exercise program for older adults. By interviewing participants while walking along the established routes in a novel data collection method, real time experiences and insights were captured. Aspects of the program design used here can inform future research interventions and community programs that are tailored for this population.

High levels of acceptability, or the suitability of the program within the given setting, was established. Of particular importance for many of the participants was the group-based structure as it added benefit on multiple dimensions. This finding was consistent with those of Finlay and colleagues who found that older adults in their study also had a fear of injury and of other parkgoers (Finlay, McKay, & Sims-Gould, 2015). Being in a group helped address these fears in the current study. However, findings from this study, differed from Bethancourt, Rosenberg, Beatty, and Arterburn (2013). In this study, the group-based structure enabled participants to complete the exercise and provided motivation to exercise more vigorously. Bethancourt and colleagues discovered that the group-based structure of gym classes was a barrier to the older adults in their sample, making them feel self-conscious and apprehensive about being able to keep up with the group and not slow the others down.

Also contributing to the acceptability of the program was the regular, weekly schedule. Participants were able to build a routine around attending and that gave them a sense of structure. This is consistent with the findings of studies lead by Kosteli and Bethancourt (Bethancourt, Rosenberg, Beatty, & Arterburn, 2013; Kosteli, Williams, & Cummings, 2016). Kosteli and colleagues found that the lack of structure in post-retirement life was a barrier to meeting physical activity recommendations, but when structure was introduced, it created a sense of

purpose in participants' lives. Bethancourt and colleagues' findings also found the value of establishing a routine, especially for those that are starting a new exercise regime. In both of the aforementioned studies, all (Kosteli and colleagues) or the majority (Bethancourt and colleagues, 81.8%) of older adults in their sample were retired. Although this study did not specifically collect employment status as a demographic, there were multiple participants who offered their status as retired during the interviews. Therefore, recommendations for future research include collecting employment status for all participants and to purposefully sample older adults who are employed. It would be important to verify that these findings are maintained, or if employed older adults have different needs that need to be accounted for in intervention or program development.

The features of the urban parks chosen to host these walking groups also contributed to Sound Steps being acceptable for participants. Finlay, McKay, and Sims-Gould (2015) found that preferable host parks are full of natural vegetation and having a bathroom on-site, which is consistent with the findings of this study. However, our findings differ in the preference of walking surface composition. In this study, participants preferred dirt and gravel paths as is was a softer impact on their aging joints. However, Finlay and colleagues discovered that there was a preference for paths with a flat concrete surface. A notable difference in the samples of our groups is that the current study consists of older adults with high mobility, whereas there were more participants in the Finaly, McKay, and Sims-Gould sample that relied on walking assistance devices. This difference suggests that there may be sub-groups among older adults that vary on the basis of mobility who have different needs of acceptable walking spaces, which warrants future inquiry.

Sounds Steps was found to be appropriate in meeting the health needs of the older adult population. Not only did it provide an accessible and approachable green exercise program, but participants perceived multiple health benefits. Similar to findings from other studies, Sound Steps participants received physical, mental, and social health benefits (Detweiler et al., 2011; Finlay, McKay, & Sims-Gould, 2015). A new finding from this study, however, was the perceived spiritual health benefits that at least three participants spoke to. Spirituality is gaining attention as the "fourth dimension of health," which will be an important consideration for holistic health recommendations and programming in the future (Dhar, 2011).

Limitations

One of the limitations of this study is that the study sample was recruited from an existing green exercise program with older adults who have chosen to participate in the program. They are mobile, high activity level individuals who are drawn to an urban green space-based program. Further investigation with older adults who do not currently walk in natural settings or lead more sedentary lifestyles is warranted.

Another study limitation is that the program locations chosen for the walking programs are expansive and well-maintained urban forests that not all metropolitan areas have access to. The parks in which the Sound Steps program occur allow for an immersive experience into forested green space. Therefore, further investigation into implementation of green exercise programs for older adults should be pursued in different types of urban green spaces that are found in different cities.

Furthermore, this study focused on the implementation outcomes that Proctor et al. (2011) identified as at the level of the consumer – acceptability and appropriateness. This was an appropriate decision for both the sampling restriction and scope of the current project. However,

there are other implementation outcomes that could warrant further investigation, particularly the outcome sustainability or others that are evaluated at the organizational level, such as adoption. In the current study, the program evaluated was an existing and established green exercise program that had ongoing organizational support. In expanding urban green exercise programming particularly to a new area, insights at the organizational level will assist in the initial buy-in of institutional or community partners as well as an understanding of the long-terms needs a program like this will require, if committed to.

Conclusion

Sound Steps was found to be an acceptable green exercise program for older adults. The group-based structure of the program lead to feelings of safety and accountability. Physical elements of the urban forests chosen to host the walks, including greenness, trail surface, and on-site facilities contributed positively to the walk experience of participants. And the weekly program frequency created routine and an opportunity to develop deeper social connections.

The program was also found to be appropriate for an older adult population and to address their health needs. Sound steps is an appealing program that also challenges participant fitness. Additionally, benefits to participants' physical, mental, social, and spiritual wellbeing were all found as a result of program participation.

This positive evaluation of the Sound Steps urban forest walking program's acceptability and appropriateness is an encouraging application of expanding green exercise research. Programs of this nature can contribute to providing patient-centered, holistic healthcare with multi-dimensional health benefits. Further development of similar green exercise programs and systems of integrating them into medical plans of care can contribute to healthy aging in older adult populations.

Conflict of Interest Statement

There was no conflict of interest in this research.

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Appendix 1. Semi-structured Interview Guide

Area 1: Program Environment

1. What are the 2-3 things you like most about walking in [location]?
2. What are the 2-3 things you like least about walking in [location]?
3. Do you prefer walking indoors or outdoors? Why?
4. Is there anything else that makes an area either appealing or less inviting to walk in? [Prompt: walking surface? Benches? Bathrooms? Lighting? Location? Safety? Graffiti? Litter?]

Area 2: Health and Nature

1. What do you feel are the health benefits of walking in [location]? [Prompts: physical, mental, social]
2. How do you feel walking in a [outdoor/indoor] space like this differs from walking in [outdoor/indoor] space? How similar?
3. In this moment, how do you feel?
4. Have you ever experienced any negative effects of walking here? Prompt: Falls? Blisters? Pulled a muscle?]

Area 3: Background on Program Participation

1. How long have you been attending Sound Steps Programs? [Prompt: how often?]
2. How did you find out about the program?
3. Why did you sign up for this program?
4. How did you get here today? How far did you have to come?
5. What does this program provide for you that you would not get without attending?
6. Do you intend to continue attending this program? Why?

Area 4: Demographic Information

1. What year were you born?
2. What is your gender?
3. What ethnicity do you identify as?

Area 5: Conclusion

1. Is there anything else that you would like to share with me?

Chapter 4 – Perceived Restorativeness of Older Adult Walking Programs: Measurement and Theory Insights

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Abstract

The Attention Restoration Theory (ART) posits that nature is a restorative environment due to the presence of factors that allow directed attention to recover. Validated measures of perceived restorativeness allow for the presence of these factors to be measured. This paper explored whether administration of a perceived restorativeness scale was feasible and whether the domains of ART were appropriate for older adults. Think-aloud processing during walking interviews with older adults in outdoor and indoor settings provided evidence of measurement error in comprehension per the traditional model of cognitive testing. These inconsistencies across participants and perceived restorativeness factors call into question the feasibility of the survey and appropriateness of ART domains for older adults.

Keywords

Restorative Environments, Older Adults, Data Quality, Cognitive Interviews, Attention Restoration Theory

Background

Physical activity is important for healthy aging. With regular exercise, older adults are able to maintain mobility, independence, and prevent chronic disease (King & Guralnik, 2010; McPhee et al., 2016). Walking is the preferred form of exercise for older adults as it does not require any specialized skill or equipment and can be performed in indoor and outdoor settings (Barton, Bragg, Wood & Pretty, 2016; Finlay, Franke, McKay, & Sims-Gould, 2015; Piercy et al., 2018). However, the recommended 150 to 300 minutes of exercise per week is often not met (Hupin et al., 2015; Physical Activity Guidelines Advisory Committee, 2018). Changing the physical location of where walking is performed to natural outdoor spaces has the potential to encourage regular physical activity. Walking outside has been shown to increase enjoyment and intention to continue walking than when walking indoors (Foucht, 2009).

Exercise performed in a natural environment, or green exercise, can provide additional health benefits compared to exercise alone (Barton & Pretty, 2010). For older adults, these benefits can include improved attention, reduced stress, lessened agitation, and reduced pain (Detweiler et al., 2011). Despite the added benefits, some older adults face barriers to getting outside including physical limitations, fall risk, and neighborhood design (Murayama, Yoshie, Sugawara, Wakui, & Arami, 2012; Rantakokko et al., 2009; Michael, Green, & Farquhar, 2006).

Two influential theoretical frameworks have been proposed to explain the restorative effects of nature and subsequent health benefits- the Stress Recovery Theory and the Attention Restoration Theory (Kaplan & Kaplan, 1989; Kaplan, 1995; Kaplan & Berman, 2010; Ulrich, 1983; Ulrich et al., 1991). Stress Recovery Theory uses a psycho-evolutionary perspective to posit that following exposure to a stressor (a situation that threatens well-being) viewing a natural landscape can expedite the recovery of the sympathetic and parasympathetic nervous

systems. In this evolutionary perspective of human survival, natural landscapes are perceived as fertile, promising food and water, expansiveness, locomotive capabilities, and lack of danger. Stress Recovery Theory has a foundation in aesthetics, highlighting that highly restorative natural environments have homogenous textures, relatively even ground surfaces, and provide enough line of sight as to be able to anticipate threats (Ulrich, 1983; Ulrich et al., 1991).

While the Stress Recovery Theory posits that restorative qualities of natural environments targets stress and the nervous system, Attention Restoration Theory (ART) posits that restoration instead targets attention and mental fatigue. Two key concepts that underpin ART are directed attention and effortless attention (also referred to as fascination). Directed attention is defined as the ability to concentrate on a task, situation, or behavior while fending off competing stimulation, leading to successful completion of the task at hand (Staats, 2012). Fascination has been defined as attention that takes no mental effort to hold (effortless attention) and is further subdivided into hard and soft fascination. The distinction between the two types of fascination depend on the intensity of stimulation that captivates the senses and precludes thinking of anything else (Kaplan, 1995; Staats, 2012). Hard fascination is raised through intense stimulation, such as at those one would experience at sporting or entertainment settings, whereas soft fascination is engaged through moderate and aesthetically pleasing stimuli (Herzog, Black, Fountaine, & Knotts, 1997; Kaplan, 1995).

As described by ART developers, directed attention takes effort and is a finite resource that is fatigued by the demands of modern, urban living (Kaplan & Kaplan, 1989; Kaplan, 1995; Kaplan & Berman, 2010). When engaged in effortless attention, the mind is theorized to rest and directed attention replenished. Hard fascination is posited to allow for shallow recovery, but soft fascination allows for a deeper state of psychological restoration. Environments that engage

fascination and facilitate this recovery are called restorative environments (Kaplan & Kaplan, 1989; Kaplan, 1995). The four components of restorative environments are posited to be: (1) fascination – complete effortless thought engagement; (2) being away - mental separation from stressors; (3) compatibility – ability to maneuver with ease, not contributing new stressors; and (4) extent – enough soft-fascinations to hold attention. Extent is further broken up into two sub-components: (a) coherence – physical structure and organization that makes sense (e.g. perceived as orderly rather than confusing); and (b) scope – imagined and physical scale of the environment (Kaplan & Kaplan, 1989).

Nature has been identified as a restorative environment for the presence of these components and facilitated directed attention recovery for a range of populations and situations (Kaplan & Kaplan, 1989; Kaplan, 1995; Bossen, 2010). ART does not focus on physical characteristics of nature that are identified as restorative, but rather whether these elements of restoration are perceived when experiencing the space (Straas, 2012). Measurement tools have operationalized the components of restorative environments as identified by ART and have been used widely to evaluate different settings on their perceived restorativeness (Berto, 2014; Hartig, Korpela, Evans & Garling, 1997; Pasini, Berto, Brondino, Hall, & Ortner, 2014). Environments that rate highly on the scale indicate the presence of restoration elements as described by ART. Higher rating, then, means that the environment has greater restorative potential (Hartig, Korpela, Evans, & Garling, 1997; Herzog, Maguire, & Nebel, 2003; Laumann, Garling, & Stormark, 2001). ART can be applied to different types of environments beyond nature, although nature is identified across cultures as having high restorative potential (Kaplan & Kaplan, 1989; Kaplan, 1995; Bossen, 2010).

Testing of the theory with different populations and in various settings is important for future development of the theory and measurement tools. ART has been cited in guiding a significant body of research, however, has been criticized for lack of overall and underlying conceptual clarity (Joye & Dewitte, 2018; Ohly et al., 2016). Furthermore, testing of the theory has been limited by possible unmeasured confounding factors, including cognitive status (Neilson, Craig, Travis, & Klein, 2019). This is of particular concern given that older adults are more likely to experience decreased cognitive function while also potentially receiving the greatest benefits as posited by ART (Von Hippel, 2007).

Therefore, this paper explored whether: 1) the administration of a validated perceived restorativeness measure was feasible for older adults, and 2) the theoretical domains of ART were appropriate for older adults. Walking group participants in both outdoor natural environments as well as indoor environments were included to capture potential diversity in perceived restorative environments for this population.

Methods

Setting

The findings in this paper are a part of a larger study that partnered with existing older adult walking programs in outdoor and indoor environments in Seattle, Washington, USA. Sound Steps is a walking program series offered free of charge by Seattle Parks and Recreation (Seattle Parks and Recreation, n.d.). Each quarter, there are 10-15 weekly volunteer-led walks in various outdoor and indoor settings around metropolitan Seattle. The goal of these programs is to encourage regular exercise and promote a healthy lifestyle to adults aged 50 and older. Two outdoor and two indoor Sound Step walk locations were selected for this study in collaboration with program coordinators.

The two outdoor walk locations are Carkeek Park (CP) and Llandover Woods Greenspace (LW). Both urban parks are located in North Seattle and offer a walking route of about 3 miles. Carkeek Park consists of lush forest, meadows, wetlands, creeks, and beach. Walking paths are natural forest trails with some hills. Llandover Woods Greenspace has a gravel path that follows a ravine through dense Northwest forest.

The two publicly accessible indoor walk locations selected were Northgate Mall (NG) and Rainier Beach Community Center (RB). Northgate Mall is a shopping center located in North Seattle. It provides an enclosed, tiled walking surface within which walkers are able to follow a route of their choosing. Rainier Beach Community Center is located in South Seattle. The walking group utilizes a gym space with basketball court surface and bleachers. Walkers complete laps around the basketball court as their established route.

Participants

A convenience sample of 29 existing Sound Steps participants (14 from the two outdoor walk program sites, 15 from the two indoor walk program sites) were interviewed for this study. Inclusion criteria for participants included being: 1) registered to participate in a Seattle Parks and Recreation Sound Steps program, 2) English language fluency, 3) aged 50 years or older, 4) able to talk while walking at a moderate pace for up to 45 minutes, and 5) willingness to have responses audio recorded.

Measure

The Perceived Restorativeness Scale and subsequent versions (shorter, different languages) were developed to assess the domains of a restorative environment (Hartig, Korpela, Evans & Garling, 1997; Pasini, Berto, Brondino, Hall, & Ortner, 2014). For this study, the Perceived Restorativeness Scale -11 (PRS-11) was chosen for its reduced question count (Pasini,

Berto, Brondino, Hall, & Ortner, 2014). This 11-item, Likert scale was derived from the longer, 17-item Perceived Restorativeness Scale (Hartig, Korpela, Evans & Garling, 1997). It evaluates the restorative environment components of fascination, being away, extent sub-component coherence, and extent sub-component scope. This measure has good fit indexes and factor loadings while also having a comprehensive indicator of restorativeness. The PRS-11 was administered orally to all participants (see Appendix 1 for interview guide).

Data Collection

Semi-structured interviews were conducted by a single interviewer in Fall 2019. Recruitment occurred in-person through pre-walk announcements, fliers, and snowball sampling (Goodman, 1961). After obtaining informed consent, the interview was conducted while walking along the normal Sound Steps program route. Participants set the walking pace and breaks were taken as needed. This novel walking interview method allows participants' experiences and the environment to be assessed in real time, unlike traditional sit-down interviews in which participants are removed from that which they are being asked about (Harris, 2016). Being immersed in the environment facilitates more accurate recall for participants, thereby increasing the validity of survey measures (Pasini, Brondino, Burro, Raccanello, & Gallo, 2016). This is particularly advantageous for older adults as memories become more generalized and lose specificity with age (Koutstaal & Schacter, 1997; Tun, Wingfield, Rosen, Blanchard, 1998). Additionally, the interviewer was able to observe how the participants interacted with their surroundings, enriching the responses with field notes directly related to responses (Finlay, Franke, McKay, Sims-Gould, 2015; Carpiano, 2009; Ståhl, Carlsson, Hovbrandt, & Iwarsson, 2008).

An interview guide was created that included the PRS-11 and supplementary open-ended questions and follow-up prompts (see Appendix 1). Open-ended questions covered background on program participation, perceived health benefits, perceived restorativeness, perceptions of walking program structure, and insights about environmental features of the selected parks. We used think-aloud methods to fully describe each respondent's process for answering survey questions to identify problems such as whether the question was misunderstood or whether the question could not be answered. We also considered the potential role of interviewer bias given interviewer/respondent differences in ethnicity, age, social class, and gender (Collins, 2003). All interviews were audio recorded and later transcribed verbatim by a professional transcription service.

Survey Cognitive-Testing Approach

We used a cognitive interviewing format to evaluate comprehension of survey items and construct validity of PRS-11 among our sample of older adults. (Blair & Piccinino, 2005). A traditional approach to cognitive testing identifies potential measurement error by assessing whether respondents consistently understand and respond similarly to survey questions and whether those responses are as the researcher intended (Collins, 2003 Campanelli, 1997; Tourangeau, 1984). The think-aloud method was used to explore how the participants went about responding to survey questions. During the introduction of the survey, participants were invited explain why they chose the response they did (Collins, 2003; Drennan, 2003; see Appendix 1 for interview guide). Comprehension of the question relies on two elements: meaning of terms and question intent. This model also identifies the impact of both context and prior knowledge on question comprehension. Context involves activating relevant pieces of background information and identifying perspectives. People can draw from different information, thus leading to

different question understandings. For example, if someone grew up exploring natural places with their family, they would have a different context for interpreting their experience of nature than someone who lived in a city their entire life and has not been exposed to natural spaces. Prior knowledge includes use of knowledge about text, stereotypical situations, and concrete details (Tourangeau, 1984). These four dimensions of comprehension measurement error were used as the framework to make sense of themes in participants' experiences and insights (Smith & Firth, 2011).

Data Analysis

The framework approach was employed in the analysis of interview data, including think-aloud responses (Ritchie & Lewis, 2003; Smith & Firth, 2011). This approach uses interconnected stages of systematically searching data until significant themes are identified. Analysis began by considering line-by-line transcript data, then creating a codebook of recurring themes, refining the codebook themes into advanced categories, and applying the codebook to an established model. Details of these stages of analysis are described below.

Interview transcripts were entered into data management software Dedoose Version 8.3.19 for analysis (SocioCultural Research Consultants, LLC, Los Angeles, CA). Thematic content analysis was employed to delineate participant feedback into distinct themes through inductive analysis coding (Graneheim & Lundman, 2004; Sandelowski, 2000; Thomas, 2006). Themes are text that represent an important concept about participants' experiences or opinions in relation to the research questions and communicated through passages or whole responses (Braun & Clarke, 2006; DeSantis & Ugarriza, 2000). Five interviews were randomly selected using a random number generator and used to develop the initial codebook, which was reviewed by two investigators to ensure coding rigor (Barbour, 2001). After consensus was reached, the

edited codebook was used to code the remaining interviews by a single investigator (Thomas & Magilvy, 2011). Following the initial application of the codebook to all interview transcripts, the codebook was reviewed and refined to ensure that each code represented a single unit of thought. Original transcripts were continually referred to check meaning and verify proper application of refined codes. Associations and links between themes were then combined into categories.

In the final stage of analysis, the categories and themes were then applied to the comprehension component of the traditional model of cognitive testing (Campanelli, 1997; Tourangeau, 1984). Measurement error occurs when respondents do not consistently comprehend and respond to a question, and respond as the researcher intended (Collins, 2003). For the two comprehension elements of meaning of terms and question intent, each participant's think-aloud responses were evaluated for delayed response, clarifying statements, and repeating back of words. We defined the occurrence of a comprehension measurement error as when speech was added in between statement delivery by the interviewer and scale rating by the participant. Specifically, we defined the occurrence of meaning of terms errors as when a participant asked for the definition of a word or repeated a word prior to answering the survey question. The instances of meaning of term errors were counted across survey questions and participant characteristics for trends in error. Question intent errors were evaluated in a similar way. We defined the occurrence of question intent error as when a participant: a) had an associated code of clarification at the level of the entire statement; b) explicitly expressed lack of understanding of the statement meaning; and/or c) qualified their response as to clarify the way they interpreted the question's intent.

The traditional model also identifies the role of context and prior knowledge in consistently responding to questions between participants and as the researcher intended

(Tourangeau, 1984). Context is the activation of relevant background information that informs one's perspective on the question asked. Context errors were defined as occurring when the participant explicitly expressed difficulty in recalling the proper information to answer the question or difficulty in applying the question to experience of the environment. Context errors were also evaluated for consistency between researcher and participants. The researcher intention for relevant information, guided by the survey developer intention, was elements of the physical space that made up the walking environment (Hartig, Korpela, Evans & Garling, 1997; Pasini, Berto, Brondino, Hall, & Ortner, 2014). An instance of error was recorded for each time context referenced by participant was something other than the physical environment. The aspect of prior knowledge includes use of concrete details, which were evaluated for consistency across participants. For each question of the survey, codes pertaining to what concrete details of the walking environment a participant used as frame of reference to answer the question were compared. Similar codes were categorized together, and error was defined as occurring when one or more participant referenced a detail that differed from one or more other participants in the sample.

This study was approved by the Institutional Review Board of the University of Washington (STUDY00008013). All approved study protocols were followed during the recruitment and interview stages of data collection. Approval for this study was also granted by program leadership at Seattle Parks and Recreation.

Results

A total of 29 participants were included in this study, 14 from outdoor walking groups and 15 from indoor walking groups. Participant ages ranged from 68 to 94 with an average age

of 78. Twenty-five participants (86%) were female and 17 identified as Caucasian (59%). See Table 1 for Participant Demographics.

Table 1. Participant demographics

	Overall	Carkeek Park (CP)	Llandover Woods Greenspace (LW)	Northgate Mall (NG)	Rainier Beach Community Center (RB)
n	29	7	7	6	9
Age	Average, years Range, years	Average 73 Range 68-78	Average 74.4 Range 68-83	Average 85.5 Range 78-94	Average 80.1 Range 73-90
Gender	Female 25 (86%) Male 4 (14%)	Female 4 Male 3	Female 6 Male 1	Female 6 Male 0	Female 9 Male 0
Race/ Ethnicity	Caucasian 17 (59%) African American 8 (28%) Asian 3 (10%) Unknown 1 (3%)	Caucasian 5 Asian 1 Unknown 1	Caucasian 6 Asian 1	Caucasian 5 Asian 1	African American 8 Caucasian 1

Meaning of Terms

Participants demonstrated difficulty in understanding specific words in the question. One way in which this is evident is by explicit comments. For example, when asked to rate the statement 'there is a clear order in the physical arrangement of this space,' participant CP4 responded by saying, "*I don't understand the word, don't understand the meaning."* In other cases, participants needed confirmation of a word or words in the question. For example, in response to the statement prompt 'places like this are fascinating, three participants replied, "*fascinating?"*

Seven of the 11 questions in the PRS-11 showed evidence of error in the meaning of a term, see Table 2 for distribution of instances in which a participant demonstrated this error by question. Of note, the restorative environment factor of fascination had a higher incidence of error than the other three factors. However, the two questions "places like this are fascinating" (n = 4) and "places like this are a refuge from nuisances" (n =3) from the domains of fascination

and being away respectively, were responsible for over half (54%) of the total number of errors. Additionally, participants in indoor walking environments contributed 77% of the error occurrences despite participants being nearly evenly distributed across outdoor and indoor walking sites.

Table 2. Meaning of Terms Error Count

PRS-11 Item	Total Number of Errors	Restorative Environment Factor		Outdoor n = 14 (48%)		Indoor n = 15 (52%)		Caucasian n = 17 (59%)		Non-white n = 11 (38%)		Unknown n = 1 (3%)	
Places like this are fascinating.	4	Fascination	6	0	0	4	6	3	5	1	1	0	0
In places like this, my attention is drawn to many interesting things.	1			0		1		1		0		0	
In places like this it is hard to be bored.	1			0		1		1		0		0	
Places like this are a refuge from nuisances.	3	Being Away	3	0	0	3	3	1	1	2	2	0	0
To get away from things that usually demand my attention I like to go to places like this.	0			N/A		N/A		N/A		N/A		N/A	
To stop thinking about the things that I must get done I like to go to places like this.	0			N/A		N/A		N/A		N/A		N/A	
There is a clear order in the physical	2	Extent-Coherence	3	2	2	0	1	1	2	0	0	1	1

arrangement of places like this.													
In places like this it is easy to see how things are organized	1			0		1		1		0		0	
In places like this everything seems to have its proper place	0			N/A		N/A		N/A		N/A		N/A	
This place is large enough to allow exploration in many directions	0	Extent-Scope	1	N/A	1	N/A	0	N/A	1	N/A	0	N/A	0
In places like this there are few boundaries to limit my possibly for moving about	1			1		0		1		0		0	
Total	13			3 (23%)		10 (77%)		9 (69%)		3 (23%)		1 (8%)	

Question Intent

Participants demonstrated difficulty in understanding what the question was trying to ask. One way in which this is evident is explicit comments. For instance, in response to the question prompt 'it is easy to see how things are organized,' participant NG5 said, "*How do you interpret that? What do you mean by that?"* In another example of question intent error, CP7 responds to the statement 'in places like this, there are few boundaries to limit my possibility for moving about' by beginning, stopping, and restarting speech more than once, as they worked through how to interpret the question.

Table 3 shows the distribution of participants demonstrating question intent error by question. The restorative environment extent factor coherence contributed 69% (n = 11) of the intent errors, a significantly higher portion than any of the other factors. Additionally, participants who identified as Caucasian contributed more errors (87.5%) despite representing 59% of the total sample and the errors being evenly distributed between the outdoor and indoor groups.

Table 3. Question Intent Error Count

PRS-11 Item	Total Number of Errors	Restorative Environment Factor		Outdoor n = 14 (48%)		Indoor n = 15 (52%)		Caucasian n = 17 (59%)		Non-white n = 11 (38%)		Unknown n = 1 (3%)	
Places like this are fascinating.	1	Fascination	2	0	0	1	2	0	1	1	1	0	0
In places like this, my attention is drawn to many interesting things.	0			N/A		N/A		N/A		N/A		N/A	
In places like this it is hard to be bored.	1			0		1		1		0		0	
Places like this are a refuge from nuisances.	1	Being Away	1	0	0	1	1	1	1	0	0	0	0
To get away from things that usually demand my attention I like to go to places like this.	0			N/A		N/A		N/A		N/A		N/A	
To stop thinking about the things that I must get done I like to go to places like this.	0			N/A		N/A		N/A		N/A		N/A	
There is a clear order in the physical	5	Extent-Coherence	11	3	6	2	5	4	10	1	1	0	0

arrangement of places like this.													
In places like this it is easy to see how things are organized	5			2		3		5		0		0	
In places like this everything seems to have its proper place	1			1		0		1		0		0	
This place is large enough to allow exploration in many directions	0	Extent-Scope	2	N/A	2	N/A	0	N/A	2	N/A	0	N/A	0
In places like this there are few boundaries to limit my possibly for moving about	2			2		0		2		0		0	
Total	16			8 (50%)		8 (50%)		14 (87.5%)		2 (12.5%)		0 (0%)	

Context

One dimension of context is activating relevant pieces of information in order to answer a question. In answering PRS-11 questions, many participants expressed difficulty to draw on the information needed to appropriately comprehend questions, as they found that either the question was not relevant to the walk environment or to their experience walking (see Table 4 for number of context errors).

In an example of how the space was not deemed relevant to answer a question, participant (which participant?) responded to the statement 'it is easy to see how things are organized' by saying, "*it's a hard question because I don't know if you can say nature is well planned and organized."* This type of context error was primarily found to be related to the restorative environment factor of extent-coherence (88%), in outdoor walking environments (75%), and reported by participants who identify as Caucasian.

In a similar way, participant LW6 was unable to find relevant information in their experience walking by answering the question prompt 'to get away from things that usually demand my attention, I like to go to places like this' with the reply, "*I don't think of it that way."* Context errors related to the walking experience were found to be related to the restorative environment factor of being away (64%) and in indoor walking environments (79%) differing from trends in context errors related to space, but similar in that they were reported mostly by participants who identify as Caucasian (93%).

Table 4. Context Error Count

		Number of Context Errors Related to Space	Number of Context Errors Related to Experience
Restorative Environment Factor	Fascination	0 (0%)	2 (14%)
	Being Away	0 (0%)	9 (64%)
	Extent-Coherence	7 (88%)	3 (21%)
	Extent-Scope	1 (12%)	0 (0%)
Walking Environment	Outdoor	6 (75%)	3 (21%)
	Indoor	2 (25%)	11 (79%)
Race/Ethnicity	Caucasian	8 (1000 %)	13 (93%)
	Non-white	0 (0%)	1 (7%)
	Unknown	0 (0%)	0 (0%)
Total		8	14

The other dimension of context is drawing on different information to answer a question. Specifically, if context referenced by a participant was something other than the physical environment. Researcher intention for the PRS-11 survey questions was to rate the physical walking environment on elements of a restorative environment. However, multiple instances (n= 6) of not only information from the space, but also the entire walking program experience, such as the group-based structure of the program, were used by participants to rate the question prompts. For example, a participant walking indoors (RB7) responded to the statement 'in places like this it is hard to be bored' by saying, "*it depends on how many people are here and whether the music's playing."* Relatedly, in response to the prompt 'in places like this there are few boundaries to limit my possibility for moving about,' a participant walking outdoors (CP1) said "*except you usually go where the group goes."*

Prior Knowledge

Advanced code categories pertaining to which concrete details of the walking environment a participant used to answer PRS-11 questions were compared. Similar codes were categorized together, and error was defined as occurring when one or more participant referenced a detail that differed from one or more other participants in the sample. Differences in code

categories suggest participants used different prior knowledge to answer the survey questions. In 10 out of the 11 PSR-11 questions, one or more participants referenced a detail in the environment that differed from other participant(s) in the sample, demonstrating an instance of error. Only for the question "places like this are fascinating" was the question comprehended consistently between participants (see Table 5 for the different concrete details used). Prior knowledge employed as frame of reference to answer questions did not differ between participants from the outdoor (CP and LW) and indoor (NG and RB) groups.

Table 5. PRS-11 Concrete Detail Advanced Code Categories Used to Determine Prior Knowledge Error

Question	**Concrete Detail Advanced Code Category 1**	**Concrete Detail Advanced Code Category 2**
Places like this are fascinating.	Changes in stimuli on different visits maintain fascination CP7, NG5	[concurrence, no error]
In places like this, my attention is drawn to many interesting things.	Stimulus present to observe NG1, CP4, CP7, LW6	General ambiance LW2
In places like this it is hard to be bored.	Feelings of boredom dependent on external stimuli CP5	Feelings of boredom managed internally NG5, LW5
Places like this are a refuge from nuisances.	Absence or presence of unwelcome stimuli NG1, CP5, LW1	Feeling of peacefulness maintained CP4, CP7
To get away from things that usually demand my attention I like to go to places like this.	Sought out environment to process daily demands CP4	Sought out things that demand their attention NG3, CP7
To stop thinking about the things that I must get done I like to go to places like this.	Distance from things that must get done is desirable NG3, NG5, CP3, LW1, LW4	Sought out environment to contemplate what must get done RB3, CP4, CP5, CP7
There is a clear order in the physical arrangement of places like this.	Absence or presence of expected elements for space NG3, CP4, CP5, LW2	Arrangement of elements to optimize function of space RB7, CP7, LW1, LW6
In places like this it is easy to see how things are organized	Relationship of all elements to each other in space RB7, CP5	Intentionality of placement of an element in space LW1, LW2, LW5
In places like this everything seems to have its proper place	Ease of ability to locate an element in space RB7, CP5	Whether element present belongs in space or not CP1, CP7, LW1, LW2, LW3, LW5, LW6

This place is large enough to allow exploration in many directions	Presence of opportunity for choice RB3, CP4, CP7	Presence of movement restrictions in space NG5, LW1, LW2, LW3, LW4, LW6
In places like this there are few boundaries to limit my possibly for moving about	Available and restricted areas of environment CP1, CP6, CP7, LW1, LW2, LW5	Ability to execute desired activity NG3, RB8, CP4

Discussion

Evidence of measurement error emerged for all four aspects of comprehension per the traditional model of cognitive testing (Campanelli, 1997; Tourangeau, 1984). Incidents of error in meaning of terms, question intent, context, and prior knowledge demonstrate inconsistent comprehension and responses of survey questions, as well as diversion of responses as the researcher intended. This calls into question the validity of the PRS-11 for use with an older adult sample. Furthermore, trends in distribution of the errors across the factors of walking environment and participant race/ethnicity question the appropriateness of ART domains for describing potential benefits of walk experiences among this diverse sample of older adults.

Attention Restoration Theory (ART) posits that nature is a restorative environment due to the ability to engage effortless attention (fascination) and allow directed attention to be restored (Kaplan & Kaplan, 1989; Kaplan, 1995; Bossen, 2010). However, criticisms of ART establish a need for testing the theory with different populations and in various settings (Joye & Dewitte, 2018; Ohly et al., 2016). Through think-aloud processing during walking interviews with older adults, evidence of measurement error in comprehension per the traditional model of cognitive testing was found (Collins, 2003; Tourangeau, 1984). Errors across domains of restorative environments, walking spaces, and participant characteristics, do not support the feasibility of Perceived Restorativeness Scale -11 (PRS-11) use and appropriateness of ART domains for older adults (Kaplan & Kaplan, 1989; Kaplan, 1995; Pasini, Berto, Brondino, Hall, & Ortner, 2014).

ART has been cited as the theoretical underpinning for a significant body of green exercise literature (Gladwwell, Brown, Wood, Sandercock, & Barton, 2010). Although the added health benefits of green exercise have been documented for older adults, the findings from this study suggest that the PRS-11 did not measure the domains of the ART effectively, making it difficult to determine if the ART framework was appropriate for this population (Detweiler et al., 2011). Additionally, trends in participant characteristics and walking environments present in this sample suggest that older adults may also find restoration through walking in indoor environments.

Comprehension measurement errors in meaning of terms, question intent, context, and prior knowledge when administered to a sample of older adults provide evidence that the PRS-11 does not adequately measure the domains of ART. Participants did not consistently understand and respond to survey questions. Furthermore, some participants did not respond as the researcher intended, evaluating aspects of their walking experiences that exceed the physical space. When these measurement errors are discovered, answers are not valid (Collins, 2003). Lack of comprehension for certain aspects of scale items affect the construct validity of the PRS-11 (Payne & Guastavino, 2018). Difficultly in interpreting question intention challenge the construct validity of the scale (Payne, 2013). Furthermore, the measurement errors suggest that participants do not have the prior knowledge needed to consistently and accurately respond to theoretical-based survey questions about the restorative effects of their walking environment (Tourangeau, 1984). Therefore, these survey questions, as designed to assess the theoretical domains of ART, are not appropriate for older adults.

Differences in error rate by race/ethnicity suggests issues of equal instrument applicability across different participants in the sample and needs further investigation (Blair &

Piccinino, 2005). When comparing participants who contributed incidents of measurement error, the majority of the participants identified as Caucasian, representing a disproportionate amount of the sample. Moreover, the four participants who completed the PRS-11 scale without incidence of measurement error all identified as non-white (three African American, one Asian). This may reflect the traditional model of cognitive testing's measurement error component of 'problems with the survey interviewer,' by the introduction of bias (i.e. observer effects, social desirability) (Collins, 2003; Tourangeau, 1984).

Inherent cultural differences were present between the young, Caucasian-presenting, female interviewer and the older adult participants, especially among those who identified as non-white (41% of the sample). Such observer effects inherently influence the behavior of research subjects and must be accounted for (Monahan & Fisher, 2010; Roberts & McGinty, 1995). In cross-cultural interactions like this, social desirability, participants editing responses to reflect how they believe the interviewer would want them to respond, can affect participants' willingness to bring up issues (Blair & Piccinino, 2005; Johnson & van de Vijver, 2003). This is consistent with more measurement errors originating from participants who are culturally congruent with the interviewer.

Furthermore, differential access can create disparities in anchors or frames of reference that participants use to answer questions (Blair & Piccinino, 2005; Tourangeau, 1984). Neighborhood design has been shown to affect older adults' perception of space and physical activity levels (Michael, Green, & Farquhar, 2006). Seattle has a history of restrictive covenants which have funneled communities of color to certain areas of the city (Seattle Civil Rights and Labor History Project, 2006). Coupled with structural racism (e.g., lower property tax base due to lower property values within communities of color), these areas are more likely to be under-

resourced and experience greater neighborhood stressors (e.g., physical disorder and perceived neglect, perceived safety) (Ross & Mirowsky, 2001). This been associated with decreased healthy behaviors, including walking, among urban community residents (Schmool, Yonas, et al, 2015). Therefore, neighborhood stressors could serve as barriers to the outdoors becoming a standard for restorativeness among communities of color (Tourangeau, 1984). Our data supported this phenomenon in that all African-American participants were in the indoor groups and most participants in the outdoor groups were Caucasian. If walking outdoors in areas with greater neighborhood stressors re-engages directed attention, then the environment that can be perceived as safe and restorative may actually be indoors. This would suggest that the PRS-11 is not measuring the same experiences across participants, further threatening construct validity past comprehension.

A limitation of this study is lack of racial minority representation in outdoor walking group samples. Although this sample as a whole is diverse, the participants are not evenly distributed. As access to and experience in natural spaces can differ among various racial groups, affecting the frame of reference used to respond to survey questions, a recommendation for future research is to purposefully sample outdoor and indoor comparison groups by race/ethnicity. Capturing past experiences and preferences of restorative environments will allow for the issue of prior knowledge to be studied in greater depth. Additionally, having interviewers who are members of the same culture groups as the participants in future studies could reduce potential bias introduced in observations by lack of cultural concordance of interviewer and respondents as well as social desirability (Blair & Piccinino, 2005; Johnson & van de Vijver, 2003; Monahan & Fisher, 2010).

Another limitation of this study is that cognitive status of participants was not assessed. The method of walking interviews was chosen so that participants were immersed in the environment that survey constructs were asking about, thus not having to rely on potentially diminishing memory capacity and increasing survey validity (Koutstaal & Schacter, 1997; Pasini, Brondino, Burro, Raccanello, & Gallo, 2016; Tun, Wingfield, Rosen, Blanchard, 1998). However, walking while responding to a survey can increase cognitive load and re-engage directed attention (Verrel, Lövdén, Schellenbach, Schaefer, & Lindenberger, 2009). With executive functioning capabilities diminishing with age, cognitive status should be captured and controlled for in future studies (Von Hippel, 2007).

Conclusion

The findings of this study do not support the feasibility of Perceived Restorativeness Scale -11 for use with an older adult population. Evidence suggests that the PRS-11 does not adequately measure the domains of ART. Lack of comprehension for certain aspects of scale items affect the construct validity of the PRS-11 (Payne & Guastavino, 2018). The word choice of questions mirrors those used in the ART, reflecting the researcher's direct interpretation of the theory concept, rather than reflecting words the public would recognize. This demonstrates lack in operationalization of ART concepts, also consistent with previous criticisms of theory (Joye & Dewitte, 2018; Neilson, Craig, Travis, & Klein, 2019).

This study contributes to the current dialog surrounding ART as an explanatory model for the added health benefits of green exercise. Issues with understanding words in the question prompts of the PRS-11 emphasize the lack of clarity in theory concepts, consistent with previous criticisms of ART (Joye & Dewitte, 2018; Neilson, Craig, Travis, & Klein, 2019). The concept of 'fascination' is central to ART's proposed mechanism of restoration. As fascination is

engaged, directed attention has an opportunity for replenishment (Kaplan & Kaplan, 1989; Kaplan, 1995). However, the fascination component questions of the PRS-11 had more meaning of terms errors than the other components. Additionally, the question that directly uses the term 'fascinating' in the prompt had more incidents of error than any other one question. Further research that investigates mechanisms for health benefits of green exercise in older adults, while controlling for racial and cognitive disparities is warranted.

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Appendix 1. Semi-structured Interview Guide

Area 1: Program Environment

1. What are the 2-3 things you like most about walking in [location]?
2. What are the 2-3 things you like least about walking in [location]?
3. Do you prefer walking indoors or outdoors? Why?
4. Is there anything else that makes an area either appealing or less inviting to walk in? [Prompt: walking surface? Benches? Bathrooms? Lighting? Location? Safety? Graffiti? Litter?]

Perceived Restorativeness Scale -11

The next section of questions use a numbered scale. The scale is 0-6 where 0=not at all and 6= completely. If you would like to add any explanation for choosing a number, you're welcome to, but it is not necessary.

0	1	2	3	4	5	6	
							Places like this are fascinating
							In places like this, my attention is drawn to many interesting things
							In places like this it is hard to be bored
							Places like that are a refuge from nuisances
							To get away from things that usually demand my attention I like to go to places like this
							To stop thinking about the things that I must get done I like to go to places like this
							There is a clear order in the physical arrangement of places like this
							In places like this it is easy to see how things are organized
							In places like this everything seems to have its proper place
							That place is large enough to allow exploration in many directions
							In places like that there are few boundaries to limit my possibility for moving about

That is the last of the numbered questions. We will now have another section of open-ended questions.

Area 2: Health and Nature

1. What do you feel are the health benefits of walking in [location]? [Prompts: physical, mental, social]
2. How do you feel walking in a [outdoor/indoor] space like this differs from walking in [outdoor/indoor] space? How similar?
3. In this moment, how do you feel?
4. Have you ever experienced any negative effects of walking here? Prompt: Falls? Blisters? Pulled a muscle?]

EuroQol five-dimension three-level (EQ-5D-3L)

The next section of questions will be multiple choice. I will read you three statements and you choose the answer that best describes you.

Mobility

I have no problems walking about	☐
I have some problems walking about	☐
I am confined to bed	☐

Self-Care

I have no problems in self-care	☐
I have some problems in self-care	☐
I am unable to wash or dress myself	☐

Usual Activities (e.g. work, study, housework, family or leisure activities)

I have no problems with performing my usual activities	☐
I have some problems with performing my usual activities	☐
I am unable to perform my usual activities	☐

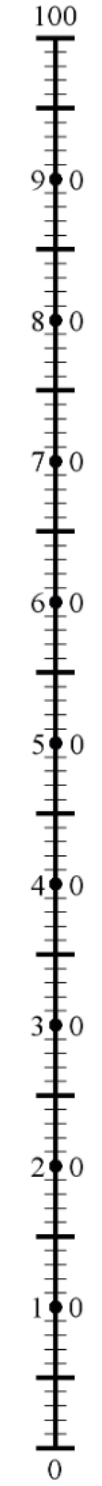
Pain/Discomfort

I have no pain or discomfort	☐
I have moderate pain or discomfort	☐
I have extreme pain or discomfort	☐

Anxiety/Depression

I am not anxious or depressed	☐
I am moderately anxious or depressed	☐
I am extremely anxious or depressed	☐

Best possible health state today



Worst possible health state today

Area 3: Background on Program Participation

1. How long have you been attending Sound Steps Programs? [Prompt: how often?]
2. How did you find out about the program?
3. Why did you sign up for this program?
4. How did you get here today? How far did you have to come?
5. What does this program provide for you that you would not get without attending?
6. Do you intend to continue attending this program? Why?

Area 5: Demographic Information

1. What year were you born?
2. What is your gender?
3. What ethnicity do you identify as?

Area 6: Conclusion

1. Is there anything else that you would like to share with me?

Chapter 5 – Conclusion

The three components of this dissertation project both formally establish a gap in existing green exercise literature and contribute to that knowledge gap. Research on green exercise interventions that include exclusively older adult samples are lacking. In response to this, the current study evaluates an older adult walking program, Sound Steps, for acceptability and appropriateness, when most of the literature supporting outcomes of such programs were investigated using children or young adult samples. The resulting conclusions demonstrate implementation success and provide recommendations for the further development of green exercise programming that is tailored for an older adult population. Furthermore, this dissertation provides the recommendation that evaluation of measurement tools for evaluating the perceived restorativeness of an environment be conducted specifically with the audience of older adults. Evidence presented demonstrates that the evaluation tool Perceived Restorativeness Scale-11 may not provide an accurate assessment of walking environments due to varying interpretation and application in this population.

The scoping review showed that green exercise interventional studies have become a larger focus of the scientific community in the last decade. The types and doses of green exercise interventions explored as well as the way in which the literature talked about the interventions varied greatly. This makes it difficult to not only identify and group together similar studies internationally, but also to evaluate efficacy across studies. Physical and mental health outcomes were the focus of evaluation in most studies without as many studies including social health outcomes. For the majority of studies, a positive effect was received by participants. Although all studies included had older adults in their sample, only two studies focused exclusively on older adults aged 65 years and older.

Sound Steps, was determined to be both acceptable and appropriate for older adults in the Seattle Metropolitan Area. Through investigation into the implementation success of this program, insights into program considerations for future intervention development were captured. Older adult participants shared that a group-based structure, regular and frequent occurrence of programs, urban parks with parking lots and bathroom amenities, and a dirt or gravel trail, and some hills make a program more appealing. Considerations of safety, particularly access to medical attention in the event of an injury, reduced foot traffic, and minimal homeless encampments, need to be considered. With a green exercise program tailored to older adults, as the Sound Steps program is, participants can receive not only physical, mental, and social health benefits, consistent with findings in children and young adult samples, but also spiritual health benefits.

Cognitive testing of the Perceived Restorativeness Scale-11 (PRS-11), developed to measure the restorative potential of environments per Attention Restoration Theory (ART), suggests that the PRS-11 does not adequately measure the domains of ART for older adults. Therefore, findings of this study do not support the feasibility of PRS-11 for use with this population. Measurement error emerged for all four aspects of comprehension per the traditional model of cognitive testing (Campanelli, 1997; Tourangeau, 1984). Incidents of error in meaning of terms, question intent, context, and prior knowledge demonstrate inconsistent comprehension and responses of survey questions, as well as diversion of responses as the researcher intended. Furthermore, trends in distribution of the errors across the factors of walking environment and participant race/ethnicity question the appropriateness of ART domains for describing potential benefits of walk experiences among this diverse sample of older adults.

Considerations for Future Research

There are a number of recommendations for future research identified through these three investigations. First, more consistent use of the term 'green exercise' to better search for and discover related studies internationally. This will assist in tracking the state of the science and identify gaps for future research. To address some of the gaps identified here, more green exercise intervention studies with limited elements as to better determine mechanisms and dose for receiving the health benefits of green exercise are needed. Furthermore, greater consistency in the health outcomes captured in interventional studies will strengthen evidence for the effect of green exercise and allow for future metanalyses.

A continued emphasis on older adult populations within green exercise research is warranted. This includes further evaluations of implementing green exercise walking programs in other regions than the Seattle Metropolitan Area, in other types of natural environments than lush urban forests, and with older adult populations of differing physical activity levels and cognitive status. With greater insights, modifications can be built into future interventions and community programming to make green exercise accessible and appealing for older adults. Also needed are more green exercise intervention studies that include only participants over the age of 65 years in the sample.

More evidence of the health benefits of green exercise, insights into program design, and consistent language being used throughout can provide substantial contributions to healthy aging research. Furthermore, continued promotion of green prescriptions for older adults can be incorporated into a patient-centered, holistic care plan in combination with biomedical treatments. As this dissertation demonstrates, there are areas in which this field can be advanced,

and in doing so, can positively impact the health and wellbeing of older adults in our communities.