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Physical Home Environment, Personal Competencies, and Psychological Well-Being of Community-Dwelling Older Adults: Development of a Structural Model

Shannon Marie Trecartin
University of Tennessee, Knoxville, strecart@vols.utk.edu

To the Graduate Council:

I am submitting herewith a dissertation written by Shannon Marie Trecartin entitled "Physical Home Environment, Personal Competencies, and Psychological Well-Being of Community-Dwelling Older Adults: Development of a Structural Model." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Social Work.

Sherry M. Cummings, Major Professor

We have read this dissertation and recommend its acceptance:

William R. Nugent, Robert T. Ladd, Sunha Choi

Accepted for the Council:

Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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Doctor of Philosophy

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Dedication

This dissertation is dedicated to my mom, dad, and brother. Mom and dad, you two are the most amazing parents. Thanks to your unconditional love and acceptance, I have always known you were, and are, proud of me. Mom, you are one of the people that inspired me to become a social worker and to pursue research with people with disabilities. You are the most resilient person I know. Dad, you are the best caregiver to my mom. Thank you so much for the excellent job you do and for providing for us. To my brother, you are the best friend ever and a great son. I am the luckiest person ever to get to grow up with such a caring and compassionate sibling. You three inspire me every day to take care of others.

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Abstract

This multi-manuscript dissertation focuses on the relationships between the physical home environment, personal competencies, and psychological well-being among older adults living in community settings. The ecological model of aging serves as the guiding theoretical framework for the exploration and design of the subsequent studies. The first paper is a critical review of the literature. Results suggest that there is little consistency in the measurement of the physical home environment across studies. Also, more research is needed to clarify the relationships between the three major constructs and to expand the area of study to U.S. populations. Finally, some support exists to suggest that personal competence moderates the effect of the physical home environment on psychological well-being. Recommendations for research and practice are given.

The second and third paper follow the research recommendations of paper one. To begin exploring the relationships between the constructs among U.S. based samples, the National Health and Aging Trends Study (NHATS) round 1 data are used. NHATS is a population-based sample of older adults drawn from the Medicare Enrollment File, which represents 96% of seniors in the continental United States.

The second paper is a description of a confirmatory factor analytic (CFA) approach that tests an *a priori* measurement model. The sample of 6,665 community-dwelling respondents is randomly split into two subsamples (sample 1= 3,330 and sample 2= 3,335). The proposed measurement model is then refined with the first sample and validated with the second sample. The final paper describes the process of fitting a structural model to the data of the entire sample and testing whether personal competence moderates the effect of physical home environment on psychological well-being.

Table of Contents

Introduction 1

References 4

Chapter I: Critical Review of the Physical Home Environment and the Relationship to Psychological Well-Being among Community-Dwelling Older Adults 5

Abstract 6

Functional Impairment and Physical Home Environment 9

Functional Impairment and Psychological Well-Being 10

Physical Home Environment and Psychological Well-Being 10

Ecological Model of Aging 12

Methods 14

Study Selection 16

Results 16

Measuring the Physical Home Environment 17

Accounting for Functional Impairment 19

State of the Evidence 21

Discussion 25

Recommendations for Research 28

Recommendations for Practice 29

References 30

Appendix 38

Chapter II: Physical Home Environment, Personal Competence, and Psychological Well-Being among Community-Dwelling Older Adults: Construction and Refinement of a Measurement Model 43

Abstract 44

Methods 47

Results 54

Discussion 58

References 63

Appendix 69

Chapter III: Physical Home Environment, Personal Competence, and Psychological Well-Being among Community-Dwelling Older Adults: Testing a Structural Model 76

Abstract 77

Methods 83

Results 89
Discussion 91
References 95
Appendix 103
Conclusion 109
References 116
Vita 120

List of Tables

Table 1-A. Original Studies of Physical Home Environment and Psychological Well-Being Indicators……...……..... 39
Table 1-B. Descriptive Statistics for Community-Dwelling Older Adults (*N* = 6,665) 70
Table 2-B. Standardized CFA Factor Loadings for Items by Latent Construct 72
Table 3-B. Fit Indices for Model Refinement 73
Table 1-C. Summary of Latent Constructs and their Respective Indicator Items and Codes.... 104
Table 2-C. Descriptive Statistics of Demographic and Model Variables 105
Table 3-C. Results of Structural Test of Moderation 106

List of Figures

Figure 1-B. Proposed Measurement Model and Predicted Relationships 74

Figure 2-B. Refined Measurement Model with Standardized Covariances and Regression Weights 75

Figure 1-C. Hypothesized Structural Equation Model 107

Figure 2-C. Plot of the Ordinal Interaction Between PHE and PC 108

Introduction

The United States is currently experiencing an aging revolution with people living longer due to health care advances, lifestyle changes, and technology advances. In 2012, 43.1 million people ages 65 and older were residing in the United States. The population of seniors has increased from 35.2 million in 2002 and is expected to reach 79.7 million (21% increase) by 2040 (Administration on Aging, 2013). The United States has experienced a steady increase in life expectancy at birth with the average life expectancy in 1900 being 47 years old and in 2008 it was 78 years old (U.S. Census Bureau, 2003; Kinsella & Wan, 2008).

Health care advances that began at the turn of the century had a direct impact on longevity. The reduction in deaths due to influenza and pneumonia as well as the development of medical technologies that prolong life have contributed to the steady rise in life expectancy (Hiller & Barrow, 2011). With health care advances, increased longevity, and the aging of America, it is expected that the number of adults with functional impairments will continue to grow, and social support systems will need to address factors that negatively impact the quality of life for this vulnerable population.

In addition to the increase in reported functional impairment with age, Americans are living longer with those impairments. For example, the rates of disability as measured by impairments increase with age in the United States. Ten percent of individuals 18 to 64 years old and 36.7 percent of individuals 65 and older are reported to have a disability related to hearing, vision, cognition, ambulation, self-care, or independent living impairment (Erickson, Lee, & von Schrader, 2012). According to the World Health Organization (2011), these trends are similar in other parts of the world. In Australia, the population under the age of 65 makes up close to 35 percent of the population with disabilities while those 65 and older making up nearly 65 percent.

In South Africa, those 65 and older make up close to 81 percent of the entire population with disabilities.

In the United States, older adults with functional impairments are a unique population for whom barriers to full integration within society can have detrimental outcomes on quality of life. As healthcare advances continue and the population continues to age, considerations of how the physical environment and functional impairments relate to psychological well-being will become more relevant to research, policy, and practice.

This dissertation addressed the relationships between the physical home environment (PHE), personal competence (functional impairment), and psychological well-being in three parts. First, a systematic critical literature review was completed to identify the current state of knowledge regarding older adults. Three specific research questions were addressed: 1) What dimensions of the PHE have been explored in empirical studies conducted with older adults? 2) Has the role of functional impairment been considered within these studies? 3) What was the quality of evidence for a relationship between the PHE and psychological well-being among older adults? Recommendations for research, practice, and social work education were given.

The results of the systematic review served as a conceptual guide for the second paper. The second paper presented a measurement model that was constructed and refined using the National Health and Aging Trends Study round one respondent data (NHATS, 2015). Confirmatory factor analysis was used to test the proposed model using the data from a random split of the sample. Next, the refined model was cross-validated against the second randomly selected half of the sample. Recommendations for research were presented.

The final paper addressed some of the research recommendations from the second paper. The measurement model from paper two served as the underlying measurement component of a

proposed structural model, which was fit to the entire NHATS data sample. Structural equation modeling was used to test the following structural hypotheses: 1) There is a negative relationship between PHE and PWB when controlling for the effect of PC on PWB, 2) There is a positive relationship between PC and PWB when controlling for the effect of PHE on PWB, and finally, 3) The relationship between PHE and PWB is moderated by PC. Specifically, this study tested for a moderation on the relationship between the physical home environment and psychological well-being, by personal competence. Recommendations were provided for research and practice.

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Chapter I: Critical Review of the Physical Home Environment and the Relationship to Psychological Well-Being among Community-Dwelling Older Adults

Abstract

This article reviews and appraises the existing literature on the relationships between the physical home environment and psychological well-being among community-dwelling older adults. The role of functional impairment is also examined. A systematic literature review was conducted using the ecological model of aging as the guiding framework. Results suggest our statistical knowledge of the relationships between these constructs is still in the early stages. While associational relationships have been established, the nature of these relationships is clouded by the inconsistency of measurement across studies and design challenges. Future research is needed to clarify these relationships and identify effective intervention points.

Keywords: aging, physical home environment, competence, psychological well-being, ecological model of aging, social work

In the United States, older adults can experience barriers to full integration in society. Older adults with functional impairments are at an even greater risk of being excluded from day-to-day life. This separation can have detrimental outcomes on quality of life. Both functional ability and the physical environment have been found to influence engagement and enjoyment in life as well as participation in activities inside and outside of the home (Centers for Disease Control, 2013). As the population continues to age and the proportion of older adults rises, it is important to understand how the physical environment relates to the psychological well-being of this vulnerable population. A clearer understanding of these relationships can help researchers, practitioners and policy makers identify promising interventions to improve the lives of this constituency. This review of the literature investigated the role of the physical home environment on the psychological well-being of older adults with diverse functional abilities. The ecological model of aging was used as a guiding framework to critique the research and develop suggestions for advancing research and practice.

The United States is currently experiencing an aging revolution with people living longer due to health care advances, lifestyle changes, and health education. The population of older adults has increased from 35.2 million in 2002 to 43.1 million in 2012 (21% increase) and is expected to reach 79.7 million by 2040 (Administration on Aging, 2013). Also, there has been a steady increase in life expectancy at birth. In 1900, older adults lived to be about 47 years old and in 2014 life expectancy was 79.56 years (U.S. Census Bureau, 2003; Central Intelligence Agency, 2015). Health care advances that began at the turn of the century had a direct impact on this 32-year longevity gain. The reduction in deaths due to influenza and pneumonia, as well as the development of medical technologies that prolong life, have contributed to the steady rise (Hiller & Barrow, 2011).

Even with these advances, older adults are at an increased risk for chronic illnesses such as heart disease, cancer, lower respiratory diseases, stroke, Alzheimer's disease, and diabetes (Centers for Disease Control and Prevention, 2013). These illnesses often lead to physical and cognitive limitations (Leon & Lair, 1990), mobility impairment (Shumway-Cook, Ciol, Yorkston, Hoffman, & Chan, 2005), and impaired ability to carry out instrumental and personal care tasks of daily living (Centers for Disease Control and Prevention, 2013). Though the United States has experienced declining rates of functional impairment among older adults for nearly four decades, sustaining these gains is not supported by emerging data trends (Guralnik, Patel, & Ferrucci, 2012). It appears that the oldest-old (80 and older) have maintained their health and functioning. However, trends for the younger age groups (60 to 69 and 70 to 79) show they are experiencing significant increases in disability related to functional impairment. Guralnik et al. (2012) suggested these findings were due to increases in chronic illnesses such as diabetes and obesity among the young-old.

In addition to the increase in reported functional impairment among the young-old, the rates of disability, as measured by the presence of functional impairments, also increase with age in the United States. Ten percent of individuals 18 to 64 years old and 36.7 percent of individuals 65 and older have at least one disability related to hearing, vision, cognition, ambulation, self-care, or independent living (Erickson, Lee, & von Schrader, 2012). These trends are similar to other parts of the world (World Health Organization, 2011). In Australia, persons under the age of 65 make up close to 35 percent of the population with disabilities, while those 65 and older account for nearly 65 percent. In South Africa, those 65 and older make up close to 81 percent of the entire population with disabilities.

Functional Impairment and Physical Home Environment

In aging studies, the terms “disability” and “functional impairment” are often used interchangeably and are frequently measured with instrumental and personal activities of daily living (ADLs) indicators (Guralnik et al., 2012). Functional impairment refers to the limitations experienced by individuals due to illness, injury, and biological or physical body structure (World Health Organization, 2011). The International Classification of Functioning, Disability, and Health (ICF) is a conceptual model of functioning and disability and is useful for explaining how impairment can contribute to disability. As an umbrella term, functioning includes all body activity, structure, and ability (World Health Organization, 2001). Functioning includes physical, social, cognitive, sensory, and psychological domains (Guralnik et al., 2012). Disability is conceptualized as impairments, activity limitations, and participation restrictions that occur as a result of the interaction between functional ability and environmental contributors (Thompson, Zack, Krahn, Andresen, & Barile, 2012; World Health Organization, 2001).

Functional impairment and physical home environment (PHE) links have been noted in previous reviews (Garin et al., 2014; Wahl, Schilling, Oswald, & Iwarsson, 2009). In this review, the PHE is defined as the fixed physical characteristics of a person’s immediate home, which are original features or modifications that have been added to the home. For this study, the physical home environment does not include the ambient environment such as lighting and environmental pollutants or durable medical equipment such as wheelchairs and walking aids. In their systematic review, Wahl et al. (2009) found evidence for causal relationships between home modifications and improvements in functional ability in 80% of the randomized control studies reviewed (8 of 10). The authors concluded that environmental interventions that were closely associated with specific domains of functional ability were more likely to be effective than

global interventions that targeted functioning in general. In contrast, Iwarsson, Horstmann, & Slaug (2007) found that ADL and instrumental activities of daily living (IADLs) were strongly associated with general housing environment in a six year follow up. Various indicators of the PHE such as environmental barriers, accessibility problems, housing type, and home density have been associated with specific health diagnoses known to include functional limitations as side-effects (Garin et al., 2014).

Functional Impairment and Psychological Well-Being

Psychological well-being is a broad construct that encompasses a range of positive moods and emotions, as well as an appraisal of life satisfaction and purpose. Happiness, lack of mental illnesses such as anxiety and depression, positive mood, and emotion have been used to capture psychological well-being (Chan, Phillips, Cheng, Chi, & Ho, 2004; Phillips, Cheng, Yeh, & Siu, 2010; Ryff et al., 2006). A reciprocal relationship has been found between functional impairment and psychological well-being among older adults such that functional impairment is both a predictor for and a result of, psychological well-being (Penninx & Comijs, 2012). Depression and anxiety have been established as both risk factors for, and consequences of, functional impairment (Ayis, Gooberman-Hill, Bowling, & Ebrahim, 2006; Cole & Dendukuri, 2003; Stuck et al., 1999). Also, Cole and Dendukuri (2003) found that disability was a significant risk factor for depression among the elderly. Inversely, Ayis et al. (2006) found that poor psychological health predicted a catastrophic decline in mobility.

Physical Home Environment and Psychological Well-Being

Despite challenges to functioning and psychological well-being, the majority of older adults prefer to age in their homes and to maintain as much independence as possible (Bayer & Harper, 2000; Rantz et al., 2011). In 2012, only a small percentage of people 65 and older (3.5%)

lived in institutional settings (Administration on Aging, 2013). Time studies indicate that older adults spend as much as 90% of their time at home (Baker, Keall, Lyn, & Howden-Chapman, 2007). With such high levels of time spent in the home, the home environment is a potential force for both enhancing and limiting psychological well-being (Oswald, Wahl, Mollenkopf, & Schilling, 2003; Wahl et al., 2009).

Research on the relationships between the physical home environment and psychological well-being outcomes has spanned seven decades though the focus on older adults is sparse (Fanning, 1967; Evans, Wells, & Moch, 2003; Garin et al., 2014). The PHE has been found to have both direct and indirect effects on mental health among various populations (Evans et al., 2003). Evans, et al. (2003) reviewed the literature on housing and mental health and found that housing type, floor level of dwelling, housing quality, and overall quality of the housing environment were correlated with psychological well-being indicators. Among these findings, floor level of the residence, neighborhood deterioration, and crowding acted as moderators between demographic and neighborhood characteristics and psychological well-being (Evans, Lercher, & Kofler, 2002b; Kasl, Will, White, & Marcuse, 1982; Levi, Ekblad, Chanhui, & Yueqin, 1991). Possible mediators of the relationships between PHE and mental health outcomes have been proposed, including identity (home as a symbol of self), insecurity, social support, parenting, restoration and personal control (Evans, 2003; Evans et al., 2003). Clark, Rowan, Stansfeld and Candy (2007) evaluated the strength of evidence of studies linking the built environment, including both neighborhood and housing indicators, to mental health outcomes. Their findings suggested that relationships between the built environment and psychological well-being have been poorly established due to methodological challenges such as low response rates, cross-sectional designs and lack of standardized and validated measurement of variables.

More recently, Garin et al. (2014) conducted the first comprehensive review of studies focused on the built environment, including both neighborhood and home environment indicators, and their influence on health outcomes for older adults specifically. Results demonstrated that researchers have focused most of their resources on understanding the impact on physical health (n=34) with fewer studies addressing psychological well-being outcomes (n=18). Housing type, housing quality, satisfaction with housing, and accommodation quality were found to be related to adverse mental health outcomes such as psychological distress, particular depressive symptoms, minor psychiatric morbidity, and clusters of depression symptoms that merit diagnoses of depression (Garin et al., 2014). Accessibility problems, usability, housing type, housing amenities, satisfaction with home, interior environment, and size of the home were related to life satisfaction indicators (Garin et al., 2014).

Ecological Model of Aging

Lawton and Nahemow's ecological model of aging is one of the most influential and useful for describing and investigating the relationships between individual functioning, the environment, and psychological well-being (Lawton & Nahemow, 1973; Scheidt & Norris-Baker, 2003). Within this model, affective and observed behavioral responses (B) are a result of the nature of the relationships that occur between features of the environment (E) and personal competencies (P) (Berrahou, 1993).

Personal competencies, as defined by Lawton (1982), are individual capacities without environmental influences. These include biological health, sensation, and perception, motor skills, cognition, and ego strength. Lawton and Nahemow (1973) acknowledged the challenge of separating competence from the environment and therefore posited that only intrapersonal

variables should be used to assess competence. Higher credence is given to biological and performance measures taken by external observers (Berrahou, 1993).

Behavioral responses include both adaptive behaviors and affective responses. Adaptive behaviors occur as a reaction to the demands of personal competence or the environment. For example, if an older adult begins to have difficulty walking up and down stairs, she or he may choose only to reside on one floor of their home, changing their behavior. Affective responses are the emotional reactions to the demands of personal competencies and environmental constraints.

According to Lawton (1970), the environment is the objective, measurable characteristics of elements that exert demands on an individual, which are located outside of a person. The environment is multidimensional including the physical environment (natural or manmade), the personal environment, the small-group environment, the supra-personal environment, and the social environment. This present study focuses exclusively on the physical environment of the home.

Lewin (1951) proposed the environmental press equation, $B = f(P, E)$, where behavior (B) is a function of personal competence (P) and environmental forces (E). Lawton (1982) modified the environmental press equation to include an interactive term, PXE, that also captured the subjective nature of the physical environment, $B = f(P, E, PXE)$. This theory hypothesizes that one's subjective appraisal of the environment or the way the environment is experienced by the individual (satisfaction with housing, for example, PXE) could have an effect on behavior (B) that is independent of the effect of the objective environment (E) and personal competence (P).

Also, Berrahou (1993) found that many theorists postulated that the person and environment interact dynamically with each adapting to the demands of the other. For example,

Lawton and Simon (1967) theorized that less competence exhibited by an individual resulted in a greater proportion of her or his behavior being attributed to the environment. This environmental docility hypothesis captures the interactive nature of the relationship between one's physical setting and functional capability. Persons who are lower in competence will have less ability to adapt to increasing demands of the environment. However, those who have higher competence will be less affected by the demands of the environment (Morgan et al., 1984).

Given the significance of the PHE for older adults, and particularly for older adults with functional impairments, a literature review was conducted to critically appraise the state of knowledge on the relationship between the PHE and indicators of psychological well-being for older adults. The literature review focused exclusively on the physical home setting, excluding neighborhood and institutional settings. Three research questions were addressed:

1) What dimensions of the PHE have been explored in empirical studies conducted with older adults?
2) Has the role of functional impairment been considered within these studies?
3) What was the quality of evidence for a relationship between the PHE and psychological well-being among older adults?

It was important to identify what has been studied, explore the role of functioning in existing research, and evaluate the quality of evidence for relationships between variables to make recommendations for future research and practice.

Methods

A critical systematic review of the literature was conducted to identify empirical research published between January 2000 and March 2015. Systematic reviews have established that before this timeframe, few studies had been published that focused on older adults. A previous

systematic review that focused on the built environment including neighborhood and housing characteristics and their relationships to physical and mental health in the general population identified only three studies published between 1990 and 2005 that examined these associations among older adults (Clark et al., 2007). All three of these studies focused on the effects of neighborhoods on mental health (Goins & Mitchell, 1999; Walters et al., 2004; Young, Russell, & Powers, 2004). Before this, a more comprehensive review spanning 1960 to 2001 focused on housing quality and mental health (Evans et al., 2003). Only two studies were found that focused on older adults (Carp, 1975; Husaini, Moore, & Castor, 1991).

The databases searched for the present study included: EBSCO databases (Academic Search Premier, (CINAHL and ERIC), Web of Science (Medline and PubMed), ProQuest databases (PsycARTICLES, PsycINFO, Environmental Abstracts, Social Service Abstracts, Sociological Abstracts, and Dissertation Abstracts), Scopus, and Social Work Abstracts. The following search terms were used: aging, elderly, older adult, older people, senior, environment, built environment, home, home environment, housing, accessibility, mental, mental health, psychological, psychological well-being, depression, and anxiety. Publications that met inclusion criteria for additional review were: (a) empirical, (b) peer-reviewed, (c) focused on middle age (50 years), and older living in the community or independent living settings, (d) included at least one independent variable that measured the PHE, and (e) contained at least one dependent variable that measured a psychological well-being outcome. Fifty years of age was selected as the lower limit as different countries define the commencement of old age at different times. Studies were excluded if they were descriptive, focused on older adults in assisted living or other institutionalized settings, and did not contain measures of the immediate PHE. Excluded studies

focused on neighborhood effects, outdoor environments, built environment indicators outside of a home setting, and those focused on the ambient environment, such as air quality.

Study Selection

The combined total of articles identified in the initial search was 12,341 including duplicates among the five databases reviewed. Titles and abstracts were reviewed to determine whether studies merited an initial review based on subject matter, population studied, and the inclusion of any built environment or psychological well-being variables. Two hundred ninety-four unique citations were selected for further analysis. These publications included theoretical, empirical, and descriptive articles. Thirty-four publications were identified that were empirical and included independent variables related to the built environment and dependent variables related to psychological well-being. After excluding those studies that focused on indicators that were external to the PHE, 11 empirical articles were selected for the critical analysis. Finally, the references of these articles were searched, and an additional four studies were added bringing the total to 15.

Results

Table 1 presents the characteristics of the 15 studies identified. In the last 15 years, most of the published studies on the relationship between PHE and psychological well-being among older adults were conducted outside of the United States (81%). The two studies that were completed in the United States occurred in specific community settings in Florida and New York (Brown et al., 2008; Brown et al., 2009; Evans, Kantrowitz, & Eshelman, 2002a). The rest of the research has been conducted using primary or secondary data samples from Sweeden (Iwarsson, et al., 2007; Oswald, Jopp, Rott, & Wahl, 2007; Wahl et al., 2009; Werngren-Elgström, Carlsson, & Iwarsson, 2009), Germany (Oswald, et al., 2003; Oswald et al., 2007; Oswald et al., 2011;

Wahl et al., 2009), the United Kingdom (Howden-Chapman, Chandola, Stafford, & Marmot, 2011; Oswald et al., 2007), Latvia (Oswald et al., 2007), Hungary (Oswald et al., 2007), The Netherlands (Knipscheer, van Groenou, Leene, Beekman, & Deeg, 2000; Thomése & van Groenou, 2006), Australia (Tomaszewski, 2013), Singapore (Ng, Broekman, Niti, Gwee, & Kua, 2009), Japan (Migita, Yanagi, & Tomura, 2005), and Taiwan (Cheng, Wang, Tang, Chu, & Chen, 2014).

Measuring the Physical Home Environment

It was evident from the review that no standard method of measuring the PHE has emerged, and neither has a consistent terminology or set of indicators. Of the 15 studies included in this review, 12 included objective measures of the PHE, with five including separate subjective and objective measures in their analyses (Howden-Chapman et al., 2011; Iwarsson et al., 2007; Knipscheer et al., 2000; Oswald et al., 2003; Oswald et al., 2007; Oswald et al., 2011; Tomaszewski, 2013), and four included only objective measures (Brown et al., 2009; Brown et al., 2008; Cheng et al., 2014; Evans et al., 2002a; Ng et al., 2009; Thomése & van Groenou, 2006). One study included only subjective indicators (Migita et al., 2005). Four of the studies combined both subjective and objective indicators into a composite variable (Iwarsson et al., 2007; Oswald et al., 2007; Wahl et al., 2009; Werngren-Elgström et al., 2009). Werngren-Elgström et al. (2009) were the only authors that used only a composite indicator.

Objective measures of the PHE in these studies fit into the following domains: 1) physical presence of features, 2) physical and evaluative dimensions of features, 3) time-related features including duration and change of features over time, and 4) housing tenure (ownership). Presence or absence of potential environmental barriers, housing amenities, stairs, home adjustments, and external conditions of the home were measured (Iwarsson et al., 2007;

Knipscheer et al., 2000; Oswald et al., 2011; Oswald et al., 2007; Oswald et al., 2003). Some studies focused on dimensions of features of the PHE including location and height of windows, parking, distance of front entrance from the street, number of rooms per person, quality of housing, housing grade, size of home, and crowding (Brown et al., 2009; Brown et al., 2008; Evans et al., 2002a; Ng et al., 2009; Oswald et al., 2011; Oswald et al., 2003; Tomaszewski, 2013). Physical home environment features that may have changed during the course of a study were sometimes measured. Examples included information that a research participant moved into a high-rise apartment during the study, and information that the home environment was modified during the course of the study (Cheng et al., 2014; Oswald et al., 2003; Thomése & van Groenou, 2006). Housing tenure (ownership versus renting) was measured in two studies (Howden-Chapman et al., 2011; Oswald et al., 2003).

Subjective measures of the PHE were evaluated using different indicators. Housing satisfaction, usability, meaning, control, quality, subjective efficacy, related financial problems, attachment to home, comfort, housing dissatisfaction, and housing inadequacy were included as predictors of psychological well-being (Howden-Chapman et al., 2011; Iwarsson et al., 2007; Knipscheer et al., 2000; Migita et al., 2005; Oswald et al., 2003; Oswald et al., 2007; Oswald et al., 2011; Tomaszewski, 2013).

Four studies used composite indicators of the physical environment that were both objective and subjective and could be characterized as estimating the fit between the person and the environment. Iwarsson et al. (2007), Oswald et al. (2007), Wahl et al. (2009) and Werngren-Elgström et al. (2009) assessed the combined objective and subjective PHE using the Housing Enabler instrument. This tool was developed for the cross-national study titled ENABLE-AGE and has undergone extensive testing, including reliability and validity studies (Iwarsson et al.,

2007). This instrument was used to calculate a final "magnitude of accessibility problems" score based on the number of environmental barriers present in the home as observed by an interviewer, self-assessed functional limitations, and dependence on mobility devices.

Accounting for Functional Impairment

Functional impairment was included either as a control, correlate, predictor or outcome variable in 12 of the 15 studies reviewed. Brown et al. (2008) found that features of the front porch of the homes of Hispanic elders significantly predicted physical functioning including self-reported health, gait speed, and grip strength (Brown et al., 2008). Wahl et al. (2009) found that magnitude of accessibility problems significantly predicted ADL dependence among Swedish and German older adults.

Functional status is a known correlate of psychological wellbeing. Several research studies included indicators of functional impairment as controls in analyses to partial out the influence on psychological well-being (Cheng et al., 2014; Evans et al., 2002a; Knipscheer et al., 2000; Oswald et al., 2003; Oswald et al., 2011). Cheng et al. (2014) found that after accounting for ADLs as well as other health indicators, moving to a high-rise apartment resulted in greater psychological well-being for older adults with leprosy. Evans et al. (2002a) controlled for the need for assistance, income, and other confounding variables in a sample of older adults from New York. In this study, housing quality was significantly related to positive affect.

A few studies only examined functional impairment as an associational variable to indicators of psychological well-being. Difficulty performing household work was found to be associated with depression in Japanese residents residing in senior housing (Migita et al., 2005). Also, Werngren-Elgström et al. (2009) found that poorer functional impairment was negatively correlated with total subjective well-being at six years and ten years follow up in a small sample

of Swedish older adults. Dependence on a mobility device was negatively correlated with physical and social well-being at six years and with social well-being and total subjective well-being at ten years follow up. The number of functional limitations was correlated with total subjective well-being and social wellbeing six and ten years later.

The ecological model of aging served as a conceptual guide for ten of the studies where functioning was positioned as an indicator for personal competency (P) (Cheng et al., 2014; Iwarsson et al., 2007; Knipscheer et al., 2000; Oswald et al., 2003; Oswald et al., 2007; Oswald et al., 2011; Thomése & van Groenou, 2006; Tomaszewski 2013; Wahl et al., 2009; Werngren-Elgström et al., 2009). Seven of the studies directly tested some aspect of the ecological model of aging and sought to determine how the environment and competence relate to each other and to psychological well-being (Iwarsson et al., 2007; Knipscheer et al., 2000; Oswald et al., 2007; Oswald et al., 2011; Thomése & van Groenou, 2006; Wahl et al., 2009; Werngren-Elgström et al., 2009). Several studies provide evidence that suggested that functioning and the physical environment should not be separated and instead should be assessed as a measure of fit (Iwarsson et al., 2007; Oswald et al., 2007; Wahl et al., 2009). These studies are part of the larger ENABLE-AGE network of studies using the same measurement instruments in a cross-national research study. These authors consistently found that “magnitude of accessibility problems” predicted psychological well-being indicators.

A few researchers included functional impairment as prominent predictors in their models. Knipscheer et al. (2000) sought to test the docility hypothesis and found that while characteristics of the objective home environment (home modifications) did not significantly predict depression symptoms, the perceived home environment measure, objective efficacy (management of environmental press), did predict symptoms. The interaction between objective

efficacy and ADLs suggests that the relationship between objective efficacy and depression symptoms is different depending on functional ability thus providing evidence in support of the docility hypothesis. Iwarsson et al. (2007) explored differences in life satisfaction by ADL and IADL levels of functioning among Swedish older adults. Results also support an interaction as the magnitude of accessibility problems and functioning led to different life satisfaction among the sample. Thomése and van Groenou (2006) examined the interaction between changes in disability status and the addition of home modifications. Results suggest that if disability status worsened, adding home modifications resulted in greater depressive symptoms and that not adding modifications did not change depressive symptoms. This finding was unexpected.

State of the Evidence

Among the studies reviewed, research findings demonstrated that several features of the PHE were related to and predicted psychological well-being among older adults. While some studies established a correlation (Brown et al., 2009; Brown et al., 2008; Evans et al., 2002a; Iwarsson et al., 2007; Knipscheer et al., 2000; Migita et al., 2005; Oswald et al., 2003; Oswald et al., 2007; Oswald et al., 2011), longitudinal studies served to provide minimal evidence for a causal relationship due to temporal ordering (Howden-Chapman et al., 2011; Ng et al., 2009; Thomése & van Groenou, 2006, Tomaszewski, 2013; Wahl et al., 2009; Werngren-Elgström et al., 2009). However, alternative explanations cannot be ruled out. One quasi-experimental study also provided some support for a causal relationship due to the nature of the design (Cheng et al., 2014). However, the lack of random assignment makes it impossible to establish a strong causal argument.

Eight of the studies reviewed were cross-sectional and demonstrated associational relationships. Evans et al. (2002a) found that housing quality was significantly and positively

associated with positive affect. This relationship was mediated by respondents' attachment to place. Two cross-sectional studies examined the relationship between aspects of the front entrance of the home and their relationship to self-reported anxiety and depression (Brown et al., 2009; Brown et al., 2008). Results suggested that features of the front of the home were related to anxiety and depression, and that relationship was mediated by social support. Knipscheer et al. (2000) found that subjective efficacy (positive attitude toward one's environment and life) was predictive of depression symptoms among respondents in The Netherlands. In Japan, older adults who reported difficulty laying out traditional Japanese bedding, difficulty standing up from traditional bedding and difficulty going up and down stairs had higher odds of psychiatric problems (Migita et al., 2005). Housing tenure (ownership), years of residence, housing amenities (Oswald et al., 2003), and size of the home (Oswald et al., 2011) were associated with life satisfaction among German respondents though the relationships differed among east versus west German samples (Oswald et al., 2003).

Oswald et al. (2007) and Iwarsson et al. (2007) both used the Housing Enabler instrument in their cross-sectional studies. In a secondary analysis, Oswald et al. (2007) assessed which features of the PHE were related to life satisfaction, environmental mastery and emotion (affect and depression symptoms) among urban older adults from Sweden, Germany, the United Kingdom, Hungary, and Latvia. Results suggested that in these countries, the magnitude of accessibility problems (a combined objective and subjective measure of the PHE) was strongly correlated with psychological well-being. A simple total number of environmental barriers did not significantly correlate with any of the psychological well-being indicators for any of the countries. Similarly, Iwarsson et al. (2007) found that magnitude of accessibility problems significantly predicted life satisfaction among Swedish adults between 80 and 89 years of age. A

statistical interaction was found as the results were moderated by the degree of functional impairment. Meaning of housing significantly predicted life satisfaction for respondents who were independent in ADLs. For those who were dependent in IADLs, meaning of housing and usability of the home significantly predicted life satisfaction. Among respondents dependent in both ADL and IADLs, only usability of home predicted life satisfaction.

Six longitudinal studies offered minimal evidence for a causal relationship between indicators of the PHE and psychological well-being due to the use of repeated measures establishing temporal ordering and the associational relationship identified between the variables measured (Kundi, 2007). However, threats to internal validity were not controlled for. In a secondary analysis using a sample of Swedish and German adults ages 80 to 89 years, Wahl et al. (2009) found that one year after the initial assessment, magnitude of accessibility problems predicted changes in depression, affect, and subjective well-being in both countries, even after controlling for age, gender, and perceived health. Similarly, Werngren-Elgström et al. (2009) found that for Swedish older adults (ages 75 to 84) magnitude of accessibility problems, as measured by the Housing Enabler instrument, was negatively correlated with subjective well-being at six and ten years follow-up. This study was limited by sample size (n= 31) and selection bias as respondents in this study represented robust older adults who were still living after ten years of the study and had remained in their homes. Howden-Chapman et al. (2011) found that among older adults in England ages 55 to 80, homeowners compared to renters had significantly lower minor psychiatric morbidity in a 22-year follow-up. However, the influence of ownership diminished with age. Housing quality and challenges with affording housing maintenance became more significant predictors with age.

A three-year longitudinal study conducted in The Netherlands with adults ages 60 and over found that though the presence of disability at baseline did not predict depression at follow-up, increases in disability from baseline to follow-up did (Thomése & van Groenou, 2006). Also, moving into a care facility if disability had increased led to fewer depression symptoms, while moving without increased disability over time resulted in significantly more depression symptoms. Though not expected, adding home adaptations for those with increased disability was associated with increased depression symptoms.

In a two-year study, better housing grade (calculated by the number of rooms per home and public versus private housing) increased the odds of aging successfully by a factor of 1.41 among Chinese elders (Ng et al., 2009). Successful aging was a multidimensional composite score consisting of cognitive and affective health, life satisfaction, engagement, physical health, and social functioning. The authors do not specify how this composite was calculated.

Tomaszewski (2013) used random effects regression in a study that followed a representative panel of older Australians aged 50 and over for nine years. Results suggested that, for this sample, the living environment had an independent effect on well-being, life satisfaction, and happiness where dissatisfaction with housing was associated with lower scores on all of these. Overcrowding was not associated with well-being though having multiple rooms per person was associated with lower scores on well-being and satisfaction.

Only one quasi-experimental study was identified in this review. Cheng et al. (2014) found that among older adults (ages 60 and older) with leprosy in Taiwan (n= 312), moving into a new high-rise apartment building for seniors resulted in greater psychological well-being scores and improved environmental quality of life compared to their counterparts who chose to remain in ground-level housing for seniors. Researchers controlled for variables with significant

pretest differences such as floor level, age, number of diseases, ADLs, perceived health status, and indicators of quality of life.

Discussion

The objectives of this critical review were to 1) summarize how the PHE has been measured in the literature, 2) determine how functional impairment has been considered among these studies, and 3) evaluate the evidence for a relationship between the PHE and psychological well-being among older adults. Throughout the studies reviewed, researchers have operationalized the PHE with objective, subjective, and combined objective and subjective measures to arrive at a composite fit score. This approach was consistent with the definitions in the ecological model of aging framework as proposed by Lawton and Nehemow (1973). Also, studies that use the Housing Enabler instrument attempted to capture an additional feature where subjective personal competencies and objective environmental indicators were quantified. This feature may best be described as environmental fit.

Functional capacity was an important part of the assessment of the relationship between PHE and PWB among 12 of the 15 studies. Importantly, indicators of functioning were found to be related to PWB (Migita et al., 2005; Werngren-Elgström et al., 2009). A few studies examined of the nature of that relationship between indicators of the three constructs. The most support is provided for indirect effects in the form of moderation. In one study, objective efficacy moderated the effect of functioning on depression (Knipscheer et al., 2000). No studies directly tested for a main effect for PHE and PC on PWB. It is unclear whether such a relationship might exist. It cannot be determined whether an environmental based intervention or a capacity based intervention will have the most impact on PWB at this point.

The evidence presented supported an associational relationship between various indicators of the PHE and psychological well-being. Every study reviewed found some relationship between at least one PHE indicator and a psychological well-being outcome. These findings suggest that among older adults, some of the objective and subjective features of the home they live in are essential to their psychological health. However, because there is little consistency in defining the PHE, it is hard to identify which features of the home are most important.

Type I error adjustments were not identified in any of the studies assessed. It is plausible that some of the significant findings were due to chance. However, finding relationships between measures of the PHE and PWB within different nations does suggest that the PHE is related to psychological well-being among older adults. Even with the unique cultural features of housing such as the Japanese style flats (Migita et al., 2005), apartments in Taiwan (Cheng et al., 2014), and rural eastern German homes (Oswald et al., 2003), features in the home were related to psychological well-being.

Though a significant amount of evidence supported a relationship between specific features of the PHE and psychological well-being outcomes, this evidence was weakened due to the lack of consistent measurement of PHE indicators. While relationships were established using correlational methods, causality, direction, and strength of such relationships were unclear. Sampling procedures presented challenges for generalizability beyond the scope of each study reviewed. Because few studies operationalized the PHE or psychological well-being in the same way, it is hard to make comparisons across studies.

Many of the authors did not present evidence for validity for measures of the physical home environment. The exception lies with those studies that were a part of the ENABLE-AGE

Project. The Housing Enabler instrument has been used in multiple cross-national studies to assess the magnitude of accessibility problems (Iwarsson et al., 2007). Evidence for cross-national inter-rater reliability has been demonstrated for both the personal component and the environmental component of the instrument with adequate to good kappa ratings (.68 to .87) (Iwarsson & Isacsson, 1996). A cross-national team of experts worked to develop the tool through multiple iterations until consensus was met providing evidence for content validity (Iwarsson et al., 2007). It is questionable whether indicators of the PHE included in the rest of the studies validly captured the construct.

The methodological flaws of these studies result in challenges to their conclusions. The inconsistency with which the PHE was defined made it impossible to compare results across studies, except those studies that used the Housing Enabler instrument. Also, the dominance of the use of cross-sectional designs indicates a need for more rigorous approaches to establishing causal relationships. Type I error rates and power analyses were not discussed yielding threats to statistical conclusion validity.

Features of sampling methods make it difficult to generalize beyond the reach of studies and in some cases, beyond a particular country. Only two studies have been conducted in the United States (Brown et al., 2009; Brown et al., 2008; Evans, et al., 2002a). These studies were nuanced by the characteristics of location and participants included in the sampling frames. Evans et al. (2002a) used a non-random sample of older adults from New York and Brown et al. (2009; 2008) focused their study on a random selection of older, non-U.S. born adults in Miami.

This review has some limitations that must be considered. Only studies that have been peer-reviewed were considered for inclusion resulting in the exclusion of unpublished findings. One author reviewed studies for inclusion and extracted data. Also, in the first stage of the

systematic review, only the titles and abstracts were reviewed for inclusion criteria. However, multiple databases were searched, including overlapping publications, increasing the likelihood of the author seeing studies multiple times for review. Also, searching the references of publications included in the review increased the probability of identifying studies that had been missed. As with all reviews, it is possible that the author inaccurately interpreted the findings of some of the reviewed studies.

Recommendations for Research

Significant gaps have been identified by this review including a dearth of research conducted with U.S. populations and inconsistency in the measurement of the PHE. The two separate studies (three articles) carried out in the U.S. included in this review were unique and specific to the location and sample, which limits the ability to generalize findings (Brown et al., 2009; Brown et al., 2008; Evans et al., 2002a). Researchers should take advantage of longitudinal population-based data to improve their ability to generalize findings to a broader sample and to disentangle causal relationships between PHE indicators and psychological well-being. Also, the relationships between the PHE, functioning, and psychological well-being are not well defined despite the use of models like the ecological model of aging. This model should be further explored using sophisticated analyses such as structural equation modeling to test the relationships between constructs in the model.

There is still very limited understanding of which features of the PHE, both subjectively and objectively measured, are related to psychological well-being. Establishing a set of predictors unified under a signal construct could assist with the advancement of this understanding and lead to a research program with implications for policy change and development as well as practice.

Recommendations for Practice

The home continues to be the primary location and first choice for living among older adults. Social work practitioners who work with this population must be able to intervene at all points of the ecological model including the physical environment, individual competence, and psychological well-being so that this population can live at home successfully. The significance of the physical structure of the home for psychological well-being outcomes for this population must be understood. To ensure this, social work educators should include readings, lectures, and experiential activities such as physical home environment inventory opportunities that help students grasp the significance of the physical home for this population. Also, practitioners should be aware that there is a subjective dimension to the home environment that can affect psychological well-being. Social workers should be educated about, and capable of, successfully linking their older clients to community agencies and policy resources that can assist with improving the fit between physical features of the home and functional abilities. Advocacy for policies that enhance aging in place, such as housing modification and repair, and increased collaborative efforts across disciplines to match housing with personal capabilities, are activities that are essential for every gerontological social worker.

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Appendix

Table 1-A
Original Studies of Physical Home Environment and Psychological Well-Being Indicators

First Author Design	Sampling Country/Total/Age	Physical Home Environment	Psychological Well-Being	Findings
Brown et al., 2008 Cross-sectional	FL, USA n=273 Ages 70 to 100	Objective Front entrance Windows	Self-report Psychological distress (anxiety and depression)	Objective measures of PHE were related to psychological distress through social support.
Brown et al., 2009 Cross-sectional	FL, USA n=273 Ages 70 and older	Objective Front entrance Windows	Self-report Anxiety Depression	Front entrance and window variables were related to psychological distress through social support. Direct relationships between PHE and psychological distress were not significant.
Cheng et al., 2014 Quasi-experimental Prospective cohort study	Taiwan n=312 Ages 60 and over Leprosy	Objective Move to high rise apartment or not	Self-report Quality of life (physical, psychological, social, environmental)	Moving to high-rise apartments resulted in greater psychological and environmental quality of life compared to those who did not move.
Evans et al., 2002a Cross-sectional	NY, USA n=497 Ages 60 and over	Objective Housing quality (developed by researchers)	Self-report Positive affect	Housing quality was positively related to positive affect. Place attachment fully mediated the relationship between housing quality and positive affect.
Howden-Chapman et al., 2011 Longitudinal (22 years) Cohort study	England Phase 9 n= 6,762 Ages 55 to 80	Objective Housing tenure Subjective Housing quality Housing financial problems	Self-report Minor psychiatric morbidity	Overall, mental health improved with age but the improvement was lessened for those who reported housing quality issues and financial challenges related to paying housing bills. Housing quality and financial burden were more important than tenure for predicting psychological health over time.
Iwarsson et al., 2007 Cross-sectional	Sweden n= 397 Ages 80 to 89	Objective Number of environmental barriers Subjective Housing satisfaction Usability Meaning Control beliefs Composite Magnitude of accessibility problems	Self-report Life satisfaction	The Degree of dependence in ADLS moderated the relationships between the magnitude of accessibility problems and life satisfaction. The Number of environmental barriers did not predict life satisfaction.

Table 1-A (Continued)

First Author Design	Sampling Country/Total/Age	Physical Home Environment	Psychological Well-Being	Findings
Knipscheer et al., 2000 Cross-sectional	Netherlands n= 2,712 Ages 55 to 85	Objective (self-report) Adjustments to the home Subjective Subjective efficacy Objective efficacy	Self-report Depression symptoms	Low subjective efficacy was associated with increased depression symptoms. Number of adjustments to the home was not associated with depression symptoms.
Migita et al., 2005 Cross-sectional	Japan n=197 65 and older	Subjective Use of traditional bedding Degree of dissatisfaction with layout (6 categories) Degree of dissatisfaction with location (5 categories)	Self-report Mental health status	Reporting difficulty laying on traditional Japanese bedding, difficulty standing up from the traditional mat and difficulty going up/and or down stairs was significantly associated with and predictive of having higher odds of psychiatric problems.
Ng et al., 2009 Longitudinal (2 years) Cohort study	Singapore Phase 2 n=865 Ages 65 and older	Objective (self-report) Housing grade (number of rooms and public vs. private)	Successful aging composite Self-report Physical health Social functioning Positive life satisfaction Objective Cognitive health	Older adults with higher grade housing were more likely to be successful in aging.
Oswald et al., 2003 Cross-sectional	Germany n= 412 ages 55 to 99	Objective East vs. West Germany Tenure Number of rooms per person Global housing amenities Years of residence Subjective Attachment to home Perceived satisfaction with home environment Perceived satisfaction with outdoor environment	General life satisfaction	Though objective housing was significantly different from East vs. West German respondents, life satisfaction was the same. Housing tenure predicted life satisfaction for East and West. Housing amenities and satisfaction with outdoor environment predicted life satisfaction in the East. Years of residence and satisfaction with the home environment predicted life satisfaction in the West.

Table 1-A (Continued)

First Author Design	Sampling Country/Total/Age	Physical Home Environment	Psychological Well-Being	Findings
Oswald et al., 2007 Cross-sectional	Sweden, Germany, UK, Hungary, Latvia n= 1,918 Ages 75 to 89	Objective Barriers in the home Subjective Housing satisfaction Usability Meaning Control beliefs Composite Magnitude of accessibility problems	Self-report Life satisfaction Environmental mastery Affect Depression and symptoms	In all five nations, older adults who have fewer accessibility challenges, but not fewer barriers, who believe their homes were useful and meaningful and had a sense of personal control over their housing had higher life satisfaction and fewer depression symptoms.
Oswald et al., 2011 Cross-sectional	Germany n= 381 Ages 65 to 994	Objective (self-report) Number of rooms Size of home in meters Barrier-free access to amenities Stairs at front entrance Subjective Comfort of home	Self-report Life Satisfaction	The size of the home independently predicted life satisfaction. Differences were found by age grouping where housing size was positively related to life satisfaction for the young-old but negatively related for the old-old. Barrier-free access and comfort of the home were not significant predictors.
Thomése & van Groenou, 2006 Longitudinal (3 years)	Netherlands Ages 60 and older n= 819	Objective Move between time 1 and time 2 Adding 3 or more home modification between time 1 and time 2	Self-report Depressive symptoms	An interaction was found between disability and adaptive response (home environment changes and use of informal or professional support) such that more adaptions paired with increased disability resulted in greater depression.
Tomaszewski, 2013 Longitudinal (9 years)	Australia n= 25,599 Ages 50 and over	Objective Crowding External conditions of the building Tenure Type of dwelling Subjective Dissatisfaction Housing inadequacy	Well-Being Life satisfaction Happiness	Social participation and living environment were found to have independent effects on well-being indicators. Dissatisfaction with housing was associated with lower well-being, lower life satisfaction, and lower happiness. Overcrowding was not associated with well-being but having two rooms or more per person was related to lower scores on well-being and life-satisfaction. Tenure was not associated with well-being after controls.

Table 1-A (Continued)

First Author Design	Sampling Country/Total/Age	Physical Home Environment	Psychological Well-Being	Findings
Wahl et al., 2009 Longitudinal Prospective	Sweden and Germany Phase 2 n=636 Ages 80 to 89	Subjective Control beliefs Composite Magnitude of accessibility problems	Self-report Depression Subjective well-being Affect	The magnitude of accessibility problems was positively correlated with depression scores and negatively correlated with positive affect and subjective well-being in both Sweden and Germany.
Werngren-Elgström et al., 2009 Longitudinal (10 years)	Sweden n= 31 Ages 75 to 84	Composite Magnitude of accessibility problems	Self-report Subjective well-being (physical, psychological, and social)	P-E fit and subjective well-being were negatively correlated at six years and ten years. The mental well-being subscale was not related P-E fit at either time.

Chapter II: Physical Home Environment, Personal Competence, and Psychological Well-Being among Community-Dwelling Older Adults: Construction and Refinement of a Measurement Model

Abstract

Many older adults prefer to grow older in their own homes. Also, many are living with varying degrees of competence that result from physical health, functioning, and cognitive ability. Both home environment and competence are known correlates of psychological well-being among older adults. The purpose of this study is to establish a measurement model including the three major constructs of the ecological model of aging. The results of a confirmatory factor analysis are presented. The resulting model was refined and cross-validated using the National Health and Aging Trends Study round one dataset (N=6,665). The final model fit the data reasonably well. Convergent and divergent validity are discussed. Personal competence and psychological well-being demonstrated good convergent validity while physical home environment did not. Also, personal competence and physical home environment were strongly correlated. Possible explanations and recommendations for research and practice are presented.

Keywords: aging, physical home environment, competence, psychological well-being, ecological model of aging, social work

A majority of older adults prefer to grow older in their own homes and to maintain as much independence as possible (Bayer & Harper, 2000; Rantz et al., 2011). As few as 3.4% of seniors have been reported to live in institutional settings (Administration on Aging, 2014). In addition, one study found they may spend as much as 90% of their day at home (Baker, Keall, Lyn, & Howden-Chapman, 2007). Even so, little is known about how features of the home environment affect the psychological well-being of older adults (Renalds, Smith, & Hale, 2010). Given that older adults spend so much time in their homes, it is important to investigate the potential of the physical home environment for enhancing or limiting psychological well-being (Oswald, Wahl, Mollenkopf, & Schilling, 2003; Wahl, Schilling, Oswald, & Iwarsson, 2009).

The ecological model of aging proposes that individual behaviors, including psychological responses, are a result of the influences of the environment and personal competence (Lawton, 1982). Within this model, the environment has been defined as both objective and subjective. Objective features of the physical home environment are those that exert demands on the individual (Lawton, 1970) while subjective elements are defined as the idiosyncratic experience that occurs when a person interacts with the environment (Lawton, 1982). Personal competence is defined as individual capacity without the influence of the environment (Lawton, 1982; Lawton & Nahemow, 1973). This construct is often measured with indicators of biological health, sensation and perception, motor skills, cognition, and ego strength (Lawton, 1982). For the purposes of the present study, psychological well-being is considered to be a broad construct that encompasses a range of positive moods and emotions, as well as an appraisal of life satisfaction and purpose (Chan, Phillips, Cheng, Chi, & Ho, 2004; Phillips, Cheng, Yeh, & Siu, 2010; Ryff et al., 2006).

As part of the ecological model of aging, Lawton and Simon (1967) also described the environmental docility hypothesis. This hypothesis postulates that persons with less competence are more affected by the environment. The docility hypothesis suggests that there is an interactive relationship between a person's environment and their capacity. Persons with less competence will have a more difficult time adapting to increasing demands of the environment. Those with more competence will be less affected by the demands of the environment (Morgan et al., 1984).

In a recent systematic literature review, Trecartin, Cummings, Choi, Nugent, and Ladd (in preparation) identified fifteen publications that focused on the relationships between the physical home environment and psychological well-being among older adults. Several studies also included personal competence in the models. Among these studies, the physical home environment was operationalized as both objective features and subjective experiences. The majority of studies reviewed were conducted outside of the United States (81%). Little conclusive evidence was found, but there was correlational data linking indicators of the home environment and individual capacity to psychological outcomes.

Of the studies investigating the relationships between measures of the physical home environment, personal capacity, and psychological well-being, multiple regression models were most often used in analyses (Howden-Chapman, Chandola, Stafford, & Marmot, 2011; Migita, Yanagi, & Tomura, 2005; Oswald et al., 2003; Thomése & van Groenou, 2006). Factor analysis is an alternative method that can be useful when independent variables are highly correlated. The advantage of factor analysis over multiple linear regression is that it allows for the examination of multiple predictor variables simultaneously and account for multicollinearity. Also, variables that are highly correlated are then parceled out into factors that indicate the underlying

measurement structure of a construct. The three prominent features in the ecological model of aging including environment, personal competence, and behavior, lend themselves to this type of analysis. In addition, no study was identified that examined the effect of the physical home environment, personal competence, and psychological well-being of older adults using a nationally representative sample of U.S. residents ages 65 and older. These studies are now possible using the National Health and Aging Trends Study (NHATS). This nationally representative longitudinal study gathered data about Medicare enrollees and included both community-dwelling and institutionalized older adults ages 65 and older (NHATS, 2015). The purpose of the present study was to test and refine a measurement model using a sample of older adults from the United States and identify which variables significantly contributed to a set of underlying latent constructs. This study addressed these gaps in knowledge by examining the factor structure of three theoretical constructs: Physical Home Environment (PHE), Personal Competencies (PC), and Psychological Well-Being (PWB).

Methods

Subjects

Approval for this project was granted by the Institutional Review Board at the University of Tennessee, Knoxville. A secondary analysis of the NHATS 2011 first round interview data was completed, and the factor structure of the three theoretical constructs was examined. The NHATS Round one data used the Medicare Recipient Data File as the sampling frame which was comprised of 96% of older adults ages 65 and older in the contiguous United States (Montaquila, Freedman, Edwards, & Kasper, 2012). A multistage and stratified random sampling approach was used. Persons aged 90 and older and African Americans were oversampled to ensure adequate representation. The response rate was 71% with a total sample of 8,245 and 7,609 community-dwelling respondents: 7,026 personally answered face-to-face interviews and

583 used a proxy (7.07%). This study included community-dwelling older adults ages 65 and older. Proxy interviews were excluded (N=583). Also, interviews that did not include the interviewer home assessment (gathers data about the PHE) were not included (N= 361). The final sample size for the present study was 6,665. Sample analytic weights were applied in the analysis of descriptive data to adjust for the sampling design of the NHATS study.

Design

A confirmatory factor analytic (CFA) approach was used to test an *a priori* measurement model. The sample of 6,665 community-dwelling respondents was randomly split into two subsamples (n of sample 1 = 3,330 and n of sample 2 = 3,335). The proposed measurement model was then refined with the first sample and validated with the second sample (Lattin, Carroll, & Green, 2003).

Data Collection

The NHATS study has multiple indicators of PHE, PC, and PWB, which are described below.

Demographics. Age, gender, race/ethnicity, and length of time living at the current residence were summarized and analyzed after adjusting for sampling weights.

Latent constructs and manifest variables. Physical Home Environment (PHE) was defined as the fixed physical characteristics of a person's immediate home, which were original features or modifications that had been added to the home, and that exerted or reduce demands by the environment on the individual. For the current study, PHE did not include the ambient environment such as lighting and environmental pollutants or durable medical equipment such as wheelchairs and walking aids. The NHATS dataset had numerous possible indicators of the PHE. These included both self-reported indicators and an interviewer assessment of PHE

features. These items were included because they represented three of the four objective categories of PHE found to be measured in previous studies including physical presence of features, the evaluative dimension of features, and housing tenure (Trecartin et al., in preparation). The self-report manifest variables included in the model were type of residence (categories were coded as binary variables for use in the measurement model), number of floor levels (single level or more than one), stairs at entrance (yes or no), ramp at entrance (yes or no), tenure (own or rent/other), and length of time at address. The interviewer assessment reviewed 10 PHE characteristics that, if present, had clear negative value as an indicator of the home environment such as the presence of peeling paint, tripping hazards, and broken or uneven flooring. This group of questions focused on housing disrepair. A summed scale was constructed from these indicators to reduce the complexity of the model. Higher scores indicated poorer PHE. A reliability analysis of the scale was conducted, and Cronbach's alpha was .80 indicating good internal consistency.

Personal Competency (PC) as conceptualized by Lawton (1982), was defined as individual capacity without environmental influences. PC included biological health, sensation and perception, motor skills, cognition, and ego strength. Lawton (1983) acknowledged the challenge of separating competence from the environment and therefore posited that only intrapersonal variables should be used to assess competence. Higher credence was given to biological and performance measures taken by external observers (Berrahou, 1993). NHATS included several indicators of personal competency; both interviewer assessed performance measures and self-report measures. Those variables included in the measurement model represented the cognitive, motor, and biological dimensions of personal competency as these were the indicators available in NHATS and represented both objective and subjective

assessments of capacity. Indicators of PC included self-reported overall health in the last month (5 levels reverse scored from poor to excellent), self-rated memory in the last month (5 levels reverse scored from poor to excellent), NHATS number of cognitive domains impaired (0 to 3 domains), and the NHATS Short Physical Performance Battery (SPPB).

The NHATS Short Physical Performance Battery (SPPB) was a composite measure of physical capacity that included five performance activities: balance tests, a 3-meter usual walking speed to measure locomotion, rapid chair stands reflecting lower body muscle function, grip strength, and peak air flow. The selection of these instruments for inclusion in the battery was informed by previous national surveys of health including the Women's Health and Aging Study (Guralnik, Ferrucci, Simonsick, Salive, & Wallace, 1995) and the Health and Retirement Survey (Kasper, Freedman, & Niefeld, 2012). These items have been shown to exhibit good reliability with samples of older adults (test-retest reliability = .61 to .91) (Seeman et al., 1994). Also, these measures have been found to predict hospital stays, nursing home placements, death, and disability (Cesari et al., 2009; Guralnik, Ferrucci, Simonsick, Salive, & Wallace, 1994; Guralnik et al., 1995). The original SPPB only incorporated the walking, chair stands, and balance tests. The NHATS SPPB added the grip strength and peak air flow to expand the assessment to the lower end of the capacity scale. This instrument was normed on the NHATS 2011 sample (Kasper et al., 2012). It is scored from 0 (lowest) to 12 (highest) (Figure 1-A). The distribution of this variable appeared to be approaching normal with a skew of 0.0 and kurtosis of 0.0. The mean score was 7.0 (*SD* =.06).

Psychological Well-Being (PWB) was conceptualized as a broad construct that encompassed a range of positive moods and emotions, as well as an appraisal of life satisfaction and purpose. Happiness, lack of mental illnesses such as anxiety and depression and positive

mood and emotion have been used to capture PWB (Chan, Phillips, Cheng, Chi, & Ho, 2004; Phillips, Cheng, Yeh, & Siu, 2010; Ryff et al., 2006). NHATS included several self-reported indicators of PWB. The Patient Health Questionnaire (PHQ-2) was a depression symptom assessment with scores ranging from 2 to 8. Totals were reverse scored so that higher scores indicated a lack of symptoms. This two-item measure was designed to be a quick screening tool for depression. The two questions were rated on a Likert scale (scored 1 to 4) and based on the last month of experience. The PHQ-2 did not provide a diagnosis of depression, but it has been found to demonstrate adequate construct validity with the scale having moderately negative correlations with scales assessing self-esteem, life satisfaction, and resilience (Kroenke, Spitzer, & Williams, 2003; Lowe et al., 2010). Also, Lowe et al. (2010) found an alpha of .75 indicating acceptable internal consistency. For this sample, alpha was .68.

The GAD-2 anxiety symptom assessment scores ranged from 2 to 8. Totals were reverse scored so that higher scores indicated a lack of symptoms. This two-item measure was created to be a brief screening to detect potential anxiety. The two questions were rated on a Likert scale (scored 1 to 4) and based on the last month of experience. The alpha for internal consistency was .82 when tested with a group of both German and U.S. respondents (Lowe et al., 2010). The GAD-2 was also moderately negatively correlated with self-esteem, life satisfaction, and resilience measures (Lowe et al., 2010). For this sample, alpha was .66.

The NHATS well-being assessment was comprised of three subscales: 1) Well-Being Affect (range 4 - 20), Well-Being Self-Realization (range 3 - 12), and Well-Being Self-Efficacy (range 3 - 9). This instrument used items that were developed from the Midlife in the U.S.A. Study of National Health and Well-Being (MIDUS). These items have been adapted from previously validated measures of psychological well-being and personal control (Lachman &

Weaver, 1998; Ryff & Keyes, 1995). The whole scale employeed a Likert approach asking respondents to rate a particular indicator based on the previous month of experience. Sub-scale totals were reverse scored for the analysis so that higher scores indicated better PWB. Cronbach's alpha for the entire scale was .75 for this sample, .70 for positive affect, .54 for self-realization, and .29 for self-efficacy.

The proposed measurement model and predicted relationships between the latent constructs and indicator variables are presented in Figure 1-B. It was expected that there would be a negative relationship between PHE and PC suggesting that as PHE was more supportive, then PC would be lower. A positive relationship between PC and PWB was expected such that as PC increased, PWB would increase. Finally, we expected the relationship between PHE and PWB to be positive where higher PHE would be associated with better PWB.

Data Analysis Plan

Programs to be used. STATA 14.0 statistical software was used for descriptive analyses and applying analytic weights in the description of measures of central tendency and construction of confidence intervals (StataCorp, 2015). Analytic weights were applied to adjust for nonresponse and oversampling of black respondents and respondents over 90 years old. AMOS 23 was used to conduct the confirmatory factor analysis (Arbuckle, 2006).

Data preparation. The dataset was supplied by the NHATS data managers at the Johns Hopkins School of Public Health and Westat (NHATS, 2015). An analysis of missing values and normality was conducted. Missingness ranges from 0% for most of the variables to 12.6% for the NHATS SPPB. The next highest missing was Tenure at 6.3%. To address these missing values, the Maximum Likelihood Estimation (MLE) algorithm available with AMOS 23 was used. According to Enders (2010), MLE is superior to mean substitution, listwise deletion, and

pairwise deletion when data are not missing completely at random (MCAR). It was determined that data were not MCAR. Instead, they were missing at random (MAR). Based on Enders' (2010) definition, data are MAR if the probability that data are missing on a variable is related to some other variable in the model, but not to the values of the variable itself. MLE has been found to generate unbiased estimates under the MAR assumption (Enders, 2010).

A preliminary univariate analysis of the skewness and kurtosis of the variables intended for use in the models suggested that the data were not multivariate normal. Non-normal data can bias standard errors and distort likelihood ratio tests as well as other fits indicators (Enders, 2010; Kline, 2011).

Analytic approach.

Confirmatory factor analysis (CFA) was used to evaluate the hypothesized measurement model and to determine which manifest variables loaded on the latent constructs (Figure 1-B). To determine which observed variables contributed to the measurement of the underlying constructs and provide evidence for convergent and divergent validity, factor loadings and fit indices were examined. Items that were not statistically significant and that had factor loadings below 0.4 were considered for exclusion following cut-off recommendations from Stevens (2012). Probability values of .05 were considered to be statistically significant. One item was considered at a time. Convergent validity was assessed by examining the within factor item loadings. Discriminant validity was assessed between constructs by reviewing the between construct correlations and comparing those to the within factor item loadings. Once the proposed measurement model was refined and demonstrated good model fit, it was then cross-validated with the 2nd half of the 50% random sample of subjects.

The Likelihood Ratio Test ($\chi 2$) was reviewed to assess the proposed model fit to the data. Statistically significant $\chi 2$ values suggest poor model fit (Bollen, 2014). The $\chi 2$ is sensitive to, and often inflated by, large samples like in the present study (Jöreskog & Sörbom, 1993). The Comparative Fit Index (CFI) and the Tucker-Lewis Index (TLI) were reviewed. Values above .90 and .95 have been suggested as evidence for acceptable and good fit (Cheung & Rensvold, 2002; Hu & Bentler, 1999). Root Mean Square Error Approximation (RMSEA) values close to .05 indicate good fit (Browne & Cudeck, 1993). PCLOSE tests the null hypothesis that RMSEA equals .05 and PCLOSE values of .05 or less suggest that it does not (Byrne, 2013).

Results

Descriptive Statistics

Descriptive statistics for the entire sample are presented in Table 1-B. More than half of the respondents were female. The average age was 75 (*SE* = .09). The majority of the sample was white with far fewer other ethnicities represented. Most lived in free standing single family homes, followed by multiunit apartment type homes. Most lived in residences with multiple floors, stairs at the entrance, and lacked a ramp. Also, the majority of the respondents owned their home. The average length of time at the residence was nearly 22 years.

PC was represented by self-reported health, self-reported memory, the NHATS dementia classification scale, and the NHATS SPPB scale. The majority of respondents rated their health as “good” or “very good.” Most were classified as “not impaired” per the NHATS Dementia classification scale. Similarly, in a self-rated assessment of memory, just over 82% said their memory was either “good” or better. The average NHATS SPPB score was 7 (*SE* = .06).

PWB indicators included the PHQ-2 depression indicator, the GAD-2 anxiety indicator, and the NHATS well-being subscales. The average respondent scored a 5.1 on both the PHQ-2

and GAD-2. The mean Affect, Self-Realization, and Self-Efficacy subscale scores were 12.0, 7.2, and 5.1 respectively.

Model Refinement

The full measurement model was estimated using data from sample 1 (n= 3,330) (Figure 1-B). The model would not estimate, and it was determined that the observed variables for type of residence were causing the S matrix to be singular. The observed indicator Other was dropped as it only contained 22 observations. Freestanding, Multiunit, and Months at Address were consecutively omitted from the analysis because the error terms were negative causing an inadmissible solution. This was likely because these variables could be predicted by each other or some other variable in the model. The resulting fit indices suggested that the model did not fit the data well, $\chi 2$ (101) = 1312.27, $p < .001$, RMSEA = .06 (90% CI = .057 - .063), PCLOSE = .001, CFI = .84, and TLI = .78. All fit indices were lower than acceptable recommendations.

Factor loadings were then reviewed, and each of the observed variables was loading highest on the assigned latent constructs (Table 2-B). Table 3-B summarizes the model refinement process. Mobile and Freestanding Attached were eliminated one at a time because they did not load onto PHE. A covariance was inserted into the model between the error terms of DepTotal and AnxTotal given that they are subscales in a broader scale and that literature has previously found these items to be highly related constructs (Clark & Watson, 1991; Henry & Crawford, 2005). Similarly, the error terms between WBSR and WBSE were also covaried and this significantly improved model fit. Domain 65, which indicated the number of domains of cognitive impairment of respondents, was also dropped from the model resulting in an improved fit. This item loaded the lowest on PWB and fell below the .04 cut-off suggested by Stevens (2012). The refined model (Figure 2-B) fit the data reasonably well, $\chi 2$ (60) = 502.15, $p < .001$,

RMSEA = .047, (90% CI = .043 - .051), PCLOSE = .90, CFI = .94, and TLI = .91. Though the significance value for $\chi 2$ was less than .05 signifying a poor fitting model, this was expected due to the power of the large sample size. RMSEA was below .05 and PLOSE supported this finding. TLI was just above .90 and the CFI was just short of .95.

Evidence for Convergent-Divergent Discriminant Validity

Items that significantly contributed to PC were Overall Health, Self-Rated Memory, and the NHATS Short Physical Performance Battery. These items all loaded above the .4 cut-off suggested by Stevens (2012). The lowest scores were .49, and the highest was .71 demonstrating moderate to good convergent validity. These items appeared to be representing PC relatively well. Lawton (1982) suggested that PC could be captured by indicators of biological health, sensation, and perception, motor skills, cognition, and ego strength. The items that remained in the final model represented three of the five categories.

PWB indicator variables that remained in the model included DepTotal (PHQ-2) capturing depression symptoms, AnxTotal (GAD-2) capturing anxiety symptoms, and three sub-scales of the psychological well-being instrument created for NHATS. These included Well-Being Affect, Well-Being Self-Realization, and Well-Being Self-Efficacy. These items all loaded higher than the .4 cut-off. The lowest loading was .55, and the highest was .82. These items appeared to be representing PWB well demonstrating moderate to good convergent validity.

The items used to measure PHE did not exhibit good convergent validity (Table 2-B). Care was taken to consider, eliminate, and retain each item that remained in the final model. Items that significantly contributed to PHE were Housing Disrepair Total, Number of Floors, Tenure, Presence of Stairs, and Presence of Ramp. These items represented three of the four

categories of PHE features that have been examined in previous literature (Trecartin et al., in preparation). Though the indicator variables loaded significantly onto the latent construct, the highest factor loading was .25 for the final model. The low loadings can partially be explained as a result of the correlations obtained between dichotomously scored manifest variables and the continuous latent construct. Biserial and point biserial correlations yield lower estimates as the distribution between binary categories departs from 50%. Dichotomizing variables can result in an intense range restriction which attenuates correlation values (Cohen, 1983). All of the items loaded in the predicted direction except for HDisTotal. It was expected that disrepair in housing would be negatively associated with the PHE, but it was positively associated with PHE.

Though two of the latent constructs, PHE and PC, were strongly correlated, evidence for discriminant validity was found in the refined model and the strong conceptual differences between constructs. Correlations between all the latent constructs were statistically significant ($p < .001$). A moderate positive relationship was found between PWB and PC ($r = .67$) as was predicted. The relationship between PC and PHE was also moderate and negative as predicted ($r = -.75$). A smaller negative relationship was found between PWB and PHE ($r = -.37$). The direction of this relationship was unexpected. CFA was then used to examine the difference between an unconstrained model and a model with the correlations between latent constructs constrained to be equal. The results provided further evidence of discriminant validity, $\Delta\chi 2 = 54.062$, $p < .001$, ΔCFI = .03. The constrained model fit significantly worse. One additional step was taken to evaluate the moderately high correlation between PC and PHE. The covariance between PC and PHE was constrained to be equal to 1 and model comparison results suggested the two constructs are distinct, $\Delta\chi 2 = 6.48$, $p = .01$, ΔCFI = .01.

Conceptually, PHE and PC were very different. The items used to measure these constructs were not similar in content or style. PHE was measured by the presence of physical items or elements in the home. PC was measured by the degree of agreement and disagreement with items that described depression and anxiety symptoms, positive affect, self-realization, and self-efficacy.

Model Cross-Validation

The final refined measurement model was simultaneously fit to the data of sample 1 and 2 using the multigroup method available in AMOS 23. Fit indices suggested the model fit reasonably well across samples: $\chi 2$ (120) = 911.17, $p < .001$, RMSEA = .031 (90% CI = .030 - .033), PCLOSE = 1.0, CFI = .94, and TLI = .91. Measurement invariance was examined by constraining the factor loadings and error covariances to be equal across samples. Comparisons of changes in model fit indices supported that the proposed measurement model was measuring the underlying latent constructs the same across samples, $\Delta\chi 2 = 13.01$, $p = .45$, ΔCFI = .001. Next, the structural covariances were constrained to be equal across groups. Comparisons of model fit indices supported that the proposed measurement model was functioning similarly across groups, $\Delta\chi 2 = 35.67$, $p = .18$, ΔCFI = .001. The measurement residuals were then constrained to be equal across groups and model fit indices provided evidence that the measurement model was providing parallel measurement across samples, $\Delta\chi 2 = 55.02$, $p = .12$, ΔCFI = .001.

Discussion

The relationships between PHE, PC, and PWB among older adults are complicated. The purpose of this study was to begin to disentangle these relationships by testing and refining a measurement model using a sample of older adults from across the United States. We sought to

identify which variables significantly contributed to a set of underlying latent constructs modeled on the ecological model of aging (Lawton, 1982). The resulting model fit the data reasonably well when cross-validated. The CFI of .94 approached the recommended cut-off value of .95 by Hu and Bentler (1999). The TLI (.91) fell between the lower and upper recommendations of .90 and .95 for satisfactory and good model fit (Cheung & Rensvold, 2002; Hu & Bentler, 1999). The $\chi 2$ was statistically significant indicating the proposed model did not fit the data well. However, $\chi 2$ is known to be influenced by sample size and is sensitive to small changes with large samples (Bryne, 2010). The RMSEA value provided support that the model fit well at .031 and PCLOSE at 1.0.

Two of the three expected relationships between constructs were confirmed. Higher scores on PWB were moderately related to higher scores in PC. This relationship suggests that there is an association between an older adult's competence including biological health, cognitive ability, and motor performance, and their PWB. Persons with lower competence tended to have worse psychological well-being. Also, a moderate negative relationship was found between PC and PHE. As older adults' competence increased, their home environment was more demanding having fewer home environment features that were accommodating. It is logical to expect that these features would not be present given that the physical home environment would not exert significant demands on persons with higher degrees of competence. Unexpectedly, a negative relationship was found between the PHE and PWB. Among the older adults in the sample, a better PHE, with more adaptations and less disrepair, was related to worse PWB. These results were similar to findings from previous studies showing that home modifications and adaptations that occur in late life were associated with depression and poorer general well-being (Thomése & van Groenou, 2006). It is plausible that older adults who are

experiencing increasing environmental press, in conjunction with decreased personal capacity, may experience additional psychological burden when their homes are being modified to meet those needs.

Alternative explanations for these results should be considered. The analytic approach used to model the latent constructs assumed they were all represented by a single factor. However, if PHE was not a single, but multiple factors, this could help to explain why the items were loading so weakly. For example, this study did not control for or model socioeconomic status or wealth. Two of the items used to represent PHE, Tenure and Housing Disrepair, may be capturing an element of SES rather than PHE.

Furthermore, it is possible that the constructs PHE and PC were part of a second order factor that better explained their shared variance. Not only did the high correlation between constructs provide evidence of this, but previous authors have also elected to combine PHE and PC into a measure of the magnitude of accessibility problems (Iwarsson et al., 2007; Oswald et al., 2007; Wahl et al., 2009).

An alternative explanation is that PHE and its associated indicators were being suppressed by PC. All of the items representing PHE loaded in the predicted direction except for HDisTotal. It was expected that disrepair in housing would be negatively associated with the PHE, but it was positively associated with PHE. A suppression effect may have been occurring due to the strong association between the latent constructs PHE and PC (Ludlow & Klein, 2014).

This study adds to the field of gerontological social work and environmental gerontology by advancing knowledge about how PHE, PC, and PWB related to each other. Establishing which manifest variables contributed to these latent constructs will later enable the field to examine how PHE and PC relate to other outcomes such as physical, mental and social health. It

is also significant because the sample approximates the older adult population of the United States.

Limitations

Survey weights were not applied to the CFA estimation process. As a result, the CFA findings from this study are not generalizable to older adults in the United States. However, the information obtained is an important first step in understanding how the constructs function among this large sample of community-dwelling older adults. At a later date, this analysis can be repeated using another software program that allows for the application of survey weights.

Also, estimation procedures that adjust for non-normal data if missing data are present were not applied. When data are non-normal, standard errors can be biased, and likelihood ratio tests can be distorted as well as other fit indicators (Enders, 2010; Kline, 2011). It is reasonable to conclude that the fit indices will be more accurate with these adjustments. AMOS 23 works best with items that are continuous and the majority of items in the PHE factor were dichotomous.

Recommendations for Research

Future studies can build on these findings in several ways. This study should be replicated with software that allows for the application of survey weights to the confirmatory factor analytic process. This can help reduce the plausibility of alternative explanations. Given that the underlying measurement design of the NHATS dataset was random, theoretically, socioeconomic status can be removed as a threat to generalizability. Also, the PHE construct needs to be explored using principal components analysis to identify how many factors are represented. In this project, it was represented by one theoretical construct. However,

mathematically it may be modeled differently. Future analyses should be conducted with software that can adjust for the underlying distribution of the manifest variables.

Researchers should test for a moderation effect between PHE and PC on PWB. The ecological model of aging describes the dynamic interaction between PHE and PC. This interaction called the "docility hypothesis," suggests that differences may exist between levels of PC (Berrahou, 1993; Lawton & Simon, 1967). The results of the present study set the stage for an examination of the ecological model of aging and the docility hypothesis with a representative sample of older adults from the United States (Lawton & Nahemow,1973). With multiple years of NHATS data now available, studies can focus on both the strength and direction of such relationships and reveal information about how to better address the needs of older adults.

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Appendix

Table 1-B
Descriptive Statistics for Community-Dwelling Older Adults (N = 6,665)

Variable	Weighted Mean / %	99% CI	Range
Demographics			
Gender (Female)	57.3		
Age	75.0	74.7 - 75.2	65 - 105
Ethnicity			
White	82.4		
Black	8.0		
Hispanic	6.0		
Other	3.0		
Physical Home Environment			
Residence Type			
Free Standing	74.1		
Attached Home	7.7		
Mobile Home	5.1		
Multiunit	12.6		
Other	0.5		
More than One Floor	58.4		
Stairs at Entrance (yes)	75.5		
Ramp at Entrance (yes)	8.9		
Tenure			
Own	80.1		
Rent	12.7		
Other	7.2		
Years at Address	21.8	20.8 - 22.9	0 - 96
Housing Disrepair	1.8	1.8 - 1.9	0 - 14
Personal Competence			
Self-Report Health			
Excellent	15.1		
Very Good	30.5		
Good	31.0		
Fair	17.5		
Poor	5.9		
Self-Report Memory			
Excellent	13.1		
Very Good	34.3		
Good	35.1		
Fair	14.4		
Poor	3.1		
NHATS Dementia			
Not Impaired	85.3		
One Domain	10.7		
Two Domains	3.2		
Three Domains	0.8		
NHATS SPPB	7.0	6.8 - 7.1	0-12

Table 1-B (Continued)

Variable	Mean/%	99% CI	Range
Psychological Well-Being			
PHQ-2	5.1	5.0 - 5.2	2 - 8
GAD-2	5.1	5.1 - 5.2	2 - 8
Well-Being			
Affect	12.0	11.8 - 12.1	4 - 20
Self-Realization	7.2	7.1 - 7.2	3 - 12
Self-Efficacy	5.1	5.0 - 5.1	3 - 9

Table 2-B
Standardized CFA Factor Loadings for Items by Latent Construct

		Sample 1 (n= 3,330)		Sample 2 (n= 3,335)
	First Model Items	Estimated	Final Model	Final Model
	HDisTotal	.23	.23	.19
	Freestanding	---	---	---
	FAttached	.04	---	---
Physical	Mobile	-.03	---	---
Home	Multiunit	---	---	---
Environment	Other	---	---	---
	Months	---	---	---
	Floors	-.12	-.12	-.15
	Tenure	.26	.24	.20
	Stairs	.13	.13	.13
	Ramp	-.26	-.25	-.18
	Health	.67	.71	.74
Personal	SRMemory	.50	.49	.48
Competence	Domain65	-.35	---	---
	SPPB	.63	.59	.60
	DepTotal	.63	.58	.59
	AnxTotal	.60	.55	.54
Psychological	WBAffect	.77	.82	.81
Well-Being	WBSR	.63	.61	.62
	WBSE	.57	.53	.51

Table 3-B
Fit Indices for Model Refinement

Removed or Covaried	(df) / $\chi 2$ / p	RMSEA	CFI	TLI
Other Freestanding Multiunit Months	(101) 1312.27 $p < .001$	.060 (.057 - .063)	.84	.78
Mobile	(87) 1263.33 $p < .001$	.064 (.061 - .067)	.84	.78
Freestanding Attached	(74) 1239.93 $p < .001$	.069 (.065 - .072)	.85	.78
Covaried Error between Depression X Anxiety	(73) 912.19 $p < .001$	.059 (.055 - .062)	.89	.84
Covaried Error between WBSE X WBSR	(72) 730.06 $p < .001$	.052 (.049 - .056)	.91	.87
Domain 65	(60) 502.15 $p < .001$	.047 (.043 - .051)	.94	.91

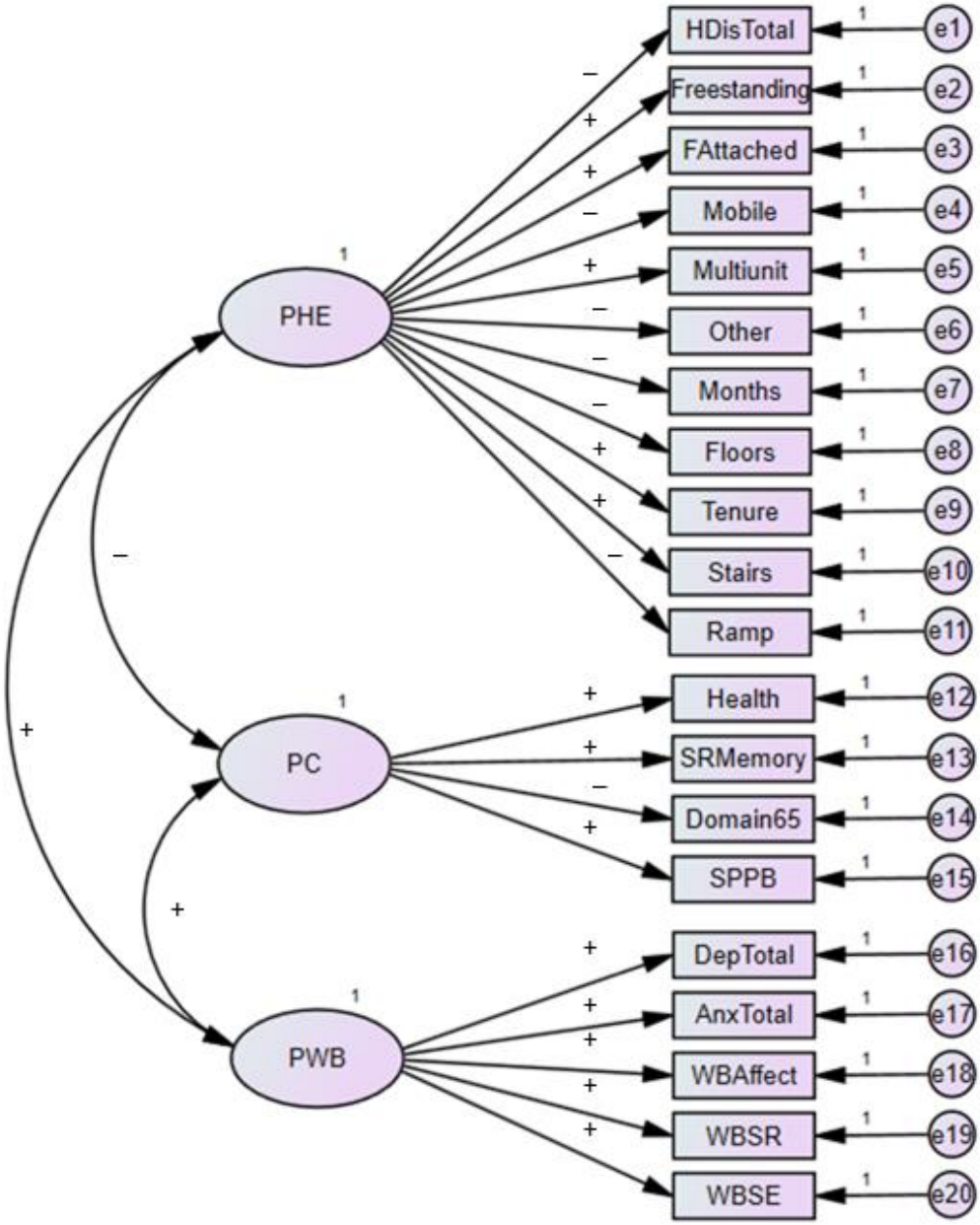

Figure 1-B. Proposed measurement model and predicted relationships.

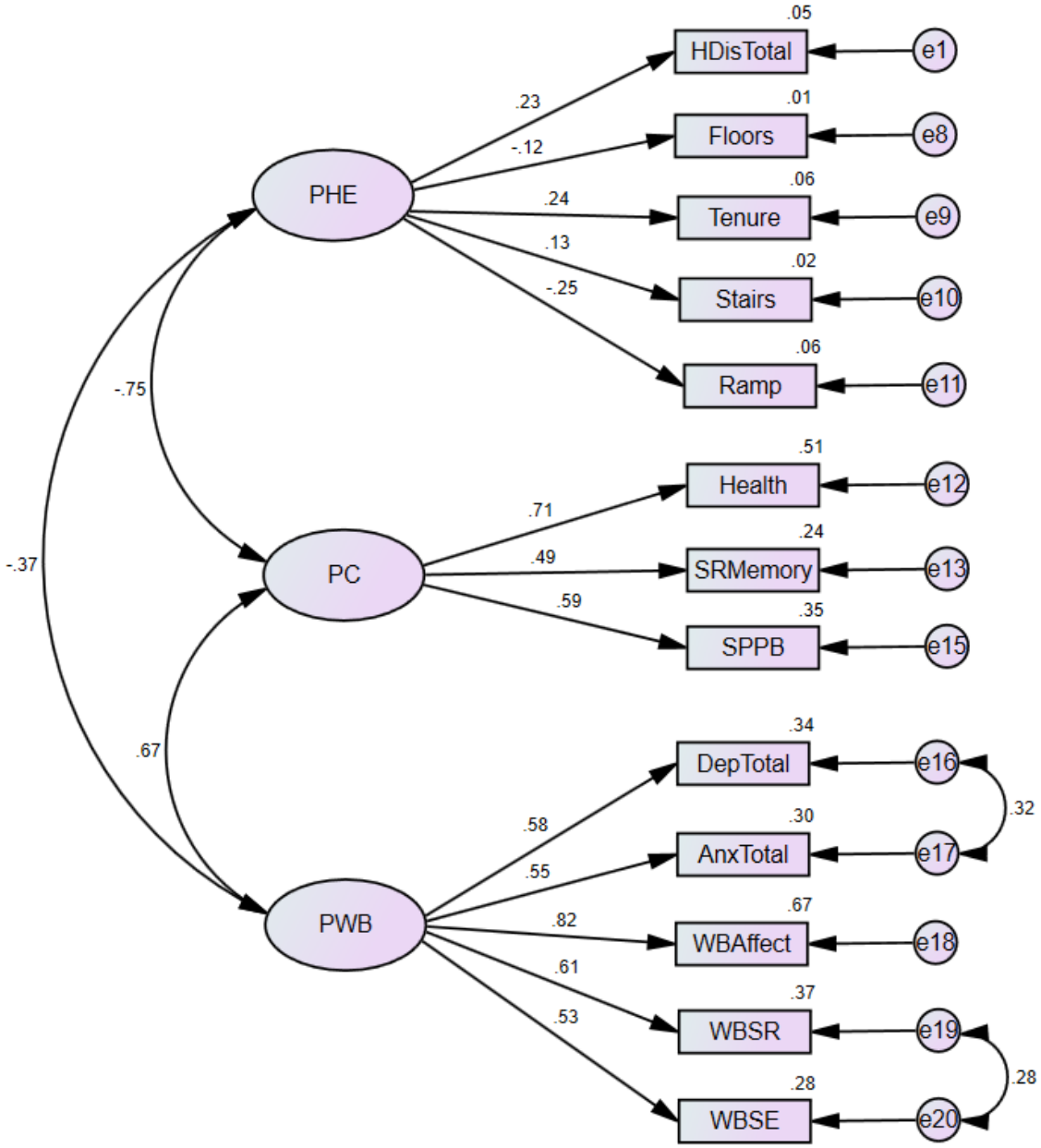

Figure 2-B. Refined measurement model with standardized covariances and regression weights.

Chapter III: Physical Home Environment, Personal Competence, and Psychological Well-Being among Community-Dwelling Older Adults: Testing a Structural Model

Abstract

Older adults in the United States often express a desire to age in their own homes. As people grow older, it is important to understand how their physical home environment and personal competence affect their psychological well-being. Using the ecological model of aging as a guiding framework, this study builds on an *a priori* measurement model and tests for a moderation of the relationship between physical home environment and psychological well-being, by personal competence. The sample (N=6,665) includes community-dwelling adults ages 65 and older from the National Health and Aging Trends Study round one data. Results support that the physical home environment does affect the psychological well-being of older adults. Also, that relationship is different depending on one's personal capacity. When older adults have better personal competence, the effect of the home environment on psychological well-being is not as strong. When they have lower personal competence, the home environment has a stronger effect on psychological well-being.

Keywords: Aging, physical home environment, competence, psychological well-being, ecological model of aging, social work

A number of national surveys report that older adults want to age in their own homes (AARP, 2005; Farber, Shinkle, Lynott, Fox-Grage, & Harrell, 2011). Also, they want to maintain as much independence as possible (Baker, Keall, Lyn, & Howden-Chapman, 2007; Bayer & Harper, 2000; Rantz et al., 2011). However, some studies suggest that a poor match between the home environment and a person's competence or functioning can have detrimental outcomes on well-being (Cornwell, 2014; Lee, Parrott, & Ahn, 2014). As people grow older, it is important to consider how their physical home environment and personal competence affect their psychological well-being. Gerontologists have long recognized that "home" contributes to well-being among older adults (Evans, Wells, & Moch, 2003; Gitlin, 2007). Also, a rich body of literature establishes the link between individual competence, including biological health and functioning, and psychological well-being (Cole & Dendukuri, 2007; Guralnik, Patel, & Ferrucci, 2012; Steptoe, Deaton, & Stone, 2015). However, little conclusive evidence exists for describing how competence and the home environment do so (Garin et al., 2014; Trecartin et al., in preparation a).

Competence, or functioning, has been found to be associated with indicators of psychological well-being in some studies (Iwarsson et al., 2007; Thomése & van Groenou, 2006). Functional impairment has acted as both a predictor and a consequence of psychological well-being among older adults (Penninx & Comijs, 2012). Depression and anxiety, two constructs whose absence often serve as indicators of psychological well-being, have been established as both risk factors for, and consequences of, functional impairment (Ayis, Gooberman-Hill, Bowling, & Ebrahim, 2006; Cole & Dendukuri, 2003; Stuck et al., 1999). Also, Ayis et al. (2006) found that poor psychological health predicted a catastrophic decline in mobility.

The physical home environment has been found to have both direct and indirect effects on mental health among various populations (Evans et al., 2003). Evans, et al. (2003) reviewed the literature on housing and mental health and found that housing type, floor level of dwelling, housing quality, and overall quality of the housing environment were correlated with psychological well-being indicators. Clark, Rowan, Stansfeld, and Candy (2007) evaluated the strength of evidence of studies linking the built environment, including both neighborhood and housing indicators, to mental health outcomes. Their findings suggested that relationships between the built environment and psychological well-being have been poorly established due to methodological challenges such as low response rates, cross-sectional designs, and lack of standardized and validated measurement of variables.

Competence, as measured by functioning, has been linked to the physical home environment in previous reviews (Garin et al., 2014; Wahl, Schilling, Oswald, & Iwarsson, 2009). In their systematic review, Wahl et al. (2009) found evidence for causal relationships between home modifications and improvements in functional ability in 80% of the randomized control studies reviewed (8 of 10). Similarly, Iwarsson (2005) found that activities of daily living (ADLs) and instrumental activities of daily living (IADLs) were strongly associated with general housing environment in a six year follow up. Various indicators of the PHE such as environmental barriers, accessibility problems, housing type, and home density have been associated with specific health diagnoses known to include functional limitations as side-effects (Garin et al., 2014). Frumkin (2005) found that disparities in physical living conditions often reflect an older adult's functional health.

Despite the effect of the physical home environment on functioning and psychological well-being, most older adults want to remain at home (Bayer & Harper, 2000; Rantz et al.,

2011). However, older adults have increased risk for chronic illnesses such as heart disease, cancer, lower respiratory diseases, stroke, Alzheimer's disease and diabetes (Centers for Disease Control and Prevention, 2013). Consequences of these illnesses can include physical and cognitive limitations, mobility impairment, and impaired ability to perform instrumental and personal care activities of daily living (Leon & Lair, 1990; Centers for Disease Control and Prevention, 2013; Shumway-Cook, Ciol, Yorkston, Hoffman, & Chan, 2005).

Ecological Model of Aging

The ecological model of aging (EMA) offers a useful theory about how physical home environment, personal competence, and psychological well-being relate to each other. The EMA proposes that affective and behavioral responses are a result of relationships that occur with and between features of the environment and personal competence (Berrahou, 1993; Lawton & Nahemow, 1973). When either the environment or personal competence begin to exert demands on an individual, adaptive behaviors, and affective responses occur (Berrahou, 1993). The environment according to Lawton and Nahemow (1973), consists of objective and measurable components that are outside of the individual and create demands for performance. While the environment can be considered multidimensional, the present study focused exclusively on the physical environment. Competence is understood as individual capacity including biological health, sensation and perception, motor ability, cognition, and ego strength (Lawton, 1982). In the present study, psychological well-being was considered to be a broad construct that encompasses a range of positive moods and emotions and an appraisal of life satisfaction and purpose (Chan, Phillips, Cheng, Chi, & Ho, 2004; Phillips, Cheng, Yeh, & Siu, 2010; Ryff et al., 2006).

Ideally, competence captures an individual's capacity or functioning in such a way that environment is controlled for (Lawton & Nahemow, 1973). When the environment demands action or puts pressure on an older adult, a person uses competencies to meet those demands. When the demand is too much, behavioral and affective responses occur. Similarly, when a person's capacity changes and places increased demands on an older adult, the environment can be the target of change.

The docility hypothesis, part of the ecological model of aging, goes on to theorize that the less competence exerted by an older adult, the more behavior and affective responses can be attributed to the environment (Lawton & Simon, 1967). This theory suggests that there is an interactive dynamic between individual competence and the environment (Berrahou, 1993). Morgan et al. (1984) postulated that people with lower competence would have less ability to adapt to the increasing demands of the environment. Knipscheer, van Groenou, Leene, Beekman, and Deeg (2000) found support for this hypothesis among older adults with varying degrees of competence. Depending on functional competence, the subjective environment affected older adults' symptoms of depression differently. Similarly, Thomése and van Groenou (2006) found that when disability status worsened, adding home modifications, an objective measure of the environment, had a greater effect on depression compared to not adding home modifications.

Multiple regression models are often used in analyses of these relationships (Howden-Chapman, Chandola, Stafford, & Marmot, 2011; Migita, Yanagi, & Tomura, 2005; Oswald, Wahl, Mollenkopf, & Schilling, 2003; Thomése & van Groenou, 2006). Structural equation modeling (SEM) is an alternative method that can be useful when independent variables are highly correlated, and multiple dependent variables are present. The advantage of SEM over multiple linear regression is that it allows for the fitting of multiple predictor variables

simultaneously and accounts for the shared underlying variance of a unifying construct (Kline, 2011). The three prominent features in the ecological model of aging, environment, personal competence, and behavior/affect, lend themselves to this type of analysis.

Tests of moderation between factors are possible. Several methods for testing moderation using SEM have been proposed. Computing the product of multiple manifest variables between a predictor latent construct and a moderator latent construct (Jöreskog & Yang, 1996; Kenny & Judd, 1984; Ping, 1996) and the product of one manifest variable between a proposed latent predictor and a proposed latent moderator (Jaccard & Wan, 1996) are two general approaches for the creation of interactions to be used in SEM models. Factors scores have also been used to represent latent constructs and compute interaction terms to be examined in structural models (Yang Jonsson, 1998). In addition, several methods for addressing data nuances like multicollinearity and non-multivariate normality have been proposed. These include mean-centering manifest variables to reduce multicollinearity between the product term and the predictor and moderator (Cohen, 1978; Jaccard & Wan, 1995; Ping, 1996) and centering manifest variables on residuals to ensure independence between the interaction and main effects and reduce constraints placed on estimated parameters (Lance, 1988; Little, Boviard, & Widaman, 2006). The two-stage least squares technique proposed by Bollen and Paxton (1998) specifically handles non-normal data and is available for many common statistical analysis packages. The latent moderated structural equations method is an efficient method for estimating interactions requiring the use of only one additional parameter (Klein & Moosbrugger, 2000; Maslowsky, Jager, & Hemken, 2014). This approach is only available with the Mplus software (Muthén & Muthén, 2015).

No studies were identified that examined the effect of the PHE and PC on the PWB of older adults or tested for a moderating effect by PC on the relationship between PHE and PWB using a nationally representative sample of U.S. residents ages 65 and older. These studies are now possible using the National Health and Aging Trends Study (NHATS). This nationally representative longitudinal study includes information about Medicare enrollees and contains both community-dwelling and institutionalized older adults ages 65 and older (NHATS, 2015).

The purpose of the present study was to address these gaps in the literature. This study tested an *a priori* structural model with a sample of older adults from the United States using an underlying measurement model that had been previously validated with the same sample (Trecartin et al., in preparation b). The proposed structural model specifically examined the docility hypothesis by testing for an interaction between the PC and PHE on PWB.

Methods

The Institutional Review Board at the University of Tennessee, Knoxville approved this study. This paper built on the results of a previous research study that tested and refined a measurement model including the three major constructs contained in the ecological model of aging. Trecartin et al. (in preparation b) developed a reasonably well fitting model to capture the underlying measurement of these constructs using the 2011 National Health and Aging Trends Study. The present study applied the results of the analysis as the underlying measurement component of an *a priori* structural model. The model and predicted relationships between the latent constructs are presented in Figure 1-C. The following relationships were predicted:

1) A negative relationship between PHE and PWB when controlling for the effect of PC on PWB.
2) A positive relationship between PC and PWB when controlling for the effect of PHE on PWB.
3) The relationship between PHE and PWB would be moderated by PC.

A negative relationship between PHE and PWB was expected such that as PHE became more demanding, PWB would be lower. We expected the relationship between PC and PWB to be positive where higher PC would be associated with better PWB scores. Finally, we expected the relationship between PHE and PWB to be moderated by PC based on previous findings that suggest that the PWB of people who were lower in personal competence were affected differently by the PHE when compared to those who are higher in personal competence (Knipscheer et al., 2000; Thomése & van Groenou, 2006). This hypothesis was consistent with Lawton and Simon's (1967) docility premise that suggested that behaviors and affect would be more influenced by the environment when a person had lower competence than higher.

Subjects

The National Health and Aging Trends Study (NHATS) Round one data was collected in 2011 from the Medicare Recipient Data File. This sampling frame comprised 96% of older adults ages 65 and older in the contiguous United States (Montaquila, Freedman, Edwards, & Kasper, 2012). Multi-stage stratified random sampling was used, and persons aged 90 and older and African Americans were oversampled to ensure adequate representation. The response rate was 71% (N = 8,245). The present study included community-dwelling older adults ages 65 and older who were able to participate in the survey themselves. The final sample size was 6,665.

Sample analytic weights were applied in the analysis of descriptive data to adjust for the sampling design of the NHATS study.

Data Analysis Plan

STATA 14.0 statistical software was used for descriptive analyses and applying analytic weights in the description of measures of central tendency and construction of confidence intervals (StataCorp., 2015). AMOS 23 was used to conduct the structural equation model (SEM) analysis and impute factor scores (Arbuckle, 2006). SPSS 23 was used to compute a cross-product term between PHE and PC for use in the analysis (IBM Corp., 2015).

Data preparation. The dataset was provided by the NHATS data managers at the Johns Hopkins School of Public Health and Westat (NHATS, 2015). An analysis of missing values and normality revealed that missing values ranged from 0 to 12.6% and that the data were not multivariate normal. Maximum Likelihood Estimation (MLE) algorithm available with AMOS 23 was used to address the missing values. MLE is superior to mean substitution, listwise deletion, and pairwise deletion when data are not missing completely at random (MCAR) (Enders, 2010). It was determined that data were not MCAR, but instead, missing at random (MAR). Based on Enders' (2010) definition, data are MAR if the probability that data are missing on a variable is related to some other variable in the model, but not to the values of the variable itself. MLE has been found to generate unbiased estimates under the MAR assumption (Enders, 2010). The violation of the multivariate normality assumption can result in biased standard errors and distorted likelihood ratio tests as well as other fits indicators (Enders, 2010; Kline, 2011).

To test the moderation hypothesis, factor scores were imputed from the previously established measurement model (Yang Jonsson, 1998), using regression imputation available in

AMOS 23. To reduce multicollinearity between the predictor and moderator, these scores were centered on the mean (Marquardt, 1980). The product between the mean-centered PHE and PC factor scores was calculated using SPSS 23 and inserted into the structural model as PHExPC (Yang Jonsson, 1998).

Analytic approach. Structural equation modeling (SEM), a factor analytic method combined with path analysis, was used to evaluate the hypothesized structural model and to test the hypothesized structural relationships (Figure 1-C). Factor analysis is based on the common factor model which assumes that the variance of observed items is subsumed by a smaller number of common factors (common variance) (Lattin, Carroll, & Green, 2003). SEM is a procedure that combines factor analysis (including exploratory and confirmatory factor analysis) and path analysis by first establishing a measurement model that depicts the underlying factor structure and then fitting a structural model onto the measurement model (Byrne, 2013). Structural equation modeling offers a few advantages over multiple regression analysis. One of the assumptions of multiple regression analysis is that variables are measured without error. It is difficult to meet this assumption. SEM allows for error to be parceled out in the measurement model. The result is that the beta coefficients (structural lines indicating relationships between constructs) are more accurate estimates of relationships (Keith, 2006). Also, multiple variables can be used to account for more variance within constructs (Kline, 2011).

Fit indices were reviewed to assess model fit. These included the Likelihood Ratio Test ($\chi 2$) the Comparative Fit Index (CFI), the Tucker-Lewis Index (TLI), the Root Mean Square Error Approximation (RMSEA), and PCLOSE. Statistically significant $\chi 2$ values provide evidence for poor model fit (Bollen, 2014). Sample size has been found to inflate this statistic resulting in small probability values (Jöreskog & Sörbom, 1993). CFI and TLI values above .90

and .95 have been suggested as evidence for reasonable to good fit (Cheung & Rensvold, 2002; Hu & Bentler, 1999). RMSEA values close to .05 have been suggested to indicate good fit (Browne & Cudeck, 1993). PCLOSE tests the null hypothesis that RMSEA equals .05 and probability values greater than .05 suggest that it does not (Byrne, 2013).

To test whether the paths between PC to PWB and PHE to PWB were significant, each path was allowed to be freely estimated while controlling for the effect of the opposite path on PWB. Probability values associated with the structural paths were examined (Table 2-C). Probability values of .05 were considered to be statistically significant. Next, the proposed model containing the interaction term was compared to the fit of a model without the interaction term. The $\chi 2$ difference was calculated by finding the difference in $\chi 2$ values and degrees of freedom between models and calculating the resulting probability value.

Data Collection

This secondary analysis of the 2011 NHATS data used multiple indicators of PHE, PC, and PWB (Table 1-C). Age, gender, race/ethnicity, and length of time living at current residence were summarized and analyzed after adjusting for sampling weights.

Latent constructs and manifest variables. The Physical Home Environment (PHE) is conceptualized as "…the physical characteristics of a person's immediate home, that are original features or modifications that have been added to the home, and that exert or reduce demands on an individual," (Trecartin et al., in preparation b). The ambient environment, such as lighting and environmental pollutants, and durable medical equipment, such as wheelchairs and walking aids were not included in this definition. The measurement model included five items from the NHATS dataset that were found to load significantly onto PHE including Housing Disrepair, Floors, Stairs at Entrance, Ramp at Entrance, and Tenure (ownership) (Trecartin et al., in

preparation b). The Housing Disrepair instrument captured the presence of negative home environment features such as peeling paint, tripping hazards, and broken or uneven flooring. These items were summed to create a composite total number of disrepair items in order to reduce model complexity. The Cronbach's alpha was .80 for the sample indicating good internal consistency. The path coefficient between Ramp and PHE was constrained to be equal to 1.0 setting the scale of PHE to be consistent with that of Ramp (Kline, 2011). Ramp was chosen as it had the highest factor loading among the manifest variables. PHE was understood as increasing environmental demands given that higher scores on Ramp signaled increased environmental demand.

Personal Competency (PC), as defined by Lawton (1982), captures an individual's capacity when the environment is constrained. Capacity can be represented by measures of biological health, sensation and perception, motor skills, cognition, and ego strength. The items included in the previously established measurement model represented the cognitive, motor, and biological dimensions of personal competency. These included Self-Reported Overall Health in the last month, Self-Rated Memory in the last month, and the NHATS Short Physical Performance Battery (SPPB). The NHATS Short Physical Performance Battery (SPPB) was a composite measure of physical capacity. Scores ranged from 0 (lowest) to 12 (highest). The distribution of this variable appeared to be approaching normal with a skew of 0.0 and kurtosis of 0.0. The mean score was 7.0 (*SE* = .06). The path coefficient between SPPB and PC was constrained to 1.0 setting the distribution of the PC to be similar to that of SPPB. This manifest variable was chosen because it had the highest factor loading with PC. PC was then interpreted like SPPB where higher factor scores meant higher PC.

Psychological Well-Being (PWB) was conceptualized as a range of positive moods and emotions as well as life satisfaction and purpose. PWB was measured with five items that had been previously identified to load onto PWB in the CFA analysis with the NHATS dataset. These included the Patient Health Questionnaire (PHQ-2) labeled DepTotal, which captured symptoms of depression, and the Generalized Anxiety Disorder scale (GAD-2) labeled AnxTotal, which captured symptoms of anxiety. For this sample, alphas were .68 for the DepTotal, .66 for the AnxTotal. These variables were reversed scored so that lower scores were interpreted as having poorer mental health. Three subscales of a well-being instrument designed for the NHATS study were also included. The NHATS well-being assessment was comprised of: 1) Positive Affect (range 4 - 20), Self-Realization (range 3 - 12), and Self-Efficacy (range 3 - 9). The whole scale used a Likert approach asking respondents to rate a particular indicator based on the previous month of experience. These scales were reverse scored so that higher scores indicated better PWB. Cronbach's alpha for the entire scale was .75 for this sample, .70 for Positive Affect, .54 for Self-Realization, and .29 for Self-Efficacy. The path coefficient between DepTotal and PWB was constrained to 1.0 and served as the scale reference variable for PWB. This item was chosen because it loaded highest onto PWB, among the other manifest variables. PWB was interpreted as higher factors scores representing better psychological well-being.

Results

Descriptive Statistics

Table 2-C shows the characteristics of demographic and model variables for the sample of community-dwelling older adults. Sample analytic weights were applied. The majority of respondents were female (57%), and the average age was 75 years old (*SE* = .10). Most self-identified as "white" (82.4%) followed by "Black" (8%) and "Hispanic" (6%). Among these older adults, most lived in homes with multiple floors, had stairs at the entrance of their homes,

and did not have ramps at the entrance of their homes. A majority owned their home (80.1%) and 12.7% rented. The average number of housing disrepair problems was 1.8 (*SE* = .04). Most of these respondents reported their health to be "good" or "very good" (45.6%). Similarly, most reported their memory to be "good" or "very good" (47.4%). The average NHATS SPPB score was 7 (*SE* = .06). Average scores on variables used to measure psychological well-being suggest that the older adults in this sample scored on the lower end of depression (M = 5.1, *SE* = .02) and anxiety (*M* = 5.1, *SE* = .02). Mean scores for Affect (*M* = 12.0, *SE* = .05), Self-Realization (*M* = 7.2, *SE* = .03), and Self-Efficacy (*M* = 5.1, *SE* = .02) fell into the mid to upper range for each distribution.

Structural Model and Hypotheses Testing

The hypothesized structural model and paths between constructs were estimated and examined (Figure 1-C). The *a priori* measurement model that had been previously refined and validated served as the underlying measurement component of the structural model. Fit statistics from previous findings provided evidence that the measurement model was fitting reasonably well, $\chi 2$ (120) = 911.17, $p < .001$, RMSEA = .031 (90% CI = .030 - .033), PCLOSE = 1.0, CFI = .94, and TLI = .91 (Trecartin et al., in preparation b). Next, the individual hypothesized paths and directions between constructs were examined, without the interaction present. Controlling for the effect of PC on PWB, the path between PHE and PWB was negative and statistically significant, β = -.38, $p = .05$. Controlling for the effect of PHE on PWB, the path between PC and PWB was positive and statistically significant, β = .97, $p < .01$.

The *a priori* structural model including the interaction term was estimated next, followed by an estimation of the model where the path between PHExPC to PWB was constrained to equal 0 as well as the covariances between PHExPC and the other latent constructs. Results

suggest that the model fit the data reasonably well, $\chi 2$ (70) = 1048.81, p < .001, RMSEA = .046 (90% CI = .043 - .048), PCLOSE = .997, CFI = .94, and TLI = .92. The path between PHExPC and PWB was statistically significant, β = .51, p = .03, as was the path between PC and PWB, β = 1.37, p = .01. However, PHE to PWB was not statistically significant, β = -.95 p = .17. The model was subsequently estimated with the interaction and covariances between associated latent constructs constrained to equal 0. Results suggested that the model deteriorated, Δdf = 3, $\Delta \chi 2$ = 718.62, p < .001, CFI = .89, RMSEA = .059 (90% CI = .057 - .061), TLI = .862. Table 3-C summarizes the results of these tests.

The interaction between PC and PHE on PWB is presented in Figure 2-C. An ordinal interaction was observed. At lower levels of PC, the PHE has a greater effect on PWB such that persons who have low competence and more demanding physical home environment have lower psychological well-being scores compared those who have low competence but less demanding environments. For those who have higher personal competence, the effect of physical home environment is not as strong on psychological well-being.

Discussion

This study sought to examine the nature of the relationships between PHE, PC, and PWB among a sample of older adults from the U.S. Specifically, a moderation of personal competence on the relationship between the physical home environment and psychological well-being was examined. Findings suggested that when an older adult had higher competence, such as better motor skills, biological health, and memory, the home environment did not have as strong of an effect on psychological well-being. But when competence was lower, the effect of the home environment was stronger on psychological well-being. Interestingly, for older adults who were higher in personal competence, their psychological well-being scores were higher than those who

were lower in competence, regardless of the demands of the home environment. The results of this study suggested that personal competence and physical home environment did interact. Also, there was a main effect for both personal competence and home environment on psychological well-being. Though the physical home environment did significantly contribute to psychological well-being, personal competence was more important to psychological wellbeing. But at lower levels of competence, the physical home environment was more important than at higher levels.

This study also provided evidence in support of the ecological model of aging and specifically the docility hypothesis. When a person is experiencing challenges in functioning, biological health, motor skills, or memory, more of their psychological well-being can be attributed to the physical home environment than if they are not experiencing those competency challenges. In the present study, the physical home environment was conceptualized as features of the home that exert or decrease demands. These included the presence of stairs, housing disrepair, home ownership versus renting or other, the presence of a ramp, or living on one floor or more. Findings among our sample suggested that home environments with fewer demands were associated with better psychological well-being.

The physical home environment is a promising area of intervention for older adults, specifically when they have decreased competence. When homes are supportive, they can potentially offset the effect of poor health, functioning, and memory on psychological well-being. These are promising results for seniors.

Limitations

The proposed study is not generalizable beyond the sample of community-dwelling older adults. Also, individuals who used proxy respondents were dropped as were people who did not answer the housing disrepair interview. Since sample weights are not applied to the SEM

analysis, the results of these analyses are not generalizable to the population of Medicare recipients in the United States, though the demographic information is. Given that the data are not multivariate normal and because of the large sample size, it is likely that small deviations resulted in statistically significant differences between the hypothesized model and the actual data (independence model) (Byrne, 2013). This complicates the interpretation of parameter estimates. This study was a cross-sectional design, so alternative plausible explanations cannot be ruled out, and causal inferences should not be made. Results can contribute to the body of evidence that supports the ecological model of aging, but experimental and longitudinal designs are necessary to rule out confounding variables. Also, the underlying measurement model was established using single item indicators that were mostly binary and ordinal to indicate the factors. SEM with AMOS works best with continuous data (Bryne, 2013).

Recommendations for Research

Future research should replicate the present study using software that allows for the application of design weights so that the results can be generalized beyond the sample. Also, it will be important to replicate this study with software that accounts for the non-continuous nature of the manifest variables. In addition, methods for computing interaction terms that account for non-normal data are available in other software packages and should be explored.

Given the longitudinal nature of the NHATS data, this study can be expanded to look at changes over time. It will be possible to examine whether changes to the home, or changes to competence, contribute to psychological well-being among the same respondents.

Recommendations for Practice

This study adds to the field of gerontological social work and environmental gerontology by providing evidence for a moderation by personal competence on the relationship between the

physical home environment and psychological well-being. This is the first study to do so using a sample of older adults from a national U.S. sample. These results can be used to further our understanding of potential intervention points in the ecological model of aging and provide evidence for the need for supportive housing to policy makers and granting agencies.

Older adults continue to prefer to age at home. Social workers and gerontologists who work with this population can recognize the added benefit of a supportive home environment to psychological well-being when assisting their clients as they age in place. Physical home environments that have supportive features and fewer demanding features may significantly improve the lives of older adults in the U.S. Social workers should recognize demanding physical home environments and identify resources for home modifications and funding to meet the needs of their clients. Finally, it is essential that social workers engage in policy advocacy that enhances funding for housing modification and adaptation.

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Appendix

Table 1-C

Summary of Latent Constructs and their Respective Indicator Items and Codes

Latent Constructs	Items	Codes
Physical Home Environment	Ramp (Scaling Item)	Yes = 1 or No= 2
	Floors	1 = 1 or More = 2
	Tenure	Own = 1 or Rent/Other = 2
	Stairs	Yes = 1 or No = 2
	Housing Disrepair	0 to 14 (higher is worse)
Personal Competence	NHATS Short Physical Performance Battery (Scaling Item)	0 to 12 (higher is better)
	Self-Rated Health	0 to 5 (higher is better)
	Self-Rated Memory	0 to 5 (higher is better)
Psychological Well-Being	PHQ-2 Depression Scale (Scaling Item)	2 to 8 (higher is better)
	GAD-2 Anxiety Scale	2 to 8 (higher is better)
	Well-Being Affect	4 to 20 (higher is better)
	Well-Being Self-Realization	3 to 12 (higher is better)
	Well-Being Self-Efficacy	3 to 9 (higher is better

Table 2-C
Descriptive Statistics of Demographic and Model Variables

Variable	Mean/%	99% CI	Range
Demographics			
Gender (Female)	57.3		
Age	75.0	74.7 - 75.2	65 -105
Ethnicity			
White	82.4		
Black	8.0		
Hispanic	6.0		
Other	3.0		
Physical Home Environment			
More than One Floor	58.4		
Stairs at Entrance (yes)	75.5		
Ramp at Entrance (yes)	8.9		
Tenure			
Own	80.1		
Rent	12.7		
Other	7.2		
Housing Disrepair	1.8	1.8 - 1.9	0 - 14
Personal Competence			
Self-Report Health			
Excellent	15.1		
Very Good	30.5		
Good	31.0		
Fair	17.5		
Poor	5.9		
Self-Report Memory			
Excellent	13.1		
Very Good	34.3		
Good	35.1		
Fair	14.4		
Poor	3.1		
NHATS SPPB	7.0	6.8 - 7.1	0 - 12
Psychological Well-Being			
PHQ-2	5.1	5.0 - 5.2	2 - 8
GAD-2	5.1	5.1 - 5.2	2 - 8
Well-Being			
Affect	12.0	11.8 - 12.1	4 - 20
Self-Realization	7.2	7.1 - 7.2	3 - 12
Self-Efficacy	5.1	5.0 - 5.1	3 - 9

Table 3-C
Results of Structural Test of Moderation

Model	Standardized Coefficient	df/ χ2/ *p*	Δdf/ Δχ2/ *p*	RMSEA (CI)	CFI	TLI
PHExPC→PWB PC→PWB PHE→PWB	.51* 1.37** -.95	(70) 1048.81, $p < .001$	Comparison Model	.046 (.043 - .048)	.94	.92
PC→PWB PHE→PWB	.97** -.38*	(73) 1767.43, $p < .001$	(3) 718.62, $p < .001$	.059 (.057 - .061)	.89	.86

*Path coefficient is significant at $p < .05$.
**Path coefficient is significant at $p < .01$.

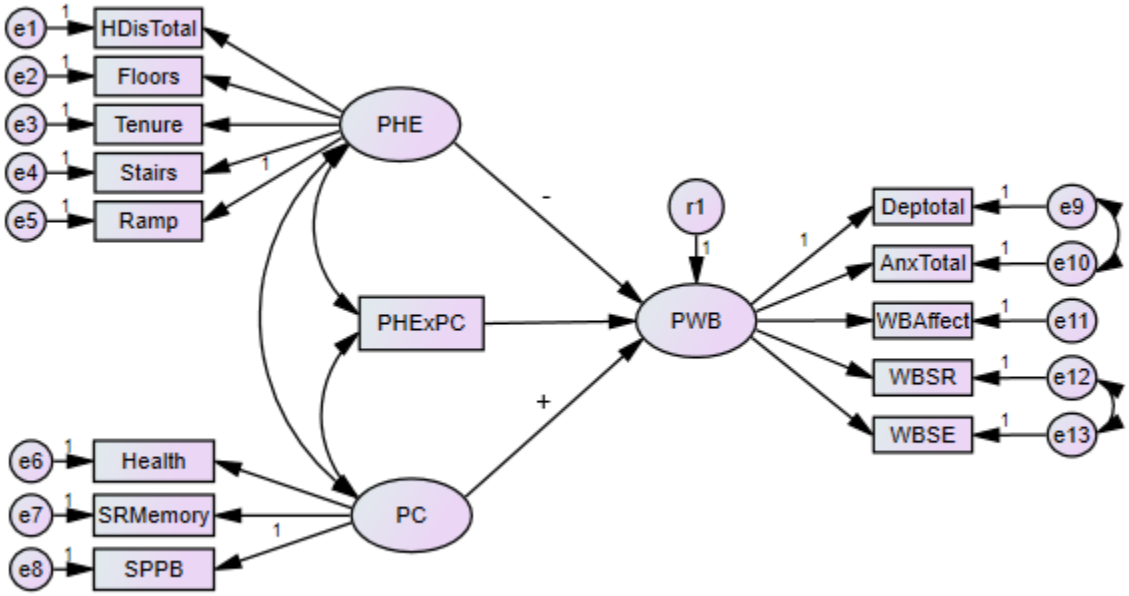

Figure 1-C. Hypothesized structural equation model.

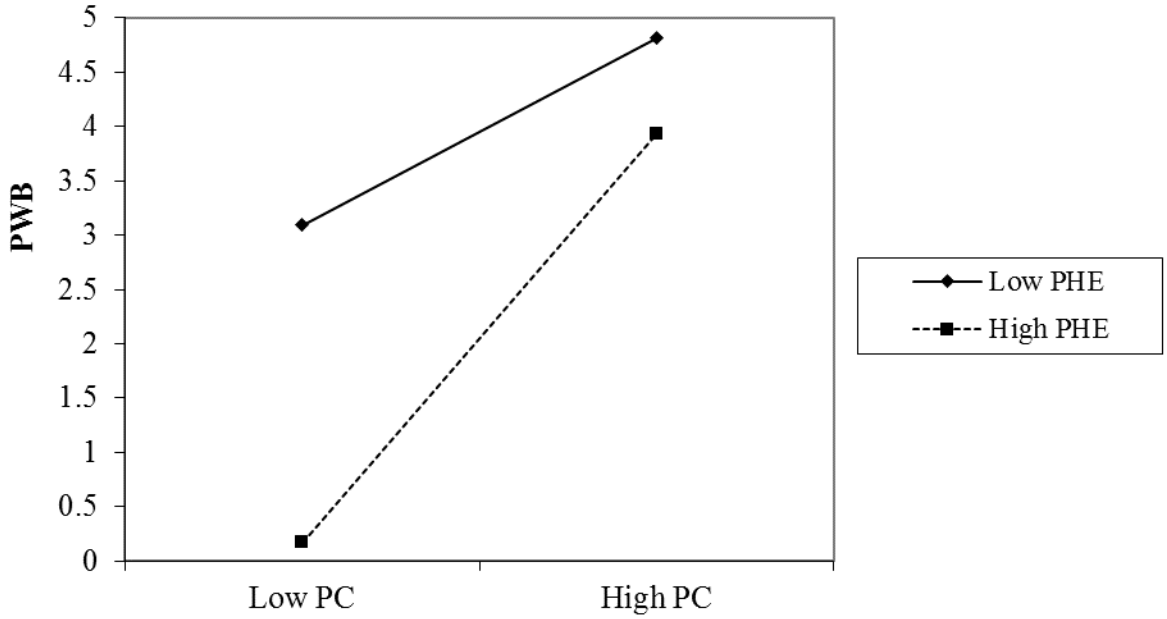

Figure 2-C. Plot of the ordinal interaction between PHE and PC using standardized coefficients. PHE has more of an effect on PWB at lower levels of PC than at higher levels of PC.

Conclusion

This dissertation addressed the relationships between the physical home environment (PHE), personal competence (functional impairment) (PC), and psychological well-being (PWB) in three parts. First, a systematic critical literature review was completed to identify the current state of knowledge regarding older adults. Three specific research questions were addressed. What dimensions of the PHE have been explored in empirical studies conducted with older adults? Has the role of functional impairment been considered within these studies? What was the quality of evidence for a relationship between the PHE and PWB among older adults?

Of the 15 studies identified for the review, 81% were conducted with samples outside of the United States. It was evident from the review that no standard method of measuring the physical home environment had emerged, and neither had a consistent terminology or set of indicators. The PHE has been measured with various objective, subjective, and composite variables. Little overlap in measurement was found.

Objective measures of the PHE in these studies fit into the following domains: 1) physical presence of features, 2) physical and evaluative dimensions of features, 3) time-related features including duration and change of features over time, and 4) housing tenure. Presence or absence of potential environmental barriers, housing amenities, stairs, home adjustments, and external conditions of the home were measured (Iwarsson, Horstmann, & Slaug, 2007; Knipscheer, van Groenou, Leene, Beekman, & Deeg, 2000; Oswald, Jopp, Rott, & Wahl, 2011; Oswald et al., 2007; Oswald, Wahl, Mollenkopf, & Schilling, 2003). Subjective measures of the PHE were evaluated using different indicators. Housing satisfaction, usability, meaning, control, quality, subjective efficacy, related financial problems, attachment to home, comfort, housing dissatisfaction, and housing inadequacy were included as predictors of psychological well-being

(Howden-Chapman, Chandola, Stafford, & Marmot, 2011; Iwarsson et al., 2007; Knipscheer et al., 2000; Migita, Yanagi, & Tomura, 2005; Oswald et al., 2003; Oswald et al., 2007; Oswald et al., 2011; Tomaszewski, 2013). Four studies used composite indicators of the physical environment that were both objective and subjective and could be characterized as estimating the fit between the person and the environment (Iwarsson et al., 2007; Oswald et al., 2007; Wahl et al., 2009; Werngren-Elgströmet al., 2009).

Functional impairment was included either as a control, correlate, predictor or outcome variable in 12 of the 15 studies reviewed. Several research studies included indicators of functional impairment as controls in analyses to partial out the influence on psychological well-being (Cheng, Wang, Tang, Chu, & Chen, 2014; Evans, Lercher, & Kofler, 2002; Knipscheer et al., 2000; Oswald et al., 2003; Oswald et al., 2011). A few studies only examined functional impairment as an associational variable to indicators of psychological well-being (Migita et al., 2005; Werngren-Elgström et al., 2009).

The ecological model of aging served as a conceptual guide for ten of the studies where functioning was positioned as an indicator for PC (Cheng et al., 2014; Iwarsson et al., 2007; Knipscheer et al., 2000; Oswald et al., 2003; Oswald et al., 2007; Oswald et al., 2011; Thomése & van Groenou, 2006; Tomaszewski 2013; Wahl et al., 2009; Werngren-Elgström et al., 2009). Seven of the studies directly tested some aspect of the ecological model of aging and sought to determine how the environment and competence relate to each other and to PWB (Iwarsson et al., 2007; Knipscheer et al., 2000; Oswald et al., 2007; Oswald et al., 2011; Thomése & van Groenou, 2006; Wahl et al., 2009; Werngren-Elgström et al., 2009).

Among the studies reviewed, research findings demonstrated that several features of the PHE were related to, and predicted, psychological well-being among older adults. However, little

conclusive evidence was found. While some studies established a correlation (Brown et al., 2009; Brown et al., 2008; Evans et al., 2002; Iwarsson et al., 2007; Knipscheer et al., 2000; Migita et al., 2005; Oswald et al., 2003; Oswald et al., 2007; Oswald et al., 2011), longitudinal studies served to provide minimal evidence for a causal relationship due to temporal ordering (Howden-Chapman et al., 2011; Ng, Broekan, Niti, Gwee, & Kua, 2009; Thomése & van Groenou, 2006, Tomaszewski, 2013; Wahl et al., 2009; Werngren-Elgström et al., 2009). However, alternative explanations cannot be ruled out.

The results of the systematic review were used as a conceptual guide for the second paper. The second paper began to fill in the research gaps identified. Specifically, this study was the first to use a representative sample of older adults from the United States to explore the relationships between these constructs. A measurement model was constructed and refined using the National Health and Aging Trends Study round one respondent data (NHATS, 2015). The data were randomly split into two halves to cross-validate the final model. The results of the confirmatory factor analysis supported that the *a priori* measurement model did not fit the data of the 1st half well. After refining the model and obtaining reasonably well fitting fit statistics, the model was cross-validated with the second half of the data. The results suggested that this model provided parallel measurement across samples.

All of the housing type variables (Freestanding, Freestanding Attached, Mobile, Multiunit, and Other) failed to load onto PHE. Also, months at address did not load onto the latent construct. The remaining manifest indicators were Housing Disrepair Total, Number of Floors, Tenure, Stairs at Entrance, and Ramp at Entrance. These variables loaded weakly onto PHE. Overall Health, Self-Rated Memory, and the NHATS Short Term Physical Performance Battery (SPPB) significantly and moderately loaded onto PC. PWB was represented well with all

five of the original manifest variables that were hypothesized. These loaded moderately to strongly onto PWB.

Several possible explanations were posited to explain the weak loadings of the PHE construct. First, though the indicator variables loaded significantly onto the latent construct, the highest factor loading was .25 for the final model. The low loadings can partially be explained as a result of the correlations obtained between dichotomously scored manifest variables and the continuous latent construct. Biserial and point biserial correlations yield lower estimates as the distribution between binary categories departs from 50%. Dichotomizing variables can result in an intense range restriction which attenuates correlation values (Cohen, 1983).

Also, PHE may not have been a single factor, but multiple factors, helping to explain why the items were loading so weakly. For example, this study did not control for or model socioeconomic status or wealth. Two of the items used to represent PHE, Tenure and Housing Disrepair, may be capturing an element of SES rather than PHE.

It is also possible that the constructs PHE and PC were part of a second order factor that better explained their shared variance. Not only did the high correlation between constructs provide evidence of this, but previous authors have also elected to combine PHE and PC into a measure of the magnitude of accessibility problems (Iwarsson et al., 2007; Oswald et al., 2007; Wahl et al., 2009). These studies provided evidence that suggested that functioning and the physical environment should not be separated and instead should be assessed as a measure of fit. The second paper of this dissertation provided some evidence for this.

An alternative explanation was that PHE and its associated indicators were being suppressed by PC. All of the items representing PHE loaded in the predicted direction except for HDisTotal. It was expected that disrepair in housing would be negatively associated with the

PHE, but it was positively associated with PHE. A suppression effect may have been occurring due to the strong association between the latent constructs PHE and PC (Ludlow & Klein, 2014). This could explain why the items loaded so weakly onto PHE.

Paper two offered several recommendations for future research including replicating this study with software that allows for the application of survey weights to the confirmatory factor analytic process. This could help reduce the plausibility of alternative explanations. Given that the underlying measurement design of the NHATS dataset was random, theoretically, socioeconomic status could be removed as a threat to generalizability. Also, it was suggested that the PHE construct needed to be explored using principal components analysis to identify how many factors underlie this construct. In this project, it was represented by one theoretical construct. However, mathematically it may be modeled differently. It is also suggested that future analyses be conducted with software that can adjust for the underlying distribution of the manifest variables.

The key recommendation from the second paper was to test for a moderation effect between PC and PHE on PWB. The ecological model of aging describes the dynamic interaction between PC and PHE. This interaction called the "docility hypothesis," suggests that differences may exist between levels of PC (Berrahou, 1993; Lawton & Simon, 1967). The results of the second study set the stage for an examination of the ecological model of aging and the docility hypothesis with a representative sample of older adults from the United States (Lawton & Nahemow,1973).

The final paper addressed some of the research recommendations from the second paper. The measurement model from paper two served as the underlying measurement component of a proposed structural model, which was fit to the entire 2011 NHATS data sample of community-

dwelling older adults who completed the survey without a proxy and had information on the Housing Disrepair instrument. Structural equation modeling was used to explore the docility hypothesis and specifically examined the following structural hypotheses: 1) There is negative relationship between PHE and PWB when controlling for the effect of PC on PWB, 2) There is a positive relationship between PC and PWB when controlling for the effect of PHE on PWB, and finally, 3) The relationship between PHE and PWB will be moderated by PC. Specifically, this study tested for a moderation on the relationship between the physical home environment and psychological well-being, by personal competence.

All three hypotheses were supported. PC was found to moderate the effect of PHE on PWB. In this sample, older adults who were lower in personal competence were more affected by their environments. Those with highly demanding environments had much lower psychological well-being than those with fewer environmental demands. Those older adults who were highly competent were less affected by the PHE.

Researchers from previous studies included competence measures as prominent predictors in their models and examined interaction effects with the home environment. Knipscheer et al. (2000) sought to test the docility hypothesis and found that while characteristics of the objective home environment (home modifications) did not significantly predict depression symptoms, the perceived home environment measure, and objective efficacy (management of environmental press), did predict symptoms. An interaction was found between objective efficacy and activities of daily living (ADLs) suggesting that the relationship between objective efficacy and depression symptoms is different depending on functional ability thus providing evidence in support of the docility hypothesis. Similarly, Iwarsson et al. (2007) explored differences in life satisfaction by ADL and instrumental activities of daily living

(IADL) levels of functioning among Swedish older adults. Results also supported an interaction as the magnitude of accessibility problems and functioning led to different life satisfaction among the sample. Thomése and van Groenou (2006) examined the interaction between changes in disability status and the addition of home modifications. Results suggested that if disability status worsened, adding home modifications resulted in greater depressive symptoms and that not adding modifications did not change depressive symptoms.

This paper concluded with recommendations for research and practice. It is suggested that future researchers can strengthen the current knowledge by replicating this study using statistical analysis software that allows for the application of design weights and adjusts for the non-continuous and non-normal distribution of the manifest variables included in the model. Also, the longitudinal nature of the NHATS dataset allows for the possibility of testing for change over time. Practice recommendations included the use of the presented findings as justification for funding for programs that address the demands of the PHE for seniors. Also, social workers were encouraged to advocate for home modifications and to recognized that they may need to intervene with either or both the PHE or PC on behalf of their older clients.

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Vita

Shannon Trecartin completed a Bachelor of Social Work degree from Southern Adventist University in 2005 and a Master of Social Work degree from Andrews University in 2008. Her practice experience includes medical social work, public health, community counseling, research, and evaluation. She has provided case management and counseling to children, adults, and families since 2005. Shannon has been teaching social work courses since 2008. She graduated with her Doctor of Philosophy degree in Social Work in August 2016. Her research is focused on aging and disabilities with an emphasis on the social and built environment as contributors to well-being.