Physical Activity among Adults Living with HIV/AIDS: Interventions, Predictors, and Measurement

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Submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy under the Executive Committee of the Graduate School of Arts and Sciences

COLUMBIA UNIVERSITY

2020
ABSTRACT

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The purpose of this dissertation was to investigate the physical activity (PA) patterns of adults living with HIV (ALWH). To achieve this purpose, the aims of this dissertation were to assess the impact of supervised PA interventions on the functional capacity of ALWH (ages 18 and over), assess potential environmental factors that acted as barriers or facilitators to regular PA participation in older ALWH (ages 50 and over), and attempt to validate a PA instrument that measured routine PA in older ALWH (ages 50 and over) that classified these individuals as low, moderately, or vigorously physically active.

The first study, *Supervised Physical Activity and Improved Functional Capacity among Adults Living with HIV: A Systematic Review*, aimed to investigate whether PA interventions supervised by clinical or allied health professionals improved functional capacity in ALWH aged 18 and over. Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines were followed. Of the 8,267 articles that resulted from the database search, 15 articles were included after screening. We found that supervised PA interventions improved functional capacity outcomes (i.e., strength, cardiovascular fitness, and flexibility) in ALWH and that the presence of clinical or allied health professionals during PA may motivate them to regularly participate in PA. This study was published in the September/October issue of the *Journal of the Association of Nurses in AIDS Care* in 2018. The second study, *The Role of Environment on Physical Activity Patterns of Older Adults Living with HIV*, aimed to investigate the PA patterns of older ALWH and the relationship between environmental factors and PA in this population.
This study was a secondary analysis of data from 100 adults, aged 50 and over, living with HIV in New York City (NYC). Descriptive statistics assessed PA patterns. Linear regression assessed the association between environmental factors and the time spent in PA. Participants were 50% female, ranged from 50-71 years, and had HIV for an average of 23 years. Participants performed below their functional capacity and males walked farther than females on the Six Minute Walk Test. In this sample, the presence of traffic hazards was the sole environmental predictor of PA participation. The third and final study, Validation of the Modified Baecke Questionnaire in Older Adults Living with HIV, aimed to assess the known groups validity, predictive validity, and internal consistency reliability of the modified Baecke Questionnaire (mBQ) in a sample of U.S. ALWH, aged 50 and older. The mBQ measures routine PA over the past 12 months and classifies participant activity as low, moderately, or vigorously physically active. This study was a secondary analysis of data from 100 adults with HIV in NYC. T-tests assessed known groups validity, comparing the physical health of older (≥ 50 years) to younger (< 50 years) ALWH; correlations and linear regression assessed predictive validity; and Cronbach’s alpha coefficient measured internal consistency reliability. The mBQ demonstrated adequate predictive validity but limited known groups validity. Internal consistency reliability was not established. Subsequently, factor analyses were performed and three items were removed from the mBQ. In this revised version of the mBQ, internal consistency reliability and construct validity were established.

This dissertation contributes three important additions to the current HIV literature. First, the dissertation adds evidence to support the expanded role of nurses as clinical professionals to motivate ALWH to regularly participate in PA. Second, it adds two studies conducted exclusively on older ALWH, a subset underrepresented in the current HIV literature. Finally, this
dissertation adds a PA instrument that demonstrated validity to predict physical health in older ALWH, an important feature needed for PA prescriptions as adjunct treatment to support healthy aging for these adults. Future studies are needed with more robust designs and larger samples of older ALWH that are geographically and demographically diverse.
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Acknowledgements

The completion of this work is a collective effort of those in my recent and distant history, as I believe every experience has shaped and prepared me for this endeavor. The last four years of my structured education is the direct result of the unwavering support of the PhD faculty at Columbia University School of Nursing, especially my incredibly generous and patient committee members, Drs. Poghosyan, Rowell-Cunsolo and Liu. This prestigious program is headed by Dr. Arlene Smaldone, whose demand for excellence is only exceeded by her steadfast encouragement. To Dr. Rebecca Schnall, I thank you for helping me find my voice, for your generosity, and for professional development. To Judith Kelson, the surrogate mother of the PhD program, your kindness tailored to each student’s needs sustains us, calms us, and reminds us that you do not have to be a nurse to care for others. The biggest and most sincere thank you to you! Dr. Taylor, you stood by my side through a difficult transition and believed in me when it felt like no one did. My gratitude for you is immeasurable. To Dr. Lusine Poghosyan, my advisor, guidance counselor, confidant, and all-around cheerleader, I could not have reached this point without you. Your empathy and patience from the beginning has meant the world to me. There is no other I would have by my side as I cross the finish line. To my cohort and extended cohort family-Caroline, Meghan T., Joanne, Irene, Melissa, Megan M., Aluem, and Richard. You have been my buoy throughout this journey.

My journey to doctoral education began at Northwell Health. To Maureen White and Patricia Farrell, thank you for acknowledging my potential, encouraging me to pursue this degree, and supporting me over the past four years. To the nurses, doctors, staff, and patients I have encountered during my eight years at Northwell and during my 13 years as a nurse, thank you for teaching me, thank you for humbling me, thank you for allowing me to care for you and
work alongside you in the profession I love. To Drs. Jessie Colin and Linda Cahill of Barry University, thank you for your support. You encouraged me to pursue doctoral study in 2010, but I was not ready. When I believed I was ready, you wrote letters of support when asked and I am grateful.

I am a first generation American of Haitian descent, raised by strict but loving parents. Mom and Pop, your hard work has paid off. I know the difference between right and wrong. I know the value of hard work and the value of a dollar. I lead my life honestly and try to be kind to everyone I meet. I may not have appreciated the rules or discipline while it was happening, but your reasoning was right and I thank you. To grandma and grandpa, Papa Paul, Tatie Immacula and other family and friends in heaven, I miss you every day and know you watch over me. To my siblings, cousins, aunts and uncles, and friends, you feed my belly and my spirit, keep me grounded and light hearted and I am grateful. To my eldest sister, for playing school with me as a child on Saturday mornings and teaching me your lessons; for always acting your shoe size and not your age; for being my best example of a healthy work-life balance, I am forever grateful. I believe each and every person is the product of their environment, their relationships, and their experiences. Because of mine, good, bad, or indifferent, I am here and I would not change a thing.

Funding

The author has received support from a partnership among the Robert Wood Johnson Foundation Future of Nursing Scholars Program, Northwell Health System, and Columbia University School of Nursing. The author is a recipient of the Provost Diversity Fellowship from Columbia University School of Nursing.
Dedication

This dissertation is dedicated to three women who have profoundly impacted my life. The first, my maternal grandmother, Yvonne Lafontant; the second and third, in sequence only, are Lessie Pryor and Lauren Rosenzweig. My grandmother is the reason I pursued nursing as a career. She emigrated to this country as a wife and mother of a young family. She cared for me and my siblings in our youth and is the center of many happy memories. She imparted on me my sense of humor, my resilience, and my ambition. Her passing when I was 11 years old changed me forever and made me want to help others. Thank you, grandma.

Lessie Pryor was my clinical instructor during nursing school for several semesters. She once said during a debrief session at the end of a clinical day, “Don’t be afraid to seek clarification. It is the hallmark of safety.” These words have guided my career as a bedside nurse and as a conscientious citizen of the world. Before she passed away from ALS, I had the chance to thank her for inspiring me to continue my education and modeling professionalism at its height. Thank you, Mrs. Pryor.

Lauren Rosenzweig was a promising young nurse that I had the pleasure of working alongside for about two years. She was a nurse’s nurse—compassionate and kind, knowledgeable and efficient, presented professionally in her appearance and was a fierce patient advocate. We were both diagnosed with illnesses in the summer of 2016. I survived, but she did not. We comforted each other along the way and she never ceased to be the nurse, asking how I was, assuring me that everything would be okay, even though her road was much harder. We, the people who knew and loved her, lost her at 28 years old. She taught me how to fight with grace and to take of myself. Thank you, Lauren. I stand on the shoulders of these women and walk with their spirits in my heart. I am who I am today in large part because of their imprint on me.
Chapter One: Introduction

The focus of this dissertation centers on physical activity (PA) as an effective strategy for health promotion among adults living with HIV (ALWH), defined as individuals living with HIV aged 18 years and over. Physical activity, as defined by the World Health Organization (2017b), is the expenditure of energy by skeletal muscles that results from any bodily movement. Exercise, a subcategory of PA, is described as planned PA that is structured, purposeful, and repetitive with the intent of improving or maintaining an aspect of fitness (Caspersen, Powell, & Christenson, 1985). The dissertation is organized into an introductory chapter (chapter 1), substantive chapters (chapters 2, 3, and 4), and a concluding chapter (chapter 5). The introductory chapter describes the overall organization of my dissertation, as well as, a brief history on the emergence of the disease in the U.S. and evolution of demographics and treatment over time. In this chapter, I also include a short discussion on the biochemical impact of the inherent inflammatory processes that accompany HIV infection, a description of the significance of PA in combating inflammation in general, and its particular importance in reducing inflammation in the HIV population. Additionally, in the introductory chapter, I identify gaps in the current literature and explain how the aims of my dissertation fill those gaps. Next, the conceptual framework guiding my dissertation, the adapted Ecological Model of Four Domains of Active Living, is explored. Finally, the study designs of each substantive chapter are described along with the journals targeted for their respective submission. Each substantive chapter, chapters 2, 3, and 4, address one research aim of this dissertation. Chapter 5, the concluding chapter, describes the intended contribution of this work to the HIV/AIDS literature, directions for future research, and considers nursing implications.
History of and Shift in HIV over Time

The Centers for Disease Control and Prevention (CDC) published a landmark *Morbidity and Mortality Weekly Report* on June 5, 1981. This report was the first official publication that documented the first diagnoses of what would later be discovered as the start of the HIV and AIDS epidemic. Five homosexual males in Los Angeles, California were diagnosed in 1981 (CDC, 1981). In July 1981, the New York Times reported a “rare gay cancer” among 41 gay men, of which, 26 were from New York City (NYC) and the San Francisco Bay area (Altman, 1981). By 1982, the CDC coined the term “AIDS,” to refer to the illness, although the cause was still unknown (CDC, 1982).

Over time, there has been a shift in the demographics of individuals living with HIV. Once considered a young person’s disease as it affected young, mostly White, homosexual men at its discovery (Altman, 1981; CDC, 2001); this is no longer the case. While the incidence of HIV remains disproportionately higher among men who have sex with men, this disparity has come to include people of color and older adults. For example, approximately 65% of all new HIV diagnoses in 2017 comprised gay and bisexual adult men aged 20 years and older (CDC, 2019b, 2019c). Despite comprising 13% of the population, African Americans accounted for 43% of HIV incidence in 2017 (CDC, 2019a). Additionally, an age disparity exists among adults living with HIV (ALWH). At present, approximately 72% of ALWH are at least 40 years old and 56% are ages 50 and over (CDC, 2017b, 2018). Along with the shift in age demographics, the priority of care has shifted from strategies for survival, as it was during the early years of disease discovery, to include strategies for healthy aging, at present. For this dissertation, older adults living with HIV were defined as those aged 50 years and over.
The shift in the focus of care from survival to healthy aging in ALWH has been chronicled over time. In the decade after the first antiretroviral agent was created and approved by the FDA, eleven more antiretroviral medications followed (U.S. Department of Health and Human Services, 2018). This influx of medications demonstrated the sense of urgency to treat the greater than 500,000 cases of HIV/AIDS diagnosed by 1995 and decrease the rate of deaths attributed to it, which at the time had reached 300,000 (CDC, 1995). This approach was characteristic of the period’s focus on the survival of ALWH. The success of antiretroviral therapy (ART) over the past four decades has resulted in increased longevity in ALWH (Samji et al., 2013) and changed HIV from a terminal diagnosis to a manageable, chronic disease (Clayson et al., 2006; Deeks, Lewin, & Havlir, 2013a).

Common strategies to promote healthy aging among ALWH include increasing PA, supportive nutrition interventions, and increased social support. In ALWH, PA interventions have been shown to reduce symptoms associated with poor cardiovascular health, reduce fatigue, and improve cognitive functioning (Dirajlal-Fargo et al., 2016; Dufour et al., 2016; Karmisholt & Gotzsche, 2005; Monroe et al., 2017; O'Brien, Tyan, Nixon, & Glazier, 2016a; Webel et al., 2016a). Supportive nutrition interventions, including increasing caloric intake with low CD4 counts, increasing protein and vitamin intake where deficient, and limiting alcohol consumption have been shown to reduce morbidity and mortality risk in ALWH (Justice et al., 2016; Kahler et al., 2017; Mangili, Murman, Zampini, & Wanke, 2006). It is also important to consider the role food insecurity plays in this population as it relates to PA participation. Food insecurity is defined as inconsistent food intake or inconsistent eating patterns due to a shortage of money or other resources (Office of Disease Promotion and Health Prevention, 2019). It affects approximately 50% of ALWH in urban dwellings (Feldman, Alexy, Thomas, Gambone, &
Irvine, 2015; Weiser et al., 2013) and has been linked to impaired physical health and reduced PA (Feldman et al., 2015). Finally, engaging in positive social interactions, including maintaining positive and supportive friendships and social support networks, and maintaining a therapeutic patient-provider relationship, has been shown to alleviate symptom burden and management as well as improve quality of life (Bhatta, Liabsuetrakul, & McNeil, 2017; Iribarren et al., 2017; Webel, Sattar, Schreiner, & Phillips, 2016b; Webel et al., 2015b). In fact, positive social interactions and social support have been cited as key motivators of regular PA participation among ALWH (Galantino et al., 2005b; Mabweazara, Ley, & Leach, 2018; Voigt, Cho, & Schnall, 2018). Of these strategies, I investigated PA as an effective strategy for health promotion among all ALWH and older ALWH in this dissertation.

**HIV and Inflammation**

The body’s primary defense against pathogens is via the release of inflammatory mediators, such as cytokines and chemokines, by the immune cells (Chou & Effros, 2013; Gruver, Hudson, & Sempowski, 2007). During an acute HIV infection, an influx of cytokines and chemokines are released in the body (Stacey et al., 2009). The degree of HIV replication, or viral load, plays a role in this inflammatory response; that is, the higher the viral load, the greater the inflammatory biomarkers that respond to fight the disease (Deeks, 2011; Deeks, Tracy, & Douek, 2013b). The function of antiretroviral therapy, or ART, is to reduce HIV viral load, thereby reducing the likelihood of advancing to AIDS and reducing overall mortality from the disease (M. S. Cohen et al., 2011; HIV Causal Collaboration, 2010; Kitahata et al., 2009). Following this logic, it would be expected that prolonged use of ART would result in reduced viral load and reduced inflammatory response. However, this is not the case. Despite prolonged use of ART, elevated levels of inflammatory biomarkers persist in ALWH (Deeks et al., 2013a;
Wing, 2016). Not only are these biomarkers present despite long-term ART, evidence suggests that circulating inflammatory biomarkers are present in higher concentrations in ALWH compared to HIV negative individuals (Deeks, 2011). This evidence suggests that both HIV and ART play a role in the sustained inflammatory response seen in ALWH.

Advances in ART have resulted in people with HIV living longer (Samji et al., 2013). However, this longevity is accompanied by decades of exposure to chronic inflammation (Deeks et al., 2013b). The consequence of this sustained immune response is acceleration toward immunosenescence, or, an aging of the immune system (Appay & Sauce, 2008). Immunosenescence contributes to the overall aging of an individual (Gruver et al., 2007) and is characterized by the body’s inability to rid itself of cells that are damaged or no longer replicating (Lopez-Otin, Blasco, Partridge, Serrano, & Kroemer, 2013).

In addition to living longer, evidence suggests that, ALWH are also aging at an accelerated rate due to the effects of immunosenescence (Deeks, 2011; Horvath & Levine, 2015; Rickabaugh et al., 2015; Wing, 2016). By one estimate, the rate of aging in ALWH is approximately 14 years that of the uninfected population (Rickabaugh et al., 2015). The presence of chronic inflammation has been linked to cardiovascular disease, obesity, and type 2 diabetes, among others, in the HIV-positive and HIV-uninfected populations (Farahani, Mulinder, Farahani, & Marlink, 2017; Lopez-Otin et al., 2013; Schouten et al., 2014b; So-Armaah et al., 2016). Of these diseases, cardiovascular disease is a leading cause of mortality in ALWH globally, accounting for approximately 15% of all non-AIDS causes of death in high-income countries (Farahani et al., 2017). Furthermore, the elder HIV population suffers from multiple comorbidities, frailty, and neurocognitive decline that also bear inflammation as a commonality (Piggott, Erlandson, & Yarasheski, 2016; Wing, 2016). Given the dependencies among HIV,
aging, and inflammation, understanding the relationship among them informs interventions that target reducing inflammation.

**HIV, Inflammation, and Physical Activity**

Engaging in regular PA is safe and effective for ALWH (Nixon, O'Brien, Glazier, & Tynan, 2005; O'Brien et al., 2016a; Yahiaoui, McGough, & Voss, 2012). PA recommendations for all U.S. adults include 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity PA per week (Department of Health and Human Services [HHS], 2008). Regular participation in PA has been shown to reduce the effects of the inflammatory processes associated with both HIV and long-term ART (d'Ettorre et al., 2014). Dirajlal-Fargo et al. (2016) found that adults with HIV who engage in 2.5 hours of moderate intensity PA per week experience lower levels of inflammation. Other studies also support the use of PA as a strategy to reduce chronic inflammation in adults living with HIV (Bonato et al., 2017; d'Ettorre et al., 2014; Gleeson et al., 2011). Despite the known benefits of PA in this population, regular participation in PA remains below recommended levels (Vancampfort et al., 2016b; Webel et al., 2015a). For example, after removing walking as a means of PA, Webel et al. (2015a) found that ALWH engaged in 1.4 hours of PA per week, substantially less than the 2.5 hours recommended by HHS. Moreover, evidence suggests that ALWH, more than other populations with chronic conditions (e.g., diabetes, depression), are more likely to drop out of PA interventions (Vancampfort et al., 2017a). Understanding the relationship among HIV, inflammation, and PA provides insights that are helpful for targeting increased PA as a means to reduce HIV-associated inflammation and promote healthy aging in this population.
Gaps in the Literature

The gaps in the current body of HIV/AIDS literature presented below were the rationale for the three studies that comprise this dissertation.

Gap 1: Lack of Data from Supervised PA Interventions in ALWH

Recent systematic reviews and meta-analyses have been focused on the effects of PA interventions on ALWH (Gomes Neto, Conceicao, Oliveira Carvalho, & Brites, 2015; Gomes Neto, Ogalha, Andrade, & Brites, 2013; Gomes-Neto, Conceicao, Oliveira Carvalho, & Brites, 2013; Kamitani et al., 2017; O'Brien et al., 2016a; O'Brien, Tynan, Nixon, & Glazier, 2017; Poton, Polito, & Farinatti, 2016; Yahiaoui et al., 2012). These findings were reported in aggregate from interventions that were supervised by professionals and unsupervised interventions. The authors of these reviews showed that PA interventions improve general health outcomes in ALWH, such as health-related quality of life, mental health, and functional capacity, such as cardiovascular fitness and flexibility. These findings, however, do not clarify which PA interventions—supervised or unsupervised—have the greatest effect on health outcomes in ALWH.

The American Heart Association defines functional capacity as the integrated efforts and health of an individual’s pulmonary, cardiovascular, and skeletal muscles to perform activities of daily living (Arena et al., 2007). Little is known about the impact of supervised PA interventions on the functional capacity of ALWH, because these interventions have yet to be assessed as distinct from unsupervised interventions. Chapter 2, a systematic review, was designed to address this gap in the literature by investigating the effect of supervised PA interventions on functional capacity among ALWH.
**Gap 2: Lack of Data on the Impact of Environmental Factors on PA in ALWH**

As previously mentioned, evidence suggests that ALWH participate in PA at lower than recommended levels (Montoya, Wing, Knight, Moore, & Henry, 2015; Simonik et al., 2016b; Vancampfort et al., 2016b; Vancampfort et al., 2016c; Webel et al., 2015a). A recent systematic review identified factors associated with PA in ALWH, in which lower levels of PA were associated with older age, lower educational level, lower CD4 count, being on ART, presence of lipodystrophy (i.e., abnormal fat deposits), pain, depression, and opportunistic infections (Vancampfort et al., 2017c). In this review, the factors identified as impediments to PA were overwhelmingly individual factors. There was little discussion of influential factors outside the individual, such as environmental or social factors. Yet, to encourage PA among ALWH, it is important to assess the environment in which PA takes place.

Evidence suggests physical and social environments affect PA patterns (Gustat, Rice, Parker, Becker, & Farley, 2012; Smith et al., 2017; Zapata-Diomed, Herrera, & Veerman, 2016). For example, installation of a sidewalk increased both observed and self-reported PA in residents of a low-income neighborhood (Gustat et al., 2012). In fact, these same residents reported significant increases in both moderate and vigorous-intensity PA after the sidewalk was installed ($p < .001$). In densely populated neighborhoods, like many neighborhoods in New York City, installing sidewalks has been shown to be a cost-effective health intervention (United States Census Bureau, 2012; Veerman et al., 2016).

To date, no studies have examined the relationship between aspects of one’s physical and social environment and PA patterns in ALWH. Therefore, the aim of this study was to: 1) describe the PA patterns of older ALWH, given the majority of ALWH are aged 50 years and
older and underrepresented in the literature, and 2) investigate the relationship between aspects of one’s physical and social environment and PA patterns of older ALWH.

**Gap 3: Lack of a PA Instrument Validated in U.S. Sample of ALWH**

Regular PA is an important intervention for ALWH. Participation in PA by ALWH can reduce the risk of cardiovascular disease (a leading cause of death in this population), improve functional capacity, and mitigate the physical limitations of chronic comorbidities and frailty (Farahani et al., 2017; Hart et al., 2018; Kamitani et al., 2017; O'Brien et al., 2016a; Piggott et al., 2016; Voigt et al., 2018). To measure PA and encourage it when deficient, a validated PA tool is needed. The Baecke Questionnaire (BQ), developed by Baecke, Burema, and Frijters (1982), was validated among a sample of Brazilian ALWH in 2006 (Florindo et al., 2006). The validation study was limited by a small sample size (n = 30) and little description of the sample aside from mean years of education (14.4 years) and mean age (37.2 years). Given the validation study was conducted thirteen years ago in Brazil and that 72% of adults with HIV in the U.S. are over 40 years old, this instrument may not be appropriate for use with an aging HIV population in the U.S. Voorrips, Ravelli, Dongelmans, Deurenberg, and Van Staveren (1991) modified and validated the BQ for use in adults aged 65 years and older (hereafter as the modified BQ, or mBQ) in a sample of HIV-uninfected older adults. Therefore, the mBQ may be an appropriate tool to measure PA in older ALWH; however, it has yet to be tested in this population.

To establish validity of the mBQ, the physical function domain of the PROMIS-29 assessment may be used as a comparator. The PROMIS-29 is a self-reported survey of health-related quality of life measures (Cella et al., 2010). The seven domains of the PROMIS-29 measure depression, anxiety, physical function, pain interference, fatigue, sleep disturbance, and participation in social roles and activities. The physical function domain measures physical
health using four polytomous response items, in which the higher the score, the better the physical functioning and physical health of the individual. Physical function is related to physical health, because individuals who display adequate physical functioning (i.e., mobility, dexterity, axial function, and the ability to carry out instrumental activities of daily living) are, in effect, physically healthy (Cella et al., 2010). The PROMIS-29 has been previously validated for use in ALWH (Schnall et al., 2017), so the physical function domain may serve as a quick measure of physical health in this population.

Therefore, the aims of this study were to assess the internal consistency reliability and known groups and predictive validity of the mBQ on the physical health of older ALWH. The known groups assessment compared mean scores of the mBQ by age group (older versus younger ALWH), and the predictive validity assessment compared the mBQ scores to the physical function domain scores of the PROMIS-29 v2.1 using correlations and linear regression. Results from this study will ultimately guide providers in their PA prescriptions for ALWH.

Aims of the Dissertation

Table 1.1 summarizes the titles, accompanying aims, and journals targeted for submission for each dissertation chapter. Chapter 2 is a systematic review of the current evidence of supervised PA interventions on functional capacity in ALWH. Chapter 3 is an evaluation of the impact of environmental factors on PA patterns in older ALWH. Chapter 4 is an attempt to validate a PA instrument in a U.S. sample of older ALWH, with mixed results.

Conceptual Framework

The Ecological Model of Four Domains of Active Living (EMFDAL) inspired the conceptual approach to this research (Sallis et al., 2006). The EMFDAL described the interplay of intrapersonal, interpersonal, organizational, community, and policy factors that affect the
adoption of health behaviors. In this dissertation, the model has been adapted for the study of ALWH and focuses on the intrapersonal, social environment, physical environment, and PA domains of the adapted EMFDAL (See Figure 1.1).

The adapted EMFDAL lays the foundation for exploring a multi-level approach to increasing regular participation in PA. Evidence in both the HIV-uninfected population (Bauman et al., 2012; Giles-Corti & Donovan, 2002; Spence & Lee, 2003) and in ALWH (Jaggers, 2018; Ley, Barrio, & Leach, 2015) suggests that interventions that target multiple levels of an ecological model are the most effective in increasing participation in PA. The intrapersonal domain of the adapted EMFDAL is comprised of demographic factors, such as age, sex, race, education level, as well as, in the case of ALWH, viral load and CD4 count. The social environment domain captures one’s perception of their environment, including factors such as perceived crime, comfort, attractiveness, safety, accessibility, and convenience. The physical environment domain refers to the setting of and access to PA, i.e., natural and built environments. The physical activity domain refers to the typology of PA, including recreation (e.g., softball, yoga), transport (e.g., walking, cycling), and household activities (e.g., gardening, ascending/descending stairs).

In summary, the adapted EMFDAL is an appropriate conceptual framework for this dissertation because it guides a theoretically informed examination of the relationships among demographics, PA patterns, and the physical and social environments. Understanding these relationships will inform future interventions that have the potential to increase long-term PA participation in ALWH. The adapted EMFDAL guides the problem definition, methodology, and analysis of this dissertation.
Study Designs

The remainder of this dissertation will investigate strategies to support PA in ALWH. Chapter 2 provides a systematic review of supervised PA interventions and their impact on functional capacity among ALWH. This systematic review has been published in the *Journal of the Association of Nurses in AIDS Care* (Voigt et al., 2018). Chapter 3 presents a secondary analysis of a cross-sectional survey study designed to assess the impact of environmental factors on PA patterns in older ALWH. Chapter 4 is a secondary analysis of data produced from a cross-sectional survey study designed to assess the reliability and validity of the mBQ to measure PA among a sample of older ALWH in New York City. Prior to primary data collection from the studies using secondary data, applications for human subjects’ research were approved by the Columbia University Medical Center’s Institutional Review Board.

Conclusions

The objective of this dissertation was to investigate the interdependencies of PA and environmental factors of ALWH guided by the adapted EMFDAL. The results of this investigation contribute to the HIV/AIDS body of literature in several ways. First, this dissertation synthesizes the evidence from the existing literature to show how supervised PA interventions increase functional capacity in ALWH. This assessment evaluates the relative effectiveness of existing supervised PA interventions at improving functional capacity in ALWH. Second, this dissertation contributes a comprehensive assessment of PA patterns in an understudied population and illuminates the impact of one’s environment on PA participation, the first ecological study of its kind in older ALWH. The results of this assessment will lay the groundwork for a multi-level, ecological approach to future PA interventions, which may support long-term PA participation this population. Third, this dissertation validates a PA survey
instrument for use in research with older ALWH in the U.S. No such instrument currently exists for this purpose. This dissertation also contributes to the literature by studying two areas underexplored in the current body of knowledge, older ALWH and the interplay between environmental factors and PA patterns in all ALWH.

Furthermore, this dissertation offers unique opportunities for nurses. The systematic review revealed a new role for nurses as facilitators of supervised PA interventions. More robust designs of studies are needed by nurse scientists to further investigate the impact of types and intensities of PA on health outcomes across the lifespan of ALWH. The findings of this dissertation may also have implications for nurse practitioners in primary care regarding the assessment of PA in patients with HIV and the prescription of PA as an adjunct therapeutic strategy in the management of the disease. Combined, these studies offer insight into PA patterns in ALWH and the interdependencies of PA and environmental factors. The findings from this dissertation will illuminate effective strategies to support and measure PA in ALWH as part of long-term health promotion.
## Tables and Figures

### Table 1.1

**Dissertation Chapters, Accompanying Aims, and Target Journals**

<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>TITLE</th>
<th>AIMS</th>
<th>TARGET JOURNALS</th>
</tr>
</thead>
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<tr>
<td>2</td>
<td>Supervised Physical Activity and Improved Functional Capacity Among Adults Living with HIV: A Systematic Review</td>
<td>1. To synthesize and present the consensus of the evidence on the impact of supervised PA interventions on functional capacity in adults living with HIV.</td>
<td>1. Journal of Nurses in AIDS Care (published)</td>
</tr>
<tr>
<td>3</td>
<td>The Role of Environment on Physical Activity Patterns of Adults Living with HIV</td>
<td>2. To describe the physical activity patterns among adults living with HIV 3. To investigate the relationship between environmental factors and PA patterns in adults living with HIV</td>
<td>2. Journal of Aging and Physical Activity 3. Journal of Physical Activity and Health 4. Journal of Nurses in AIDS Care</td>
</tr>
<tr>
<td>4</td>
<td>Validation of the Modified Baecke Questionnaire in Older Adults Living with HIV</td>
<td>4. To investigate the predictive validity of the mBQ by assessing the relationship between PA, as measured by the mBQ, and physical health, as measured by the physical function subscale of the PROMIS-29</td>
<td>5. Medicine and Science and Sports and Exercise 6. Journal of Nurses in AIDS Care 7. Nursing Research</td>
</tr>
</tbody>
</table>
Figure 1.1. Adapted Ecological Model of Four Domains of Active Living

Note. This ecological model describes the interdependence of interpersonal and environmental factors and physical activity participation.
Chapter Two: Supervised Physical Activity and Improved Functional Capacity among Adults Living with HIV: A Systematic Review

Chapter Two addresses Aim 1 of the dissertation in a systematic review evaluating and synthesizing the evidence of the impact of supervised PA interventions on the functional capacity of ALWH. The final manuscript was published in the 2018 September-October issue of the Journal of the Association of Nurses in AIDS Care (doi: 10.1016/j.jana.2018.05.001). The published version is included in Appendix A.

Abstract

Physical Activity (PA) combats the effects of multi-morbidity and antiretroviral therapy in adults living with HIV (ALWH), but ALWH often don’t meet recommended PA guidelines. The purpose of our review was to investigate whether supervised PA improved functional capacity in ALWH. Preferred Reporting Items for Systematic Reviews and Meta-Analyses were followed. Five databases were searched for randomized controlled trials in English, with participants ages 18 years and older, and a supervised PA intervention. A database search yielded 8,267 articles, with 15 eligible for review inclusion. We found a low risk of bias within and across studies. Combined aerobic/progressive resistance training (PRT) improved strength, cardiovascular, and flexibility outcomes; aerobic interventions alone showed no significant improvements; PRT improved strength outcomes; yoga or yoga/meditation showed no outcome differences; and t’ai chi showed cardiovascular and flexibility improvements. We found that supervised PA increased functional capacity in ALWH and that self-report was not a reliable assessment.

Keywords: functional capacity, HIV, physical activity, supervision
Introduction

There are currently 1.1 million people living with HIV in the United States (Centers for Disease Control and Prevention [CDC], 2017a). Due to advances in antiretroviral therapy (ART), people with HIV are living longer (Antiretroviral Therapy Cohort Collaboration, 2008; Boyd, 2009) and HIV is now managed as a chronic disease in much of the developed world (Deeks et al., 2013a). Despite the steady increase in life expectancy (Samji et al., 2013), non-HIV-related mortality, specifically cardiovascular disease, has eclipsed HIV-related mortality as the major cause of death among adults living with HIV (ALWH) (Farahani et al., 2017).

Evidence has suggested that physical activity (PA) is safe and beneficial in promoting the health and medical stability of ALWH (Hand, Lyerly, Jaggers, & Dudgeon, 2009; Jaggers, 2018; Nixon et al., 2005; O'Brien, Tyan, Nixon, & Glazier, 2016b; Yahiaoui et al., 2012). Specifically, PA can effectively mitigate the effects of cardiovascular disease (Hand et al., 2009; Kamitani et al., 2017; O'Brien et al., 2016b), the leading cause of death among ALWH (Farahani et al., 2017), and symptoms of long-term HIV exposure and long-term ART (O'Brien et al., 2016b; Webel et al., 2015a; Yahiaoui et al., 2012). For example, ALWH who participate in PA have a reduced risk for heart disease, increased energy, improved regulation of bowel function, improved sleep, and lower stress (Hand et al., 2009; U.S. Department of Veterans Affairs, 2015; Yahiaoui et al., 2012). PA is also an important strategy for improving aerobic capacity, muscle strength, and flexibility in this population (Haskell et al., 2007; Jones & Carter, 2000; O'Brien et al., 2016b; Poton et al., 2016).

The Centers for Disease Control and Prevention (2015) defined PA as any expenditure of energy by skeletal muscles to produce any bodily movement. PA is a broader concept than exercise, as exercise, a subset of PA, is defined as a planned, structured, and repetitive activity.
Recommended PA for ALWH includes 20 to 40 minutes of combined aerobic and resistance exercise at least 3 times per week (O'Brien et al., 2016b; Yahiaoui et al., 2012). These recommendations were shown to reduce the severity of comorbidities (Dirajlal-Fargo et al., 2016; Kamitani et al., 2017; Yahiaoui et al., 2012) and reduce inflammation associated with long-term HIV and long-term ART (d'Ettorre et al., 2014; Hand et al., 2009; Webel et al., 2015a). Given the benefits of PA, regular participation for ALWH is essential; however, their PA participation has remained below recommended levels (Montoya et al., 2015; Simonik et al., 2016a; Vancampfort et al., 2016a; Webel et al., 2015a). Weekly PA recommendations make no mention of supervision, despite being based on studies of both supervised and unsupervised PA interventions (O'Brien et al., 2016b; Yahiaoui et al., 2012).

Supervised PA has the potential to encourage ALWH to participate in PA regularly. Studies of adults with other chronic conditions (e.g., arthritis, obesity, kidney failure patients on dialysis, heart failure, diabetes, and cancer) were shown to have increased PA participation after involvement in a PA intervention supervised by a clinician or allied health professional (Akbaba, Yeldan, Guney, & Ozdincler, 2016; Casla et al., 2014; Daul, Schafers, Daul, & Philipp, 2004; Klempfner et al., 2015; Kuru Colak et al., 2017; Negri et al., 2010; Nicolai et al., 2009). In some cases, regular participation in PA continued well beyond the end of the study (Azad, Bouchard, Mayhew, Carter, & Molnar, 2012; Casla et al., 2014; Trinh, Mutrie, Campbell, Crawford, & Courneya, 2014).

Additionally, when outcomes were compared between supervised and unsupervised PA interventions, more pronounced improvements were seen as a result of supervised PA. To detail, participants of supervised PA interventions showed significant improvement in cardiovascular fitness, muscle strength, and significantly decreased fat mass, body mass index (BMI), and body
weight, compared to controls (Akbaba et al., 2016; Boshuizen, Stemmerik, Westhoff, & Hopman-Rock, 2005; Dalager et al., 2015; Nicolai et al., 2009; Rossomanno, Herrick, Kirk, & Kirk, 2012). However, the evidence to support the benefits of supervised PA as the main intervention for ALWH is missing from the current body of literature. Past systematic reviews have examined the effects of both supervised and unsupervised PA interventions for ALWH and reported aggregate results (Gomes Neto et al., 2015; Gomes Neto et al., 2013; Jaggers, 2018; O'Brien et al., 2016b; Poton et al., 2016; Yahiaoui et al., 2012). None have segregated supervised from unsupervised interventions in their reviews or analyzed the outcomes of these respective interventions separately. The purpose of our review was to investigate the impact of supervised PA interventions on functional capacity among adults living with HIV.

**Methods**

**Search Strategy**

Our review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher, Liberati, Tetzlaff, & Altman, 2009). A total of five databases were systematically searched for all relevant literature including PubMed, Cumulative Index to Nursing and Allied Heath Literature (CINAHL), PsycINFO, Embase, and Physical Education Index. First, search terms were created based on the population and interventions of interest in PubMed. Second, comparable search terms were identified in each subsequent database. For example, a combination of MeSH terms, MeSH headings, keywords and phrases, and Boolean operators were used to create the search terms used in PubMed. The resultant search terms in PubMed were as follows: ("HIV"[Mesh] OR HIV [Text Word] OR "HIV Long-Term Survivors"[Mesh] OR "HIV Long-Term Survivors" OR "HIV Infections"[Mesh] OR "HIV Infections" OR "HIV Seropositivity"[Mesh] OR "HIV Seropositivity" OR "HIV

Eligibility Criteria

Study inclusion criteria included studies that (a) were randomized controlled trials (RCTs) that evaluated the effect of a supervised PA intervention as compared to usual care, (b) examined functional capacity as an outcome, (c) included adults ages 18 and older living with HIV, and (d) were available as full text articles in English. Supervised PA was defined in our review as PA interventions that were supervised by a health care or allied health professional. Functional capacity was defined as per the American Heart Association definition, as the integrated efforts and health of an individual’s pulmonary, cardiovascular, and skeletal muscles to perform activities of daily living (Arena et al., 2007). Functional capacity outcomes in our review included strength measures, cardiovascular fitness measures, flexibility measures, and self-reported measures of functional capacity. We excluded poster sessions, presentations, protocols, letters, comments, editorials, correspondence, or grey literature (e.g., blogs, newsletters, videos).

Study Selection and Data Extraction

We used Covidence (Veritas Health Innovation, 2018), a web-based program designed to support the systematic review process, to facilitate screening at the title/abstract and full text level, as well as for data extraction, adjudication of disagreements, and confirmation of data. A
hand search was conducted for additional studies meeting inclusion criteria. Two authors independently assessed eligibility and a third consulted in instances of uncertainty/disagreement. The following information was extracted from the final studies: name of the first author, publication year, locations of the studies, study sample size, type of supervised PA interventions, frequency/duration of interventions, and duration of the studies. No publication date or restrictions were used in the search.

Quality Assessment

The quality appraisal was conducted using the Cochrane Collaboration Risk of Bias Tool (CCRBT; J. P. Higgins et al., 2011). The CCRBT describes six domains to assess possible avenues of bias: sequence generation; allocation concealment; blinding of participants, personnel, and outcome assessors; incomplete outcome data; selective outcome reporting, and, other sources of bias. Each domain is evaluated as yes (low risk of bias), no (high risk of bias), or unclear (uncertain risk of bias); each study is then assigned an overall grade of high, moderate, or low risk of bias. Two authors independently appraised the quality of the studies, and discrepancies were reviewed until consensus was reached.

Results

Study Selection

The database literature search yielded 8,267 articles. One hundred twenty-six articles were identified from the hand search. One hundred ninety-five articles remained for full text screening after duplicates were removed and title and abstract screening was completed; 180 articles were excluded based on the full text review. Of the 180 excluded articles, full text for 28 abstracts were not found despite independent searches, the assistance of university librarians, and requests from other institutions via interlibrary loan. Fifteen studies remained and were included
in this systematic review. Figure 2.1 summarizes the results of the search and study selection.

**Study Characteristics**

The combined studies had 537 participants whose ages ranged between 18 and 73 years. The supervisors of the PA interventions included certified yoga instructors, exercise physiologists, nurse trainers, physical therapists, exercise specialists, physiotherapists, cardiologists, and personal trainers. Table 2.1 summarizes the characteristics of the included studies. The duration of the PA interventions ranged between 31 minutes and 2 hours and the intensity ranged from low to vigorous. The length of the PA interventions ranged from 6 weeks to 6 months across studies.

**Study Findings**

Supervised PA interventions were classified into the following categories: (a) aerobics, (b) progressive resistance training (PRT), (c) combined aerobics and progressive resistance training, (d) yoga and meditation, and (e) t’ai chi. Each intervention in the review was assessed as a change in one or a combination of four functional capacity outcomes of interest: cardiovascular (e.g., vo2max [maximal aerobic capacity]; BMI; the 6-Minute Walk Test [6MWT]), strength (e.g., the one-repetition maximum [1-RM], 6-repetition maximum[6-RM]), flexibility and balance (i.e., Sit and Reach and Forward Reach tests), and self-report (e.g., SF-36 Physical Functioning and Role Limitations due to Physical Health subscale scores, exit interview questions, health diary). Table 2.2 describes the functional capacity outcomes of each study.

**Aerobics interventions (n = 4).** Four studies employed aerobic interventions in their respective study samples (Baigis et al., 2002; Galantino et al., 2005a; McDermott et al., 2016; Terry et al., 2006). Three out of four studies reported no significant differences between intervention and control group participants in cardiovascular and self-reported outcomes (Baigis
et al., 2002; McDermott et al., 2016; Terry et al., 2006). However, the participants in the Galantino et al. (2005a) study showed improvements in both cardiovascular ($p < .05$) and flexibility outcomes ($p < .01$).

**Progressive resistance training interventions (n = 2).** Agin et al. (2001) and Strawford et al. (1999) administered PRT as the intervention in their studies. Both studies showed significant improvements in strength outcomes in the intervention group compared to those in the control group ($p < .001$ and $p < .05$, respectively).

**Combined aerobic and PRT interventions (n = 7).** Seven studies employed combined aerobic and PRT interventions (Dolan et al., 2006; Driscoll et al., 2004; Dudgeon et al., 2012; Farinatti, Borges, Gomes, Lima, & Fleck, 2010; Fillipas, Oldmeadow, Bailey, & Cherry, 2006; Ogalha et al., 2011; Perez-Moreno et al., 2007). All strength, cardiovascular, and flexibility outcome measures associated with these interventions demonstrated a significant improvement ($p \leq .05$) in the intervention group as compared to control group participants. However, BMI in the Farinatti et al. (2010) and Ogalha et al. (2011) studies and health related quality of life (HRQOL) in the Fillipas et al. (2006) study demonstrated no significant difference between intervention and control groups ($p > .05$).

**Yoga and meditation interventions (n = 2).** One study administered a combined yoga and meditation intervention (Agarwal, Kumar, & Lewis, 2015) and another employed yoga alone (Cade et al., 2010). Both studies measured change in functional capacity via self-reported measures, the SF-36 Physical Functioning and Physical Limitations subscale scores. In both studies, changes in functional capacity were not significantly different from the control group at study end.

**T’ai chi intervention (n = 1).** The t’ai chi group showed significant improvements in
both flexibility ($p < .01$) and cardiovascular ($p < .05$) outcomes (Galantino et al., 2005a).

**Study Quality**

Seven of 15 studies had a low risk of bias (Agin et al., 2001; Baigis et al., 2002; Dolan et al., 2006; Fillipas et al., 2006; Galantino et al., 2005a; Perez-Moreno et al., 2007; Strawford et al., 1999). The remaining eight studies had an unclear risk (Agarwal et al., 2015; Cade et al., 2010; Farinatti et al., 2010; McDermott et al., 2016; Terry et al., 2006) or high risk of bias (Driscoll et al., 2004; Dudgeon et al., 2012; Ogalha et al., 2011). For sequence generation, allocation concealment, blinding of participants, personnel, and outcome assessors the risk of bias was low or unclear risk for all studies. Most of the studies demonstrated low risk of bias for incomplete outcome data. The results of the assessment of study quality using CCRBT are reported in Figure 2.2, and the Cochrane risk of bias summary is reported in Figure 2.3.

**Discussion**

We examined the impact of supervised PA interventions on the functional capacity of ALWH. Overall, our findings supported supervised PA interventions as an effective intervention for increasing functional capacity among adult ALWH. Supervised combined aerobics and PRT interventions improved functional capacity outcomes across all of the following outcomes: cardiovascular, strength, flexibility and balance, and self-report. However, studies that assessed functional capacity via self-reported measures alone revealed inconsistent results.

We found that supervised combined aerobics and PRT was the most effective intervention followed by t’ai chi, PRT, aerobics, yoga, and combined yoga and meditation to increase functional capacity in this population. The participants in all seven studies involving supervised combined aerobics and PRT (Dolan et al., 2006; Driscoll et al., 2004; Dudgeon et al., 2012; Farinatti et al., 2010; Fillipas et al., 2006; Ogalha et al., 2011; Perez-Moreno et al., 2007)
showed statistically significant improvements in cardiovascular, strength, and flexibility and balance outcomes. Improvements in cardiovascular health, strength, and flexibility have been associated with reduced cholesterol and risk of heart attack and stroke, increased muscle mass and strengthening of bones, and reduced stress in both ALWH and those without HIV infection (Lachman et al., 2018; U.S. Department of Veterans Affairs, 2015; Yahiaoui et al., 2012). These health benefits are of particular import to ALWH as the incidence of heart attack, lipodystrophy, and wasting syndrome are high in this population (Deeks et al., 2013b; Farahani et al., 2017; Nguyen, Peer, Mills, & Kengne, 2016; Palmeira dos Santos et al., 2017; Schouten et al., 2014a). While yoga is considered a form of PA and has been shown to effectively improve health-related outcomes in both healthy and diseased populations (Govindaraj, Karmani, Varambally, & Gangadhar, 2016; Ross & Thomas, 2010), in our review, yoga failed to demonstrate an improvement in functional capacity for ALWH.

Supervised combined aerobics and PRT interventions showed improvements in strength, cardiovascular, and flexibility and balance outcomes; however, cardiovascular outcomes associated with supervised aerobics interventions showed no significant changes between groups in three out of four studies (Baigis et al., 2002; McDermott et al., 2016; Terry et al., 2006). In our review, when PRT was included with aerobics, cardiovascular outcomes demonstrated significant improvement in functional capacity. Improved cardiovascular outcomes in the Galantino et al. (2005a) study may be attributed to three possible reasons: (a) the sample of male only subjects, where the subjects in the other aerobics studies were comprised of male and female subjects; (b) the investigator was not blinded to the participants in the Galantino et al. (2005a) study and, therefore, introduced a source of bias in the data collection or analysis; and (c) the cardiovascular outcome measures in the Galantino et al. (2005a) study involved the
simpliest interactions with equipment and, thus, a reduced likelihood of equipment malfunction or failure, unlike the measures in the Baigis et al. (2002), McDermott et al. (2016), and Terry et al. (2006) studies. For instance, the latter studies used vO2max, peak heart rate, and blood pressure as cardiovascular outcomes among others. Measuring vO2max involves a mouth guard, nose clip, and treadmill. Peak heart rate measurements require electrode sensors and an EKG machine. Blood pressure was measured with an automated sphygmomanometer. Sit up and stair climbing tests in the Galantino et al. (2005a) study involved counts of each within a specified time frame.

Of the studies that relied on self-reported measures, (Agarwal et al., 2015; Agin et al., 2001; Baigis et al., 2002; Cade et al., 2010; Dolan et al., 2006; Fillipas et al., 2006; Ogalha et al., 2011), the findings were inconclusive. Self-reported improvement of functional capacity was only significant when supervised PRT was included in the PA intervention. This finding is supported by evidence that subjective assessments of PA are only beneficial to ranking participants as more or less physically active, but not quantifying PA in terms of time spent in each level of PA (Masse & de Niet, 2012). In other words, reporting bias may have affected participant recall for time spent in PA.

Our findings support evidence that PA interventions are effective at improving cardiovascular fitness and muscular strength in ALWH (Gomes-Neto et al., 2013; O’Brien et al., 2016b, 2017; Poton et al., 2016). While other systematic reviews focused on overall PA levels in ALWH (Schuelter-Trevisol et al., 2012; Vancampfort et al., 2016a), benefits of PA and PA recommendations (Gomes Neto et al., 2015; Gomes-Neto et al., 2013; Kamitani et al., 2017; O’Brien et al., 2016b), or facilitators and barriers of PA (Vancampfort et al., 2017b), our review stands apart because of the focus on the supervisory aspect of PA interventions and its potential to improve functional capacity for ALWH. Essentially, our review showed that supervision of
PA increases functional capacity in adult ALWH and may be an enabling factor to support PA among ALWH.

HIV is now managed as a chronic illness for many ALWH in the United States and the developed world due to the success of ART (Deeks et al., 2013a; Samji et al., 2013). Research has shown that chronically ill persons are less likely to engage in PA (Mansfield, Thacker, Spahr, & Smith, 2018; Miravitlles, Cantoni, & Naberan, 2014; Volaklis et al., 2018). Studies of supervised PA interventions in HIV-uninfected, chronically ill populations have suggested that incorporation of formal, structured programs may facilitate increased PA participation (Allen & Morey, 2010; Bousquet-Dion et al., 2018) and supervision may play a role in retaining participants in PA interventions (Akbaba et al., 2016; Dalager et al., 2015; Rossomanno et al., 2012). Increases in PA may be due, in part, to the reported improved morale and confidence to engage in PA when a clinician is supervising the activity (Bauman et al., 2012; Kuru Colak et al., 2017; Tully, Morgan, Burke, & McGee, 2010). Studies of people living with diabetes, heart failure, kidney failure, cancer, arthritis, and obesity have demonstrated empirical improvement in PA participation where supervised PA was the intervention under inquiry (Akbaba et al., 2016; Azad et al., 2012; Casla et al., 2014; Daul et al., 2004; Klempfner et al., 2015; Kuru Colak et al., 2017; Negri et al., 2010; Nicolai et al., 2009; Tully et al., 2010). Therefore, supervised PA interventions can serve as formal, structured programs to increase and maintain regular PA among ALWH.

**Recommendations and Implications**

**Recommendations.** The therapeutic alliance between a health professional and patient, an important component in patient engagement (T. Higgins, Larson, & Schnall, 2017), may increase regular PA in ALWH. For example, the benefit of the therapeutic alliance during a PA
intervention was demonstrated in the Galantino et al. (2005a) study. Those participants reported a newly formed “brotherhood,” working harder during the PA, and that the added presence of a leader facilitated their participation in the PA, where they would not have participated if a leader was not present. A recent systematic review and meta-analysis investigating dropout from PA interventions with ALWH revealed reduced dropout rates involving supervised PA interventions ($p < .001$) and interventions using qualified professionals ($p < .001$; Vancampfort et al., 2017a). Therefore, supervised PA interventions modeled after the general medicine therapeutic alliance, with the presence of a health care or allied health professional, may increase regular PA participation and ultimately sustained improvement in functional capacity in ALWH.

**Nursing implications.** Findings from our study present a unique opportunity for nurses who care for ALWH. Because supervised PA has been shown to improve outcomes in ALWH and nurses are the largest sector of health professionals, this provides an opportunity for nurses to supervise PA interventions for ALWH. Moreover, the presence of a health care professional, such as a nurse, during PA may encourage ALWH to participate in and work harder during the PA interventions, improve long-term adherence to PA, and improve motivation and self-efficacy to reach PA goals (Peddle-McIntyre, Bell, Fenton, McCargar, & Courneya, 2013; Trinh et al., 2014; Vancampfort et al., 2017a). Nurses can fill that gap by becoming the PA facilitator.

Additionally, our findings present an opportunity for nurse scientists to help fill gaps in the literature. Specifically, the current literature is comprised of studies with small sample sizes and high variability of intervention components (e.g., frequency, session duration, and length) and outcome measures. This variability makes comparison via meta-analysis and drawing succinct conclusions difficult. Further research by nurse scientists with more rigorous and robust research designs will enhance knowledge of the ability of PA interventions to improve health.
outcomes in ALWH.

Limitations

Inclusion of only English studies was a limitation, because there may be relevant studies published in African languages, given that the burden of the HIV epidemic persists in Africa (World Health Organization, 2017a). In our review, none of the included studies took place in an African country. Therefore, the external validity of our findings is limited to the countries represented: Australia, Brazil, Ireland, Spain, and the United States. Additionally, 9 of the 15 studies had samples of 30 or less and all had fewer than 100 participants. Selection bias may be present as the study participants may represent ALWH who were already motivated to take ownership of their health and participate in PA. The small sample sizes in the individual studies also presented the potential for a type 1 error. Inclusion of RCTs and the inherent randomization, however, elevated the level of evidence presented here and counters the potential for selection bias and type 1 error. The number of articles included in this review may also be a limitation, as 15 articles may be considered a small number of articles to comprise a systematic review. However, PRISMA guidelines were followed and the search strategy and selection criteria were developed a priori. The resulting articles included for review reflected the dearth of studies on this topic. Our systematic review will, nonetheless, make an important contribution to the literature considering increased longevity in ALWH and the benefits of supervised PA interventions on health outcomes in this population.

The heterogeneity of studies, including the length of the interventions, duration of the study, follow-up assessment period, assessment instruments, and assessment modality, precluded a meta-analysis. Like other systematic reviews, our review demonstrated the need for consistent protocols and outcome measures across studies (Gomes-Neto et al., 2013; Schuelter-Trevisol et
al., 2012; Vancampfort et al., 2017b). At the individual study level, clinical significance may have been present where statistical significance was absent. For instance, at the end of 16 weeks in the McDermott et al. (2016) study, there was a trend toward improvement in cardiovascular fitness that may have revealed statistically significant improvements with a longer follow-up period.

**Conclusions**

The results of our review indicate that supervised PA interventions are associated with improved functional capacity in ALWH and may motivate ALWH to regularly participate in PA. Of all the interventions, the supervised aerobics and PRT interventions demonstrated improvements in strength, cardiovascular, and flexibility and balance outcomes. The inclusion of PRT with aerobics interventions demonstrated improved cardiovascular outcomes compared to aerobics alone. Furthermore, functional capacity assessed by self-report rather than objective measures may not reflect improvements in functional capacity, except where PRT is included in the intervention.

Future studies should consider PA interventions with and without supervision to quantify the benefit of these interventions in this population. A special focus should be placed on the long-term impact and outcomes of supervised PA for elderly ALWH as the average age of ALWH continues to rise.
Key Considerations

- Supervised physical activity interventions can increase functional capacity in adults living with HIV.
- Supervised aerobics and progressive resistance training are amongst the most effective physical activity interventions to improve cardiovascular, strength, and flexibility and balance outcomes in adults living with HIV.
- There is discordance between self-report and physiological outcomes of functional capacity in adults living with HIV.
- Supervised physical activity interventions may encourage regular physical activity in adults living with HIV.
Tables and Figures

Figure 2.1. Flow Diagram of Study Selection

Identification

Records identified through database searching ($n = 8,267$):
- PubMed = 2,090
- CINAHL = 1,617
- PsycINFO = 214
- Embase = 4,076
- Physical Education Index = 270

Additional records identified through other sources ($n = 126$)

Screening

Records identified ($n = 8,393$)

Duplicate records excluded ($n = 1,130$)

Records screened by title and abstract ($n = 7,263$)

Records excluded by title and abstract ($n = 7,068$)

Eligibility

Full-text articles assessed for eligibility ($n = 195$)

Full-text articles excluded, with reasons ($n = 180$):
- Wrong intervention ($n = 82$)
- Wrong study design ($n = 50$)
- No full text ($n = 28$)
- Wrong outcomes ($n = 11$)
- Dissertations ($n = 6$)
- Non-English ($n = 3$)

Included

Studies included in systematic review ($n = 15$)
Table 2.1

**Characteristics of the Physical Activity Interventions of Included Studies (n = 15)**

<table>
<thead>
<tr>
<th>Study &amp; Sample Size</th>
<th>Country</th>
<th>Intervention</th>
<th>Frequency (per week)</th>
<th>Session Duration</th>
<th>Study Length (weeks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agarwal et al., 2015 (n = 24)</td>
<td>USA</td>
<td>Yoga &amp; Meditation</td>
<td>2</td>
<td>60 min</td>
<td>8</td>
</tr>
<tr>
<td>Agin et al., 2001 (n = 30)</td>
<td>USA</td>
<td>PRT</td>
<td>3</td>
<td>3 sets, 8-10 repetitions per muscle group</td>
<td>14</td>
</tr>
<tr>
<td>Baigis et al., 2002 (n = 99)</td>
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<td>Aerobics</td>
<td>3</td>
<td>40 min</td>
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</tr>
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<td>USA</td>
<td>Yoga</td>
<td>2-3</td>
<td>60 min</td>
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<td>Dolan et al., 2006 (n = 38)</td>
<td>USA</td>
<td>Aerobics &amp; PRT</td>
<td>3</td>
<td>120 min</td>
<td>16</td>
</tr>
<tr>
<td>Driscoll et al., 2004 (n = 25)</td>
<td>USA</td>
<td>Aerobics &amp; PRT</td>
<td>3</td>
<td>Weeks 1-2: 20 min aerobics + PRT Weeks 3-12: 30 min aerobics + PRT PRT: 3 sets, 10 repetitions per muscle group</td>
<td>12</td>
</tr>
<tr>
<td>Dudgeon et al., 2012 (n = 26)</td>
<td>USA</td>
<td>Aerobics &amp; PRT</td>
<td>2</td>
<td>Aerobics: 30 min PRT: 1 set, 12 repetitions per muscle group</td>
<td>6</td>
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<tr>
<td>Farinatti et al., 2010 (n = 27)</td>
<td>Brazil</td>
<td>Aerobics &amp; PRT</td>
<td>3</td>
<td>90 min</td>
<td>12</td>
</tr>
<tr>
<td>Fillipas et al., 2006 (n = 35)</td>
<td>Australia</td>
<td>Aerobics &amp; PRT</td>
<td>2</td>
<td>60 min</td>
<td>24</td>
</tr>
<tr>
<td>Galantino et al., 2005 (n = 38)</td>
<td>USA</td>
<td>Aerobics &amp; T’ai Chi</td>
<td>4</td>
<td>60 min</td>
<td>8</td>
</tr>
<tr>
<td>McDermott et al., 2016 (n = 11)</td>
<td>Ireland</td>
<td>Aerobics</td>
<td>3</td>
<td>31-52 min</td>
<td>16</td>
</tr>
<tr>
<td>Ogalha et al., 2011 (n = 63)</td>
<td>Brazil</td>
<td>Aerobics &amp; PRT</td>
<td>3</td>
<td>60 min</td>
<td>24</td>
</tr>
<tr>
<td>Perez-Moreno et al., 2007 (n = 19)</td>
<td>Spain</td>
<td>Aerobics &amp; PRT</td>
<td>3</td>
<td>90 min</td>
<td>16</td>
</tr>
<tr>
<td>Study</td>
<td>Country</td>
<td>Intervention</td>
<td>Duration</td>
<td>Frequency</td>
<td>Notes</td>
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<tr>
<td>Strawford et al., 1999 (n = 22)</td>
<td>USA</td>
<td>PRT</td>
<td>60 min</td>
<td>3</td>
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<tr>
<td>Terry et al., 2006 (n = 30)</td>
<td>Brazil</td>
<td>Aerobics</td>
<td>60 min</td>
<td>3</td>
<td>12</td>
</tr>
</tbody>
</table>

*Note.* PRT = progressive resistance training.
## Table 2.2

Functional Capacity Outcomes of Intervention Groups in the Included Studies (n = 15)

<table>
<thead>
<tr>
<th>Type of Supervised PA</th>
<th>Study (Year)</th>
<th>Functional Capacity Measure</th>
<th>Functional Capacity Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerobics</td>
<td>Baigis (2002)</td>
<td>VO2max, Diary, DASI, MOS-HIV, SIP</td>
<td>Ø</td>
</tr>
<tr>
<td></td>
<td>Galantino (2005)</td>
<td>Sit-up, Stair climbing</td>
<td>↑</td>
</tr>
<tr>
<td></td>
<td>McDermott (2016)</td>
<td>VO2max, Treadmill time, Light/Moderate/Vigorous PA</td>
<td>Ø</td>
</tr>
<tr>
<td></td>
<td>Terry (2006)</td>
<td>Peak HR, BMI, BP</td>
<td>Ø</td>
</tr>
<tr>
<td></td>
<td>Strawford (1999)</td>
<td>1-RM</td>
<td>↑</td>
</tr>
<tr>
<td></td>
<td>Dolan (2006)</td>
<td>VO2max, Bike time, 6MWT, Change in strength, Exit interview questions</td>
<td>↑</td>
</tr>
<tr>
<td></td>
<td>Driscoll (2004)</td>
<td>BP, Exercise time, Change in strength 1 &amp; 2</td>
<td>↑, Ø</td>
</tr>
<tr>
<td>Aerobics + Progressive Resistance Training</td>
<td>Dudgeon (2012)</td>
<td>Change in strength</td>
<td>↑</td>
</tr>
<tr>
<td></td>
<td>Farinatti (2010)</td>
<td>BMI, Heart rate, 12-RM, Sit and reach</td>
<td>↑</td>
</tr>
<tr>
<td></td>
<td>Fillipas (2006)</td>
<td>Heart rate, HRQOL</td>
<td>↑</td>
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<tr>
<td></td>
<td>Ogalha (2011)</td>
<td>BMI, Resting HR, VO2max, MET, Change in muscle mass, SF-36</td>
<td>Ø, ↑</td>
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<tr>
<td></td>
<td>Perez-Moreno (2007)</td>
<td>Workload, Peak HR, Decline HR, 6-RM</td>
<td>↑</td>
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<tr>
<td>Yoga + Meditation</td>
<td>Agarwal (2015)</td>
<td>SF-36</td>
<td>Ø</td>
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<td>Cade (2010)</td>
<td>SF-36</td>
<td>Ø</td>
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<tr>
<td>T’ai Chi</td>
<td>Galantino (2005)</td>
<td>Forward reach, Sit and reach</td>
<td>↑</td>
</tr>
</tbody>
</table>

Note. Ø = no significant change in functional capacity; ↑ = significantly improved functional capacity; VO2max = maximal aerobic capacity; PA = physical activity; BMI = body mass index; DASI = Duke Activity Status Index; MOS-HIV = Medical Outcomes Study, HIV Health Survey; SIP = Sickness Impact Profile; HR = heart rate; BP = blood pressure; 1-RM = 1 repetition
maximum; 6-RM = 6 repetition maximum; 12-RM = 12 repetition maximum; SF-36 = Medical Outcomes Study, 36-item Short Form Health Survey; 6MWT = 6-Minute Walk Test; Change in strength 1: leg curl, leg extension, lateral pull down, arm curl, chest press; Change in strength 2: leg press; HRQOL = Health Related Quality of Life; MET = metabolic equivalent.
Figure 2.2. Risk of Bias within Studies

<table>
<thead>
<tr>
<th></th>
<th>Random sequence generation (selection bias)</th>
<th>Allocation concealment (selection bias)</th>
<th>Blinding of participants and personnel (performance bias)</th>
<th>Blinding of outcome assessment (detention bias)</th>
<th>Incomplete outcome data (attrition bias)</th>
<th>Selective reporting (reporting bias)</th>
<th>Other bias</th>
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<td>Agin 2001</td>
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**Figure 2.3. Risk of Bias across Studies**
Chapter Three: The Role of Environment on Physical Activity Patterns of Adults Living with HIV

Chapter Three addresses Aims 2 and 3 of the dissertation, using a secondary data analysis to assess the PA patterns of older ALWH and the impact of environmental factors on PA patterns in this population. The journal targeted for this manuscript is the *Journal of Aging and Physical Activity*.

Abstract

**Aims:** To study the physical activity (PA) patterns of older adults with HIV and investigate the relationship between environmental factors and PA in this population. **Methods:** This study was a secondary analysis of data from adults, aged 50 and over, living with HIV in New York City. Descriptive statistics assessed PA patterns. Linear regression assessed the association between environmental factors and time spent in PA. **Results:** All participants were on antiretroviral therapy; ranged in age from 50 - 71 years, were 50% female, and had HIV for 23 years on average. Participants performed at 75% of their functional capacity \( p < .0001 \) and females walked less than males \( p < .05 \). Traffic hazards were the sole environmental predictor of PA participation in this sample. **Conclusion:** Targeted interventions are needed to increase PA in this growing population. Interventions at the policy level should reduce traffic hazards to support PA.

**Keywords:** Elderly, Exercise, AIDS
Introduction

An estimated 56% of the 1.1 million people living with human immunodeficiency virus in the United States are aged 50 years and older (Centers for Disease Control and Prevention [CDC], 2017b). The longevity seen in adults living with HIV (ALWH) is largely due to the effectiveness of antiretroviral therapy (ART) (ART Cohort Collaboration, 2008; Samji et al., 2013). A recent meta-analysis examining survival rates of nearly 300,000 ALWH, showed that although most HIV patients progress to acquired immunodeficiency syndrome (AIDS) within the first decade of diagnosis, those on ART survive longer than 10 years following their AIDS diagnosis, while those not on ART die within 2 years of their AIDS diagnosis (Poorolajal, Hooshmand, Mahjub, Esmailnasab, & Jenabi, 2016). The findings of this study demonstrate the positive impact of ART on life expectancy in ALWH.

Despite its contribution to longevity, long-term ART and HIV exposure (i.e., years living with HIV) have been linked to systemic inflammation (Deeks et al., 2013b; Samji et al., 2013). The body responds to an acute HIV infection much like any other viral infection, with the release of inflammatory mediators to fight the virus and prevent it from replicating (Chou & Effros, 2013; Gruver et al., 2007). The role of ART is to prevent mortality from HIV/AIDS by reducing HIV replication, also known as viral load (HIV Causal Collaboration, 2010). Therefore, it is expected that consistent ART would reduce the body’s inflammatory response because of the reduction in viral load. However, this is not the case. Evidence suggests elevated levels of inflammatory biomarkers persist in ALWH despite long-term ART (Deeks et al., 2013a; Wing, 2016) and compared against HIV-negative controls (Armah et al., 2012; Deeks, 2011; Gandhi et al., 2017; Neuhaus et al., 2010). Thus, despite its role in reduced mortality in ALWH, ART seems to play a role in the sustained inflammation in this population.
In the existing literature, the inflammation associated with HIV has been measured as an increase in inflammatory biomarkers, such as C-reactive protein, IL-6, and D-dimer, present in their blood (Deeks et al., 2013b; Gandhi et al., 2017; Hart et al., 2018; Sokoya, Steel, Nieuwoudt, & Rossouw, 2017). These elevated biomarkers are also found among patients with cancer, cardiovascular, metabolic, kidney, and bone diseases (Deeks et al., 2013b; Schouten et al., 2014b). These diseases are common comorbidities of ALWH, with cardiovascular disease being a leading non-AIDS cause of death in this population (Farahani et al., 2017). Long-term ART and HIV exposure, therefore, are associated with the increased presence of inflammatory biomarkers, morbidity, and mortality seen in ALWH (Hart et al., 2018; Schouten et al., 2014b; So-Armah et al., 2016; Sokoya et al., 2017).

Physical activity (PA) has been shown to reduce the inflammation associated with HIV and ART among adults living with the disease (Bonato et al., 2017; d'Ettorre et al., 2014; Dirajlal-Fargo et al., 2016). PA is defined as any bodily movement that results in energy expenditure; whereas exercise, a subset of PA, is planned, repetitive movement performed with the intention of improving or maintaining an aspect of fitness (Caspersen et al., 1985). PA not only reduces the inflammation associated with HIV and ART, it also improves cardiovascular fitness in ALWH (O'Brien et al., 2016a, 2017; Poton et al., 2016). Researchers have found additional benefits of PA in ALWH, which include decreased depression—the most prevalent mental health disorder in this population (Do et al., 2014; Rubin & Maki, 2019), improved body composition, reduced lipodystrophy, increased strength, improved health-related quality of life, and prevention of cardiovascular diseases and cancers (Jaggers, 2018; Kamitani et al., 2017; O'Brien et al., 2016a, 2017; Poton et al., 2016). Thus, ALWH are encouraged to participate in PA to: (1) counter the effects of inflammation associated with long-term ART and HIV.
exposure; (2) reduce the risk of common comorbidities associated with non-AIDS causes of death; and (3) improve overall healthy aging, given that a growing majority of this population is aged 50 and over.

The U.S. Department of Health and Human Services (HHS) recommends 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity PA per week for all adults as part of overall health maintenance (HHS, 2008). However, federal PA guidelines designed specifically for ALWH do not yet exist. Yahiaoui et al. (2012) have developed PA recommendations for adults over 50 years living with HIV, hereafter referred to as older ALWH, that include a minimum of 20-40 minutes of aerobic exercise followed by resistance training, at least three days per week. A 5- to 10-minute session of stretching is also recommended before and after each PA session to prevent injury.

Despite the wide-ranging benefits of PA among all ALWH, they reportedly participate in PA at rates substantially below the minimum recommended guidelines (Webel et al., 2019). For example, upon excluding walking from the list of acceptable forms of PA, researchers found that ALWH participated in only 1.4 hours of PA per week, far less than the 2.5 hours recommended by HHS (Webel et al., 2015a). Walking and stretching, considered low-intensity PA, are among the most common forms of PA performed or reported by ALWH (Webel et al., 2015a), which limits the health benefits to be gained from PA that occurs at moderate and vigorous-intensity (O'Brien et al., 2016a, 2017; Poton et al., 2016). A recent meta-analysis examining PA levels in ALWH found that only 50.7% of this population was compliant with the HHS guidelines of 150 minutes of moderate-intensity PA (Vancampfort et al., 2016b). Furthermore, dropout from PA interventions during randomized controlled trials is higher in ALWH than in populations with other chronic conditions, such as type 2 diabetes and clinical depression (Vancampfort et al.,
Thus, ALWH not only engage in less PA when compared to guidelines set for all U.S. adults, ALWH underperform when compared to individuals from other chronic conditions. This evidence suggests that ALWH exhibit a unique inability to participate in PA.

To encourage PA in ALWH, as in other populations, it is important to assess the physical and social environments in which the PA takes place. Previous studies have shown that the characteristics of physical and social environments affect PA patterns among adults in the general population (Gustat et al., 2012; Smith et al., 2017; Veerman et al., 2016; Zapata-Diomed & Veerman, 2016). For example, in a study in which a walking path (physical environment) was installed in a low-income neighborhood, both self-reported and observed PA increased compared to demographically and structurally similar neighborhoods lacking a walking path (Gustat et al., 2012). In fact, the proportion of people who engaged in moderate- and vigorous-intensity PA also significantly increased. Additionally, favorable perceptions of safety and social cohesion (social environment) within a neighborhood, as well as, perceptions of low levels of criminal incivilities (social environment), were associated with increased PA of its residents on a regular basis (Evenson et al., 2012; Samuel et al., 2015). Evidence from these studies informed the need to assess the environments in which ALWH might participate in PA.

Aspects of the physical environment that promote PA include accessibility of recreational resources, presence of sidewalks and bike lanes, street connectivity, reduced noise and air pollution, and the availability and cost of healthy foods (Diez Roux, 2003; Diez Roux, Mujahid, Hirsch, Moore, & Moore, 2016). Aspects of the social environment that promote PA include perceptions of increased safety and reduced violence, social support and cohesion, and positive social norms and behaviors (Diez Roux, 2003; Diez Roux et al., 2016). While these studies provide valuable insights into the impact of social and physical environments on PA, to date no
studies have examined the relationship between the attributes of social and physical environments and PA patterns of older ALWH.

**Study Aims**

This study aimed to: (1) describe the PA patterns of older ALWH, and (2) investigate the relationship between environmental factors—including social and physical environments—and PA patterns of older ALWH.

**Methods**

**Conceptual Framework**

The Ecological Model of Four Domains of Active Living, created by Sallis et al. (2006), inspired the conceptual approach to this study. The model, hereafter referred to as the EMFDAL, has been adapted, as illustrated in Table 3.1, to construct a framework relevant to this study’s particular aims. The adapted EMFDAL contains four domains depicted as concentric circles. From outermost to innermost, the constructs of this conceptual model include the physical environment, social environment, intrapersonal domain, and physical activity domain.

The outermost circle of the adapted EMFDAL describes the *physical environment*, which represents the natural, physical, and built aspects of one’s environment in which PA may take place. This domain accounts for both access to PA and the settings in which PA occurs. Moving inward, the next circle is the *social environment*, which describes an individual’s perceptions of aspects of their surrounding environment that influence their participation in PA. The aspects of interest in the social environment include perceptions of crime, comfort, convenience, safety, accessibility, and environmental aesthetic. The next circle is the *intrapersonal* domain. This domain describes the demographic characteristics of an individual (e.g., age, sex, race/ethnicity, marital status, CD4 count, etc.) and their potential influence on one’s ability to engage in PA.
Finally, the *physical activity* domain describes the actual types of PA that take place, including PA during recreation, transport, occupation, and within one’s household activities.

This conceptual model posits that multilevel interventions are necessary to achieve population changes regarding PA engagement. For example, to increase jogging in a community, the neighborhood may require sidewalks or green spaces where one would jog (physical environment). To jog in that space, one must feel they can easily access a park and feel safe jogging there (social environment). Next, jogging may be challenging for an individual with poorly managed asthma or obesity (intrapersonal domain), but walking may be more feasible (physical activity domain). In short, the adapted EMFDAL model illustrates how certain interdependent conditions must be present in order for PA to occur, and therefore served as the guiding framework of this study.

**Study Design and Data Source**

This study was a secondary analysis of data drawn from a cross-sectional study conducted in 2016. The original study, conducted in New York City (NYC), was part of a large multi-site investigation into PA patterns and cardiorespiratory fitness of ALWH by age and sex across the lifespan (Webel et al., 2019).

**Participants**

In the parent study, a sample of 100 older ALWH was purposively recruited by season (i.e., 25% in each quarter of the calendar year) between January and December 2016. The reason for this sampling technique was to account for potential confounding effects of weather as it related to PA participation. Participants were recruited via flyers posted at HIV clinics and community-based organizations in NYC, as well as on websites, such as Facebook and Craigslist. Recruitment via the aforementioned websites has proven successful in past studies of
ALWH (Iribarren et al., 2017; Schnall et al., 2017). Interested participants responded to posted flyers via telephone and were screened for study eligibility at that time.

ALWH were eligible to participate if they: (1) were adults aged 50 years or older, (2) could read and write in English, and (3) had been diagnosed with HIV. HIV diagnosis was confirmed via documentation provided by the participant from their physician that demonstrated HIV-positive blood test results. Study exclusion criteria included a current or prior condition that contraindicated PA as designated by the American Heart Association (e.g., active endocarditis, acute pulmonary embolism or pulmonary infarct, uncontrolled cardiac arrhythmias, or decompensated symptomatic heart failure), a physical disability that precluded PA (e.g., spinal cord injuries, muscular dystrophy, limb amputations without prosthetics), or dependence on an assistive device, such as a walker or cane, to perform PA (Fletcher et al., 2001).

**Procedures**

Approval for the parent study was obtained from the Institutional Review Board of Columbia University Medical Center (IRB-AAAQ2321). All eligible participants reported to Columbia University School of Nursing as the study site. Informed consent was obtained via written documentation from each participant upon arrival and prior to any data collection, and participants were provided with a copy of their signed consent form. All study activities, including surveys and anthropometric measurements, were completed in a private office. The exception was the 6MWT, which was completed in a hallway outside of the office. The estimated time to completion of the entire study was 45 minutes, and participants were provided with $25 cash upon completion.
Measures

Each of the measures included in the current study were aligned with the domains of the adapted EMFDAL (see Table 3.1).

**Intrapersonal domain.** The intrapersonal domain (i.e., individual characteristics of the study participants) was assessed using two measures, a self-reported demographics questionnaire and anthropometrics.

**Demographics questionnaire.** Study participants in the original study completed a 20-item, self-reported, polytomous response demographic questionnaire. In the current study, 11 of the 20 demographic survey items were used, because they aligned with the adapted EMFDAL. The 11 items queried age, sex, race/ethnicity, education level, marital status, employment status, income level, presence of comorbidities, type of comorbidities present, viral load, and CD4 count.

**Anthropometrics.** Researchers collected four measures of anthropometrics (i.e., height, weight, and hip and waist circumference). These variables were measured using a yardstick for height in inches, a digital scale to record weight in pounds, and a cloth tape measure for hip and waist circumference (in inches).

**Social and physical environment domains.** The social and physical environment domains of the adapted EMFDAL were measured using the abbreviated Neighborhood Environment Walkability Scale (NEWS-A; Cerin et al., 2006). This scale was chosen because it was developed to measure both the social and physical environments, has been widely used in the literature (Arvidsson, Kawakami, Ohlsson, & Sundquist, 2012; Cerin, Leslie, Owen, & Bauman, 2008; Cerin, Macfarlane, Ho, & Chan, 2007; De Bourdeaudhuij, Sallis, & Saelens, 2008).
2003; Hallal et al., 2010), and has demonstrated strong psychometric properties (Adams et al., 2009; Cerin et al., 2008; Cerin et al., 2006).

The NEWS-A is a 54-item, self-administered survey that measures aspects of one’s environment related to PA, namely the social environment (one’s perception of their environment) and how it relates to their physical environment (where actual PA takes place). The survey contains 12 subscales (see Table 3.1). Subscales of the social environment include land-use mix access, aesthetics (describing environmental aesthetics), traffic hazards, crime, and lack of parking. Subscales of the physical environment included residential density, land-use mix-diversity, street connectivity, infrastructure for safety and walking, lack of cul-de-sacs, hilliness, and physical barriers.

**Residential density and land-use mix-diversity subscales.** Defined as the frequency of types of residences (single-family detached homes versus multi-story apartments or condominiums), residential density was measured on a 5-point Likert scale from none (i.e., not present) to all (i.e., only type present). The land-use mix-diversity subscale assessed the walking distance between home and various stores and facilities, such as gas stations, clothing stores, or supermarkets. Items in this subscale were measured on a 6-point Likert scale including 1-5 minutes, 6-10 minutes, 11-20 minutes, 21-30 minutes, 31+ minutes, and don’t know.

**Remaining 10 subscales.** 1) Land-use mix-access (i.e., places within 10-15 minutes of home), 2) street connectivity, 3) infrastructure and safety for walking, 4) aesthetics (i.e., environmental aesthetics), 5) traffic hazards, 6) crime, 7) lack of parking, 8) lack of cul-de-sacs, 9) hilliness, and 10) physical barriers queried level of participant agreement with subscale-specific statements and were measured on a 4-point Likert scale from 1 (strongly disagree) to 4 (strongly agree).
Scoring. Scores of the subscales of the NEWS-A were computed based on the instrument’s scoring instructions (Cerin et al., 2006). Responses were summed to produce subscale scores. Higher scores, indicating the greater walkability of a neighborhood, were favorable among all subscales except traffic hazards, crime, hilliness, and physical barriers. Higher scores in these four subscales indicated less walkability of a neighborhood and thus, were reverse coded to allow for uniform interpretation.

Psychometrics. The NEWS-A has strong psychometric properties. Factorial validity, using confirmatory factor analysis, has been established by correlating scores from the factors of the NEWS-A with scores from the factors of the NEWS, the original version of the questionnaire which has been previously validated in the literature (Saelens, Sallis, Black, & Chen, 2003). Resultant correlations between the NEWS-A and NEWS range from .82 to .98 ($p = .001$) (Cerin et al., 2006), where correlations of .70 or greater indicate a high or very high correlation (Mukaka, 2012). Therefore, the NEWS-A demonstrates a high degree of factorial validity. Reliability coefficients from the NEWS-A, measured as intraclass correlations, ranged from .63 to .80 ($p < .03$), indicating a moderate to high degree of test-retest reliability (Saelens et al., 2003) (see Appendix B for the complete NEWS-A).

Physical activity domain. The physical activity domain of the adapted EMFDAL was measured using the 7-Day PA Recall (7-Day PAR), developed by Sallis et al. (1985), and the 6-Minute Walk Test (6MWT), developed by Enright and Sherrill (1998).

7-Day PAR. The 7-Day PAR assesses routine PA among adults over a 7-day period. The 7-Day PAR was designed as a semi-structured interview format. The researcher guided the participant through their recall of time spent in each intensity category of PA over the seven days prior to the interview. As participants were guided through recall of PA during different periods
of the day (i.e., morning, afternoon, and evening), they were instructed to describe their PA as moderate, hard, or very hard intensity. These intensities were defined by each participant according to the 7-Day PAR interviewer guidelines; “moderate” PA is similar to the feeling of walking at a normal pace, “hard” PA is more difficult than walking but not as strenuous as running, and “very hard” PA is similar to how one feels when running (Sarkin et al., 1997). Immediately following the interview, the researcher calculated the duration of each intensity category of PA for each portion of each day in minutes according to the instrument’s scoring instructions (Sallis et al., 1985). In terms of psychometrics, the 7-Day PAR has been previously validated (Blair et al., 1985; Hayden-Wade, Coleman, Sallis, & Armstrong, 2003; Racette, Schoeller, & Kushner, 1995; Rauh, Hovell, Hofstetter, Sallis, & Gleghorn, 1992); and test-retest reliability has been established with Pearson correlation coefficients for moderate-intensity (r = .75, p < .0001) and vigorous-intensity PA (r = .83, p < .0001) (Sallis et al., 1985).

*The 6-Minute Walk Test (6MWT).* The 6MWT is a commonly used measure of functional capacity that is easily administered and well tolerated among those being studied (Bohannon & Crouch, 2017; Galiano-Castillo et al., 2016; Kobayashi, Himuro, & Takahashi, 2017; Kubo et al., 2018; Uszko-Lencer et al., 2017; Vandecasteele et al., 2016). In the parent study, participants were asked to continuously walk between two cones, set 50 feet apart, for 6 minutes. Using a counter, the researcher would count each lap as the point when the participant reached a cone. The sum distance completed in 6 minutes was then compared to the expected distance of an individual, given their age, sex, height, and weight. The comparison of actual-to-expected distance represents one’s functional capacity. The 6MWT formulas used to calculate expected distance for male and female participants were obtained from the original study (Enright & Sherrill, 1998).
Criterion validity of the 6MWT has been established using Pearson correlation coefficients comparing the 6MWT to treadmill time (r = .78, CI = .62 - .88), 6MWT to cycle ergometer (r = .58, p < .001), and test-retest reliability using intraclass correlations (R = .94, CI = .90 - .96) (Guyatt et al., 1985; Rikli & Jones, 1998, 1999). Study survey instruments and the domains they describe are listed in Table 3.1. (See Appendix C for the data collection tool used for the 7-Day PAR).

**Data Analysis**

Analyses for this study comprised a combination of descriptive statistics and linear regression. All analyses were performed in SAS version 9.4. Participant demographics were summarized using frequency tables to describe categorical variables and means and standard deviations to describe continuous variables. 6MWT data was analyzed in two ways: descriptive statistics and linear regression. To measure PA patterns of older ALWH, we used descriptive statistics to summarize the results of the 6MWT. To assess whether older ALWH were performing PA at their maximum capability, we compared the mean expected distance to the mean actual distance walked in 6 minutes. We used linear regression analyses to further assess PA patterns in which the actual distance walked during the 6MWT was the outcome variable and HIV-specific variables were independent variables (i.e., CD4 count, viral load, and years living with HIV), controlling for demographics (i.e., sex, presence of comorbidities, and education level). Evidence suggests differences in PA patterns among sex (i.e., males versus females), presence of comorbidities, and across levels of education exist in ALWH; therefore, we used these variables as control variables in our model (Balderson et al., 2013; Vancampfort et al., 2017c; Webel et al., 2015a).
To build the linear regression models, we first checked for missing data and multicollinearity of the independent variables. We tested for multicollinearity using a Variance Inflation Factor (VIF) less than 10, where variables with a VIF < 10 indicated the absence of multicollinearity (Kutner, Nachtsheim, Neter, & William, 2005). Next, we conducted bivariate analyses between each variable with a VIF < 10 and the outcome variable using t-tests for significance. If the $p$-value was less than .2, the variable was included in the final multivariable model (Hosmer, Lemeshow, & Sturdivant, 2013).

Next, we assessed the relationship between one’s environment and PA patterns. The outcome variable in this model was the self-reported, combined time spent in moderate and vigorous PA obtained from the 7-Day PAR. The independent variables for our model included the subscales of the NEWS-A as our environmental factors. The model was adjusted for demographics and potential covariates (e.g., sex, education level, comorbidity, viral load). We used a similar model-building approach as above. After checking for missing data, we tested for multicollinearity using a VIF less than 10 and excluded the variables with a VIF greater than 10. Next, we conducted bivariate analyses between each remaining variable and the outcome variable using t-tests for significance. If the result was a $p$-value less than .2, the variable was included in the final multivariable model (Hosmer et al., 2013). Regression coefficients and $p$-values were reported to assess the strength and direction of the association between each variable and outcome in all linear regression models. The alpha level was set at .05 to control for type 1 error in the current study for all linear regression models.
Results

Participant Demographics

The majority of participants, 76%, were between the ages of 50 and 59, with a range of 50 to 71 years. Half of the participants were female, 61% identified as African American, and 62% were single. Fifty-five percent of participants earned a high school education/GED equivalent or less, 6% were currently employed, and 72% earned less than $1,000 per month. Regarding HIV status, 84% had an undetectable viral load, with a mean viral load of 5,564 and a range of 20-289,000, while 59% had a CD4 count greater than 500, with a mean CD4 count of 645 and a range of 7-1,950. The mean number of years living with HIV was approximately 21 years, with a range from 1 to 34 years. All participants reported taking antiretroviral therapy.

Eighty-four percent of the sample reported having at least one chronic comorbidity, the top self-reported conditions including mood disorders (e.g., depression, anxiety, bipolar) at 43% and cardiac disease (e.g., high blood pressure, atrial fibrillation, high cholesterol) at 35% (see Table 3.2).

Physical Activity Patterns

The average distance walked was 382.9 feet in 6 minutes, with a range of 255 to 645 feet. The average distance expected to walk was 507.8 feet in six minutes, with a range of 393.6 to 638.7 feet. Participants in this sample performed at 75.4% of their expected capacity ($p < .0001$). Females in the sample walked approximately 45 feet less than males in this sample ($p = .0033$).

Having earned a high school diploma or GED equivalent was associated with walking about 47 feet farther on the 6MWT compared to those that had less than a high school education ($p < .05$). Higher levels of education, specifically having completed two years of college/technical school training or being a college graduate or beyond, were only marginally
associated with an increase of about 49 feet during the 6MWT, \( p = .056 \) and \( .053 \), respectively. In this sample, the presence of one or more comorbid conditions was not associated with functional capacity as measured by the distance walked in the 6MWT. Finally, the mean time spent in light, moderate, and vigorous PA per week was 3.88 minutes, 1.54 minutes, and .37 minutes, respectively. See Table 3.3 for results of the linear regression analysis of the 6MWT.

**Environmental Impact on Physical Activity**

Table 3.4 shows the results of the linear regression analyses of the impact of environmental factors on time spent in moderate and vigorous PA. In this model, the presence of comorbidities \( (p = .029) \) and traffic hazards \( (p = .036) \) were significant predictors for time spent in combined moderate and vigorous PA, controlling for sex, education level, viral load, and years living with HIV. Further analyses were done to identify which class of comorbidities predicted time spent in PA. Participants with comorbidities classified as ‘other’ (e.g., eczema, retinal detachment, hyper/hypothyroid, glaucoma) were significant predictors of combined time spent in moderate and vigorous PA \( (p = .0012, \beta = -56.55) \). Those with respiratory conditions, such as asthma and COPD, were marginally associated with combined time spent in PA \( (p = .085, \beta = -36.16) \).

**Discussion**

The findings of this study expanded on the benefits of PA for ALWH (Jaggers, 2018; O'Brien et al., 2017; Vancampfort et al., 2018) by focusing on older ALWH. This study also contributes to the current literature by examining the association between environmental factors and PA in older ALWH. Finally, this study adds to the body of HIV literature because it offers evidence on older ALWH, an under-researched segment of this population.
Evidence suggests that residents of high-density compared to low-density neighborhoods, like many neighborhoods in NYC, report more time spent in PA (D. A. Cohen, Han, Kraus, & Young, 2018; Kerr et al., 2016; Saelens et al., 2003). However, older ALWH in our study engaged in PA below national guidelines, achieving only 75% of their functional capacity and reporting fewer than six minutes of PA in total per week. Six minutes of PA per week is suboptimal, because the benefits to be gained from PA, specifically the protective effects against cardiovascular disease as a leading cause of death in this population, are based on the national guidelines of 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity PA per week.

Despite the low levels of PA in our study, our findings are consistent with the current HIV literature. A recent systematic review and meta-analysis showed ALWH are insufficiently active but focused only on ALWH ages 37-58 years (Vancampfort et al., 2016b). Our findings produce new evidence about the PA patterns of older adults with HIV ages 50-71 years, extending our understanding of PA patterns into older adulthood in this population.

Furthermore, the reduced PA findings in our study are consistent with what we know about PA in HIV-negative older adults. A study examining PA trends from three national surveys of adults 65 and over in the U.S. showed that only 27-44% of older Americans met PA guidelines (Keadle, McKinnon, Graubard, & Troiano, 2016). This same study demonstrated that older males engaged in more PA than older females and that as age increased, PA participation decreased.

Overall, our descriptions of PA patterns not only add to the HIV literature a key missing demographic, they also draw parallels among all older adults, HIV-positive and negative. Perhaps if parallels in behavior exist across populations, interventions that improve PA in the
HIV uninfected may also prove successful among older ALWH. A recent review by Amireault, Baier, and Spencer (2019) found that older adults in the HIV-uninfected population prefer low-intensity PA, specifically walking, to moderate and vigorous intensity PA. Future research should assess the PA preferences of older ALWH in order to encourage consistent PA participation in this population.

One strategy to improve functional capacity in older ALWH is the use of PA interventions supervised by a clinical or allied health professional (Vancampfort et al., 2017a; Voigt et al., 2018). Evidence suggests the success of supervised PA interventions is based on expanding the provider role in an already trusted provider-patient relationship (T. Higgins et al., 2017; Voigt et al., 2018). Given that in our study participants performed below expectations on both an objective and subjective measure of PA (6MWT and 7-Day PAR), incorporating supervised PA interventions may improve their functional capacity.

An individual’s environment, perceived safety from crime, and walking behavior are interrelated (Hong & Chen, 2014; Kerr et al., 2016). In particular, traffic-related fears, in which cars fail to obey speed limits, are known to reduce walking (Carlson, Paul, Watson, Schmid, & Fulton, 2016; Orstad, McDonough, Klenosky, Mattson, & Troped, 2017). Our findings are consistent with the existing literature and show that reduced time spent in combined moderate- and vigorous-intensity PA is related to the presence of traffic hazards. In an attempt to understand the factors that may inhibit PA in an already low-performing population, it is important to account for any time lost in PA. While our regression model showed a decrease of approximately two minutes of time spent in PA related to traffic hazards, those two minutes represent one-third of the time spent in PA in our sample. This finding draws yet another parallel between HIV-positive and negative older adults. Perhaps interventions to reduce the traffic
hazards that hinder PA in the HIV uninfected can be tested in older ALWH to ultimately develop strategies to improve PA in older ALWH.

There were no other significant associations between time spent in moderate and vigorous PA and the remaining five environmental subscales of the NEWS-A. One potential explanation could be that residents of NYC do not encounter many cul-de-sacs, generalized hilliness, or physical barriers in their neighborhoods in the same way as residents of a suburban or rural community might. Lack of parking may not resonate with this population for two reasons: 1) their finances may preclude them from owning a car, as most of our study participants reported a monthly income of less than $1000; and 2) mass transit is readily available across NYC to meet transportation needs. For these reasons, a lack of parking would not impact their ability to participate in PA. One potential reason why the diversity of land-use mix (e.g., the presence of grocery stores, libraries, clothing stores) was not associated with time spent in moderate or vigorous PA could be because visiting these locations involves light PA or walking, as part of daily activities and errands. Finally, the presence of one or more comorbidities, part of the interpersonal domain, was associated with reduced time spent in moderate and vigorous PA. This finding is also consistent with the literature, because activity limitation is a consequence of comorbidities (e.g., mood, cardiac, respiratory) (Cordova-Rivera, Gibson, Gardiner, & McDonald, 2018; de Oliveira, Souza, Rodrigues, Fett, & Piva, 2019; O'Brien et al., 2016a; Ozsoy et al., 2019; Saquib et al., 2018).

**Study Implications**

Older ALWH possess a unique set of circumstances that necessitate PA guidelines that are distinct from those for the general population. Even the recommendations by Yahiaoui et al. (2012) for older ALWH do not fully account for the multifaceted impediments faced by these
individuals. The circumstances that limit PA participation in older ALWH include, but are not limited to, physical limitations, limited social support, reduced motivation and comprehension, economic insecurity, and environmental factors.

Older ALWH experience physical limitations as a result of chronic conditions, as previously described. In our sample, 84% reported one or more chronic conditions. Individually, any one of these conditions limits PA; however, older ALWH experience multiple comorbidities, which may have a potentiating effect on limiting PA. Additionally, older ALWH have a high prevalence of frailty (Levett, Cresswell, Malik, Fisher, & Wright, 2016; Willig, Overton, & Saag, 2016), a condition associated with reduced physical function (Branas et al., 2017). Stigma and social isolation have accompanied this disease since its inception and remain associated with HIV at present (Chambers et al., 2015; Earnshaw, Smith, Chaudoir, Amico, & Copenhaver, 2013; Jang & Bakken, 2017). Feelings of stigma and social isolation are negatively associated with PA (Rueda et al., 2016). Reduced motivation in the form of depression, the most prevalent mental illness among ALWH (Do et al., 2014; Rubin & Maki, 2019), is also negatively associated with PA (de Oliveira et al., 2019). Reduced comprehension in the form of cognitive impairment may affect one’s ability to appreciate the importance of PA (Moye & Marson, 2007) and a substantial portion of older ALWH experience cognitive impairment (Rosenthal & Tyor, 2019). Economic insecurity may also preclude PA participation. In our sample, 78% of participants were unemployed or disabled and 72% reported a monthly income of less than $1000 as residents of NYC, the fifth most costly city to live in the U.S. (Frohlich, 2018). After the costs of living in NYC, there may be little, if any, disposable income for other purchases, like a gym membership or even tennis shoes. Finally, evidence from this study showed how traffic hazards act an environmental deterrent to PA. Taken together, these factors demonstrate a
complex interplay of circumstances unique to older ALWH in NYC that may affect their PA patterns.

**Limitations and Strengths**

There are limitations to this study. First, because this was a secondary analysis of data, our research questions were limited by the variables available in our data set. The secondary nature of the data also precluded the recruitment of additional study participants, resulting in a limited sample size. The sample size limited our ability to examine associations between subscales of the NEWS-A by demographic subgroups; it also was not sufficiently large to detect the relationship between all 12 NEWS-A subscales on time spent in moderate and vigorous PA. An important strength of this study, however, was our use of a valid and reliable instrument (i.e., NEWS-A), appropriate statistical analyses, and parsimonious models.

Second, the sample in this study comprised older ALWH in NYC and the findings may only be generalizable to other older ALWH living in similar urban settings. That said, this study fills a gap in the literature by examining the role of environment to support PA specifically in older ALWH. It also includes a high proportion of females, who are largely underrepresented in HIV research more generally (Grewe, Ma, Gilbertson, Rennie, & Tucker, 2016; Johnston & Heitzeg, 2015).

Finally, the cross-sectional design of the original study is limiting. Although some aspects of one’s social and physical environments are associated with PA participation, the cross-sectional design did not allow us to identify whether these associations were causal. Future studies with larger sample sizes should examine whether the associations we observed persist in larger studies of older ALWH from diverse urban, suburban, and rural communities.
Conclusions

Older adults living with HIV participate in PA at lower than recommended levels. Targeted interventions that: (1) encourage long-term sustainable PA behavior, (2) prevent and manage chronic conditions that may limit PA participation, and (3) shape policy to reduce traffic hazards as an environmental deterrent, are needed to support PA in this population. Future studies that assess interventions to increase PA in older ALWH should measure PA preferences in larger sample sizes from diverse communities using objective measures of PA to reduce the possibility of recall and social desirability biases from self-reported data.
### Table 3.1

*Description of Study Survey Instruments by Conceptual Framework Domain*

<table>
<thead>
<tr>
<th>Framework Domain</th>
<th>Survey Instrument</th>
<th>Instrument Components</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intrapersonal</strong></td>
<td>Demographic Survey</td>
<td>11 items</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Age, sex, race/ethnicity, education level, marital status, employment status, income level, presence of comorbidities, types of comorbidities present, viral load, CD4 count</td>
</tr>
<tr>
<td></td>
<td>Anthropometrics</td>
<td>4 items</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Height, weight, hip and waist circumference</td>
</tr>
<tr>
<td><strong>Social and Physical Environments</strong></td>
<td>Neighborhood Environment Walkability Scale-Abbreviated</td>
<td>12 subscales, 54 items</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Social environment subscales: land-use mix access, aesthetics, traffic hazards, crime, lack of parking</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Physical environment subscales: residential density, land-use mix-diversity, street connectivity, infrastructure for safety and walking, lack of cul-de-sacs, hilliness, physical barriers</td>
</tr>
<tr>
<td><strong>Physical Activity</strong></td>
<td>7-Day Physical Activity Recall</td>
<td>Semi-structured interview of prior 7 days of varying PA intensity</td>
</tr>
<tr>
<td></td>
<td>Six-Minute Walk Test</td>
<td>Distance walked in 6 minutes between two cones (in feet)</td>
</tr>
</tbody>
</table>
Table 3.2

*Characteristics of the Study Sample (n = 100)*

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years, mean (SD)</td>
<td>56.4 (4.88)</td>
</tr>
<tr>
<td>Sex, n</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>50</td>
</tr>
<tr>
<td>Female</td>
<td>50</td>
</tr>
<tr>
<td>Race, n</td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>61</td>
</tr>
<tr>
<td>White</td>
<td>21</td>
</tr>
<tr>
<td>Other*</td>
<td>18</td>
</tr>
<tr>
<td>Completed education level, n</td>
<td></td>
</tr>
<tr>
<td>High school or less</td>
<td>55</td>
</tr>
<tr>
<td>Some college/technical school training</td>
<td>20</td>
</tr>
<tr>
<td>2 years of college/technical training</td>
<td>12</td>
</tr>
<tr>
<td>Bachelor’s degree or higher</td>
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</tr>
<tr>
<td>Marital status, n</td>
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<tr>
<td>Single</td>
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</tr>
<tr>
<td>Widowed</td>
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</tr>
<tr>
<td>Married/partnered</td>
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</tr>
<tr>
<td>Separated/divorced</td>
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<tr>
<td>Employment status, n</td>
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</tr>
<tr>
<td>Employed</td>
<td>6</td>
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<tr>
<td>Unemployed</td>
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<tr>
<td>Disabled</td>
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</tr>
<tr>
<td>Other**</td>
<td>16</td>
</tr>
<tr>
<td>Monthly income, n</td>
<td></td>
</tr>
<tr>
<td>≤ $399</td>
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</tr>
<tr>
<td>$400-$599</td>
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<td>$600-$799</td>
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<tr>
<td>$800-$999</td>
<td>25</td>
</tr>
<tr>
<td>≥ $1,000</td>
<td>28</td>
</tr>
<tr>
<td>Comorbidity***, n</td>
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</tr>
<tr>
<td>Cardiac</td>
<td>35</td>
</tr>
<tr>
<td>Respiratory</td>
<td>17</td>
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<tr>
<td>Musculoskeletal</td>
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</tr>
<tr>
<td>Metabolic</td>
<td>11</td>
</tr>
<tr>
<td>Mood disorder</td>
<td>43</td>
</tr>
<tr>
<td>STI</td>
<td>21</td>
</tr>
<tr>
<td>Race Category</td>
<td>Years living with HIV, mean (SD)</td>
</tr>
<tr>
<td>-----------------------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td>Other****</td>
<td>21.1 (6.93)</td>
</tr>
<tr>
<td></td>
<td>27</td>
</tr>
</tbody>
</table>

*Note. *Other in the race category described adults of mixed race (i.e., African American and White) and Hawaiian/Pacific Islander. **Other employment status included keeping house, students, and volunteering. ***Comorbid categories were not mutually exclusive. ****Other comorbid conditions included eczema, retinal detachment, hyper/hypothyroid, glaucoma, Crohn’s disease, lymphoma, etc.
Table 3.3

*Multivariable Linear Regression Model Assessing Predictors of the 6-Minute Walk Test in Adults Living with HIV*

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Predictor</th>
<th>Estimate</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance walked during 6-Minute Walk Test</td>
<td>Sex</td>
<td>-44.79</td>
<td>.0033</td>
</tr>
<tr>
<td></td>
<td>Female vs. Male</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comorbidity Present</td>
<td>Yes vs. No</td>
<td>-10.77</td>
<td>.6086</td>
</tr>
<tr>
<td>Education Level*</td>
<td>1 vs. 0</td>
<td>46.82</td>
<td>.0175</td>
</tr>
<tr>
<td></td>
<td>2 vs. 0</td>
<td>19.57</td>
<td>.3770</td>
</tr>
<tr>
<td></td>
<td>3 vs. 0</td>
<td>49.27</td>
<td>.0559</td>
</tr>
<tr>
<td></td>
<td>4 vs. 0</td>
<td>48.54</td>
<td>.0532</td>
</tr>
</tbody>
</table>

*Note.* *Education levels (0 = 11th grade or less; 1 = high school graduate or GED; 2 = some college or technical school training; 3 = 2 years of college or technical school training; 4 = college bachelor’s degree or higher.*
Table 3.4

*Multivariable Linear Regression Model of Combined Time Spent in Moderate and Vigorous Physical Activity*

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Predictor</th>
<th>Estimate</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combined time spent in moderate and vigorous PA</td>
<td>Sex</td>
<td>-0.67</td>
<td>0.5596</td>
</tr>
<tr>
<td></td>
<td>Female vs. Male</td>
<td>-0.67</td>
<td>0.5596</td>
</tr>
<tr>
<td></td>
<td>Education level*</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 vs. 0</td>
<td>0.04</td>
<td>0.9783</td>
</tr>
<tr>
<td></td>
<td>2 vs. 0</td>
<td>-0.58</td>
<td>0.7178</td>
</tr>
<tr>
<td></td>
<td>3 vs. 0</td>
<td>-0.56</td>
<td>0.7681</td>
</tr>
<tr>
<td></td>
<td>4 vs. 0</td>
<td>2.93</td>
<td>0.1340</td>
</tr>
<tr>
<td>Comorbidity</td>
<td>Yes vs. No</td>
<td>-3.79</td>
<td>0.0293</td>
</tr>
<tr>
<td>Viral load category**</td>
<td>2 vs. 1</td>
<td>0.11</td>
<td>0.9578</td>
</tr>
<tr>
<td></td>
<td>3 vs. 1</td>
<td>2.48</td>
<td>0.2197</td>
</tr>
<tr>
<td>Years living with HIV</td>
<td></td>
<td>0.14</td>
<td>0.0777</td>
</tr>
<tr>
<td>NEWS-A subscales</td>
<td>Land-use mix-diversity score</td>
<td>0.26</td>
<td>0.7351</td>
</tr>
<tr>
<td></td>
<td>Traffic hazards score</td>
<td>-1.94</td>
<td>0.0357</td>
</tr>
<tr>
<td></td>
<td>Lack of parking score</td>
<td>0.55</td>
<td>0.3316</td>
</tr>
<tr>
<td></td>
<td>Lack of cul-de-sacs score</td>
<td>0.99</td>
<td>0.0696</td>
</tr>
<tr>
<td></td>
<td>Hilliness score</td>
<td>-0.12</td>
<td>0.8385</td>
</tr>
<tr>
<td></td>
<td>Physical barriers score</td>
<td>-0.59</td>
<td>0.3193</td>
</tr>
</tbody>
</table>

*Note.* *Education levels: 0 = 11th grade or less; 1 = high school graduate or GED; 2 = some college or technical school training; 3 = 2 years of college or technical school training; 4 = college bachelor’s degree or higher. **Viral load category: 1 = less than 50/undetectable, 2 = 50 – 499, 3 = 500 or greater.
Figure 3.1. Adapted Ecological Model of Four Domains of Active Living

Note. This ecological model describes the interdependence of interpersonal and environmental factors and physical activity participation.
Chapter Four: Validation of the Modified Baecke Questionnaire in Older Adults Living with HIV

In Chapter 4, Aim 4 of the dissertation is addressed in a quantitative secondary data analysis that attempts to validate and demonstrate reliability of the modified Baecke Questionnaire in a sample of older ALWH. The target journal for this manuscript is *Medicine and Science in Sports and Exercise*.

Abstract

**Purpose:** To assess the internal consistency reliability, known groups validity, and predictive validity of the modified Baecke Questionnaire (mBQ), which measures physical health in older adults, in a U.S. sample of adults living with HIV (ALWH) ≥ 50 years.

**Methods:** A secondary data analysis from ALWH in New York City (n = 100). T-tests assessed known groups validity of the mBQ, comparing the physical health of older (≥ 50 years, n = 71) to younger (< 50 years, n = 29) participants. Spearman correlations and linear regression assessed the validity of the mBQ to predict physical health in older participants, using the physical function domain of the PROMIS-29 v2.1 as the comparator in the correlation analysis and as an independent variable in the regression. Cronbach’s alpha assessed internal consistency reliability of the mBQ in older participants.

**Results:** Cronbach’s alpha coefficient of the mBQ and its household subscale were .57 and .60, respectively. The leisure activity subscale of the mBQ distinguished between the physical health of older (≥ 50 years) from younger (< 50 years) adults with HIV (p < .05). The mBQ was correlated with the physical function domain of the PROMIS-29 v2.1 (r = .343, p = .0034). Our linear regression model revealed the physical function domain of the PROMIS-29 v2.1 was a
significant predictor of physical health, measured as the mBQ score, in older participants ($p < .05$) when controlling for comorbidities and computer use.

**Conclusions:** The mBQ demonstrates adequate predictive validity but limited known groups validity. Results should be interpreted cautiously as reliability was not initially established. Subsequent factor analyses resulted in the removal of three items and thus, adequate validity and reliability of a revised version of the mBQ. Future studies should test the psychometric properties of the revised mBQ in larger, more diverse samples of older ALWH.

**Keywords:** Physical Activity, Exercise, AIDS, Survey
Introduction

The U.S. Department of Health and Human Services (2008) recommends 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity physical activity (PA) per week for all adults to maintain overall health. However, many adults living with HIV (ALWH) fail to meet these guidelines, with older age associated with lower levels of PA (Vancampfort et al., 2016b; Vancampfort et al., 2017c; Webel et al., 2019). The reduced PA in this population may result in part from frailty. Evidence suggests that older ALWH, defined as those aged 50 and over (Work Group for HIV and Aging Consensus Project, 2012), experience frailty at a rate twice that of adults aged 65 and over in the general population (Branas et al., 2017). The frailty in older ALWH has been linked to functional impairment, which reduces overall PA participation (Branas et al., 2017; Piggott et al., 2016; Willig et al., 2016).

PA may also be impacted by the presence of comorbidities. In adults in the general population with one chronic condition, having at least one additional comorbidity significantly reduced PA level irrespective of comorbidity type (Sievi et al., 2015). This is especially important in ALWH as they acquire comorbid conditions on average five years earlier than their uninfected counterparts, which may explain their reduced PA (Horvath & Levine, 2015; Schouten et al., 2014b). Older ALWH in particular are 1.5 to 2.1 times more likely to have a chronic disease and 2.4 to 7 times more likely to have up to five chronic comorbid conditions when compared to their uninfected counterparts (Friedman & Duffus, 2016). When comparing ALWH to other populations with chronic conditions (i.e., clinical depression and type 2 diabetes), ALWH were more likely to drop out from studies where PA interventions were under investigation (Vancampfort et al., 2017a). Thus, among ALWH, the presence of frailty and early-onset chronic comorbidities play a role in impeding PA participation and contribute to the
A recent systematic review showed that PA levels decrease as age increases in ALWH (Vancampfort et al., 2017c), and it is estimated that 56% of ALWH are aged 50 years and older (Centers for Disease Control and Prevention, 2018). Turning 50 has become a significant transitional period in this population. As stated above, it is during older adulthood that individuals with HIV are more likely to experience frailty, multiple comorbidities, and decreases in PA compared to younger ALWH (i.e., ALWH under 50 years old). However, as a growing majority of ALWH age, PA becomes an increasingly essential lifestyle component to improve and maintain health. PA can preserve independence by mitigating the physical limitations associated with chronic conditions and frailty (Erlandson et al., 2018; O'Brien et al., 2017; Piggott et al., 2016). PA has been shown to improve depression, the most common mental health disorder affecting this population (Do et al., 2014; Rubin & Maki, 2019), as well as improve health-related quality of life (Jaggers, 2018). PA can also reduce the risk of cardiovascular disease in older ALWH, a leading non-AIDS cause of death (Farahani et al., 2017). Therefore, encouraging PA is important to maintain physical health, mental health, independence, and, reduce morbidity and mortality in older ALWH. Instruments to measure PA in this population are limited, however, and older ALWH remain an underrepresented group in the HIV literature. This study aims to fill this gap in the literature by measuring PA in older ALWH.

A valid and reliable instrument that measures PA in ALWH is needed that classifies activity by intensity. The designation of PA intensity (i.e., light, moderate, or vigorous) provides insight into PA patterns and informs the prescription of PA needed. Thus far, many studies that measure PA in ALWH have employed instruments validated in other populations and have not
classified activity by intensity (Vancampfort et al., 2017c), with the exception of three PA instruments. To date, the only three PA instruments that have been validated in ALWH include the International Physical Activity Questionnaire (IPAQ) (Fillipas, Cicuttini, Holland, & Cherry, 2010), the Patient Reported Outcomes Measurement Information System (PROMIS)-29 (Schnall et al., 2017), and the Baecke Questionnaire (BQ) (Florindo et al., 2006). Each has limitations.

Although the IPAQ was validated in ALWH, in past studies inconsistencies were noted. For example, the IPAQ overestimated measurements of vigorous PA performed when compared to an accelerometer, considered the gold standard of PA measurement (Fillipas et al., 2010; Ramirez-Marrero et al., 2008). The IPAQ also failed to identify physical inactivity in this population, was deemed better suited as a preliminary PA assessment, and its use to classify PA by intensity was discouraged (Fillipas et al., 2010). The PROMIS-29 is a health-related quality of life survey designed to measure self-reported physical, mental, and social health and well-being (Cella et al., 2010). It contains seven domains and has been validated in a U.S. sample of ALWH (Schnall et al., 2017). The physical function domain of the PROMIS-29 contains 4 items as a quick measure of current physical health. It does not measure regular PA, an indication of patterned PA behavior, nor does it classify PA by intensity. Finally, the BQ measures routine PA and has been validated in a sample of ALWH in Brazil (Florindo et al., 2006). In addition to a limited sample size (n = 30), the validation study lacked sufficient description of the sample. The demographics described included mean education level (14.4 years) and a mean age of 37.2 years. At present, 72% of American ALWH are at least 40 years old (Centers for Disease Control and Prevention, 2018); thus, the BQ sample was, on average, younger than most ALWH in the U.S. Additionally, the study was conducted 13 years ago on Brazilian adults, so the applicability of the instrument to the U.S. context is unknown. Despite its limitations, the BQ remains the only
valid, reliable, full-scale instrument that measures and classifies routine PA by intensity in ALWH without major reservations. No PA instrument has been validated specifically for use in older ALWH. This study aims to address this gap in the literature.

To measure regular PA patterns in adults aged 65 and older, Voorrips et al. (1991) modified the BQ (hereafter referred to as mBQ). A key feature of the mBQ is the replacement of the occupational activities subscale from the original version with the household activities subscale to reflect a shift in responsibilities among older adults from outside to inside the home. Although the mBQ was validated for use in adults aged 65 and over in the general population, it may be an appropriate tool to measure PA in older ALWH for two reasons: clinical presentation and reduced employment. The clinical presentation of older ALWH (e.g., frailty, multi-morbidity) is comparable to the clinical presentation of many adults 65 and over in the general population (Bandeen-Roche et al., 2015). Additionally, unpublished data from a prior study showed that only 6% of older ALWH reported full or part-time employment (Voigt, Liu, Rowell-Cunsolo, Schnall, & Poghosyan, 2019), demonstrating reduced time spent in occupational activity. However, the ability of the mBQ to measure PA in an aging HIV population in the U.S. has yet to be tested.

**Study Purpose and Aims**

The purpose of this study was to assess the reliability and validate the mBQ in a U.S. sample of older ALWH, as none exists thus far. Specifically, we aim to assess: 1) the internal consistency reliability of the mBQ in a sample of older ALWH in the U.S.; 2) the known groups validity of the mBQ to distinguish between the physical health of older ALWH (aged 50 and over) and the physical health of younger ALWH (under 50 years) by comparing scores between
the two groups; and 3) the validity of the mBQ to predict physical health by comparing scores of the mBQ to scores of the physical function domain of the PROMIS-29 v2.1.

Methods

Study Design and Data Source

This study was a secondary analysis of cross-sectional survey data from the Gender Supplement of the Video Information Provider for HIV-Associated Non-AIDS (VIP-HANA) Symptoms study (R01 NR015373-02S1), which aimed to evaluate the HIV symptom experiences of women during phases of menopause (i.e., pre-, peri-, and post-) when compared to HIV-positive male controls.

Participants

In the parent study, a purposive sample of 100 ALWH were recruited for participation, 75 women (25 pre-menopausal, 25 peri-menopausal, 25 post-menopausal) and 25 men. This sampling technique accounted for the variation of symptom experience across stages of menopausal transition. Participants were recruited via posted information and flyers in clinics and community-based organizations in New York City. Study flyers and information were also posted electronically on websites, such as Craigslist, Scruff, and Facebook. Recruiting study participants via electronic social media platforms has been effective in past studies of ALWH (Schnall et al., 2017). Participants interested in the study responded by calling the phone number on the flyer. At the time of the phone call, participants were screened for eligibility and scheduled for an appointment to take part in the study. Participants were eligible if they were HIV positive, had been prescribed antiretroviral therapy (ART), were a U.S. resident, were able to read and provide consent in English or Spanish, owned a cell phone with text messaging capability, self-identified as cis-gender, and self-identified as African American or
Latino/Hispanic. Females had to report having at least one menstrual period in their lifetime. Study participants with a history of hypertension, hyperlipidemia, diabetes, or thyroid disease were included in the study as long as they were in treatment and had been stable on therapy for at least three months. ALWH were excluded from the study if they had taken any form of hormonal birth control or hormone replacement therapy or were pregnant or breast-feeding within the previous three months, or if they had undergone a hysterectomy.

**Procedures**

Approval for the parent study was obtained from the Institutional Review Board of Columbia University Medical Center (IRB-AAAR1727). All eligible participants in the parent study came to Columbia University School of Nursing as the study site. Written, informed consent was obtained in either English or Spanish and prior to any data collection. Participants received a copy of their signed consent form. Participants completed all surveys within a private office at the study site.

All surveys in the parent study were self-administered electronically via Qualtrics. Qualtrics, a Columbia University approved protected health information secure system, is an online survey platform that allows for survey creation and data collection (Qualtrics, 2018). Participants completed all tools during one visit at the study site. All data collected via Qualtrics surveys were exported into a statistical software program. Participants received $75 cash as compensation for completing the parent study. In the current study, de-identified data collected from the participants in the parent study was used. The data were extracted using computers maintained on the Columbia University School of Nursing servers that are compliant with HIPAA and data security standards.
Measures

**Demographic survey.** Eleven items were used to measure the following variables: age, body mass index (BMI), sex, race, employment status, presence of comorbidities, ART use, CD4 count, viral load, frequency of computer use, and frequency of mobile device use. Mobile devices were defined as smart phones, cell phones, or tablets. In the parent study, CD4 count and viral load were collected as categorical rather than continuous variables.

**Physical function domain of the PROMIS-29 v2.1.** The PROMIS-29 v.2.1 is a valid and reliable health-related quality of life tool that contains seven domains measuring depression, anxiety, physical function, pain interference, fatigue, sleep disturbance, and participation in social roles and activities. The physical function domain measures physical health using four polytomous response items. The items query the degree of difficulty experienced when completing tasks such as doing chores at home, ascending and descending stairs, walking for at least 15 minutes, and running errands. Participants respond on a 5-point Likert scale that ranges from 5 (without any difficulty) to 1 (unable to do). Scores for each domain of the PROMIS-29 are calculated by summing the responses of each item. The higher the domain score, the greater the measurement of the concept. In this case, the higher the physical function domain score, the better the physical health of the individual. (See Appendix D for the physical function domain of the PROMIS-29 v2.1).

**Modified Baecke Questionnaire.** The mBQ is a valid and reliable instrument that measures routine physical activity in the elderly, classifying individuals as low, moderate, or vigorously physically active. The survey contains three subscales comprised of a mix of polytomous and free-response items. The first subscale, *household activities*, contains eight polytomous-response and two free-response items that query the activities performed around the
An example of one item in this subscale asks, “Do you prepare warm meals yourself, or do you assist in preparing?” The participant would then choose a response from the following options: 0) never, 1) sometimes (once or twice a week), 2) mostly (three to five times a week), or 3) always (more than five times a week).

The *sports activities* subscale contains one free-response item that queries participation in a sport (“Do you play a sport?”). If the answer is affirmative, the participant names the sport, describes the intensity and frequency of participation, as well as the number of months per year that the sport is played. This is repeated for up to a maximum of two sports. Thus, the number of items in the sport activities subscale depends on whether the participants engage in any sports activities. Likewise, the *leisure activity* subscale contains one free-response item that queries PA participation during leisure time. If the answer is affirmative, the process repeats as in the *sports subscale*, in which the participant names the activity, intensity, frequency, and months per year of each leisure time activity up to a maximum of six activities. (See Appendix E for the complete mBQ).

The overall score of the mBQ is calculated by summing the score of the three subscales. Scoring the *household activities* subscale is computed by taking the mean of the responses from items 1-10. Scoring the *sports* and *leisure activity* subscales requires the use of codes developed by the researchers based on energy costs that describe the intensity of the activity (Voorrips et al., 1991). Additional codes are provided for frequency (number of hours per week) and number of months per year. Based on the activity reported, codes for intensity, frequency, and number of months per year are multiplied, resulting in a score for each individual activity. The sum of the individual activity scores in their respective subscale result in the final score for that subscale. For example, the sum of the individual activity scores for a participant reporting yoga and
growing as a leisure activity would comprise the subscale score for the leisure activity subscale of the mBQ. Classification of low, moderate, or vigorously physically active was based on tertiles calculated from the sample under inquiry then compared to cut points reported in the original study, 9.0 and 12.6 (Hertogh, Monninkhof, Schouten, Peeters, & Schuit, 2008; Voorrips et al., 1991).

**Data Analysis**

De-identified data was obtained from the parent study and analyzed using SAS version 9.4. Descriptive statistics of participant demographics were calculated. Frequency tables were used to describe categorical variables. Means and standard deviations described continuous variables. Descriptive statistics of responses on the mBQ were also calculated. Aim 1 of this study—to assess the internal consistency reliability of the mBQ in older ALWH—was estimated using Cronbach’s alpha coefficient. In SAS, PROC CORR and ALPHA were used to meet this aim. Cronbach’s alpha coefficient values were acceptable if results fell between .70 and .90 (Tavakol & Dennick, 2011). To address Aim 2 of this study—to assess the known groups validity of the mBQ— independent sample t-tests were used. The sample was first dichotomized by age, under 50 years (n = 29) and aged 50 years and older (n = 71). Next, we compared the mean scores of the mBQ by age group using PROC TTEST in SAS. Means, standard deviations, and p-values were reported to demonstrate the ability of the mBQ to distinguish the differences in physical health between age groups of ALWH. We hypothesized that older ALWH would score lower on the mBQ, demonstrating reduced physical health when compared to younger ALWH.

To address Aim 3 of this study—to assess the validity of the mBQ to predict physical health of older ALWH (n = 71)—the analysis was twofold: correlation analysis and linear
regression. Correlation coefficients were used as a preliminary analysis to determine the strength and direction of the association between scores from the mBQ and the physical function domain of the PROMIS-29 v2.1. We also analyzed the scatterplots that resulted from these correlations to assess the strength and direction of the relationship. First, PROC UNIVARIATE was used to evaluate the normality of the data and to determine which correlation coefficient would be used—Pearson coefficients for normally distributed or Spearman coefficients for non-normally distributed data. Second, PROC CORR calculated the correlation between scores from the mBQ and the physical function domain of the PROMIS-29 v2.1. Correlation coefficients of .70 or greater indicated a high or very high correlation, coefficients of .50-.69 indicated a moderate correlation, coefficients of .30-.49 indicated a low correlation, and correlations less than .30 were considered negligible (Mukaka, 2012).

Next, we used linear regression to assess the predictive validity of the mBQ using data from participants aged 50 and older (n = 71). Our outcome variable in this model was the score from the mBQ. Our independent variable was the physical function domain of the PROMIS-29 v2.1. The covariates included demographic variables, i.e., age, sex, BMI, race, employment status, presence of comorbidities, ART use, CD4 count, viral load, frequency of computer use, and frequency of mobile device use. Frequency of computer and mobile device use were used as proxy measures for time spent in activities other than PA, where computer use was specifically a proxy measure for sedentary time. After assessing for missing data using PROC MEANS and NMISS in SAS, we used COLLIN VIF TOL in SAS to check for multicollinearity using a Variance Inflation Factor (VIF) less than 10. Covariates with a VIF less than 10 indicated an absence of multicollinearity (Kutner et al., 2005). We then conducted bivariate analyses between each covariate with a VIF less than 10 and the outcome variable using t-tests for significance.
Covariates were included in the final model if the resulting $p$-value was less than .20 (Hosmer et al., 2013). The final linear regression model was computed using PROC REG. Regression coefficients and $p$-values were reported to describe the strength and direction of the association between the independent variable, covariates, and the outcome in the final model.

**Results**

**Participant Demographics**

Participants ranged in age from 24 to 67 years with a mean age of 51.5 years. Most participants, 76%, self-identified as African-American. The body mass index (BMI) ranged from 15.8 to 53.2 with a mean BMI of 29.5. Comorbidities (e.g., cardiovascular disease, asthma, high cholesterol, diabetes) were reported in 92% of the sample, and 65% percent were unemployed or disabled. Regarding HIV status, 98% reported taking antiretroviral therapy, 51% reported a CD4 count of 500 or greater, and 86% reported an undetectable viral load. In the parent study, CD4 count and viral load were collected as categorical rather than continuous variables. Data on frequency of computer and mobile device use were also collected. Ninety-one percent of our sample reported using a mobile device (i.e., smart phone, cell phone, or tablet) at least once daily and 41% reported using a computer at least once daily. See Table 4.1 for the complete demographic results of the sample.

**Internal Consistency Reliability**

Internal consistency reliability, as assessed by Cronbach’s alpha coefficient, of the mBQ among the older subset of the sample ($n = 71$) was .57 and of the *household* subscale was .60. Internal consistency reliability of the individual *sport* and *leisure activity* subscales could not be calculated due to insufficient data points; that is, each participant reported only one sport and one activity during leisure time.
Known Groups Validity

Known groups validity was measured as the difference in mean total and subscale scores of the mBQ, comparing older to younger ALWH. Table 4.2 contains the descriptive statistics of scale scores for the study participants. Scores comparing the total mBQ by age group ($p = .08$) and the scores on the *household* subscale by age group ($p = .08$) fell short of statistical significance. Comparison of mean scores on the *sport* subscale were not significant. Statistically significant differences between age groups were found on the *leisure activity* subscale ($p < .05$), where ALWH aged 50 and over performed more PA than ALWH under 50 years during leisure time. Table 4.3 contains the complete results of the known groups validity evaluation.

Predictive Validity

Spearman’s coefficient, $r$, described the correlation between scores from the mBQ and physical function domain of the PROMIS-29 v2.1. A significant modest correlation was found between the aforementioned scores, $r = .343$, $p = .0034$. Additionally, results from the linear regression analysis showed the physical function domain of the PROMIS-29 v2.1 was able to predict physical health of study participants, measured by the mBQ score, in older ALWH ($p < .05$) when controlling for the presence of comorbidities and the frequency of computer use. Table 4.4 shows the complete results of the linear regression analysis of the predictive validity of the mBQ predicting the physical health of older ALWH.

Discussion

This study evaluated the reliability and validity of the mBQ in a U.S. sample of older ALWH. The study findings show the *leisure activity* subscale of the mBQ demonstrated known groups validity in its ability to distinguish the physical health of older ALWH from the physical health of younger ALWH. Contrary to what was hypothesized, older ALWH demonstrated better
physical health with leisure activities than younger ALWH. This may be due to the increased time available for leisure activity in older ALWH. In fact, Table 4.2 supports this idea given that 45% (32 out of 71) of older compared to only 31% (5 out of 29) of younger ALWH reported leisure activity. This finding can be used to guide clinicians in encouraging PA during leisure time (e.g., yoga, swimming, cycling), rather than encouraging structured sports engagement or PA during household chores (e.g., climbing stairs, vacuuming/cleaning), as the evidence suggests leisure time as optimal for PA participation in older ALWH.

The *sports activities* subscale failed to demonstrate known groups validity. One explanation for the failure of the *sports* subscale to establish known groups validity is that few study participants reported any sports participation. About 85% of older ALWH and 83% of younger ALWH reported no sports activities. Given the physical demands of sports (e.g., swimming, cycling), the activity-limiting comorbidities prevalent among ALWH, and reduced functional capacity due to frailty in this population, it is no surprise that a majority of ALWH do not participate in sports. Descriptive statistics of participant scores on the mBQ showed more affirmative responses of leisure activity—45% of older adults and 31% of younger adults—than for sports—only 15% for older adults and 17% for younger adults. Higher reports of leisure activity contributed to demonstrating known groups validity of that subscale. However, the poor performance in sport and leisure activity was also reflected in the respondents’ scores. Of participants who reported engaging in sports or leisure activity on the mBQ, the average score on the total mBQ was 2.85, with scores from the older cohort (adults 50 and over) as the greater influence on the mean—3.08 for older ALWH compared to 2.27 for younger ALWH. Moreover, the difference between the mean mBQ scores of the participants compared to mean scores from the original study by Voorrips et al. (1991)—2.85 versus 11.0, respectively—reveals the poor
physical health of our participants and supports the findings in the current literature (Vancampfort et al., 2016b).

The study findings show the scores of the mBQ and the physical function domain of the PROMIS-29 v2.1 are significantly correlated in older ALWH. Furthermore, the mBQ can significantly predict physical health in older ALWH after controlling for the presence of comorbidities and frequency of computer use. Despite not meeting the statistical threshold for inclusion in our regression model ($p$-value of .2 or less), the decision to include comorbidities and computer use as covariates rested on their clinical importance. Evidence presented earlier supported the inclusion of the presence of comorbidities, because comorbidities limit activity and are present more often and in greater number in ALWH (Friedman & Duffus, 2016; Horvath & Levine, 2015; Schouten et al., 2014b). Likewise, time spent on a computer demonstrated clinical relevance and was used as a proxy measure for sedentary time. Unlike using a mobile device, which can be done anywhere, using a computer suggests being stationary, often sitting. Forty-four percent of the participants reported using their computers at least once a day, most of whom reported computer use several times a day, revealing bouts of time not spent in PA. These findings may inform providers to query computer time when caring for older ALWH and suggest forms of PA that may be performed in lieu of this sedentary activity. Additionally, because these findings demonstrate the validity of the mBQ to predict physical health in older ALWH, this tool may be used to classify their activity as low, moderately, or vigorously physically active, and make appropriate PA prescriptions as part of overall strategies for healthy aging.

Finally, Cronbach’s alpha coefficient measuring internal consistency reliability fell short of the acceptable range of values. One explanation for this could be the reduced sport and leisure activity reported in the study sample. As Cronbach’s alpha compares the relatedness of items
(measured as the correlations between items), fewer item responses may affect the robustness of the measure (Tavakol & Dennick, 2011). Another reason for the low alpha may be because the mBQ does not fully capture physical health as a concept in older ALWH. Low Cronbach’s alpha coefficients may result from inadequately measured concepts (Tavakol & Dennick, 2011). If the latter is the case, items in the mBQ may need to be revised or discarded or a new PA instrument may need to be developed specifically for this population.

**Study Implications**

The benefits of PA in ALWH are well-established (Erlandson et al., 2018; Jagers, 2018; O'Brien et al., 2017; Piggott et al., 2016). As an important adjunct therapy for an aging HIV population, PA recommendations cannot be individually tailored if a thorough baseline assessment is not obtained. The mBQ can be used as part of that assessment. In the era of precision medicine and patient-centered care, care plans for ALWH should include a detailed physical health assessment and individually tailored PA prescriptions. Our study adds a valid instrument for providers to use to predict physical health in older ALWH. This tool is an important first step toward assessing physical health and aids in tailoring PA prescriptions to encourage healthy aging in this population. The findings of this study have particular temporal significance. As previously stated, the majority of ALWH are now aging beyond the fifth decade of life. This is a fairly recent phenomenon that is the result of the success of antiretroviral therapy over the past four decades. It is only in the current moment that strategies for healthy aging may be considered, as the focus of care for many years centered on survival. Strategies that promote healthy aging are needed now more than ever to support the quality of life of this population by mitigating the limitations associated with frailty and preserving independence.
Using the mBQ to measure baseline PA may be used to inform prescriptions of PA to meet these goals.

**Limitations and Strengths**

There are limitations to this study. As this study was a secondary analysis, we were limited by the size and demographic makeup of the sample. The small sample size precluded more rigorous analysis. Additionally, our sample included only African-American and Hispanic/Latino participants living in New York City. The generalizability of our findings may be limited to African-American and Hispanic/Latino ALWH living in similar urban settings. Finally, as the mBQ measures routine PA patterns over the past 12 months, recall bias may have been present.

Despite these limitations, a strength of our study was the use of appropriate statistical analyses and a parsimonious regression model to counter the limitations of the sample size. Another strength of this study was the inclusion of 75% women, a demographic largely underrepresented in the HIV literature (Johnston & Heitzeg, 2015). Furthermore, our study fills a significant gap in the current HIV literature. This study is the first to assess the validity of a PA instrument in older ALWH. Despite the mixed results, the attempt at validation is significant as it describes shortfalls in our efforts that may inform the direction of future studies. In fact, the results of our factor analysis suggest a revised mBQ that demonstrated construct validity and reliability and should be tested in a new sample. Investigating instruments to measure PA in older ALWH addresses a clinical need for an understudied population. The ability to measure and prescribe PA is important to support healthy aging in this population and this study describes movement toward that ultimate goal.
Conclusions

The mBQ demonstrates validity to predict the physical health of older ALWH. The leisure activity subscale of the mBQ demonstrates known groups validity in its ability to distinguish the physical health of older ALWH from younger ALWH. However, the validity results should be interpreted with caution as reliability was not established in the mBQ. Future studies should include a factor analysis and be replicated using a larger, more demographically representative sample of older ALWH.

Acknowledgments

The National Institute of Nursing Research of the National Institutes of Health under award number R01NR015737-02S1 supported the research reported in this publication. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Conflicts of Interest

The authors have no conflicts of interest to declare. The results of the present study do not constitute endorsement by the American College of Sports Medicine. The results of this study were presented clearly, honestly, and without fabrication, falsification, or inappropriate data manipulation.
Addendum: Confirmatory Factor Analysis and Results

Because known groups validity was not established across all subscales of the mBQ and reliability was not established, the construct validity of the tool, that is, the extent of the tool’s ability to measure PA in older ALWH, was in question. To address this concern, a factor analysis was considered after reviewing the study results. Factor analysis (FA) is a multivariate statistical approach that, among a wide variety of purposes, is used to provide evidence of construct validity in self-reporting instruments (Thompson, 2004; Williams, Onsman, & Brown, 2010). In order to perform a FA, certain criteria must be met, one of which is an adequate sample size. While a general rule of thumb dictates a sample size of at least 100, a FA may be conducted with smaller sample sizes (i.e., less than 100) if there are high communalities greater than .6 and well-determined factors (Tabachnick & Fidell, 2013).

Methods

PROC FACTOR was used in SAS to perform the FA in this sample using a maximum likelihood estimation. A confirmatory factor analysis (CFA) was subsequently performed to evaluate the factor loadings of the items within each subscale and exhaust all possible validation efforts. PROC CALIS was entered in SAS to execute the CFA. When evaluating the CFA results, a small chi-square (i.e., closer to 0) indicates better model fit (Hinkin, 1995). The root mean square error of approximation (RMSEA) accounts for issues with sample size, a concern in this study, where a value or 0.6 or less, on a scale of 0 to 1, is indicative of an acceptable model fit (Brown, 2015). Other indices that indicate a good model fit include the standardized root mean square residual (SRMR) where a 0.08 or less is desired (Brown, 2015), and goodness of fit index (GFI) where .9 or greater is favorable (Baumgartner & Hombur, 1996). Values of the latter two indices are on a scale of 0 to 1.
Results

Results using PROC FACTOR revealed overall low communalities (less than .5), three factors based on the subscales of the mBQ, and chi-square of 3.51 (p = .32). Results from the initial CFA using PROC CALIS showed all the items loaded onto their respective factors (subscales), and results of the fit indices indicated a poor model fit: a large chi-square = 143.9, degrees of freedom = 66, RMSEA = .057, SRMR = .089, and GFI = .880. After removing three items from the household subscale (items 3, 7, and 8) because of large p-values (i.e., > .05), PROC CALIS was repeated. Results after removal of the above three items revealed a stronger model and better model fit (i.e., a smaller chi-square and larger goodness-of-fit indices): chi-square =107.6, degrees of freedom = 36, RMSEA = .053, SRMR = .074, GFI = .925. Furthermore, in the household subscale, p-values for the remaining items improved and the Cronbach’s alpha coefficient increased from .60 to .70, meeting the threshold for internal consistency reliability.

Conclusion

Construct validity and internal consistency reliability of the mBQ were established after confirmatory factor analysis and removal of three items, resulting in a revised mBQ. Future studies should test the validity and reliability of this revised version of the mBQ in larger, more diverse samples of older ALWH. See Appendix F for the results of the confirmatory factor analysis of the mBQ.
### Table 4.1

**Demographic Characteristics of the Study Sample (n = 100)**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Total sample n = 100*</th>
<th>Adults ≥ 50 n = 71</th>
<th>Adults &lt; 50 n = 29*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age, mean (SD)</strong></td>
<td>51.5 (7.66)</td>
<td>55.2 (3.69)</td>
<td>42.4 (7.27)</td>
</tr>
<tr>
<td><strong>BMI, mean (SD)</strong></td>
<td>29.5 (6.35)</td>
<td>29.3 (5.85)</td>
<td>30 (7.53)</td>
</tr>
<tr>
<td><strong>Sex, n</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>25</td>
<td>19 (26.76%)</td>
<td>6 (20.69%)</td>
</tr>
<tr>
<td>Female</td>
<td>75</td>
<td>52 (73.24%)</td>
<td>23 (79.31%)</td>
</tr>
<tr>
<td><strong>Race, n</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>76</td>
<td>55 (77.46%)</td>
<td>21 (72.41%)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>13</td>
<td>8 (11.27%)</td>
<td>5 (17.24%)</td>
</tr>
<tr>
<td>Mixed Race</td>
<td>11</td>
<td>8 (11.27%)</td>
<td>3 (10.34%)</td>
</tr>
<tr>
<td><strong>Employment Status, n</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employed</td>
<td>19</td>
<td>11 (15.49%)</td>
<td>8 (27.59%)</td>
</tr>
<tr>
<td>Unemployed/Disabled</td>
<td>65</td>
<td>49 (69.01%)</td>
<td>16 (55.17%)</td>
</tr>
<tr>
<td>Student/Retired</td>
<td>7</td>
<td>5 (7.04%)</td>
<td>2 (6.90%)</td>
</tr>
<tr>
<td>PNA**/Multiple Options Chosen</td>
<td>9</td>
<td>6 (4.23%)</td>
<td>3 (10.34%)</td>
</tr>
<tr>
<td><strong>Comorbidity, n</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>92</td>
<td>67 (94.37%)</td>
<td>25 (89.29%)</td>
</tr>
<tr>
<td>No</td>
<td>7</td>
<td>4 (5.63%)</td>
<td>3 (10.71%)</td>
</tr>
<tr>
<td><strong>Frequency of Computer Use, n</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Several times per day</td>
<td>30</td>
<td>19 (26.76%)</td>
<td>11 (37.93%)</td>
</tr>
<tr>
<td>Once daily</td>
<td>11</td>
<td>8 (11.27%)</td>
<td>3 (10.34%)</td>
</tr>
<tr>
<td>Several times per week</td>
<td>16</td>
<td>12 (16.90%)</td>
<td>4 (13.79%)</td>
</tr>
<tr>
<td>Several times per month</td>
<td>11</td>
<td>9 (12.68%)</td>
<td>2 (6.90%)</td>
</tr>
<tr>
<td>Once per month or less</td>
<td>17</td>
<td>10 (14.08%)</td>
<td>7 (24.14%)</td>
</tr>
<tr>
<td>Never</td>
<td>15</td>
<td>13 (18.31%)</td>
<td>2 (6.90%)</td>
</tr>
<tr>
<td><strong>Frequency of Mobile Device Use</strong>, n</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Several times per day</td>
<td>86</td>
<td>60 (84.51%)</td>
<td>26 (89.65%)</td>
</tr>
<tr>
<td>Once daily</td>
<td>5</td>
<td>4 (5.63%)</td>
<td>1 (3.45%)</td>
</tr>
<tr>
<td>Several times per week</td>
<td>7</td>
<td>5 (7.04%)</td>
<td>2 (6.90%)</td>
</tr>
<tr>
<td>Several times per month</td>
<td>1</td>
<td>1 (1.41%)</td>
<td>0</td>
</tr>
<tr>
<td>Never</td>
<td>1</td>
<td>1 (1.41%)</td>
<td>0</td>
</tr>
<tr>
<td><strong>ART Use, n</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>98</td>
<td>70 (98.59%)</td>
<td>28 (96.55%)</td>
</tr>
<tr>
<td>No</td>
<td>2</td>
<td>1 (1.41%)</td>
<td>1 (3.45%)</td>
</tr>
<tr>
<td><strong>CD4 Count, n</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than 200</td>
<td>14</td>
<td>11 (15.49%)</td>
<td>3 (10.34%)</td>
</tr>
<tr>
<td>201-349</td>
<td>4</td>
<td>2 (2.82%)</td>
<td>2 (6.90%)</td>
</tr>
<tr>
<td>350-599</td>
<td>17</td>
<td>11 (15.49%)</td>
<td>6 (20.69%)</td>
</tr>
<tr>
<td>500+</td>
<td>51</td>
<td>39 (54.93%)</td>
<td>12 (41.38%)</td>
</tr>
<tr>
<td></td>
<td>I don’t know</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------</td>
<td>--------------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Viral Load Count, n</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undetectable</td>
<td>86</td>
<td>62 (87.32%)</td>
<td>24 (82.76%)</td>
</tr>
<tr>
<td>Detectable</td>
<td>12</td>
<td>8 (11.27%)</td>
<td>4 (13.79%)</td>
</tr>
<tr>
<td>PNA</td>
<td>2</td>
<td>1 (1.41%)</td>
<td>1 (3.45%)</td>
</tr>
</tbody>
</table>

*Note.* *Missing comorbidity data, n = 1. **Prefer not to answer. ***Mobile device = smartphone, cell phone, tablet*
Table 4.2: Descriptive Statistics of Scale Scores of the Modified Baecke Questionnaire for Sample of Adults Living with HIV

<table>
<thead>
<tr>
<th>Subscale</th>
<th>Mean (SD)</th>
<th>Median (IQR)</th>
<th>Range (IQR)</th>
<th>Total Sample, n = 100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household</td>
<td>6.7 (1.3)</td>
<td>1.4 (0.5)</td>
<td>0 - 6.96</td>
<td>u = 100</td>
</tr>
<tr>
<td>Leisure</td>
<td>2.2 (1.3)</td>
<td>1.2 (0.5)</td>
<td>0 - 2.8</td>
<td>u = 100</td>
</tr>
<tr>
<td>Adults ≥ 50, n = 71</td>
<td>2.5 (0.6)</td>
<td>1.1 (0.5)</td>
<td>0 - 1.4</td>
<td>u = 16</td>
</tr>
<tr>
<td>Adults &lt; 50, n = 29</td>
<td>2.9 (0.6)</td>
<td>1.2 (0.5)</td>
<td>0 - 1.4</td>
<td>u = 41</td>
</tr>
</tbody>
</table>

Note: Classification of low, moderate, or vigorous physical activity was based on tertiles using cut points reported in the original study, 9.0 and 12.6.
### Table 4.3

**Known Groups Validity of the Modified Baecke Questionnaire Comparing Scores between Older and Younger Adults Living with HIV (n = 100)**

<table>
<thead>
<tr>
<th></th>
<th>ALWH &lt; 50 (n= 29)</th>
<th>ALWH ≥ 50 (n = 71)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Total mBQ*</td>
<td>2.26</td>
<td>1.51</td>
<td>3.08</td>
</tr>
<tr>
<td>Household PA Subscale</td>
<td>1.60</td>
<td>.41</td>
<td>1.81</td>
</tr>
<tr>
<td>Sport Subscale</td>
<td>.40</td>
<td>1.43</td>
<td>.30</td>
</tr>
<tr>
<td>Leisure Activity PA Subscale</td>
<td>.27</td>
<td>.67</td>
<td>.97</td>
</tr>
</tbody>
</table>

*Modified Baecke Questionnaire. Each subscale of the mBQ measured the physical activity a participant performed around the home (household subscale), as a sport (sport subscale), and the physical activity performed during leisure time (leisure activity subscale).*

**Note:**
### Table 4.4

*Validity of the Modified Baecke Questionnaire to Predict Physical Health in Older Adults Living with HIV (n = 71)*

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Predictor</th>
<th>Estimate</th>
<th>95% Confidence Limits</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical health (mBQ* score)</td>
<td>Physical function domain, PROMIS-29 v2.1**</td>
<td>.1865</td>
<td>.008 – .365</td>
<td>.041</td>
</tr>
<tr>
<td></td>
<td>Presence of Comorbidities</td>
<td>.6116</td>
<td>-2.493 – 3.716</td>
<td>.696</td>
</tr>
<tr>
<td></td>
<td>Frequency of Computer Use</td>
<td>-.3752</td>
<td>-.763 – .012</td>
<td>.058</td>
</tr>
</tbody>
</table>

*Note.* *Modified Baecke Questionnaire. **Patient Reported Outcomes Measurement Information System-29.*
Chapter Five: Synthesis and Conclusion

The studies comprising the three manuscripts of this dissertation explored aspects of PA in ALWH guided by the adapted Ecological Model of Four Domains of Active Living (EMFDAL). Together, the findings provide new evidence regarding the impact of PA in ALWH. The findings of this dissertation serve three purposes: (1) to provide evidence to support health care professionals to care for these individuals, (2) to direct future research, and (3) to inform policies that ultimately affect PA participation in ALWH. In this final chapter, results from each manuscript will be summarized; limitations discussed; implications for research, policy, and practice offered; and conclusions provided.

Summary of Results and Future Directions

The first manuscript, *Supervised Physical Activity and Improved Functional Capacity among Adults Living with HIV: A Systematic Review*, assessed the impact of supervised PA interventions on functional capacity in ALWH. Prior research from multiple countries on PA interventions conducted under the supervision of clinical or allied health professionals on adults aged 18 and over who were living with HIV were identified, appraised, and synthesized. Results revealed that the presence of clinical or allied health professionals (e.g., physical therapists, exercise physiologists, nurse trainers) improved functional capacity outcomes—namely strength, cardiovascular fitness, and flexibility—in ALWH. Another notable finding in this review was that the presence of professionals during PA acted as a motivating factor for ALWH to regularly participate in PA. This practice may be easily incorporated into the existing therapeutic relationship between provider and patient. This review suggested an opportunity for nurse scientists to conduct more robust research at the intersection of older ALWH and PA, because few studies exist thus far. In fact, the paucity of randomized controlled trials among older
ALWH precluded a systematic review. More research studies on older ALWH are needed with larger sample sizes, rigorous methodologies, and robust study designs in order to better understand the impact of supervised PA interventions on health outcomes as these individuals age.

The second manuscript, *The Role of Environment on Physical Activity Patterns of Older Adults Living with HIV*, presented findings from a secondary analysis of data collected from older ALWH in New York City (NYC). The aim of the study was to describe PA patterns in older ALWH and investigate the relationship between one’s environment and PA participation. While this study supported the current literature regarding suboptimal PA participation among ALWH, it also filled a critical gap by providing evidence on the PA patterns of older ALWH, a growing population that remains underrepresented in the HIV literature. Additionally, this study revealed the inverse relationship between PA and traffic hazards, where the presence of traffic hazards reduced the amount of time spent in moderate or vigorous-intensity PA. This finding was significant as it described the impact of environment on PA participation, the first study of its kind among older ALWH. Future research is needed with larger, more geographically and demographically diverse samples of ALWH to better understand the interdependence of environmental factors and PA participation and achieve broad generalizability of these relationships in this population.

In the third manuscript, *Validation of the Modified Baecke Questionnaire in Older Adults Living with HIV*, secondary data from older ALWH in NYC was analyzed. The aims of this study were to assess the internal consistency reliability of the modified Baecke Questionnaire (mBQ) and establish known groups and predictive validity of the mBQ on the physical health of older ALWH. Known groups validity tests differences in mean scores between groups known to
be different. A statistically significant difference between older ALWH and younger ALWH was found on the leisure activity subscale of the mBQ. This finding showed that older ALWH participated in more PA during leisure time compared to younger ALWH, contrary to current evidence and our hypothesis. Predictive validity tests the extent to which scores on a particular measure correlate with scores on a criterion measure. Findings that supported the predictive validity of the mBQ for use in older ALWH included significant, modest correlations between the mBQ and the physical function domain of the PROMIS-29 v2.1, and statistically significant results from the linear regression analysis. These validity findings are important in identifying an individual’s level of PA participation-low, moderate, or vigorously physically active-and serve as the basis for PA prescription as part of promoting strategies for healthy aging. However, despite establishing known groups and predictive validity of the mBQ, internal consistency reliability fell below the acceptable standard value of .70, and led to factor analyses to further examine the construct validity of the tool. Findings from the factor analysis reduced the number of items in the household activities subscale which subsequently raised the Cronbach’s alpha coefficient, and thus established the validity and reliability of the tool. Future studies should focus on replicating the validity and reliability findings of this revised version of the mBQ in larger, more diverse samples as the need for a PA measurement tool in older ALWH remains.

**Limitations and Strengths**

There are limitations to the research presented in this dissertation. For the systematic review, the inclusion of studies in English excluded studies published in other languages, particularly languages spoken in African countries where the HIV/AIDS epidemic persists. The generalizability of our findings was limited to the countries represented by the studies included in the review: Australia, Brazil, Ireland, Spain, and the U.S. This review was also limited by
potential selection bias, because the included studies may have an overrepresentation of adults who were already motivated to improve their health by participating in PA. In addition, the inclusion of only randomized controlled trials excluded other study designs and gray literature which may have offered other insights into the functional capacity outcomes of ALWH under the supervision of clinical or allied health professionals.

The nature of secondary analyses presented methodological limitations in Chapters 3 and 4. Chapter 3 assessed the relationship between environmental factors and PA patterns in ALWH. Our research questions were limited by the variables available in the existing dataset. The sample size \(n = 100\) prevented testing the associations between other environmental factors important for predicting PA, such as crime or street connectivity. Furthermore, the sample size was not sufficient to detect the relationship between all twelve NEWS-A subscale scores and time spent in moderate and vigorous PA. When relationships between environmental factors and PA participation were assessed, the cross-sectional design of this study did not allow for identifying causation. The generalizability of the study findings was limited by the demographic makeup of the sample; because the participants of this study were older ALWH in NYC, the generalizability of the findings is limited to older ALWH living in similar urban communities.

Chapter 4, the validation study of the mBQ, was also a secondary analysis of data and, therefore, was subject to some of the same limitations discussed above, particularly the size and demographic makeup of the sample. The sample size \(n = 100\) precluded more rigorous statistical analyses. Building more robust regression models, including more independent variables and covariates, for example, would have required a larger sample size. Additionally, the demographic makeup of the sample included only older African-American and Hispanic/Latino participants living in NYC, so the results of this study were generalizable only
to African-American and Hispanic/Latino ALWH living in similar urban settings. This study used the mBQ as one measure of PA, and, because it measures routine PA over the past twelve months, recall bias may have been present.

Despite the above limitations, this dissertation has clear strengths. The systematic review was the first to focus on the impact of supervision during PA on functional capacity of ALWH. This review also offered evidence supporting the presence of nurses as clinical professionals during PA to improve functional capacity and potentially motivate sustained PA in ALWH. This dissertation also contributes two studies exclusively on older ALWH, a subset underrepresented in the current HIV literature. Our study on the impact of environment on PA added evidence that traffic hazards act as a deterrent to PA in older ALWH, the first environmental study of its kind in older ALWH. Finally, this research tested a PA instrument that not only demonstrated validity to predict physical health in older ALWH, but also demonstrated the utility of classifying individuals by level of physical activity. This classification is an important specification needed for PA prescriptions that will ultimately serve as adjunct therapy for healthy aging for these adults.

Implications for Research, Policy, and Practice

This dissertation was guided by the adapted Ecological Model of Four Domains of Active Living (EMFDAL). This conceptual model, presented as concentric circles, posits that certain conditions must be present to support PA participation. For example, from outermost to innermost circle of the model, one’s physical environment (the access to and settings where PA occur) must provide space where PA can be performed. One must have a favorable perception of their surroundings, such as perceived low crime, comfort, or neighborhood aesthetics, for example, to participate in PA. Finally, an individual’s characteristics, (e.g., weight, presence and
number of comorbidities, CD4 count, viral load) must be optimized before they can safely and regularly participate in PA. Only when all of these conditions are met is PA possible. Therefore, interventions that target multiple levels of the adapted EMFDAL are necessary to achieve population changes regarding PA engagement (Sallis et al., 2006). The adapted EMFDAL served as the lens through which this dissertation was developed and through which the implications of this dissertation were examined. Chapter 2, the systematic review of supervised PA interventions, aligned with the social environment domain of the adapted EMFDAL. Chapter 3, the exploration of the impact of environment on PA, aligned with both the physical and social environment domains; and, Chapter 4, the validation study, aligned with the physical activity domain. The interpersonal domain was considered in each study and described the demographic makeup of the study participants.

**Research.** The findings of this dissertation will be presented at conferences in nursing, aging, and HIV care. The studies in Chapters 3 and 4 will be submitted for publication to disseminate findings. Results from this dissertation suggest directions for future research. The systematic review, for example, showed that nurses ought to play a larger role in facilitating sustained PA in ALWH. Further research, namely much-needed randomized controlled trials designed and conducted by nurse scientists, could investigate which interventions employed by nurses motivate and yield the best functional capacity outcomes in ALWH. The findings from Chapter 3 (environmental impact on PA) suggest that the study ought to be replicated by nurse scientists, using more robust research designs and with larger, more demographically and geographically diverse sample sizes. Given that ALWH live in diverse communities across the country, further studies are needed to inform how their respective environments may support or hinder PA for healthy aging. Finally, there remains a need for a valid and reliable PA tool for use
in research among ALWH. Future studies designed by nurse scientists should focus on PA instrument development for use in ALWH, particularly older ALWH as the largest sector of this population. Lack of participation in PA can no longer be viewed as simply a failure of the individual, if their environment fails to support regular PA.

**Policy.** The national guidelines for PA are recommended for all adults (HHS, 2008), yet there is no national PA guideline to govern the PA participation of adults with chronic, activity-limiting conditions. As presented throughout this dissertation, older ALWH often have multiple, chronic comorbidities that are acquired several years earlier than their age-matched, non-HIV counterparts. The findings of this dissertation have implications for policy interventions. First, policies could be implemented to encourage primary care provider offices, public health organizations, and acute care facilities to encourage PA among ALWH through insurance reimbursements or other incentives to provide education on PA or create regular, structured PA classes or activity groups (e.g., walking) for ALWH. Second, it may be possible to implement policies that encourage state-level public health campaigns that target all adults with chronic, activity-limiting conditions, including ALWH, on the importance of PA in their overall health. These education campaigns could offer creative ways in which PA may be performed in urban settings or settings with limited resources or environmental obstacles. Lastly, policies within healthcare organizations could be put in place that screen and identify older ALWH in poor physical health and connect them with community resources that support regular PA participation. Data monitoring systems could track the outcomes of these individuals and lead to reimbursements for their providers for providing effective, preventative care through such programs.
Although the policies proposed are for ALWH, they could benefit all adults with multiple comorbidities, many of which may be activity-limiting. This broad appeal may gain favor with insurance companies and local governments to create incentive programs that could ultimately have long-term cost savings across a range of disease processes.

**Practice.** As the largest and most trusted profession in the health care industry, nurses (advanced practice and otherwise) will be at the forefront of care delivery of ALWH. Findings from the systematic review suggested an expanded role for nurses as facilitators and motivators of PA participation. Prior research has demonstrated the benefit of the therapeutic relationship between provider and patient. Therefore, modeling the relationship between the nurse as the motivator during PA participation and ALWH, after the therapeutic relationship traditionally found between provider and patient, may increase PA participation in ALWH.

Additionally, prescribing PA as an adjunct therapy in the care of ALWH should begin with a baseline assessment. As part of that assessment, advanced practice nurse providers caring for ALWH should assess the aspects of one’s environment and PA patterns through a focused patient interview. This understanding can create an opportunity for nurse providers to offer suggestions on how to overcome environmental barriers to PA, such as lack of parking or infrastructure for safety and walking, by connecting ALWH with resources (e.g., walking groups, transportation programs or vouchers, carpools). Another part of the baseline assessment may include using the mBQ to understand the physical health of the individual and individually tailor PA prescriptions to support optimal health.

In addition to caring for patients, advanced practice nurses may partner with patients to advocate for improvements of the physical surroundings of their patients. Research findings can be used to advocate to local government officials, including local representatives and
departments of transportation which have jurisdiction over speed, traffic, and sidewalk concerns, in order to shape improvements to physical and social environments that support PA. These efforts will not only help ALWH but will also benefit entire communities who are discouraged from participating in PA due to these environmental obstacles. Because these improvements have broad appeal and the potential for widespread benefit, government officials may be inclined to hear and address concerns that will serve multiple communities and populations, including ALWH.

Conclusions

PA participation is important for the overall health of ALWH. Older ALWH are the largest segment of the HIV/AIDS population in the U.S.; thus, it is particularly important to encourage their participation in PA, because they typically present with activity-limiting comorbidities and frailty. One way to increase PA in ALWH is to have nurses present during PA. As part of a PA assessment, providers should assess the social and physical environments in which PA takes place and use a valid instrument in older ALWH to establish a baseline measurement of PA. These two actions should be done prior to individually tailoring PA prescriptions to ALWH.

This dissertation provides evidence to encourage and support PA in ALWH, offers directions for future research that will advance the extant HIV literature, and suggests policy interventions that could serve all populations with chronic conditions, including ALWH. In addition, it guides advance practice nurses in the care of ALWH by focusing on PA assessment and prescriptions as adjunct therapy. Finally, this dissertation addresses critical gaps in the current HIV literature and the needs of a growing underrepresented population.
References


doi:10.1016/S0140-6736(12)60735-1

marketing and consumer research: A review. *International Journal of Research in
Marketing, 13*, 139-161.

improving quality of life of HIV infected people receiving antiretroviral therapy: a
systematic review and meta-analysis. *Health Qual Life Outcomes, 15*(1), 80.
doi:10.1186/s12955-017-0662-4

Blair, S. N., Haskell, W. L., Ho, P., Paffenbarger, R. S., Jr., Vranizan, K. M., Farquhar, J. W., &
Wood, P. D. (1985). Assessment of habitual physical activity by a seven-day recall in a

Bohannon, R. W., & Crouch, R. (2017). Minimal clinically important difference for change in 6-
minute walk test distance of adults with pathology: a systematic review. *J Eval Clin
Pract, 23*(2), 377-381. doi:10.1111/jep.12629

pilot study of brisk walking in sedentary combination antiretroviral treatment (cART)-
treated patients: benefit on soluble and cell inflammatory markers. *BMC Infect Dis,

physical therapists' guidance on improvement in a strength-training program for the frail

Bousquet-Dion, G., Awasthi, R., Loiselle, S. E., Minnella, E. M., Agnihotram, R. V., Bergdahl,
prehabilitation programme in cancer patients undergoing colorectal resection: a

Opin HIV AIDS, 4*(3), 194-199. doi:10.1097/COH.0b013e328329fc8d


Jang, N., & Bakken, S. (2017). Relationships between demographic, clinical, and health care provider social support factors and internalized stigma in people living with HIV. *Journal of the Association of Nurses in AIDS Care, 28*(1), 34-44. doi:10.1016/j.jana.2016.08.009


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Supervised Physical Activity and Improved Functional Capacity among Adults Living with HIV: A Systematic Review

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Physical activity (PA) combats the effects of multimorbidity and antiretroviral therapy in people living with HIV (PLWH), but PLWH often do not meet recommended PA guidelines. The purpose of our review was to investigate whether supervised PA improved functional capacity in PLWH. Preferred Reporting Items for Systematic Reviews and Meta-Analyses were followed. Five databases were searched for randomized controlled trials in English, with participants ages 18 years and older, and a supervised PA intervention. A database search yielded 8,267 articles, with 15 eligible for review inclusion. We found a low risk of bias within and across studies. Combined aerobic/progressive resistance training (PRT) improved strength, cardiovascular, and flexibility outcomes; aerobic interventions alone showed no significant improvements; PRT improved strength outcomes; yoga or yoga/meditation showed no outcome differences; and tai chi showed cardiovascular and flexibility improvements. We found that supervised PA increased functional capacity in PLWH and that self-report was not a reliable assessment.

(Journal of the Association of Nurses in AIDS Care, 29, 667-680) Copyright © 2018 Association of Nurses in AIDS Care

Key words: functional capacity, HIV, physical activity, supervision

There are currently 1.1 million people living with HIV (PLWH) in the United States (Centers for Disease Control and Prevention [CDC], 2017). Due to advances in antiretroviral therapy (ART), PLWH are living longer (Antiretroviral Therapy Cohort Collaboration, 2008; Boyd, 2009) and HIV is now managed as a chronic disease in much of the developed world (Deeks, Lewin, & Havlir, 2013). Despite the steady increase in life expectancy (Samji et al., 2013), non-HIV-related mortality, specifically, cardiovascular disease, has eclipsed HIV-related mortality as the major cause of death among PLWH (Farahani, Mulinder, Farahani, & Marlink, 2017).

Evidence has suggested that physical activity (PA) is safe and beneficial in promoting the health and medical stability of PLWH (Hand, Lyster, Jaggers, & Dudgeon, 2009; Jaggers, 2018; Nixon, O’Brien, Glazier, & Tynan, 2005; O’Brien, Tynan, Nixon, & Glazier, 2016; Yahiaoui, McGough, & Voss, 2012). Specifically, PA can effectively mitigate the effects of cardiovascular disease (Hand et al., 2009; Kamitani et al., 2017; O’Brien et al., 2016), the leading cause of death among PLWH (Farahani et al., 2017), and symptoms of long-term HIV exposure and long-term ART (O’Brien et al., 2016; Webel et al., 2015; Yahiaoui et al., 2012). For example, PLWH who
participate in PA have a reduced risk for heart disease, increased energy, improved regulation of bowel function, improved sleep, and lower stress (Hand et al., 2009; U.S. Department of Veterans Affairs, 2015; Yahiaoui et al., 2012). PA is also an important strategy for improving aerobic capacity, muscle strength, and flexibility in this population (Haskell et al., 2007; Jones & Carter, 2000; O’Brien et al., 2016; Poton, Politò, & Farinati, 2016).

The CDC (2015) defined PA as any expenditure of energy by skeletal muscles to produce any bodily movement. PA is a broader concept than exercise, as exercise, a subset of PA, is defined as a planned, structured, and repetitive activity (Caspersen, Powell, & Christenson, 1985). Recommended PA for adult PLWH includes 20 to 40 minutes of combined aerobic and resistance exercise at least three times per week (O’Brien et al., 2016; Yahiaoui et al., 2012). These recommendations were shown to reduce the severity of comorbidities (Dirajal-Fargo et al., 2016; Kanitani et al., 2017; Yahiaoui et al., 2012) and reduce inflammation associated with long-term HIV and long-term ART (d’Ettorre et al., 2014; Hand et al., 2009; Weibel et al., 2015). Given the benefits of PA, regular participation for PLWH is essential; however, their PA participation has remained below recommended levels (Montoya, Wing, Knight, Moore, & Henry, 2015; Simonik et al., 2016; Vancampfort et al., 2016; Weibel et al., 2015). Weekly PA recommendations make no mention of supervision, despite being based on studies of both supervised and unsupervised PA interventions (O’Brien et al., 2016; Yahiaoui et al., 2012).

Supervised PA has the potential to encourage PLWH to participate in PA regularly. Studies of adults with other chronic conditions (e.g., arthritis, obesity, kidney failure patients on dialysis, heart failure, diabetes, and cancer) were shown to have increased PA participation after involvement in a PA intervention supervised by a clinician or allied health professional (Akbar, Yeldan, Guney, & Ozdincler, 2016; Casla et al., 2014; Colak et al., 2017; Daul, Schaifers, Daul, & Philipp, 2004; Klempfner et al., 2015; Negri et al., 2010; Nicolai et al., 2009). In some cases, regular participation in PA continued well beyond the end of the study (Azad, Bouchard, Mayhew, Carter, & Molnar, 2012; Casla et al., 2014; Trinh, Murie, Campbell, Crawford, & Courneya, 2014).

Additionally, when outcomes were compared between supervised and unsupervised PA interventions, more pronounced improvements were seen as a result of supervised PA. To detail, participants of supervised PA interventions showed significant improvement in cardiovascular fitness, muscle strength, and significantly decreased fat mass, body mass index (BMI), and body weight, compared with controls (Akbar et al., 2016; Boshuizen, Stemmerik, Westhoff, & Hopman-Rock, 2005; Dalager et al., 2015; Nicolai et al., 2009; Rossomanno, Herrick, Kirk, & Kirk, 2012). However, the evidence to support the benefits of supervised PA as the main intervention for PLWH is missing from the current body of literature. Past systematic reviews have examined the effects of both supervised and unsupervised PA interventions for PLWH and reported aggregate results (Gomes-Neto, Conceicao, Carvalho, & Brites, 2015; Gomes-Neto, Ogilha, Andrade, & Brites, 2013; Jaggers, 2018; O’Brien et al., 2016; Poton et al., 2016; Yahiaoui et al., 2012). None have segregated supervised from unsupervised interventions in their reviews or analyzed the outcomes of these respective interventions separately. The purpose of our review was to investigate the impact of supervised PA interventions on functional capacity among adults living with HIV.

Methods

Search Strategy

Our review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher, Liberati, Tetzlaff, & Altman, 2009). A total of five databases were systematically searched for all relevant literature, including PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), PsycINFO, Embase, and Physical Education Index. First, search terms were created based on the population and interventions of interest in PubMed. Second, comparable search terms were identified in each subsequent database. For example, a combination of MeSH terms, MeSH headings, keywords and phrases, and Boolean operators were used to create the search terms used in PubMed. The resultant search terms in PubMed were as follows: ("HIV"[Mesh] OR HIV [Text Word]) OR

Eligibility Criteria

Study inclusion criteria included studies that (a) were randomized controlled trials that evaluated the effect of a supervised PA intervention as compared with usual care, (b) examined functional capacity as an outcome, (c) included adults ages 18 years and older living with HIV, and (d) were available as full text articles in English. Supervised PA was defined in our review as PA interventions that were supervised by a health care or allied health professional. Functional capacity was defined as per the American Heart Association definition, as the integrated efforts and health of an individual's pulmonary, cardiovascular, and skeletal muscles to perform activities of daily living (Arona et al., 2007). Functional capacity outcomes in our review included strength measures, cardiovascular fitness measures, flexibility measures, and self-reported measures of functional capacity. We excluded poster sessions, presentations, protocols, letters, comments, editorials, correspondence, or gray literature (e.g., blogs, newsletters, videos).

Study Selection and Data Extraction

We used Covidence (Veritas Health Innovation, 2018), a web-based program designed to support the systematic review process, to facilitate screening at the title/abstract and full text level, as well as for data extraction, adjudication of disagreements, and confirmation of data. A hand search was conducted for additional studies meeting inclusion criteria. Two authors independently assessed eligibility, and a third consulted in instances of uncertainty/disagreement. The following information was extracted from the final studies: name of the first author, publication year, locations of the studies, study sample size, type of supervised PA interventions, frequency/duration of interventions, and duration of the studies. No publication date or restrictions were used in the search.

Quality Assessment

The quality appraisal was conducted using the Cochrane Collaboration Risk of Bias Tool (CCRBT; Higgins et al., 2011). The CCRBT describes six domains to assess possible avenues of bias: sequence generation; allocation concealment; blinding of participants, personnel, and outcome assessors; incomplete outcome data; selective outcome reporting; and, other sources of bias. Each domain is evaluated as yes (low risk of bias), no (high risk of bias), or unclear (uncertain risk of bias). Each study is then assigned an overall grade of high, moderate, or low risk of bias. Two authors independently appraised the quality of the studies, and discrepancies were reviewed until consensus was reached.

Results

Study Selection

The database literature search yielded 8,267 articles; 126 articles were identified from the hand search. One hundred ninety-five articles remained for full text screening after duplicates were removed and title and abstract screening was completed; 180 articles were excluded based on the full text review. Of the 180 excluded articles, full text for 28 abstracts were not found despite independent searches, the assistance of university librarians, and requests from other institutions via interlibrary loan. Fifteen studies remained and were included in this systematic review. Figure 1 summarizes the results of the search and study selection.

Study Characteristics

The combined studies had 537 participants whose ages ranged between 18 and 73 years. The
supervisors of the PA interventions included certified yoga instructors, exercise physiologists, nurse trainers, physical therapists, exercise specialists, physiotherapists, cardiologists, and personal trainers. Table 1 summarizes the characteristics of the included studies. The duration of the PA interventions ranged between 31 minutes and 2 hours, and the intensity ranged from low to vigorous. The length of the PA interventions ranged from 6 weeks to 6 months across studies.

Study Findings

Supervised PA interventions were classified into the following categories: (a) aerobics, (b) progressive resistance training (PRT), (c) combined aerobics and PRT, (d) yoga and meditation, and (e) t’ai chi. Each intervention in the review was assessed as a change in one or a combination of four functional capacity outcomes of interest: cardiovascular (e.g., VO₂max [maximal aerobic capacity]; BMI; the 6-Minute Walk Test), strength (e.g., the one-repetition maximum, 6-repetition maximum), flexibility and balance (i.e., Sit and Reach and Forward Reach tests), and self-report (e.g., SF-36 Physical Functioning and Role Limitations due to Physical Health subscale scores, exit interview questions, health diary). Table 2 describes the functional capacity outcomes of each study.

Aerobics interventions (n = 4). Four studies employed aerobic interventions in their respective study samples (Baigis et al., 2002; Galantino et al., 2005; McDermott et al., 2016; Terry et al., 2006). Three out of four studies reported no significant differences between intervention and control group participants in cardiovascular and self-reported outcomes (Baigis et al., 2002; McDermott et al., 2016; Terry et al., 2006). However, the participants in the Galantino and colleagues (2005) study showed improvements in both cardiovascular (p < .05) and flexibility outcomes (p < .01).
Table 1. Characteristics of the Physical Activity Interventions of Included Studies (n = 15)

<table>
<thead>
<tr>
<th>Study and Sample Size</th>
<th>Country</th>
<th>Intervention</th>
<th>Frequency (per Week)</th>
<th>Session Duration</th>
<th>Study Length (Weeks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agarwal et al., 2015</td>
<td>USA</td>
<td>Yoga &amp; meditation</td>
<td>2</td>
<td>60 min</td>
<td>8</td>
</tr>
<tr>
<td>(n = 24)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agin et al., 2001</td>
<td>USA</td>
<td>PRT</td>
<td>3</td>
<td>3 sets, 8-10 repetitions per muscle group</td>
<td>14</td>
</tr>
<tr>
<td>(n = 30)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baigis et al., 2002</td>
<td>USA</td>
<td>Aerobics</td>
<td>3</td>
<td>40 min</td>
<td>15</td>
</tr>
<tr>
<td>(n = 99)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cade et al., 2010</td>
<td>USA</td>
<td>Yoga</td>
<td>2-3</td>
<td>60 min</td>
<td>20</td>
</tr>
<tr>
<td>(n = 50)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dolan et al., 2006</td>
<td>USA</td>
<td>Aerobics &amp; PRT</td>
<td>3</td>
<td>120 min</td>
<td>16</td>
</tr>
<tr>
<td>(n = 38)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Driscoll et al., 2004</td>
<td>USA</td>
<td>Aerobics &amp; PRT</td>
<td>3</td>
<td>Weeks 1-2: 20 min aerobics + PRT</td>
<td>12</td>
</tr>
<tr>
<td>(n = 25)</td>
<td></td>
<td></td>
<td></td>
<td>Weeks 3-12: 30 min aerobics + PRT</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PRT: 3 sets, 10 repetitions per muscle group</td>
<td></td>
</tr>
<tr>
<td>Dudgeon et al., 2012</td>
<td>USA</td>
<td>Aerobics &amp; PRT</td>
<td>2</td>
<td>Aerobics: 30 min</td>
<td>6</td>
</tr>
<tr>
<td>(n = 26)</td>
<td></td>
<td></td>
<td></td>
<td>PRT: 1 set, 12 repetitions per muscle group</td>
<td></td>
</tr>
<tr>
<td>Farinatti et al., 2010</td>
<td>Brazil</td>
<td>Aerobics &amp; PRT</td>
<td>3</td>
<td>90 min</td>
<td>12</td>
</tr>
<tr>
<td>(n = 27)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Filippas et al., 2006</td>
<td>Australia</td>
<td>Aerobics &amp; PRT</td>
<td>2</td>
<td>60 min</td>
<td>24</td>
</tr>
<tr>
<td>(n = 35)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Galantino et al., 2005</td>
<td>USA</td>
<td>Aerobics &amp; Tai Chi</td>
<td>4</td>
<td>60 min</td>
<td>8</td>
</tr>
<tr>
<td>(n = 38)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>McDermott et al., 2016</td>
<td>Ireland</td>
<td>Aerobics</td>
<td>3</td>
<td>31-52 min</td>
<td>16</td>
</tr>
<tr>
<td>(n = 11)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ogalha et al., 2011</td>
<td>Brazil</td>
<td>Aerobics &amp; PRT</td>
<td>3</td>
<td>60 min</td>
<td>24</td>
</tr>
<tr>
<td>(n = 63)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perez-Moreno et al., 2007</td>
<td>Spain</td>
<td>Aerobics &amp; PRT</td>
<td>3</td>
<td>90 min</td>
<td>16</td>
</tr>
<tr>
<td>(n = 19)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strawford et al., 1999</td>
<td>USA</td>
<td>PRT</td>
<td>3</td>
<td>60 min</td>
<td>8</td>
</tr>
<tr>
<td>(n = 22)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Terry et al., 2006</td>
<td>Brazil</td>
<td>Aerobics</td>
<td>3</td>
<td>60 min</td>
<td>12</td>
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<tr>
<td>(n = 30)</td>
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</tbody>
</table>

Note: PRT = progressive resistance training.

Progressive resistance training interventions (n = 2). Agin and colleagues (2001) and Strawford and colleagues (1999) administered PRT as the intervention in their studies. Both studies showed significant improvements in strength outcomes in the intervention group compared to those in the control group (p < .001 and p < .05, respectively).

Combined aerobic and PRT interventions (n = 7). Seven studies employed combined aerobic and PRT interventions (Dolan et al., 2006; Driscoll et al., 2004; Dudgeon et al., 2012; Farinatti, Borges, Gomes, Lima, & Fleck, 2010; Filippas, Oldmeadow, Bailey, & Cherry, 2006; Ogalha et al., 2011; Perez-Moreno et al., 2007). All strength, cardiovascular, and flexibility outcome measures associated with these interventions demonstrated a significant improvement (p ≤ .05) in the intervention group as compared to control group participants. However, BMI in the Farinatti and colleagues (2010) and Ogalha and colleagues (2011) studies and health-related quality of life in the Filippas and colleagues (2006) study demonstrated no significant difference between intervention and control groups (p > .05).

Yoga and meditation interventions (n = 2). One study administered a combined yoga and meditation
### Table 2. Functional Capacity Outcomes of Intervention Groups in the Included Studies (n = 15)

<table>
<thead>
<tr>
<th>Type of Supervised PA</th>
<th>Study (Year)</th>
<th>Functional Capacity Measure</th>
<th>Functional Capacity Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerobics</td>
<td>Baigis (2002)</td>
<td>VO$_{2\text{max}}$</td>
<td>Ø</td>
</tr>
<tr>
<td></td>
<td>Galantino (2005)</td>
<td>Diary, DASI, MOS-HIV, SIP</td>
<td>Ø</td>
</tr>
<tr>
<td></td>
<td>McDermott (2016)</td>
<td>VO$_{2\text{max}}$, treadmill time, light/moderate/</td>
<td>Ø</td>
</tr>
<tr>
<td></td>
<td>Terry (2006)</td>
<td>vigorous PA</td>
<td>Ø</td>
</tr>
<tr>
<td>Progressive Resistance Training</td>
<td>Agin (2001)</td>
<td>1-RM</td>
<td>Ø</td>
</tr>
<tr>
<td></td>
<td>Strawford (1999)</td>
<td>1-RM</td>
<td>Ø</td>
</tr>
<tr>
<td>Aerobics</td>
<td>Dolan (2006)</td>
<td>VO$_{2\text{max}}$, Bike time, 6MWT</td>
<td>Ø</td>
</tr>
<tr>
<td></td>
<td>Progressive Resistance Training</td>
<td>Exit interview questions</td>
<td>Ø</td>
</tr>
<tr>
<td></td>
<td>Driscoll (2004)</td>
<td>BP, Exercise time</td>
<td>Ø</td>
</tr>
<tr>
<td></td>
<td>Dudgeon (2012)</td>
<td>Change in strength</td>
<td>Ø</td>
</tr>
<tr>
<td></td>
<td>Farinatti (2010)</td>
<td>BMI</td>
<td>Ø</td>
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<tr>
<td></td>
<td>Fillipas (2006)</td>
<td>Heart rate, 12-RM, Sit and reach</td>
<td>Ø</td>
</tr>
<tr>
<td></td>
<td>Ogala (2011)</td>
<td>HRQoL</td>
<td>Ø</td>
</tr>
<tr>
<td></td>
<td>Perez-Moreno (2007)</td>
<td>Workload, Peak HR, Decline HR</td>
<td>Ø</td>
</tr>
<tr>
<td>Yoga</td>
<td>Agarwal (2015)</td>
<td>SF-36</td>
<td>Ø</td>
</tr>
<tr>
<td></td>
<td>Cade (2010)</td>
<td>SF-36</td>
<td>Ø</td>
</tr>
<tr>
<td>Meditation</td>
<td>T'ai Chi</td>
<td>Galantino (2005)</td>
<td>Forward reach, Sit and reach</td>
</tr>
</tbody>
</table>

Note. Ø = no significant change in functional capacity; † = significantly improved functional capacity; VO$_{2\text{max}}$ = maximal aerobic capacity; PA = physical activity; BMI = body mass index; DASI = Duke Activity Status Index; MOS-HIV = Medical Outcomes Study, HIV Health Survey; SIP = Sickness Impact Profile; HR = heart rate; BP = blood pressure; 1-RM = 1 repetition maximum; 6-RM = 6 repetition maximum; 12-RM = 12 repetition maximum; SF-36 = Medical Outcomes Study, 36-item Short Form Health Survey; 6MWT = 6-Minute Walk Test; Change in strength 1: leg curl, leg extension, lateral pull down, arm curl, chest press; Change in strength 2: leg press; HRQoL = Health Related Quality of Life; MET = metabolic equivalent.

intervention (Agarwal, Kumar, & Lewis, 2015) and another employed yoga alone (Cade et al., 2010). Both studies measured change in functional capacity via self-reported measures, the SF-36 Physical Functioning and Physical Limitations subscale scores. In both studies, changes in functional capacity were not significantly different from the control group at study end.

_T'ai chi intervention (n = 1)_. The t'ai chi group showed significant improvements in both flexibility (p < .01) and cardiovascular (p < .05) outcomes (Galantino et al., 2005).

### Study Quality

Seven of 15 studies had a low risk of bias (Agin et al., 2001; Baigis et al., 2002; Dolan et al., 2006; Fillipas et al., 2006; Galantino et al., 2005; Perez-Moreno et al., 2007; Strawford et al., 1999). The remaining eight studies had an unclear risk (Agarwal et al., 2015; Cade et al., 2010; Farinatti et al., 2010; McDermott et al., 2016; Terry et al., 2006) or high risk of bias (Driscoll et al., 2004; Dudgeon et al., 2012; Ogala et al., 2011). For sequence generation, allocation concealment, blinding of participants, personnel, and outcome
assessors, the risk of bias was low or unclear for all studies. Most of the studies demonstrated low risk of bias for incomplete outcome data. The results of the assessment of study quality using CCRBT are reported in Figure 2, and the Cochrane risk of bias summary is reported in Figure 3.

**Discussion**

We examined the impact of supervised PA interventions on the functional capacity of adult PLWH. Overall, our findings supported supervised PA interventions as an effective intervention for increasing functional capacity among adult PLWH. Supervised combined aerobics and PRT interventions improved functional capacity outcomes across all of the following outcomes: cardiovascular, strength, flexibility and balance, and self-report. However, studies that assessed functional capacity via self-reported measures alone revealed inconsistent results.

We found that supervised combined aerobics and PRT was the most effective intervention, followed by supervised T’ai chi, PRT, aerobics, yoga, and

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<tr>
<th>Study</th>
<th>Random sequence generation (selection bias)</th>
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*Figure 2. Risk of bias within studies.*
combined yoga and meditation to increase functional capacity in this population. The participants in all seven studies involving supervised combined aerobicics and PRT (Dolan et al., 2006; Driscoll et al., 2004; Dudgeon et al., 2012; Farinatti et al., 2010; Fillipas et al., 2006; Ogala et al., 2011; Perez-Moreno et al., 2007) showed statistically significant improvements in cardiovascular, strength, and flexibility and balance outcomes. Improvements in cardiovascular health, strength, and flexibility have been associated with reduced cholesterol and risk of heart attack and stroke, increased muscle mass and strengthening of bones, and reduced stress in both PLWH and those without HIV infection (Lachman et al., 2018; U.S. Department of Veterans Affairs, 2015; Yahiaoui et al., 2012). These health benefits are of particular import to PLWH, as the incidence of heart attack, lipodystrophy, and wasting syndrome are high in this population (Deeks, Tracy, & Douek, 2013; Farahani et al., 2017; Nguyen, Peer, Mills, & Kengne, 2016; Palmeira dos Santos et al., 2017; Schouten et al., 2014). While yoga is considered a form of PA and has been shown to effectively improve health-related outcomes in both healthy and diseased populations (Govindaraj, Karmani, Varambally, & Gangadhar, 2016; Ross & Thomas, 2010), in our review, yoga failed to demonstrate an improvement in functional capacity for PLWH.

Supervised combined aerobicics and PRT interventions showed improvements in strength, cardiovascular, and flexibility and balance outcomes; however, cardiovascular outcomes associated with supervised aerobicics alone showed no significant changes between groups in three out of four studies (Baigis et al., 2002; McDermott et al., 2016; Terry et al., 2006). In our review, when PRT was included with aerobicics, cardiovascular outcomes demonstrated significant improvement in functional capacity. Improved cardiovascular outcomes in the Galantino and colleagues (2005) study may be attributed to three possible reasons: (a) the sample of male-only subjects, whereas the subjects in the other aerobicics studies were comprised of male and female subjects; (b) the investigator was not blinded to the participants in the Galantino and colleagues (2005) study, and therefore, introduced a source of bias in the data collection or analysis; and (c) the cardiovascular outcome measures in the Galantino and colleagues (2005) study involved the simplest interactions with equipment, and thus, a reduced likelihood of equipment malfunction or failure, unlike the measures in the Baigis and colleagues (2002), McDermott and colleagues (2016), and Terry and colleagues (2006) studies. For instance, the latter studies used VO2max, peak heart rate, and blood pressure as cardiovascular outcomes among others. Measuring VO2max involves a mouth guard, nose clip, and treadmill. Peak heart rate measurements require electrode sensors and an electrocardiogram machine. Blood pressure was measured with an automated sphygmomanometer. Sit-up and stair-climbing tests in the Galantino and colleagues (2005) study involved counts of each within a specified time frame.

Of the studies that employed self-reported measures, (Agarwal et al., 2015; Agin et al., 2001; Baigis et al., 2002; Cade et al., 2010; Dolan et al.,
2006; Fillipus et al., 2006; Ogalha et al., 2011), the findings were inconclusive. Self-reported improvement of functional capacity was more likely to be significant when supervised PRT was included in the PA intervention. This finding is supported by the evidence that subjective assessments of PA are beneficial only to ranking participants as more or less physically active, but not quantifying PA in terms of time spent in each level of PA (Masse & de Niet, 2012). In other words, reporting bias may have affected participant recall for time spent in PA.

Our findings support evidence that PA interventions are effective at improving cardiovascular fitness and muscular strength in PLWH (Gomes-Noel, Conceicao, Carvalho, & Brites, 2013; O’Brien et al., 2016; O’Brien, Tynan, Nixon, & Glazier, 2017; Poton et al., 2016). While other systematic reviews focused on overall PA levels in PLWH (Schueler-Trevisol et al., 2012; Vancampfort et al., 2016), benefits of PA and PA recommendations (Gomes-Noel et al., 2015; Gomes-Noel et al., 2013a,b; Kamitani et al., 2017; O’Brien et al., 2016), or facilitators and barriers of PA (Vancampfort, Mugisha, Richards, De Hert, Probst, & Stubbs, 2017a,b), our review stands apart because of the focus on the supervisory aspect of PA interventions and its potential to improve functional capacity for PLWH. Essentially, our review showed that supervision of PA increases functional capacity in adult PLWH and may be an enabling factor to support regular PA among PLWH.

HIV is now managed as a chronic illness for many PLWH in the United States and the developed world due to the success of ART (Deeks, Lewin, et al., 2013; Sunj, et al., 2013). Research has shown that chronically ill persons are less likely to engage in PA (Mansfield, Thacker, Spahr, & Smith, 2018; Miravitles, Canoni, & Naberan, 2014; Volakis et al., 2018). Studies of supervised PA interventions in HIV-uninfected, chronically ill populations have suggested that incorporation of formal, structured programs may facilitate increased PA participation (Allen & Morey, 2010; Bousquet-Dion et al., 2018), and supervision may play a role in retaining participants in PA interventions (Akkaba et al., 2016; Dalager et al., 2015; Rossonanno et al., 2012). Increases in PA may be due, in part, to the reported improved morale and confidence to engage in PA when a clinician is supervising the activity (Bauman et al., 2012; Colak et al., 2017; Tully, Morgan, Burke, & McGee, 2010). Studies of people living with diabetes, heart failure, kidney failure, cancer, arthritis, and obesity have demonstrated empirical improvement in PA participation where supervised PA was the intervention under inquiry (Akbaba et al., 2016; Azad et al., 2012; Casda et al., 2014; Colak et al., 2017; Daul et al., 2004; Klemperer et al., 2015; Negri et al., 2010; Nicolai et al., 2009; Tully et al., 2010). Therefore, supervised PA interventions can serve as formal, structured programs to increase and maintain regular PA among PLWH.

Recommendations and Implications

Recommendations. The therapeutic alliance between a health professional and patient, an important component in patient engagement (Higgins, Larson, & Schnall, 2017), may increase regular PA in PLWH. For example, the benefit of the therapeutic alliance during a PA intervention was demonstrated in the Galantino and colleagues (2005) study. Those participants reported a newly formed “brotherhood,” working harder during the PA, and that the added presence of a leader facilitated their participation in the PA, where they would not have participated if a leader was not present. A recent systematic review and meta-analysis investigating dropout from PA interventions with PLWH revealed reduced dropout rates involving supervised PA interventions ($p < .001$) and interventions using qualified professionals ($p < .001$; Vancampfort, Mugisha, Richards, De Hert, Lazzarotto, et al., 2017a,b). Therefore, supervised PA interventions modeled after the general medicine therapeutic alliance, with the presence of a health care or allied health professional, may increase regular PA participation and ultimately sustained improvement in functional capacity in PLWH.

Nursing implications. Findings from our study present a unique opportunity for nurses who care for PLWH. Because supervised PA has been shown to improve outcomes in PLWH and nurses are the largest sector of health professionals, this provides an opportunity for nurses to supervise PA.
interventions for PLWH. Moreover, the presence of a health care professional, such as a nurse, during PA may encourage PLWH to participate in and work harder during the PA interventions, improve long-term adherence to PA, and improve motivation and self-efficacy to reach PA goals (Peddle-McIntyre, Bell, Fenton, McCargar, & Courneya, 2013; Trinh et al., 2014; Vancampfort, Mugisha, Richards, De Hert, Lazzarotto, et al., 2017a,b). Nurses can fill that gap by becoming the PA facilitator.

Additionally, our findings present an opportunity for nurse scientists to help fill gaps in the literature. Specifically, the current literature is comprised of studies with small sample sizes and high variability of intervention components (e.g., frequency, session duration, and length) and outcome measures. This variability makes comparison via meta-analysis and drawing succinct conclusions difficult. Further research by nurse scientists with more rigorous and robust research designs will enhance knowledge of the ability of PA interventions to improve health outcomes in PLWH.

Limitations

Inclusion of only English language studies was a limitation because there may be relevant studies published in African languages, given that the burden of the HIV epidemic persists in Africa (World Health Organization, 2017). In our review, none of the included studies took place in an African country. Therefore, the external validity of our findings is limited to the countries represented: Australia, Brazil, Ireland, Spain, and the United States. Additionally, 9 of the 15 studies had samples of 30 or less and all had fewer than 100 participants. Selection bias may be present as the study participants may represent PLWH who were already motivated to take ownership of their health and participate in PA. The small sample sizes in the individual studies also presented the potential for a type I error. Inclusion of randomized controlled trials and the inherent randomization, however, elevated the level of evidence presented here and countered the potential for selection bias and type I error. The number of articles included in this review may also be a limitation, as 15 articles may be considered a small number of articles to comprise a systematic review. However, PRISMA guidelines were followed and the search strategy and selection criteria were developed a priori. The resulting articles included for review reflected the dearth of studies on this topic. Our systematic review will, nonetheless, make an important contribution to the literature considering increased longevity in PLWH and the benefits of supervised PA interventions on health outcomes in this population.

The heterogeneity of studies, including the length of the interventions, duration of the study, follow-up assessment period, assessment instruments, and assessment modality, precluded a meta-analysis. Like other systematic reviews, our review demonstrated the need for consistent protocols and outcome measures across studies (Gomes-Neto, Concejiao, et al., 2013; Schaufel-Trevisol et al., 2012; Vancampfort, Mugisha, Richards, De Hert, Probst, et al., 2017a,b). At the individual study level, clinical significance may have been present where statistical significance was absent. For instance, at the end of 16 weeks in the McDermott and colleagues (2016) study, there was a trend toward improvement in cardiovascular fitness that may have revealed statistically significant improvements with a longer follow-up period.

Conclusions

The results of our review indicate that supervised PA interventions are associated with improved functional capacity in adult PLWH and may motivate PLWH to regularly participate in PA. Of all the interventions, the supervised aerobics and PRT interventions demonstrated improvements in strength, cardiovascular, and flexibility and balance outcomes. The inclusion of PRT with aerobics interventions demonstrated improved cardiovascular outcomes compared to aerobics alone. Furthermore, functional capacity assessed by self-report rather than objective measures may not reflect improvements in functional capacity, except where PRT is included in the intervention.

Future studies should consider PA interventions with and without supervision to quantify the benefit of these interventions in this population. A special focus should be placed on the long-term impact and
outcomes of supervised PA for elderly PLWH as the average age of PLWH continues to rise.

Key Considerations

- Supervised physical activity interventions can increase functional capacity in adults living with HIV.
- Supervised aerobicics and progressive resistance training are among the most effective physical activity interventions to improve cardiovascular, strength, and flexibility and balance outcomes in adults living with HIV.
- There is discordance between self-report and physiological outcomes of functional capacity in adults living with HIV.
- Supervised physical activity interventions may encourage regular physical activity in adults living with HIV.

Disclosures

The authors report no real or perceived vested interests that relate to this article that could be construed as a conflict of interest.

Acknowledgments

The authors would like to thank Alexandra Medicine and Alexandra Sepelen for their assistance in the development of this manuscript. Natalie Voigt is supported by the Robert Wood Johnson Foundation Future of Nursing Scholars Program, Columbia University School of Nursing, and Northwell Health. Research reported in this publication was supported by the National Institute of Nursing Research of the National Institutes of Health under Award Number R01NR015737. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

References


Dolan S. E., Fronten W., Librizzi J., Ljungquist K., Juan S., Dorman R., ... Grinspoon S. (2006). Effects of a supervised home-based aerobic and progressive resistance training regimen in women infected with human immunodeficiency virus: a randomized trial. Archives of Internal Medicine, 166(11), 1225-1231.


Appendix B. Neighborhood Environment Walkability Scale-Abbreviated

We would like to find out more information about the way that you perceive or think about your neighborhood. Please answer the following questions about your neighborhood and yourself. Please circle the answer that best applies to you and your neighborhood.

A. Types of residences in your neighborhood. About how long would it take to get from your home to the nearest businesses or facilities listed below. If you walked to them? Please choose only one answer for each business or facility.

1. How common are detached single-family residences in your immediate neighborhood?  
   - None  
   - A few  
   - Some  
   - Most  
   - All

2. How common are townhouses or row houses of 1-3 stories in your immediate neighborhood?  
   - None  
   - A few  
   - Some  
   - Most  
   - All

3. How common are apartments or condos 1-3 stories in your immediate neighborhood?  
   - None  
   - A few  
   - Some  
   - Most  
   - All

4. How common are apartments or condos 4-6 stories in your immediate neighborhood?  
   - None  
   - A few  
   - Some  
   - Most  
   - All

5. How common are apartments or condos 7-12 stories in your immediate neighborhood?  
   - None  
   - A few  
   - Some  
   - Most  
   - All

6. How common are apartments or condos more than 13 stories in your immediate neighborhood?  
   - None  
   - A few  
   - Some  
   - Most  
   - All

Total

Residential Density Score

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142
### B. Land-use mix: Diversity. Stores, facilities, and other things in your neighborhood (example: gas station)

Please circle the answer that best applies to you and your neighborhood. Both local and within walking distance mean within a 10-15 minute walk from your home.

**Stores, facilities, and other things in your neighborhood**

1. **How long does it take to walk to the convenience store?**
   - 1-5 mins
   - 6-10 mins
   - 11-20 mins
   - 21-30 mins
   - 31+ mins
   - Don’t know

2. **How long does it take to walk to the supermarket?**
   - 1-5 mins
   - 6-10 mins
   - 11-20 mins
   - 21-30 mins
   - 31+ mins
   - Don’t know

3. **How long does it take to walk to the hardware store?**
   - 1-5 mins
   - 6-10 mins
   - 11-20 mins
   - 21-30 mins
   - 31+ mins
   - Don’t know

4. **How long does it take to walk to the fruit/vegetable market?**
   - 1-5 mins
   - 6-10 mins
   - 11-20 mins
   - 21-30 mins
   - 31+ mins
   - Don’t know

5. **How long does it take to walk to the laundromat/dry cleaners?**
   - 1-5 mins
   - 6-10 mins
   - 11-20 mins
   - 21-30 mins
   - 31+ mins
   - Don’t know

6. **How long does it take to walk to the clothing store?**
   - 1-5 mins
   - 6-10 mins
   - 11-20 mins
   - 21-30 mins
   - 31+ mins
   - Don’t know

7. **How long does it take to walk to the post office?**
   - 1-5 mins
   - 6-10 mins
   - 11-20 mins
   - 21-30 mins
   - 31+ mins
   - Don’t know
8. How long does it take to walk to the library?
   - 1-5 mins
   - 6-10 mins
   - 11-20 mins
   - 21-30 mins
   - 31+ mins
   - Don't know

9. How long does it take to walk to the elementary school?
   - 1-5 mins
   - 6-10 mins
   - 11-20 mins
   - 21-30 mins
   - 31+ mins
   - Don't know

10. How long does it take to walk to the other schools?
    - 1-5 mins
    - 6-10 mins
    - 11-20 mins
    - 21-30 mins
    - 31+ mins
    - Don't know

11. How long does it take to walk to the book store?
    - 1-5 mins
    - 6-10 mins
    - 11-20 mins
    - 21-30 mins
    - 31+ mins
    - Don't know

12. How long does it take to walk to a fast food restaurant?
    - 1-5 mins
    - 6-10 mins
    - 11-20 mins
    - 21-30 mins
    - 31+ mins
    - Don't know

13. How long does it take to walk to a coffee place?
    - 1-5 mins
    - 6-10 mins
    - 11-20 mins
    - 21-30 mins
    - 31+ mins
    - Don't know

14. How long does it take to walk to the bank?
    - 1-5 mins
    - 6-10 mins
    - 11-20 mins
    - 21-30 mins
    - 31+ mins
    - Don't know

15. How long does it take to walk to a non fast food restaurant?
    - 1-5 mins
    - 6-10 mins
    - 11-20 mins
    - 21-30 mins
    - 31+ mins
    - Don't know

16. How long does it take to walk to the video store?
    - 1-5 mins
    - 6-10 mins
    - 11-20 mins
    - 21-30 mins
    - 31+ mins
    - Don't know
17 How long does it take to walk to the pharmacy?  
- 1-5 mins  
- 6-10 mins  
- 11-20 mins  
- 21-30 mins  
- 31+ mins  
- Don't know

18 How long does it take to walk to the salon/barber shop?  
- 1-5 mins  
- 6-10 mins  
- 11-20 mins  
- 21-30 mins  
- 31+ mins  
- Don't know

19 How long does it take to walk to work?  
- 1-5 mins  
- 6-10 mins  
- 11-20 mins  
- 21-30 mins  
- 31+ mins  
- Don't know

20 How long does it take to get to the bus or train stop?  
- 1-5 mins  
- 6-10 mins  
- 11-20 mins  
- 21-30 mins  
- 31+ mins  
- Don't know

21 How long does it take to get to the park?  
- 1-5 mins  
- 6-10 mins  
- 11-20 mins  
- 21-30 mins  
- 31+ mins  
- Don't know

22 How long does it take to get to the recreation center?  
- 1-5 mins  
- 6-10 mins  
- 11-20 mins  
- 21-30 mins  
- 31+ mins  
- Don't know

23 How long does it take to get to the gym?  
- 1-5 mins  
- 6-10 mins  
- 11-20 mins  
- 21-30 mins  
- 31+ mins  
- Don't know

Total  

Land Use Mix Diversity Score  

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C. Land-Use Mix-Access
Please select the answer that best applies to you and your neighborhood. Both "local" and "within walking distance" mean within a 10-15 minute walk from your home.

Please select the answer that best applies to you and your neighborhood.

1 Stores are within easy walking distance of my home.  ○ Strongly disagree
○ Somewhat disagree
○ Somewhat agree
○ Strongly agree

2 There are many places to go within easy walking distance of my home.
○ Strongly disagree
○ Somewhat disagree
○ Somewhat agree
○ Strongly agree

3 It is easy to walk to a transit stop (bus, train) from my home.
○ Strongly disagree
○ Somewhat disagree
○ Somewhat agree
○ Strongly agree

Total

Land Use Mix Access Score

D. Street Connectivity

1 The distance between intersections in my neighborhood is usually short (100 yards or less; the length of a football field or less).
○ Strongly disagree
○ Somewhat disagree
○ Somewhat agree
○ Strongly agree

2 There are many alternative routes for getting from place to place in my neighborhood. (I don't have to go the same way every time.)
○ Strongly disagree
○ Somewhat disagree
○ Somewhat agree
○ Strongly agree

Total

Street Connectivity Score

E. Infrastructure and safety for walking

1 There are sidewalks on most of the streets in my neighborhood.
○ Strongly disagree
○ Somewhat disagree
○ Somewhat agree
○ Strongly agree

2 Sidewalk are separated from the road/traffic in my neighborhood by parked cars.
○ Strongly disagree
○ Somewhat disagree
○ Somewhat agree
○ Strongly agree
3 There is a grass/dirt strip that separates the streets from the sidewalks in my neighborhood.  
- Strongly disagree  
- Somewhat disagree  
- Somewhat agree  
- Strongly agree

4 My neighborhood streets are well lit at night.  
- Strongly disagree  
- Somewhat disagree  
- Somewhat agree  
- Strongly agree

5 Walkers and bikers on the streets in my neighborhood can be easily seen by people in their homes.  
- Strongly disagree  
- Somewhat disagree  
- Somewhat agree  
- Strongly agree

6 There are crosswalks and pedestrian signals to help walkers cross busy streets in my neighborhood.  
- Strongly disagree  
- Somewhat disagree  
- Somewhat agree  
- Strongly agree

Total  
Infrastructure and safety for walking Score  

---

**F. Aesthetics**

1 There are trees along the streets in my neighborhood.  
- Strongly disagree  
- Somewhat disagree  
- Somewhat agree  
- Strongly agree

2 There are many interesting things to look at while walking in my neighborhood.  
- Strongly disagree  
- Somewhat disagree  
- Somewhat agree  
- Strongly agree

3 There are attractive natural sights in my neighborhood (such as landscaping, views).  
- Strongly disagree  
- Somewhat disagree  
- Somewhat agree  
- Strongly agree

4 There are attractive buildings/homes in my neighborhood.  
- Strongly disagree  
- Somewhat disagree  
- Somewhat agree  
- Strongly agree

Total  
Aesthetics Score  

---

147
### G. Traffic Hazards

1. There is so much traffic along nearby streets that it makes it difficult or unpleasant to walk in my neighborhood.
   - [ ] Strongly disagree
   - [ ] Somewhat disagree
   - [ ] Somewhat agree
   - [ ] Strongly agree

2. The speed of traffic on most nearby streets is usually slow (30mph or less).
   - [ ] Strongly disagree
   - [ ] Somewhat disagree
   - [ ] Somewhat agree
   - [ ] Strongly agree

3. Most drivers exceed the posted speed limits while driving in my neighborhood.
   - [ ] Strongly disagree
   - [ ] Somewhat disagree
   - [ ] Somewhat agree
   - [ ] Strongly agree

Total

Traffic Hazards Score

### H. Crime

1. There is a high crime rate in my neighborhood
   - [ ] Strongly disagree
   - [ ] Somewhat disagree
   - [ ] Somewhat agree
   - [ ] Strongly agree

2. The crime rate in my neighborhood makes it unsafe to go on walks during the day. High crime makes it unsafe
   - [ ] Strongly disagree
   - [ ] Somewhat disagree
   - [ ] Somewhat agree
   - [ ] Strongly agree

3. The crime rate in my neighborhood makes it unsafe to go on walks at night.
   - [ ] Strongly disagree
   - [ ] Somewhat disagree
   - [ ] Somewhat agree
   - [ ] Strongly agree

Total

Crime Score

### I. Lack of Parking

1. Parking is difficult in local shopping areas.
   - [ ] Strongly disagree
   - [ ] Somewhat disagree
   - [ ] Somewhat agree
   - [ ] Strongly agree

Total
### J Lack of cul-de-sacs

| J1 The streets in my neighborhood do not have many cul-de-sacs (dead-end streets). | ○ Strongly disagree  
| | ○ Somewhat disagree  
| | ○ Somewhat agree  
| | ○ Strongly agree  

Total


### K Hilliness

| K24 The streets in my neighborhood are hilly, making my neighborhood difficult to walk in. | ○ Strongly disagree  
| | ○ Somewhat disagree  
| | ○ Somewhat agree  
| | ○ Strongly agree  

Total


### L Physical Barriers

| L1 There are major barriers to walking in my local area that make it hard to get from place to place (for example, freeways, railway lines, rivers). | ○ Strongly disagree  
| | ○ Somewhat disagree  
| | ○ Somewhat agree  
| | ○ Strongly agree  

Total
Appendix C. 7-Day Physical Activity Recall

1. Were you employed in the last seven days?

2. How many days of the last seven did you work?

3. How many total hours did you work in the last seven days?

4. What two days do you consider your weekend days? (Mark days below with a squiggle.)

5. Compared to your physical activity over the past three months, was last week's physical activity more, less or about the same?
   a. More  
   b. Less  
   c. About the same

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<th>2</th>
<th>3</th>
<th>4</th>
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</tbody>
</table>

150
1. Were there any problems with the 7-Day PAR interview?
   a. No  b. Yes (If yes, please explain.)

2. Explain any problems you had with this interview:

3. Do you think this was a valid 7-Day PAR interview?
   a. No  b. Yes

4. Please list below any activities reported by the subject which you don't know how to classify.

5. Please provide any other comments you may have in the space below.
Appendix D. Physical Function Domain, PROMIS-29 v2.1

1. Are you able to do chores such as vacuuming or yard work?
   (5) Without any difficulty
   (4) With a little difficulty
   (3) With some difficulty
   (2) With much difficulty
   (1) Unable to do

2. Are you able to go up and down stairs at a normal pace?
   (5) Without any difficulty
   (4) With a little difficulty
   (3) With some difficulty
   (2) With much difficulty
   (1) Unable to do

3. Are you able to go for a walk of at least 15 minutes?
   (5) Without any difficulty
   (4) With a little difficulty
   (3) With some difficulty
   (2) With much difficulty
   (1) Unable to do

4. Are you able to run errands and shop?
   (5) Without any difficulty
   (4) With a little difficulty
   (3) With some difficulty
   (2) With much difficulty
   (1) Unable to do
Appendix E. Modified Baecke Questionnaire for the Elderly

Physical activity questionnaire

Appendix

Questionnaire, codes and method of calculation of scores on habitual physical activity in elderly people.

Household activities.

1) Do you do the light household work? (dusting, washing dishes, repairing clothes etc.)?
   0. Never (< once a month)         \_\_1
   1. Sometimes (only when partner or help is not available)
   2. Mostly (sometimes assisted by partner or help)
   3. Always (alone or together with partner)

2) Do you do the heavy housework? (washing floors and windows, carrying trash disposal bags, etc.)?
   0. Never (< once a month)         \_\_1
   1. Sometimes (only when partner or help is not available)
   2. Mostly (sometimes assisted by partner or help)
   3. Always (alone or together with partner)

3) For how many persons do you keep house? (including yourself; fill in "0" if you answered "never" in Q1 and Q2.)
   \_\_1

4) How many rooms do you keep clean, including kitchen, bedroom, garage, cellar, bathroom, ceiling, etc.? (Fill in "0" if you answered "never" in Q1 and Q2.)
   0. Never do housekeeping         \_\_1
   1. 1 - 6 rooms
   2. 7 - 9 rooms
   3. 10 or more rooms

5) If any rooms, on how many floors? (fill in "0" if you answered "never" in Q4.)
   \_\_1

6) Do you prepare warm meals yourself, or do you assist in preparing?
   0. Never                         \_\_1
   1. Sometimes (once or twice a week)
   2. Mostly (three to five times a week)
   3. Always (more than 5 times a week)
Physical activity questionnaire

7) How many flights of stairs do you walk up per day?
   (one flight of stairs is 10 steps.)
   
   0. I never walk stairs
   1. 1-5
   2. 6-10
   3. More than 10

8) If you go somewhere in your hometown, what kind of transportation do you use?
   
   0. I never go out
   1. Car
   2. Public transportation
   3. Bicycle
   4. Walking

9) How often do you go out for shopping?
   
   0. Never or less than once a week
   1. Once a week
   2. Twice to four times a week
   3. Every day

10) If you go out for shopping, what kind of transportation do you use?
    
   0. I never go out for shopping
   1. Car
   2. Public transportation
   3. Bicycle
   4. Walking

Household score = (Q1+Q2+...+Q10)/10

Sport activities

Do you play a sport?

Sport 1: name
         intensity (code)           (1a)
         hours per week (code)     (1b)
         period of the year (code) (1c)
Physical activity questionnaire

Sport 2: name
   intensity (code)       (2a)
   hours per week (code) (2b)
   period of the year (code) (2c)

Sport-score: $\sum_{i=1}^{2} (la * lb * ic)$

Leisure time activities

Do you have other physical active activities?

Activity 1: name
   intensity (code)       (1a)
   hours per week (code) (1b)
   period of the year (code) (1c)

Activity 2 till 6: as activity 1.

Leisure time activity score: $\sum_{j=1}^{6} (ja * jb * jc)$

Questionnaire score = household score + sport score + leisure time activity score.

Codes:

Intensity code $^1$:

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<th>Code</th>
<th>Description</th>
<th>Code</th>
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<tr>
<td>8</td>
<td>walking, body movements, cycling, swimming</td>
<td>1.890</td>
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</table>
**Physical activity questionnaire**

Hours per week:

1. less than one hour/week: code 0.5
2. [1,2> hours per week code 1.5
3. [2,3> hours per week code 2.5
4. [3,4> hours per week code 3.5
5. [4,5> hours per week code 4.5
6. [5,6> hours per week code 5.5
7. [6,7> hours per week code 6.5
8. [7,8> hours per week code 7.5
9. more than 8 hours per week code 8.5

Months a year:

1: less than one month per year code 0.04
2: 1-3 months code 0.17
3: 4-6 months code 0.42
4: 7-9 months code 0.67
5: more than 9 months per year code 0.92

\(^1\) unitless intensity code, originally based on energy costs.
Appendix F. Factor Loading Results of the Modified Baecke Questionnaire in Older Adults with HIV

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<th>Factor Loading Matrix: Estimate/Std Error/t-value/p-value</th>
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