THE EFFECTS OF EARLY LIFE FACTORS ON ELDER PHYSICAL ACTIVITY
DISPARITIES IN HIGH AND MIDDLE INCOME COUNTRIES

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Abstract

To delay chronic disease and promote general health among older adults, physical activity (PA) is often recommended and promoted in a public health setting. Unfortunately, there are a number multi-level factors associated with low PA that occur prior to old age, known as early life adversities. It is well established across the globe that social and economic adversity are associated with poor health outcomes and behaviors. This dissertation presents findings from two quantitative studies with a global sample and one qualitative study with a local sample to examine the effect of life course factors and older adult physical performance and PA behavior disparities. The first two studies utilized global health data from the International Mobility in Aging Study (IMIAS), and found that site location, gender, income, and sex were associated to PA. In addition, economic adversity transition is associated to physical performance. The third study found that neighborhood type (urban vs. rural) played a role in Native Hawaiian older adult PA type and physical performance. This relationship could possibly be mediated by how discrimination and poverty are perceived, as they were perceived differently by older adults from the two different neighborhoods. Results from this dissertation support targeting childhood and life course environmental and socio-demographic factors as effective ways to improve older adult PA and physical performance. Future PA promoting interventions should be tailored to their target population based on region, and not just ethnicity. To build on findings from this dissertation, future research is needed to further examine how childhood adversity and perceived discrimination plays a role in older adult physical performance and PA behaviors.

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List of Abbreviations

ACEs	Adverse Childhood Experiences Study
CCHS	Canadian Community Health Survey
CDC	Centers for Disease Control
GCW	God's Country Waimanalo
HMO	Health Maintenance Organization
IMIAS	International Mobility in Aging Study
LTPA	Leisure-time physical activity
PA	Physical activity
RQ	Research question
WHO	World Health Organization

CHAPTER 1. INTRODUCTION

Background

Global Trends in Aging

The definition of an older adult can be based on chronology, change in social role, and/or change in capabilities [1]. In most developed countries, older adult is defined chronologically, and the starting age ranges between 60-65 years of age [2]. In the United States, older adulthood is largely defined according to policy implications. The majority of adults are eligible for Medicare at age 65, and eligibility for full Social Security benefits is age 66 or 67.

In 1950, about 5% of the world population was age 65 and older, and 15% were under age 5 [3]. Since then, due to improvements in medical technology and public health efforts, the prevalence of older adults has been steadily increasing, while the prevalence of young children has been steadily decreasing [4]. Average life expectancy increased from 50 years in 1900 to 83 years in 2000 [5,6]. Concurrently, in most world regions, major health threats shifted away from infectious and parasitic diseases that mainly affected young children to chronic non-communicable diseases such as cardiovascular diseases, cancer, dementia, and diabetes; diseases associated with advancing age (CITE).

 It is predicted that the population of older adults in the world will increase from 524 million in 2010 to nearly 1.5 billion in 2050 [7]. Although more economically developed countries generally have higher average life expectancies, less economically developed countries are the most rapidly aging countries [7]. Thus, older adult health is a global issue.

Older Adult Health Concerns

As individual age, they have a higher chance of suffering from vision and hearing loss, cognitive decline, physical inactivity, and frailty compared to younger ages. In fact, 45.5% of older adults in the U.S. suffer from having two or more chronic diseases [8]. Physical and mental health limitations lead to potentially devastating life events such as hospitalizations, nursing home admissions, and loss of independent living. These events, in addition to the physiological effects of disease, are often the cause of older adult death[9].

Older Adult Physical Activity Trends

Physical activity (PA) is defined as any bodily movement of major skeletal muscles that produces work output [10]. Physical inactivity is the 4th leading risk factor for global mortality [2]. PA is one of the most popular health promotion strategies to manage or delay chronic diseases and promote general health [11–13]. Over the years, numerous studies across the globe have shown the health benefits of regular PA for older adults. PA is protective against chronic diseases and delays the onset of age-related health complications such as frailty, poor vision, and poor cognition [1,6,8,10,11,14–16]. Therefore, adding PA to life's activities is an effective method to prevent, control, and alleviate certain health conditions. Leisure time physical activity (LTPA), in particular, is more effective in improving overall health compared to transportation, occupational, and sport-related PA [17–19].

Unfortunately, being physically active is a challenge. Despite the established evidence on the benefits of physical activity, in 2012, 51.7% of United States older adults

age 65-74 did not meet the federally recommended PA guidelines, and 67.2% of 75 years and older did not meet the federally recommended PA guidelines [20]. Similarly to studies conducted in the United States, studies conducted across the globe show that PA engagement is inversely related to age [21–24]. Federal PA guidelines are the same as the World Health Organization (WHO), and that is that older adults engage in at least 150 minutes of moderate-intensity aerobic PA per week or at least 75 minutes of vigorous-intensity aerobic PA per week. PA includes LTPA as well as transportation-related and occupational PA. Older adults also should engage in muscle strengthening and balance-improving activities 2 or 3 times per week. This recommendation is currently in place in a growing number of countries [25].

Physical Activity and Physical Performance

PA is measured by an individual's activity behavior and can be defined by frequency, intensity, or type. Physical performance is measured by the individual's functional ability, and to some extent, fitness level. Older adult physical performance is often measured using an objective test that assesses lower or upper body, strength or flexibility. These tests are developed for the average older adult and not for professional athletes; therefore, test procedures often include simple every day functional actions such as sitting, standing, walking, and balancing. Physical performance is an established predictor of several health risks in a clinical and population-based setting. These include: functional independence, short-term mortality, frailty, and future risk for hospitalization [26–30]. PA is often associated with physical performance. Across the life course, sufficient PA may be protective against loss of physical performance in old age. However, at older age, a minimal physical performance level is needed in order to be physically active. [31]

Due to the often circular relationship between PA and physical performance, physical performance is commonly included as an objective measure to strengthen self-reported PA measures.

Factors Relating to Older Adult Physical Activity Behaviors

Most early PA research focused on the effects of individual-level psychological and demographic variables such as self-efficacy, enjoyment, locus of control (the level in which an individual feels in charge of their lives), intention to exercise, stage of change, self-motivation, parental status, gender, and income on PA behavior. [32–39]. In fact a literature review on adult PA correlates show that only a handful of studies examined social and physical environment correlates. [40] In contrast, after the early 2000's, older adult PA research began to include underserved populations such as ethnic minorities, and take an ecological approach [40].

Early studies identified low income as a strong determinant of physical inactivity, but did not observe how these trends may also be related to other demographical variables and ultimately increase our understanding of health disparities. Underserved older adults from disadvantaged communities have been associated with their inability to access assistive technology [26], severity of health deterioration [41–43], frailty [44], poor anthropometric measures [45], unhealthy diet, and low PA engagement [46]. Being that the presence of disadvantaged communities is largely due to environmental infrastructure and health policies, multi-level approaches conducive to PA are most reasonable [47]. Common physical and social environmental correlates to PA behavior are neighborhood safety, hilly terrain, social norms, and social support [36,48–52].

Life Course Perspective

As a result of early individual-level focused PA-behavior studies, there is no shortage of behavior-based interventions directed to increase older adult PA. Unfortunately, whether it be home-based, group-based, or educational-based, tests of these interventions have come to the same conclusion—individual behavior reinforcement strategies alone are not effective in maintaining older adult PA behavior [53–55]. Previous studies posit that early-life and life course interventions are needed to offset older adulthood physical inactivity patterns [56]. Therefore, a life course perspective is useful to examine a range of factors associated with PA behaviors over time among older adults.

Life course epidemiology is defined as the study of long-term effects accumulated from early life exposure during gestation, early childhood, adolescent, and/or adult years [57,58]. The life course perspective in health is a framework that often, explicitly examines how early life events influence health trajectories over time. It emphasizes a social and temporal perspective, and therefore allows researchers to document patterns of health and disease across time [58]. Current efforts in life course epidemiology involve a multi-disciplinary approach that calls for investigation of biological and social causation [59]. Life course epidemiology is ideal to identify the upstream and downstream effects of certain health outcomes of interest. That certain exposures can only logically occur prior to the outcome allows researchers to more accurately identify causation using retrospective indicators. Understanding life course conditions and aging across diverse populations can inform the necessary public health measures to achieve healthy aging [59–61].

Life Course Adversity

Among the many exposures life course researchers have examined, early-life exposures seem to be the most cogently popular. Much of our knowledge about the association between childhood and adult health comes from the Adverse Childhood Experiences (ACE) study, a collaborative effort between the Centers of Disease Control and Kaiser Permanente in San Diego, California. Its investigators, Robert F. Anda and Vincent J. Felitti, both from Kaiser Permanente, sought to examine the association between childhood maltreatment and later life health outcomes, including death [62]. Health Maintenance Organization (HMO) members of Kaiser Permanente in San Diego, California were recruited. Participants voluntarily underwent a physical examination and completed self-reported questionnaires on family health history and health appraisal. The family health history questionnaire asked questions about an individual's experience with childhood abuse, neglect, and family dysfunction (ACE score). Higher ACE scores indicated more stress experienced during childhood. The health appraisal questionnaire asked questions regarding the person's health history. Both questionnaires had male and female versions. Baseline data were collected from 1995-1997, and 17,373 adults (over age 18) enrolled in this study. Although no new participants have been enrolled since 1997, current participants' health history is tracked, making this a longitudinal study.

Overall results from the ACE study show that childhood trauma is significantly associated with health, social, and economic risks. In summary, an increased ACE score is associated with increased risk of alcoholism, depression, fetal death, chronic obstructive pulmonary disease, quality of life, illicit drug use, multiple sexual partners, sexually transmitted diseases, smoking, ischemic heart disease, liver disease, risk for intimate partner violence, suicide attempts, unintended pregnancies, early initiation of

smoking, early initiation of sexual activity, and adolescent pregnancy [63–71]. It is clear from the ACE studies that the combined effects of lifetime events effect outcomes in adulthood and older adult age.

Other studies have uncovered a range of health outcomes associated with early life adversity. Research results with a Swedish cohort showed that female gender, social and material adversity, and living in a disadvantaged neighborhood each contributed independently to overall negative health during adulthood [72]. Early socioeconomic adversity has been shown to increase risk of cardio-metabolic disease [73]. A series of studies demonstrated that childhood adversity is associated with adulthood sleep disorders [74]. The strong associations between early-life adversity and later-life health outcomes suggest that early-life events can be viewed as the first step on a pathway towards determining individual health status [75]. Alarmingly, the negative health effects of early life adversity extend beyond the individual who experiences it first-hand [76]. Pregnant women who experience childhood physical abuse and household alcohol abuse are more likely to experience excessive maternal weight gain during pregnancy, therefore putting their unborn children at risk for obesity and type 2 diabetes [77].

The positive relationship between life course adversity and health outcomes is more complex than a direct correlation. The number, type, severity, and timing of adverse exposures appear to affect the severity of the health outcome [78]. For example, living in a disadvantaged neighborhood as a child has a larger impact on overall health compared to living in a disadvantaged neighborhood only as an adult [72]. Finally, molecular studies show that individuals who were physically abused between the ages of 3-5 years of age had higher stress markers than those abused during adolescence [79]. These studies identify

how critical periods during a life time may have profound effect on late life health outcomes. It appears from these studies that some adversities are more damaging when they are experienced in childhood, and others are more damaging when they are experienced in adulthood, suggesting a need to access critical periods by studying adversity transitions.

A number of studies have shown the association between childhood adversity and overall poor health outcomes. However, few have examined how different transitions of adversity over the life course may affect health outcomes. Individuals who have experienced early life adversity can have positive later life mental health outcomes if a supportive relationship is maintained during midlife [80]. This suggests that the adversity transitions throughout life can improve or worsen health outcomes. This interaction was also observed among trauma victims. Individuals who experienced trauma during both childhood and adulthood stages experienced more severe negative? later life health outcomes compared to individuals who only experienced trauma in adulthood [81].

Gaps in Research

A large portion of PA literature is dedicated to personal level influences of PA behaviors [82]. As a result, resources and interventions originate from a clinical perspective and stress personal responsibility. Interpersonal and person-environment influences of PA remain a challenge [83]. Systematically understanding the temporal and socioeconomic factors that exist on multiple levels, using a life course perspective, may provide a sustainable influence on PA engagement among older adults.

Previous studies that utilize a life course model, such as ACEs, are not able capture the role disparity plays in predicting health outcomes due to the homogenous

demographics their population sampled. ACEs only recruited adults that already have health insurance with Kaiser, and these individuals are likely to be of middle or high socioeconomic statuses. This dissertation extends ACE findings by including participants from a variety of socioeconomic levels from countries of middle and high-income standing. Currently, there are studies that examine the relationship between early life adversity and later life functional fitness or mobility, but not physical activity behaviors [44]. Since physically active older adults have fewer functional limitations than physically inactive older adults, this dissertation aims to explore the relationship between PA behaviors and early life adversity. Findings from this etiological retrospective study will allow researchers to identify critical periods and causal pathways to PA behavior. This information can inform public health policies and resource allocation. Findings also can be used to support prevention efforts, which are more cost effective than treatment interventions [84].

Purpose, Research Questions, and Conceptual Framework

The effect of factors from all levels of the socioecological framework--individual, household, community, and ecological—on PA behavior over an individual's lifetime are examined. These factors include childhood adversity, older adult adversity, income, education, sex, age, city of residence, and physical health correlates of PA behavior. In this dissertation, the association of these factors with PA behavior in later life are analyzed using a mixed-methods approach, which includes quantitative and qualitative methodologies. These factors are examined on a global and local level.

Figure 1 is the conceptual framework depicting the association between participant/population characteristics, health outcomes, physical activity behavior, and

the indicators used to represent each construct. Areas on Figure 1 where constructs overlap represent a relationship between the constructs. It is indicated in Figure 1 which research question will address the relationships between constructs. This dissertation aims to examine the association between life course factors and older adult PA behaviors by analyzing global-level quantitative data and local-level qualitative data through the following research questions (RQ):

RQ1: What is the relationship between childhood adversity and physical activity behaviors among older adults in Kingston and St. Hyacinthe, Canada; Tirana, Albania; Manizales, Colombia; and Natal, Brazil? Secondary data analyses will be conducted using 2012 data from the International Mobility in Aging Study (IMIAS). Regression models will be estimated to assess correlates (e.g., sex, city of residence, income, education, and childhood adversity) of LTPA engagement (yes/no). Although previous studies[44] have shown disparities in mobility within each of the IMIAS regions/countries, none have examined and compared cross-societal PA behaviors. Results from RQ1 will explore the significace of childhood adversity drivers on PA across different societies.

RQ2: How do adversity transitions from childhood to older adulthood influence physical performance? Participants will be recoded into four categories: those who experienced both childhood and older adult adversity, only childhood adversity, only older adult adversity, and neither childhood nor older adult adversity. The adversity transition will be associated with later-life physical performance. Results from this RQ will identify risk and protective factors of adversity transitions on physical performance.

RQ3: How do life course events experienced by Native Hawaiians affect their perceptions and behaviors toward PA? Hawaii is culturally, historically, and

geographically unique compared to the rest of the United States. Hawaii's colonization history is the root of historical adversity experienced by its indigenous people [85]. RQ3 builds on previous literature and results from RQ's 1 and 2 to guide a series of elicitation interviews with Native Hawaiian elders. Results from this study provide an in-depth understanding of how and why Native Hawaiian elders' PA perceptions and behaviors change over time, with a focus on the role of adversity. This information may be used to develop PA promotion materials and interventions among Native Hawaiian elders.
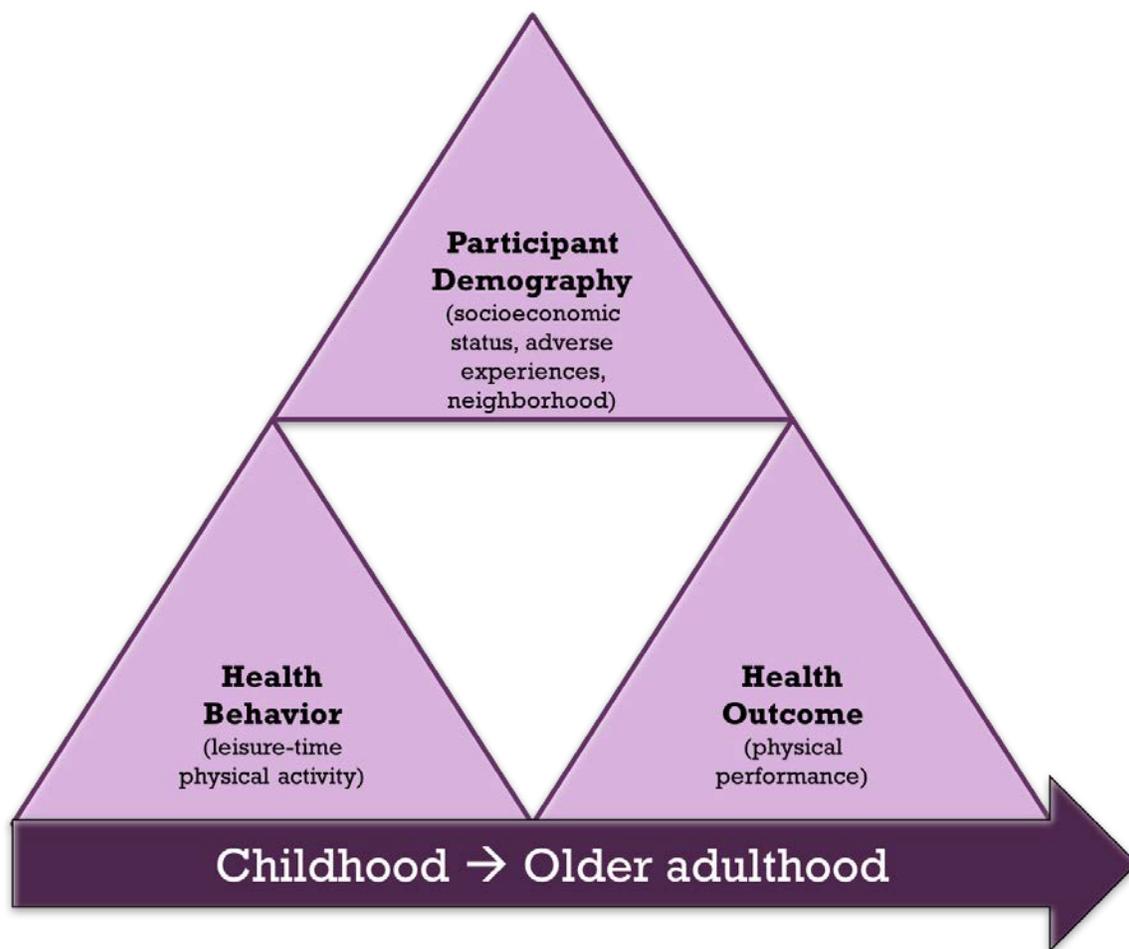
Figure 1. Conceptual Framework

Community Partners
International Mobility in Aging Study

The International Mobility in Aging Study (IMIAS) is a longitudinal cross-national study that collects data from Kingston and St. Hyacinthe Canada; Tirana, Albania; Manizales, Colombia; and Natal, Brazil. This study was designed to examine older health using life course theory. Baseline data were collected in 2012 through a two-hour structured interview of participants ages 65-74 in each location who passed a cognitive test. Approximately 400 subjects completed the questionnaire per site. Wave 2 data were collected in 2014. For this dissertation, only data obtained from the 2012 baseline IMIAS questionnaire will be used to address RQ's 1 and 2, because the aims of this study involve retrospective events in the participant's life. IMIAS research team members come from an interdisciplinary background and have agreed to provide biostatistics and epidemiology support when needed.

God's Country Waimanalo

God's Country Waimanalo (GCW) is a nonprofit grassroots organization that began as a food sovereignty project in Waimanalo in 2008. Since then, GCW has offered a variety of programs that address Native Hawaiian Health in the Waimanalo community. One of the programs focuses on kupuna (elder) health by providing la'aulapa'au (Native Hawaiian medicine) and physical activity. The director of GCW, Ilima Ho-Lastimosa, has agreed to assist in RQ3 by actively recruiting participants for key informant interviews from GCW's kupuna health programs, and allowing me access to GCW facilities.

CHAPTER 2. RQ1: CHILDHOOD ADVERSITY AND PHYSICAL ACTIVITY

Title

Childhood adversity and leisure time physical and sports activity in older adults: a cross-sectional analysis from the International Mobility in Aging Study

Abstract

The purpose is to examine the relationship between childhood adversity and LTPA among community-dwelling older adults from Kingston, Canada; St. Hyacinthe, Canada; Tirana, Albania; Manizales, Colombia; and Natal, Brazil. High-income sites had higher LTPA prevalence than middle-income sites. Females were less likely to engage in LTPA compared to males in Tirana (OR:0.53, 95%CI:0.30-0.94), but were more likely to engage in LTPA in Manizales(OR:2.54, 95%CI:1.54-4.18). Low education was less likely than high education to engage in LTPA in Kingston (OR: 0.38, 95%CI:0.19-0.73) and Natal(OR: 0.52, 95%CI:0.28-0.97). Poor income was less likely than high income to engage in LTPA in St. Hyacinthe(OR: 0.42, 95%CI:0.20-0.89) and Manizales(OR: 0.33, 95%CI: 0.16-0.55). In Tirana, poor income was more likely than high income to engage in LTPA(OR: 5.27, 95%CI:2.06-13.51). Childhood economic and social adversity were not significantly associated with LTPA. Findings demonstrate strong site-specific effects of socio-demographic factors.

Introduction

Physical activity is protective against chronic diseases and delays the onset of age-related health complications [8,14,15,86,87]. Leisure time physical activity (LTPA) in particular is more effective in improving overall health than transportation, occupational,

and sport-related PA among elders (Fisher 2015; Ford 2005; van Baak 2003). Unfortunately, the amount of LTPA decreases as age increases [88].

A large portion of PA literature explores individual level theories of PA behavior change, such as self-efficacy theory and the transtheoretical model, or individual-microenvironment level theories, such as the social cognitive model [82]. Consequently, there is no shortage of behavior-based interventions directed to increase older adult PA. Whether home, group, or educational-based, evaluations of these interventions have come to the same conclusion: individual behavior reinforcement strategies alone are not effective in maintaining older adult PA behavior [53–55]. Etiological studies applying a life course perspective may be informative for interventions aimed in improving PA [88].

The life course perspective in health is a framework that, among other things, examines how early life events influence health trajectories over time. It emphasizes a social and temporal perspective, and therefore allows researchers to document patterns of health and disease across time and between social groups [57]. Since certain exposures can only logically occur prior to the outcome, a life course perspective allows researchers to investigate retrospective events with cross-sectional sampling.

Among the many exposures life course researchers have examined, early-life exposures appear the most cogently popular. Studies have shown that early life exposures and socio-demographic characteristics affect an individual's health behaviors and outcomes. Gender, social and material adversity, and living in a disadvantaged neighborhood are all documented to influence overall health during adulthood [72,74]. The well-known Adverse Childhood Experiences (ACE) study discovered that, as childhood adversity scores increase, the following health behaviors increase in a graded fashion into

adulthood: alcoholism, illicit drug use, multiple sexual partners, smoking, risk for intimate partner violence, suicide attempts, unintended pregnancies, early initiation of smoking, early initiation of sexual activity, and adolescent pregnancy [63–71,89]. These findings suggest that early childhood events may have long-term consequences on health behaviors and that PA behaviors may have roots situated in early life circumstances.

Many previous studies that utilize a life course model, such as ACEs, were unable to examine cross-societal influences on behaviors due to sample homogeneity. As early as the 1800s, it was recognized that health behaviors are conditioned by social factors, such as standards of living [90]. These social factors may vary substantially across societies and entail dramatically different resulting individual behavior patterns [91]. Consequently, cross-societal investigations may provide insights on the contribution of broad social structures to PA behaviors, which in turn, may improve interventions geared at individual behavior change.

This study includes participants of a wide variety of socioeconomic statuses, recruited as part of the International Mobility in Aging Study (IMIAS) [92]. The present study's objective is to examine the relationship between childhood adversity, occurring before 15 years of age, and self-reported PA behaviors among community-dwelling older adults from diverse global settings. Since early-life adversity negatively impacts many later life health behaviors, the authors hypothesize that childhood adversity is associated with lower levels of elder PA behavior.

Methods
Site Location Descriptions

IMIAS is a longitudinal study focused on older adult health. Baseline data were obtained in 2012, with follow-up collections in 2014 and 2016. Data were collected at the

following study sites: Kingston and St. Hyacinthe, Canada; Tirana, Albania; Natal, Brazil; and Manizales, Colombia. In Canada, St. Hyacinthe, a predominantly Catholic and French-speaking community, has a population of approximately 50,000. Kingston is a city comprised of 130,000, mostly English-speaking Protestant inhabitants [92]. Tirana is the capital of Albania and is comprised of approximately 700,000 inhabitants. Albania, a post-communist republic, is one of the poorest countries in Europe. Natal is the capital of the province of Rio Grande do Norte in Brazil. It has approximately 800,000 inhabitants and is situated in an impoverished region of the country. Finally, Manizales, a coffee-growing zone of the Colombian Andes Mountains, is comprised of approximately 400,000 inhabitants. Population socioeconomic, cultural, and religious demographics within each study site are relatively homogenous, whereas between sites there is substantial heterogeneity in socio-demographic characteristics [92]. These five sites were chosen because the varying demographic factors maximize the spectrum of exposures that participants face across the life-course.

Population & Data Collection

Participants of this study are male and female community-dwelling older adults age 65-74 at baseline. Baseline data was collected in 2012: January – June in Manizales, Natal, and St. Hyacinthe; January – December in Kingston, and September – December in Tirana. At the Canadian sites, university ethics committees did not allow researchers to recruit or contact potential participants directly. Therefore, family physicians sent letters of invitation to potential participants that invited them to contact a field coordinator for further information regarding the study. Participants were recruited from health center registries in Tirana, Natal, and Manizales. A random sample of potential participants was

drawn from health center registries, and these individuals were approached directly by interviewers to participate in study [93]. Interviewers were trained with a standardized protocol. Response rates were 90% in Tirana, nearly 100% in Manizales and Natal, and 30% in Kingston and St. Hyacinthe. The differences in response rate may be due to the difference in recruitment strategy as noted above. It should be noted that these five sites operate under a universal healthcare system, which greatly reduces the socioeconomic gradient with regards to accessing healthcare. Comparisons of recruited participants to census data suggest samples are representative of the towns/cities from which they were recruited. Individuals who had four or more errors on Leganes Cognitive Test orientation scale [94] were excluded from the study. Low scores indicated inability to complete study procedures. Recruitment continued until about 400 responses were obtained in each locale. Thus, baseline data from 2,002 individuals is available for analysis.

Exposure

Childhood adversity was measured using a series of retrospective questions on events that occurred within the first 15 years of the participants' life. IMIAS survey questions regarding childhood adversity were from the Survey on Health and Well-being Elders (SABE study) [44,95], and the Canadian Community Health Survey (CCHS) [96]. The events were: death of parent, parental substance abuse, parental divorce, witnessing physical violence in the family, low economic status, having been hungry, having been physically abused, and parental unemployment. Members of the IMIAS team previously performed an exploratory factor analysis on these indicators to yield two categories: economic adversity (poor economic status, hunger, and parental unemployment), and social adversity (parental substance abuse, witnessing family physical violence, having

been physically abused) [97]. Final adversity scores of economic and social adversity were recoded into two variables with binary responses—having experienced adversity in childhood and no adversity experiences in childhood.

Covariates

Education, income, age, and sex were chosen as covariates based on research into the social determinants of health [98]. Education was previously coded into three categories: illiterate/primary school only, secondary schooling, and post-secondary schooling. Analyses indicated insufficient variability within sites for comparison across sites. For example, in Kingston, 9.6% of participants were illiterate or only had primary school education, whereas in the Natal, 89.8% were illiterate or only had primary school education. To allow for comparisons across sites, total years of education was split categorically into tertiles of high, medium, and low education by site to obtain a variable called "relative education". Thus, it is possible for a participant to have high educational attainment relative to his/her community, but medium or low attainment compared to another site in IMIAS. Sex is an interviewer reported categorical variable (male/female). Age is a self-reported continuous variable re-coded into a binary categorical variable (64-69/70-75). Income is a self-reported continuous variable of annual income recoded into a categorical variable (poor/middle/high) based on site-specific poverty thresholds. Site location is based on the location of data collection.

Outcomes

The outcomes for this study were LTPA and LTSA. LTPA was defined as leisure time activity that involved bodily movement produced by large skeletal muscles that require energy expenditure [99]. LTSA was defined as any reported leisure time activity

that is considered an official event in the Olympics [100]. LTSA is a subset of LTPA. Refer to Table 1 for a list of LTPA and LTSA examples. Participants were asked to report any leisure time activities and to specify those activities. Responses were categorized into yes or no LTPA or LTSA based on the definitions above.

Statistical Analysis

STATA/SE 14.0 was used to conduct the analyses. Bivariate analyses were performed using Pearson's chi-squared test for categorical data. Correlates of LTPA and LTSA behavior were identified using logistic regression. Preliminary studies showed a strong site-specific interaction; therefore, analyses were stratified by site. All regression models statistically adjusted for age, educational attainment, current income, sex, and site location.

Results

The prevalence of LTPA and LTSA engagement by site is displayed in Table 2. Kingston (68.1%) and St. Hyacinthe (51.4%) had higher prevalence of LTPA compared to Tirana (17.5%), Manizales (27.3%), and Natal (22.6%). Similar patterns were also observed in LTSA. Of the participants, 36.7% in Kingston, 31.7% in St. Hyacinthe, 4.1% in Tirana, 5.7% in Manizales, and 5.5% in Natal engaged in LTSA.

Table 3 summarizes socio-demographic characteristics and adversity. In Manizales, compared to men, women were significantly more likely to report LTPA engagement (33.8% versus 21.9%). At both Canadian sites, those with higher levels of education were significantly more likely to report LTPA compared to those with medium and low site-specific education levels. In Kingston for example, 81.8% of highly educated participants report LTPA compared to 63.5% of those with low education. It should be noted, however, that even low educated participants from Kingston and St.

Hyacinthe reported more LTPA than any educational category at the middle-income sites. Income was significantly associated with LTPA engagement in St. Hyacinthe, Tirana, and Manizales. However, the nature of these associations varied by site. In both St. Hyacinthe and Manizales, high income participants were more likely to report LTPA engagement (67.4% and 41.7%, respectively), compared to poor income participants (47.2% and 23.2%, respectively). The opposite was true in Tirana. Poor income participants were more likely to report LTPA engagement (32.6%) compared to high income (10.6%). In Tirana, 21.3% of participants who experienced childhood economic adversity engaged in LTPA compared to 13.3% of those who didn't experience childhood economic adversity.

Table 4 summarizes socio-demographic characteristics and adversity by LTSA engagement. Men were significantly more likely to report LTSA engagement in Kingston (49.3%), St. Hyacinthe (43.1%), and Tirana (7.1%) compared to women (29.8%, 29.3%, and 1.5%, respectively). The younger age group (43.8%) was significantly more likely to engage in LTSA compared to the older age group (32.9%) only in Kingston. In Manizales, high education and high income were significantly associated with LTSA engagement. In Tirana, presence of childhood economic adversity was significantly associated with LTSA engagement. In Natal, presence of childhood social adversity was significantly associated with LTSA.

Tables 5 and 6 summarize the results of the multivariate models. Childhood social and economic adversities were not significantly associated with LTPA engagement in all sites. In Kingston, participants with lower education were less likely to engage in LTPA (OR: 0.38, 95% CI: 0.19-0.73) compared to high education. In St. Hyacinthe, poor

income participants were less likely to engage in LTPA (OR: 0.42, 95% CI: 0.20-0.89) compared to high income. The opposite relationship was observed in Tirana. Poor (OR: 5.27, 95% CI: 2.06-13.51) and middle income (OR: 2.44, 95% CI: 1.20-4.99) participants were more likely to engage in LTPA compared to high income. In Manizales, women were more likely to engage in LTPA compared to men (OR: 2.54, 95% CI:1.54-4.18). Also, poor (OR: 0.33, 95% CI: 0.16-0.65) and medium income participants (OR: 0.46, 95% CI: 0.23-0.92) were less likely to engage in LTPA compared to high income participants from this site. In Natal, participants with low education were also less likely to engage in LTPA compared to high education (OR: 0.52, 95%CI: 0.28-0.97). For LTSA in Natal, participants who experienced childhood social adversity were more likely to engage in LTSA compared to those who did not (OR: 3.31, 95% CI: 1.31-8.41). Females were less likely to engage in LTSA compared to males in Kingston (OR: 0.40, 95% CI: 0.25-0.65) and Tirana (OR: 0.17, 95% CI: 0.04-0.64). In Manizales, medium education level participants were less likely to engage in LTSA compared to high level (OR: 0.25, 95% CI: 0.10-0.82). In Natal, middle income participants were less likely to engage in LTSA compared to high income (OR: 0.29 95% CI: 0.10-0.82).

Table 1. Examples of LTPA[a] and LTSA[b] activities

Leisure Time Physical Activities	Leisure Time Sports Activities[c]
Aerobic exercise, aquafit, badminton, bicycle, bowling, callisthenic exercise, canoe/kayak, cardio exercise, curling, croquet, dance, elliptical, fishing, various fitness classes, football, golf, gym, gymnastics, hiking, hockey, jiu-jitsu, hopscotch, horseback riding, jazzercise, mini trampoline, Nordic track machine, petanque, racquet, rowing, running, sailing, shoveling (snow), skate, ski, soccer, stretching, squash, walking stairs, table tennis, tai chi, walking, weight training, yardwork, yoga, zumba	Biking, badminton, bowling, canoe/kayak, croquet, curling, football, golf, gymnastics, hockey, jiu-jitsu, racquets, rowing, running, sailing, skate, ski, soccer, softball, squash, table tennis, tennis, swim

[a]LTPA = Leisure time physical activity done for leisure that results in energy expenditure by major skeletal muscles.
[b]LTSA = Leisure time sports activity done for leisure that requires physical exertion and skill for competition.
[c]Leisure time sports activities is a subset of leisure time physical activities

Table 2. Proportion of participants reporting leisure time physical and sports activity engagement by site

	Kingston (*N*=398)	St. Hyacinthe (*N*=401)	Tirana (*N*=394)	Manizales (*N*=407)	Natal (*N*=402)
LTPA engagement *n*(%)[a]	68.1%	51.4%	17.5%	27.3%	22.6%
LTSA engagement *n*(%)[b]	36.7%	31.7%	4.1%	5.7%	5.5%
Missing n (%)	6.0%	11.5%	1.8%	2.5%	0.0%

[a]LTPA = activity done for leisure that results in energy expenditure by major skeletal muscles.
[b]LTSA = activity done for leisure that requires physical exertion and skill for competition.

Table 3. Summary of leisure time physical activity engagement (LTPA)[a] by participant socio-demographic characteristics and childhood adversity, according to site

	LTPA Engagement				
	Kingston (N=398)	St. Hyacinthe (N=401)	Tirana (N=394)	Manizales (N=407)	Natal (N=402)
Sex, n(%)					
Male	76.6%	59.9%	21.7%	21.9%**	24.0%
Female	68.7%	56.4%	14.3%	33.8%	21.4%
Age in years, n(%)					
64 to 69	72.4%	59.5%	17.1%	26.9%	24.2%
70 to 74	72.6%	55.5%	18.7%	29.2%	20.9%
Education, n(%)[d]					
Low	63.5%**	50.0%**	17.9%	26.1%	16.7%**
Medium	76.5%	61.3%	18.3%	23.2%	24.5%
High	81.8%	66.1%	17.0%	35.9%	19.0%
Income, n(%)					
Poor	64.4%	47.2%*	32.6%*	23.2%**	12.1%
Middle	72.9%	66.4%	19.0%	28.07%	21.0%
High	74.5%	67.4%	10.6%	41.7%	27.6%
Childhood Economic Adversity, n(%)[b]					
Yes	71.7%	55.0%	21.3%**	28.9%	22.0%
No	72.7%	59.7%	13.3%	27.4%	22.0%
Childhood Social Adversity, n(%)[c]					
Yes	74.7%	55.0%	21.7%	27.7%	26.2%
No	71.6%	59.1%	17.0%	28.2%	21.4%

Pearson's Chi-square analysis was used to test for association of categories within sites
*p<0.001
**p<0.05
[a]Leisure time physical activity is defined as activity done for leisure that results in energy expenditure by major skeletal muscles. [b]Childhood economic adversity is defined as having experiencedpoor economic status, hunger, or parental unemployment. [c]Childhood social adversity is defined as having experienced parental substance abuse, family physical violence, or physical abuse.
[d]Education calculated from total years of education categorized by site-specific tertiles

Table 4. Summary of leisure time sportactivity engagement (LTSA)[a] by participant socio-demographic characteristics and childhood adversity, according to site

	LTSA Engagement				
	Kingston (*N*=398)	St. Hyacinthe (*N*=401)	Tirana (*N*=394)	Manizales (*N*=407)	Natal (*N*=402)
Sex, *n (%)*					
Male	49.3%*	43.1%**	7.1%**	6.1%	6.8%
Female	29.8%	29.3%	1.5%	5.5%	4.3%
Age in years,*n(%)*					
64 to 69	43.8%**	35.3%	3.6%	7.1%	6.5%
70 to 74	32.93%	36.7%	4.7%	4.3%	4.3%
Education, *n (%)*[d]					
Low	33.9%	34.5%	5.2%	4.9%**	5.1%
Medium	43.1%	33.1%	3.9%	2.9%	5.8%
High	39.4%	39.1%	3.0%	10.3%	5.8%
Income, *n (%)*					
Poor	34.0%	32.0%	5.2%	4.9%**	5.1%
Middle	45.9%	36.6%	3.9%	2.9%	5.8%
High	39.4%	40.2%	3.0%	10.3%	5.6%
Childhood Economic Adversity, *n (%)*[b]					
Yes	44.2%	34.9%	6.3%**	5.4%	4.6%
No	36.8%	36.3%	1.2%	6.09%	7.1%
Childhood Social Adversity, *n (%)*[c]					
Yes	35.8%	34.1%	5.8%	2.1%	9.4%**
No	40.3%	36.4%	3.8%	7.0%	4.1%

Pearson's Chi-square analysis was used to test for association of categories within sites
*p<0.001
**p<0.05
[a]Leisure time sport activity is defined as activity done for leisure that requires physical exertion and skill for competition.
[b]Childhood economic adversity is defined as having experienced poor economic status, hunger, or parental unemployment. [c]Childhood social adversity is defined as having experienced parental substance abuse, family physical violence, or physical abused
[d]Education calculated from total years of education categorized by site-specific tertiles

Table 5. Association of participant socio-demographic characteristics and childhood adversity measures with self-reported LTPAa[a,b]

	Kingston (*N*=398)		St. Hyacinthe (*N*=401)		Tirana (*N*=394)		Manizales (*N*=407)		Natal (*N*=402)	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI

	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Sex										
Male	1.00		1.00		1.00		1.00		1.00	
Female	0.74	0.44-1.23	1.24	0.74-2.05	0.53*	0.30-0.94	2.54*	1.54-4.18	0.99	0.60-1.65
Age, (years)										
64 to 69	1.00		1.00		1.00		1.00		1.00	
70 to 74	1.18	0.72-1.95	0.89	0.56-1.43	0.91	0.53-1.58	1.08	0.68-1.70	0.81	0.50-1.31
Education[e]										
Low	0.38*	0.19-0.73	0.78		0.80	0.38-1.71	0.83	0.44-1.54	0.52*	0.28-0.97
Medium	0.88	0.43-1.78	1.05	0.55-2.00	0.83	0.41-1.69	0.65	0.36-1.19	0.85	0.47-1.52
High	1.00		1.00		1.00		1.00		1.00	
Income										
Poor	0.82	0.40-1.67	0.42*	0.20-0.89	5.27*	2.06-13.51	0.33*	0.16-0.65	0.35	0.11-1.10
Middle	1.31	0.72-2.39	0.95	0.49-1.83	2.44*	1.20-4.99	0.46*	0.23-0.92	0.76	0.44-1.31
High	1.00		1.00		1.00		1.00		1.00	
Childhood Economic Adversity[c]										
Yes	0.96	0.56-1.64	0.86	0.53-1.39	1.65	0.92-2.93	1.29	0.79-2.09	1.19	0.71-1.99
No	1.00		1.00		1.00		1.00		1.00	
Childhood Social Adversity[d]										
Yes	1.42	0.78-2.56	1.08	0.63-1.85	0.93	0.47-1.87	0.90	0.52-1.56	1.43	0.84-2.45
No	1.00		1.00		1.00		1.00		1.00	

*p<0.05

[a]Leisure time physical activity is defined as activity done for leisure that results in energy expenditure by major skeletal muscles.

[b]Logistic regression models have been adjusted for age, sex, education, and income.

[c]Childhood economic adversity is defined as having experienced poor economic status, hunger, or parental unemployment. [d]Childhood social adversity is defined as having experienced parental substance abuse, family physical violence, or physical abuse

[e]Education calculated from total years of education categorized by site-specific tertiles

Table 6. Association of participant socio-demographic characteristics and childhood adversity measures with self-reported LTSA[a,b]

	Kingston (N=398)		St. Hyacinthe (N=401)		Tirana (N=394)		Manizales (N=407)		Natal (N=402)	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Sex										
Male	1.00		1.00		1.00		1.00		1.00	
Female	0.40*	0.25-0.65	0.65	0.39-1.08	0.17*	0.04-0.64	1.09	0.44-2.67	0.70	0.27-1.85
Age, (years)										
64 to 69	1.00		1.00		1.00		1.00		1.00	
70 to 74	0.64	0.40-1.02	1.14	0.71-1.83	1.04	0.36-2.97	0.59	0.24-1.46	0.64	0.25-1.60
Education[e]										
Low	0.89	0.49-1.61	0.95	0.51-1.75	2.05	0.46-9.10	0.54	0.17-1.69	1.56	0.48-5.10
Medium	1.62	0.90-2.93	1.17	0.62-2.19	1.28	0.29-5.65	0.25*	0.07-0.87	1.44	0.46-4.54
High	1.00		1.00		1.00		1.00		1.00	
Income										
Poor	1.01	0.50-2.05	0.59	0.28-1.24	3.88	0.79-10.07	0.65	0.18-2.36	0.53	0.10-2.69
Middle	1.21	0.69-2.10	0.84	0.44-1.59	1.37	0.37-5.03	1.42	0.44-4.58	0.29*	0.10-0.82
High	1.00		1.00		1.00		1.00		1.00	
Childhood Economic Adversity[c]										
Yes	1.62	0.98-2.66	0.88	0.54-1.43	4.35	0.94-20.13	1.31	0.50-3.39	0.60	0.24-1.51
No	1.00		1.00		1.00		1.00		1.00	
Childhood Social Adversity[d]										
Yes	0.78	0.46-1.34	1.10	0.64-1.92	0.76	0.22-2.69	0.24	0.5-1.10	3.31*	1.31-8.41
No	1.00		1.00		1.00		1.00		1.00	

*p<0.05
[a]Leisure time sport activity is defined as activity done for leisure that requires physical exertion and skill for competition.
[b]Logistic regression models have been adjusted for age, sex, education, and income.
[c]Childhood economic adversity is defined as having experienced poor economic status, hunger, or parental unemployment. [d]Childhood social adversity is defined as having experienced parental substance abuse, family physical violence, or physical abuse
[e]Education calculated from total years of education categorized by site-specific tertiles

Discussion

This study examined the relationship between childhood adversity, occurring before 15 years of age, and self-reported physical activity behaviors among community-

dwelling older adults from diverse global settings. Childhood social adversity was associated with self-reported LTPA only in Tirana and Natal. Presence of childhood economic adversity was not associated with physical activity engagement.

Childhood adversity and physical activity behavior

In a previous IMIAS study, the presence of social and economic childhood adversity was associated with poor physical performance. However, the mechanisms of this relationship were unexplored [97]. Since physical activity is commonly associated with good physical performance [101], we hypothesized that low physical activity engagement may partially explain the association observed by Sousa et al.

Contrary to our hypotheses, self-reported childhood adversity experiences did not correlate strongly with LTPA/LTSA engagement among older adults. Moreover, the nature of the association differed from what we hypothesized. In Tirana, self-reported childhood economic adversity was marginally associated with both LTPA/LTSA engagement. While not statistically significant, participants in Tirana who reported childhood economic adversity had 4.35 times the odds of reporting LTSA engagement. In Natal, reporting childhood social adversity was also associated with LTSA.

There is no doubt that early life adversity is associated to poor health behaviors and health outcomes in later life [102]. Therefore, it was puzzling to find that early life adversity did not correlate strongly with LTPA/LTSA. Unfortunately, there is currently no literature that examines the relationship between childhood adversity and later life physical activity behaviors to which we can compare this study. Our current results suggest that physical activity behavior may not explain the relationship between early life adversity and physical performance.

One possible explanation for our contrary findings may be selective survival, since data were collected only among older adults aged 65-74 [103], and the average life expectancies at birth between the sampled sites varied greatly. For example, in 1960, the life expectancy at birth in Brazil was 54.7 years, whereas Canada's average life expectancy was 71.13 years old (World Bank, 1960). Therefore, those in Brazil who survived until study recruitment reflect the survivors of their birth cohort. Selective survival has been observed in previous studies where the differences in health and mortality between groups of high and low socioeconomic statuses decline as age increases [104]. In fact, a study conducted in Israel found that older adults who survived past 61 years old have higher community resilience scores compared to the younger population, indicating that healthy older adults have a better ability to alleviate the detrimental effects of adverse events [105]. This may explain why childhood adversity was associated with physical activity engagement in the middle income sites. Those who managed to overcome childhood adversity and live past the average life expectancy of their cohort may have distinctively different behaviors from those who did not survive.

Site-specific influences on physical activity behavior

Overall, childhood adversity did not correlate as strongly to LTPA/LTSA as compared to the other socio-demographic factors that were observed in this study. LTPA/LTSA engagement was notably greater in high income (Kingston, St. Hyacinthe) compared to middle-income sites (Tirana, Manizales, Natal). These results were consistent with a study that analyzed physical activity trends using data from the World Health Organization. Among adults ages 15 years and over, Brazil, Colombia, and Albania's physical inactivity rates were higher than Canada's [106]. Additionally, the

authors found that LTPA increased as occupational PA decreased over time in high-income countries. The same analysis could not be done with low and middle-income countries because these data were not available [106]. Our study is one of the first to estimate LTPA prevalence in community dwelling older adults from middle-income settings.

The observed associations between socio-demographic factors and reported PA behavior varied notably by study site as well. The relationships between LTPA/LTSA engagement and socio-demographic variables may be dependent on site-specific norms. For example, income was significantly associated with LTPA engagement in St. Hyacinthe, Tirana, and Manizales, but not in a consistent direction. In Tirana, poor income participants were five times more likely to engage in LTPA compared to high income participants, whereas in St. Hyacinthe, poor income participants were less likely to engage in LTPA compared to high income. Our study further justifies that social norms may influence PA behaviors. Similar results can be found within the United States [107,108], and high-income East Asian countries [109]. However, to the authors' knowledge, no studies have identified cross-societal differences of factors associated to LTPA engagement across study sites of varying income categorization.

LTPA versus LTSA

This paper examined PA behavior by type—LTPA and LTSA. LTSA is a subcategory of LTPA. It can be said that all LTSA is considered LTPA, but not all LTPA is considered LTSA. LTSA have a set of rules and goals to train and excel in specific athletic skills. Moreover, LTSA in general, has a more competitive edge [110,111]. In this study, sex was a significant correlate to LTSA engagement for all sites except Natal.

Males were more likely to engage in LTSA compared to females. Yet, sex was not significantly associated to LTPA. Results from this study were congruent to other studies that examined sex differences in PA behaviors. In the United States, females are less likely to engage in vigorous PA from adolescence to adulthood [88]. Among college attending young adults, females were less likely to engage in sports compared to males [112]. Historical and anthropological studies suggest that males experience an evolutionary history of physical competition for courtship and warfare more often than females [113,114]. Further, men are more likely to engage in extreme physical competitive aggression compared to women [115]. Understanding how sex is correlated with physical activity type preference may give us insight on the social norms of PA, and guide sex-specific PA intervention design.

Limitations

Although the large gap between middle and high-income sites clearly shows a difference in PA engagement prevalence, bivariate site-specific analyses that examine the correlates to PA engagement may have been underpowered as very few participants from middle income sites reported LTSA engagement, and relatively few reported LTPA engagement. A second limitation to this study is that the LTPA/LTSA measure used has not been previously validated. However, widely used LTPA measurement tools such as Godin Leisure Time Questionnaire, International Physical Activity Questionnaire, and Sedentary Behavior Questionnaire have been only validated with populations aged 18 to 69 years old, just missing the older adult population [116]. Further, pilot studies were previously conducted to validate the IPAQ in Santa Cruz, Brazil, using accelerometers. Results showed that IPAQ had poor validity [117]; therefore, it was not considered for this

study. Future studies should examine the intensity of LTPA/LTSA engagement and validation studies in middle-income sites and among older adults are needed.

Strengths

Since the 1990's, there has been a progress in research that examines environment-level factors correlates and causes of PA [40]. Unfortunately, many studies focused only on high-income countries [33]. As the world ages, and the global burden of non-communicable diseases increase, health behaviors such as PA are becoming more relevant in lower-income settings. Several studies have shown a link between childhood adversity at adult PA behavior, but have not followed the participants into older adulthood [118]. This study is one of the few that makes cross-societal inferences on the effects of childhood adversity on elder PA behavior and it highlights the powerful influences of social norms on LTPA/LTSA engagement.

Conclusion

Overall, childhood adversity did not correlate with elder LTPA/LTSA engagement in our sample of older adults. High-income sites had higher LTPA/LTSA engagement prevalence compared to the middle-income sites. Socio-demographic factors such as sex, income, and education were associated to LTPA/LTSA engagement, but the relationship varied by site location. Current PA resources and interventions often originate from clinical practice, stress on personal responsibility, and come from high-income nations. Interpersonal and person-environment influences of PA remain a challenge [83]. Identifying cross-societal correlates to PA in high and middle-income countries allows us to see how environmental factors can drive health behaviors that were once thought of as only occurring on the individual level. The paradigms surrounding PA behavior may vary depending on geographical, cultural, social, and possibly historical

influences. Thus, there is no "cure-all" solution to promoting PA. Understanding the

complex systems that explain PA is the first step to promoting PA [119]. Future efforts to

increase PA engagement should target environmental exposures.

CHAPTER 3. ECONOMIC ADVERSITY TRANSITIONS AND PHYSICAL PERFORMANCE

Title

Economic adversity transitions from childhood to older adulthood are differentially associated with later-life physical performance measures in men and women

Abstract

Physical performance is a predictor of older adult functional decline, short-term mortality, and nursing home admission. This study examines the relationship between economic adversity transitions from childhood to older adulthood and older adulthood physical performance among 1,998 community dwelling older adults in cities in Canada, Albania, Colombia, and Brazil participating in the International Mobility in Aging Study (IMIAS). The principle exposure variable was economic adversity transition. No-adversity encompassed not experiencing poverty in both childhood and older adulthood, improved described having only experienced poverty in childhood, worsened captured having experienced poverty in older adulthood, and severe is having experienced poverty in both childhood and older adulthood. The short physical performance battery (SPPB) was used for outcome measures. Analyses of the continuous SPPB score employed linear regression, while analysis of a binary outcome (SPPB<8 versus ≥8) employed Poisson regression models with robust error variance, both adjusting for sex, education, and site location. In sex-stratified models, a strong association between economic adversity and SPPB was found for females; the SPPB<8 prevalence rate ratio was higher for the severe (PRR: 2.80, 95% CI: 1.70, 4.61), worsened (PRR: 2.40, 95%CI: 1.41, 4.09), and improved (PRR: 1.82, 95%CI: 1.11, 3.01) groups, compared to those with no adversity in

childhood or as adults. Findings from this study indicate that persistent economic adversity has a negative cumulative effect on older adult physical performance, especially among women. Should the observed association be causal, findings highlight the importance of poverty alleviation across the life course.

Introduction

A robust body of literature documents that poverty is associated with poor health outcomes across the globe.[120] Beside examining how current income status is associated with health status at one point in time, life course epidemiology approaches allow researchers to examine the temporal and/or cumulative effects of poverty on health outcomes.[57] Life course studies provide compelling evidence that sustained lifetime poverty is independently associated with poor physical, psychological, and cognitive health outcomes during adulthood.[121]

Research on older adults show that an individual's biological risk increases and years of life decrease as his/her poverty experiences accumulate over time. This may explain why certain demographic groups age less successfully than others.[122] For example, there is robust literature showing that women suffer from greater health disparities in older age compared to men.[92,97,123] Of the many health outcomes examined in older adults, functional decline is an important indicator because such decline impacts quality of life for both the affected individuals and their families by increasing the older adult's risk of falls, risk for subsequent overall health decline, need for assistance, and cost for both health care and daily living.[124]

Physical performance tests are commonly used in research to detect functional decline.[125] Although functional decline naturally occurs in older adults, the degree of

decline depends on multiple risk factors, including social inequities, such as poverty across the life span. Having experienced childhood poverty is consistently associated with higher odds of older adult physical performance decline.[126,127] Since physical performance has been observed to vary by economic exposures in previous studies, physical performance is an ideal measure of older adult physical health for this study.

Current life course literature documents the significant impact of childhood poverty on adult and older adulthood health, separately. [128,129] However, no research, to our knowledge, examines how different poverty trajectories affect the level of physical performance at older age. While poverty is well documented to have a cumulative impact over a life course (REFS), to the authors' knowledge, it is unknown how improvement or worsening of an individual's economic situation later in life may affect physical performance measures. The purpose of this study is to examine the relationship between economic adversity transitions from childhood to older adulthood and older adulthood physical performance among community dwelling older adults in five sites—Kingston and St. Hyacinthe, Canada; Tirana, Albania; Manizales, Colombia; and Natal, Brazil. We hypothesize that physical performance scores will vary according to a gradient of high to low in the following order: individuals with neither childhood nor older adulthood economic adversity (no adversity), individuals with economic adversity in childhood but not in older adulthood (improved), individuals with economic adversity in older adulthood but not in childhood (worsened), and individuals with both childhood and older adulthood economic adversity (severe).

Methods

Study Population

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Data were collected as part of the longitudinal International Mobility in Aging Study (IMIAS) at the following study sites: Kingston (N=398) and St. Hyacinthe (N=401), Canada; Tirana, Albania (N=394); Natal, Brazil (N=407); and Manizales, Colombia (N=402). Each site had near equal proportions of men and women, with the total sample containing 953 men and 1045 women. These five sites were chosen because the varying demographic factors maximize the spectrum of exposures that participants face across the life-course.[92] Baseline data were obtained in 2012, with follow-up collections in 2014 and 2016. Only baseline data were used for these analyses. Four participants were missing data on physical performance. Therefore, of the 2,002 participants at baseline, 1,998 were used in the analysis.

Participants comprised community-dwelling older adults ages 65 to 74 at baseline. University ethics committees did not allow researchers to recruit or contact potential participants directly in Kingston and St. Hyacinthe. Thus, family physicians were engaged to send study invitation letters to potential participants that invited them to contact a field coordinator for further information regarding the study. In Tirana, Natal, and Manizales, participants were randomly sampled and recruited from health center registries. Potential participants were approached directly by interviewers to participate in the study [93]. All interviewers were trained with a standardized protocol. Response rates were 90% in Tirana, nearly 100% in Manizales and Natal, and 30% in Kingston and St. Hyacinthe. Samples of recruited participants are representative of their respective towns/cities. Individuals who had four or more errors on the Leganes Cognitive Test orientation scale [94] were excluded from the study, as low scores indicated inability to complete study procedures.

Exposures

The principal exposure variable, economic adversity transition, depended on the presence of any childhood and older adulthood economic adversity, and was categorized as no adversity, improved, worsened, or severe. To create this variable, we employed measures of childhood and older adulthood adversity. Childhood economic adversity was measured using a series of retrospective questions on events that occurred within the first 15 years of the participants' lives. The events were: low economic status, having been hungry, and parental unemployment.[97] Individuals who experienced any of these events were considered to have childhood economic adversity. Older adulthood current economic adversity was measured using actual income and self-reported income sufficiency. Responses for actual/ current income were poor, middle, middle high, and high. Responses for income sufficiency were very well, suitably, and not/not very well. Participants categorized as either poor or middle actual income, or not/not very well income sufficient were considered to have endured older adulthood economic adversity. Thus, based on the childhood and adulthood measures, the following four categories were delineated: The no-adversity group encompassed participants who had experienced neither childhood nor older adulthood economic adversity; The improved category included participants who reported experiencing economic adversity in childhood, but not in older adulthood; Worsened. The worsened group included participants who reported experiencing economic adversity in older adulthood, but not in childhood; and the severe category included participants who reported experiencing both childhood and older adulthood economic adversity.

Covariates

Correlates of SPPB scores were identified previously through literature review. Education, age, and sex were chosen as covariates based on research into the social determinants of health.[98] Education was previously coded into three categories: illiterate/primary school only, secondary schooling, and post-secondary schooling. Analyses indicated insufficient variability within sites for direct comparison across sites. For example, in Kingston, 9.6% of participants were illiterate or only had primary school education, whereas in the Natal, 89.8% were illiterate or only had primary school education. To compare across sites, total years of education was split categorically into tertiles of high, medium, and low education by site to obtain a variable called "relative education". Thus, it is possible for a participant to have high educational attainment relative to his/her community, but medium or low attainment compared to another site in IMIAS. Sex is an interviewer reported categorical variable (male/female). Age is a self-reported continuous variable re-coded into a binary categorical variable (64-69/70-75). Site location is based on the location of data collection.

Outcomes

Physical performance was evaluated using the Short Performance Physical Battery test (SPPB). [26] SPPB was measured using balance, gait speed, and chair stand score. Each component has a maximum score of four. Total possible SPPB score is 12. Balance was measured by asking participants to stand for 10 seconds in three increasingly difficult positions: feet together, in semi-tandem position, and tandem position. The gait speed test measures the time of the participant walking, at his/her normal pace, four meters. The chair stand tests the participant's ability to stand up and sit

down in a chair five times. Continuous SPPB measures (balance, gait speed, chair stand, and total scores) were used as dependent variables for analyses. A binary categorical response of low and high SPPB was also generated. SPPB scores of less than eight were considered to be of low or limited physical performance, and SPPB scores of eight of more were considered to indicate higher physical performance. [97]

Statistical Analysis

STATA/SE (version 14.0; StataCorp LP, College Station, TX USA) was used to conduct the analyses. Bivariate analyses were performed using Pearson's chi-squared test for categorical data and one-way ANOVA for continuous data. Poisson regression with robust variance and multilinear regression were used to examine the strength of associations between covariates and outcome measures. The data met linear regression assumptions; therefore, no transformations were was required. For binary outcomes, Poisson regression with robust variance was selected over logistic regression because prevalence rate ratios are more interpretable for the general public and provide more accurate estimates for cross-sectional studies.[130] All regression models statistically adjusted for age, educational attainment, and sex. Previous research from IMIAS demonstrate significant differences in physical performances by site location and sex.[7,8] Therefore, multivariate models were stratified by site location and sex. A test for trend in association was conducted to identify trends in economic adversity transitions by total SPPB score.

Results

The distribution of participant characteristics by economic transition category is shown in Table 7. Based on self-report, a greater proportion of men than women experienced improvements in their economic conditions over their life courses (30%

versus 21%). In contrast, a greater proportion of women (19%) reported deteriorating economic conditions over their life courses compared to men (12%). Differences between men and women were smaller (<5%) in the no and severe adversity categories. There was a similar distribution of participants according to age category for all economic transition categories. Regarding educational attainment, stark differences were observed in the no and severe adversity categories. For example, 30% of those in the low relative education category reported no economic adversities compared to 50% of those with relatively high educations. In comparison, only 10% of those with high relative educations reported both childhood and adulthood economic adversity versus 28% among those of low relative educations. There was a much higher proportion of individuals in the no adversity group in Kingston (65.9%) and St. Hyacinthe (61.1%) compared to the other study sites (23% in Tirana and Manizales and 19% in Natal). In contrast, approximately one-third of participants from all three middle-income sites reported severe economic adversity across the life course compared to less than 5% of participants from the Canadian sites.

Notable differences were observed in poor physical performance measures according to economic transition category. Of those with high physical performance (SPPB≥8), there was a greater proportion of individuals in the no-adversity group (40.3%) compared to improved (25.9%), worsened (15.1%), and severe groups (18.7%). Of those with low physical performance, there was a higher proportion of individuals in the severe (38.1%) compared to no-adversity (20.8%), improved (22.3%), and worsened groups (18.9%).

Mean physical performance test scores by covariates in Table 8 corroborate with results of SPPB categories in Table 7. Males consistently scored higher than females in

balance, gait, chair stand, and total score. The younger age group consistently scored on average higher in all three physical performance tests compared to the older group. A gradient of low to high physical performance scores was observed in those with low to high levels of education, respectively. In addition, for all physical performance tests, a gradient of high to low physical performance scores, by economic adversity transitional category, was observed from no-adversity, improved, worsened, to severe. It should be noted that although all three physical performance tests total to a score of 4, average chair stand tests scores per covariate were consistently lower (total mean=2.5), by about 1 point, compared to balance (total mean=3.6) and gait speed (total mean=3.5).

Multivariate models were used to examine covariate-adjusted associations between economic adversity transitions with high/low physical performance (Table 9) and continuous physical performance scores (Table 10). In the overall sample, controlling for covariates, individuals from the severe group were almost twice as likely to have low physical performance (SBBP<8) in older adulthood (PRR: 1.91, 95%CI: 1.33, 2.75) compared to the no-adversity group. For those in the worsened category, the confidence interval barely crossed 1.0 (95%CI: 0.99, 2.20); the prevalence rate ratio of those in the worsened category compared to no adversity was 1.47. Similar to the overall model, in fact stronger, associations were observed in St. Hyacinthe. Interestingly, in Kingston, PRR for the worsened group was 4.86 (95%CI: 1.08, 21.91) compared to 3.65 in the severe group (95%CI: 1.01-13.26). Although not statistically significant, similar trends were observed in Manizales. In Tirana, the PRR for those in the severe category compared to no-adversity was 2.14 (95%CI: 1.22, 3.76), but there was no association for

other categories of economic transition. In Natal, no association was observed between economic adversity transition and poor physical performance.

Large differences in economic adversity transition associations were observed when stratified by sex in Table 9. The effects of economic adversity transitions on low physical performance were not significant for males. However, for females, a significant gradient in PRR was observed from severe (PRR: 2.80, 95%CI: 1.70, 4.61), worsened (PRR: 2.40, 95% CI: 1.41, 4.09), to improved (PRR: 1.82, 95% CI: 1.11, 3.01), all compared to the no adversity category.

Table 10 presents the study-site-adjusted and sex-stratified results for the continuous total SPPB scores. With both sexes combined, participants in the severe group had lower total SPPB scores (β: -0.28, 95%CI: -0.44, -0.12) compared to those in the no-adversity group. In the test for trend, a gradient effect was observed in males, females, and both. Among females, the severe (β: -0.95, 95%CI: -1.37, -0.55) and worsened groups (β: -0.64, 95%CI: -1.06, -0.22) had significantly lower total SPPB scores compared to the no-adversity group.

Table 7. Participant characteristics by economic transition category[a]

	No adversity (N=739)		Improved (N=497)		Worsened (N=305)		Severe (N=416)		p value
	n	%	n	%	n	%	n	%	
Sex									
Male	362	38.5	283	30.1	113	12.0	182	19.4	<0.001
Female	377	37.1	214	21.0	192	18.9	234	23.0	
Age									
64 to 69	427	39.8	265	24.7	166	15.5	216	20.1	0.21
70 to 75	312	35.3	232	26.3	139	15.7	200	22.7	
Education[b]									
Low	229	30.6	190	25.4	117	15.6	213	28.4	<0.001
Medium	235	36.0	146	22.4	122	18.7	149	22.9	
High	275	49.5	161	29.0	66	11.9	54	9.7	
Site location									
Kingston	243	65.9	110	29.8	8	2.2	8	2.2	<0.001
St. Hyacinthe	236	61.1	123	31.9	12	3.1	15	3.9	
Tirana	90	22.8	103	26.1	78	19.8	123	31.2	
Manizales	93	22.9	49	12.1	143	35.2	121	29.8	
Natal	77	19.2	112	27.9	64	15.9	149	37.1	
SPPB[e]									
SPPB >=8	681	40.3	438	25.9	255	15.1	315	18.7	<0.001
SPPB <8	55	20.8	59	22.3	50	18.9	101	38.1	

[a]*Missing values: SPPB(n=4)*
[b]*Education calculated from total years of education categorized by site-specific tertiles*
[c]*No adversity=not having experienced any childhood and older adulthood economic adversity, Improved= having experienced any childhood economic adversity and not having experienced older adulthood economic adversity, Worsened= not having experienced any childhood economic adversity and having experienced any older adulthood economic adversity, Severe= having experienced both any childhood economic adversity and older adulthood economic adversity.*
[d]*Missing values: Economic adversity transition (n=44 or 2.2% of total sample)*
[e]*SPPB=Short Performance Physical Battery, SPPB test scores of less than 8 are considered low or limited physical performance,*

Table 8. Mean levels and standard deviations of physical performance tests[a] by covariates (N=2002)[b]

	Balance (n=1998)		Gait (n=1998)		Chair (n=1998)		Total Score[c] (n=1998)		SPPB[d] <8 (n=267)		SPPB >=8 (n=1731)	
	mean	SD	mean	SD	mean	SD	mean	SD	n	%	n	%
Sex												
Male	3.72	0.76	3.60	0.69	2.70	1.12	10.04	1.94	91	9.55	862	90.45
Female	3.54	0.90	3.39	0.86	2.38	1.16	9.32	2.29	176	16.40	869	83.16
Age												
64 to 69	3.68	0.80	3.57	0.73	2.64	1.13	9.90	2.05	117	10.61	986	89.39
70 to 75	3.56	0.88	3.39	0.85	2.41	1.17	9.38	2.26	150	16.76	745	83.24
Education[e]												
Low	3.53	0.93	3.40	0.82	2.39	1.16	9.34	2.23	120	16.54	646	83.46
Medium	3.62	0.85	3.45	0.84	2.55	1.15	9.65	2.23	90	13.55	574	86.45
High	3.76	0.68	3.66	0.64	2.71	1.11	10.14	1.89	49	8.75	511	91.25
Site location												
Kingston	3.80	0.67	3.80	0.56	2.72	1.11	10.32	1.80	27	6.82	369	93.18
St. Hyacinthe	3.74	0.68	3.81	0.50	2.66	1.05	10.20	1.61	25	6.23	376	93.77
Tirana	3.52	0.97	3.21	0.96	2.39	1.32	9.13	2.66	80	20.41	312	79.59
Manizales	3.69	0.64	3.43	0.75	2.39	1.00	9.59	1.85	45	11.06	362	88.94
Natal	3.38	1.09	3.20	0.85	2.51	1.22	9.09	2.41	90	22.39	312	77.61
Economic Adversity Transition[f]												
Severe	3.41	1.02	3.11	0.95	2.26	1.21	8.80	2.53	101	24.28	315	75.72
Worsened	3.59	0.86	3.32	0.86	2.41	1.17	9.34	2.28	50	16.39	255	83.61
Improved	3.66	0.81	3.57	0.72	2.59	1.17	9.83	1.95	59	11.87	438	88.13
No adversity	3.73	0.71	3.70	0.60	2.69	1.10	10.14	1.85	55	7.47	681	92.53

[a]*Physical performance test is the Short Performance Physical Battery (SPPB) which consists of balance, chair stand, and gait speed tests. Higher scores indicate better physical performance. Total possible score for balance, chair stand, and gait speed is 4 each*
[b]*Missing values: Economic adversity transition (n=44 or 2.2% of total sample)*
[c]*Total score is sum of balance, chair stand, and gait speed scores and the maximum score is 12*
[d]*SPPB test scores of less than 8 are considered low or limited physical performance*
[e]*Education calculated from total years of education categorized by site-specific tertiles*
[f]*No adversity=not having experienced any childhood and older adulthood economic adversity, Improved= having experienced any childhood economic adversity and not having experienced older adulthood economic adversity, Worsened= not having experienced any childhood economic adversity and having experienced any older adulthood economic adversity, Severe= having experienced both any childhood economic adversity and older adulthood economic adversity.*

Table 9. Poisson regression models with robust error variance for poor physical performance according to study site, sex, and full sample combined

SPPB<8	Kingston (N=396)		St. Hyacinthe (N=401)		Tirana (N=392)		Manizales (N=407)		Natal (N=402)		Male (N=953)		Female (N=1,045)		Combined (N=1,998)	
	PRR	95% C.I.	PRR	95% C.I.	PRR	95% C.I.	PRR	95% C.I.	PRR	95% C.I.	PRR	95% C.I.	PRR	95% C.I.	PRR	95% C.I.
Sex																
Male	1.00		1.00		1.00		1.00		1.00						1.00	
Female	0.95	0.46, 1.95	1.56	0.68, 3.57	2.30*	1.48, 3.55	1.64	0.92, 2.93	1.61*	1.10, 2.35					1.66*	1.31, 2.10
Age																
64 to 69	1.00		1.00		1.00		1.00		1.00		1.00		1.00		1.00	
70 to 75	2.04	0.91, 4.59	1.41	0.65, 3.06	1.33	0.92, 1.94	1.69	0.98, 2.92	1.44*	1.00, 2.08	1.43	0.95, 1.23	1.48*	1.14, 1.92	1.48*	1.19, 1.84
Education																
Low	1.04	0.43, 2.56	1.67	0.58, 4.78	2.06*	1.05, 4.06	2.19	0.95, 5.03	1.11	0.69, 1.79	1.35	0.82, 2.25	1.61*	1.07, 2.42	1.47*	1.08, 2.00
Medium	0.81	0.28, 2.34	1.20	0.36, 3.95	1.98*	1.02, 3.87	1.75	0.73, 4.19	0.92	0.56, 1.51	1.23	0.75, 2.01	1.32	0.86, 2.03	1.25	0.90, 1.72
High	1.00		1.00		1.00		1.00		1.00		1.00		1.00		1.00	
Economic Adversity Transition																
Severe	3.65*	1.01,13.26	6.06*	2.03, 18.10	2.14*	1.22, 3.76	1.49	0.59, 3.73	1.05	0.62, 1.80	1.20	0.69, 2.09	2.80*	1.70, 4.61	1.91*	1.33, 2.75
Worsened	4.86*	1.08, 21.91	4.29*	1.03, 17.78	0.91	0.44,1.85	1.72	0.71, 4.19	0.96	0.51, 1.81	0.57	0.25, 1.32	2.40*	1.41, 4.09	1.47	0.99, 2.20
Improved	1.34	0.58, 3.09	2.69*	1.10, 6.57	1.06	0.52, 1.13	1.18	0.34, 3.99	0.92	0.52, 1.65	0.89	0.53, 1.48	1.82*	1.11, 3.01	1.31	0.91, 1.88
No adversity	1.00		1.00		1.00		1.00		1.00		1.00		1.00		1.00	
Site location																
Kingston											1.00		1.00		1.00	
St. Hyacinthe											0.74	0.32, 1.72	1.12	0.57, 2.18	0.99	0.58, 1.68
Tirana											1.72	0.82, 1.58	2.62*	1.46, 4.72	2.30*	1.45, 3.66
Manizales											1.23	0.57, 2.66	1.31	0.68, 2.52	1.28	0.77, 2.13
Natal											2.45*	1.21, 4.92	2.38*	1.32, 4.31	2.46*	1.53, 3.93

[a]*Missing values: Economic adversity transition (n=44), SPPB (n=4)*
[b]*Education calculated from total years of education categorized by site-specific tertiles*
[c]*No adversity=not having experienced any childhood and older adulthood economic adversity, Improved= having experienced any childhood economic adversity and not having experienced older adulthood economic adversity, Worsened= not having experienced any childhood economic adversity and having experienced any older adulthood economic adversity, Severe= having experienced both any childhood economic adversity and older adulthood economic adversity.*
[d]*SPPB=Short Performance Physical Battery, SPPB test scores of less than 8 is considered low or limited physical performance*
*p<0.05

Table 10. Linear multiple regression models for physical performance test total score[a,b] by economic adversity transitions according to sexes and both sexes combined

	Male (N=953)		Female (N=1,047)		Both Sexes (N=2,002)	
	β	95% C.I.	β	95% C.I.	β	95% C.I.
Economic Adversity Transition[d]						
Severe	-0.36	-0.76, 0.03	-0.95*	-1.37, -0.55	-0.28*	-0.44, -0.12
Worsened	0.15	-0.30, 0.60	-0.64*	-1.06, -0.22	-0.12	-0.29, 0.05
Improved	-0.05	-0.35, 0.26	-0.22	-0.58, 0.13	-0.08	-0.21, 0.05
None	0.00		0.00		0.00	
p for trend	$p<0.05$		$p<0.05$		$p<0.05$	

All models adjusted for site location, age, sex, and education
[a]*Physical performance test is the Short Performance Physical Battery (SPPB) test which consists of balance, chair stand, and gait speed tests. Higher scores indicate better physical performance.*
[b]*Total score is sum of balance, chair stand, and gait speed score*
[c]*None=not having experienced any childhood and older adulthood economic adversity, Improved= having experienced any childhood economic adversity and not having experienced older adulthood economic adversity, Worsened= not having experienced any childhood economic adversity and having experienced any older adulthood economic adversity, Severe= having experienced both any childhood economic adversity and older adulthood economic adversity.*
*p<0.05

Discussion

Using global health data from middle and high-income sites, we examined how economic adversity transitions over the life course affect older adult physical performance. Although not always statistically significant, overall results, when adjusted for sex, site location, education, and age, corresponded with our hypothesis. Physical performance in older age occurs on a gradient that appears linked to economic adversity transitions. Results from the total sample suggest that economic adversity transitions associated with highest to lowest physical performance outcomes in older adulthood were as follows: no adversity in childhood and older adulthood, improved (adversity only in childhood), worsened (adversity only in older adulthood), and severe (adversity in both childhood and older adulthood). This trend was observed in our bivariate and multivariate analyses using categorical and continuous physical performance measures. Findings support previous literature highlighting that the accumulation of poverty experiences over the life course is associated with poor health outcomes. [58,131] It also provides evidence that the worsening of economic circumstances from childhood to adulthood is disadvantageous for one's physical health.

Although overall results aligned with our hypothesis, results differed greatly when stratified by site location and sex. For site location, Natal had the lowest proportion of older adults in the no adversity (19.2%) category and the highest proportion of older adults in the severe category (37.1%). In contrast, Kingston had the highest proportion of older adults in the no adversity category (65.9%), and the lowest proportion of older adults in the severe (2.2%) and worsened (2.2%) categories. Similar patterns were

observed in mean physical performance scores, with Kingston having the highest and Natal the lowest.

Perhaps due to differences in economic adversity distributions by site, findings from multivariate models by site location did not follow the same overall gradient observed with all sites combined. For example, there was no observed association or general trend between physical performance and economic adversity transitions in Natal. It may be that absolute poverty is so pervasive in Natal that relative improvements in one's economic situation do not translate into health gains, and that other socioeconomic factors may be better predictors of the poor physical performance scores we observed in Natal. Because this study focused only on individual-level income transition, we did not model possible community-level socioeconomic factors such as community area economic conditions and intergenerational poverty transmissions. An area's economic condition is a predictor of one's abilities to adapt to decreased income and employment loss, [132] as individuals living in poor area economic conditions have fewer resources, and thus less public assistance. Further, poverty transmitted consecutively through multiple generations seems to be more difficult to overcome compared to poverty experienced in a single generation. Therefore, negative impacts on or missed opportunities by children caused by inter-generational poverty transmissions may be more difficult to overcome. [133] Factors beyond individual-level economic adversity transition may play a role in poor physical performance in Natal. Future studies should examine community-level socioeconomic factors.

The most interesting finding from this study is the strong association, along a gradient, observed in women and the lack of such an association in men. Parallel to

previous literature, more women are living in poverty and have poorer physical performance compared to men. [134] In models stratified by sex, economic adversity transitions seem to have much stronger associations with physical performance in females compared to males, and to both sexes combined, suggesting that the associations seen in the combined models were driven mainly by females. These findings corroborate existing literature on poverty-accumulation disparities between sexes. For example, Hernandez and Pressler found that lifetime poverty accumulation was detrimental to female physical health outcomes, yet protective for males. [135] This may suggests that males and females take different social paths when exposed to poverty. For example, poverty among young men is often associated with manual jobs, such as construction, [136] and these jobs often require vigorous physical activity. It is well documented in the literature that physical activity is associated with high physical performance and good health outcomes. [137] On the other hand, poverty among young females is associated with earlier ages at first childbirth and elevated lifetime parity. [138] Women who gave birth during their teens often have low socioeconomic status prior to the pregnancy. [139,140] The accumulated physiological demands of childbearing may directly and/or indirectly contribute to physical function decline among women, as previously observed in IMIAS and elsewhere. [123,141] We should recognize that the negative effects of poverty may differ in strength between demographic groups across the globe.

Since this and previous studies highlight the important role financial status plays on health outcomes, it may be worth further investigating the mechanisms behind and other possible mediators involved in differences in physical performance observed between high and middle-income sites and across the sexes. Understanding these

mechanisms can better identify demographic specific approaches to improving health outcomes.

Strengths and Limitations

There are several strengths of this study. First is the uniqueness of the IMIAS dataset, which allows researchers to observe how global geographical and socioeconomic differences affect study outcomes. Recall bias is often cited as a limitation in studies using self-reported retrospective events. Recall bias is a concern when there is differential reporting in exposure groups according to the outcome measure. This is unlikely in our study because the outcome measure was the SPPB test, which is an objective measure of physical function, and any recall bias regarding retrospective events would most probably have been non-differential across the outcome measure. The fact that participants with low cognitive functioning were excluded from this study reinforces this point. Lastly, the protocols used in this study were pre-tested and standardized. A.[142] In addition, instruments in IMIAS were either previously validated, or validated in a pilot study conducted in Saint-Bruno, Canada, and Santa Cruz, Brazil conducted prior to the IMIAS baseline collection.[34-36]

Although this study has some notable strengths, limitations also exist. First, older adulthood economic adversity data were collected at the same time as the physical performance data, e.g. during older adulthood. Since physical performance and older adulthood economic adversity were collected simultaneously, it is possible that loss of physical performance contributed to impoverishment during older adulthood, rather than the other way around. Further, economic adversity was only collected at two time points; future studies should examine the effects of economic adversity trajectory through

childhood, adulthood, and older adulthood. Being that our participants were older adults, selective survival also is a possible limitation to this study. If the most at-risk individuals in each community died before cohort selection, then the effect sizes may be smaller than observed. The effects of selective survival can be seen as socioeconomic gradients tend to lessen in older aged groups. [145] Since high-income countries tend to have higher average life expectancies compared to middle and low-income countries, there may be differences in socioeconomic gradients between site locations for this study. [146] Thus, the associations within our middle-income sites with lower life expectancy may not be as strong as the high-income sites. This may explain the lack of association that we observed in Natal.

Conclusion

Economic adversity is widely accepted to be directly related to poor health outcomes. Findings from this study indicate that persistent economic adversity has a negative cumulative effect on older adult physical performance, and that these negative effects were stronger among women than for men. Results suggest that physical performance in older age for females occurs on a gradient that is tightly linked to lifetime economic adversity experiences. Should the observed association be causal, it highlights the importance of poverty alleviation across the life course, especially for women.

CHAPTER 4. EXPLORING NATIVE HAWAIIAN ELDERS' PERSPECTIVES ON PHYSICAL ACTIVITY

Title

Exploring how life course exposures affect Native Hawaiian elders' PA attitudes, perceptions, and behaviors

Abstract

In the United States, fewer Native Hawaiians (NH) and Pacific Islanders meet the physical (PA) recommendations than other ethnic groups. Previous studies have shown that NH are not receptive to some national evidence-based PA interventions due to the lack of relevance to their interests. The purpose of this paper? is to explore how early life exposures experienced by NH may affect their perceptions and behaviors towards PA. In-depth interviews were conducted with 20 NH community-dwelling elders ages 55 years and older recruited from Oahu, Hawaii. Interviews were transcribed, and two researchers independently coded transcripts. Of the participants, 60% were female, and 35% spent most of their childhood in urban, population dense areas. Three major themes were identified in this study. First, most elders were engaged in PA post-retirement, but PA type varied by neighborhood. Second, childhood PA behaviors and adult PA perspectives were contextual, based on neighborhood. Third, PA perspectives and behaviors were influenced by gender expectations. Findings suggest that PA behaviors are shaped by early experiences and settings.

Introduction

Native Hawaiians are the indigenous people of the Hawaiian Islands, tracing their ancestry to individuals residing on these islands prior to Western contact in 1788. [147] It is well documented that Native Hawaiians were socially and physiologically healthy prior to Western influence. [148] Today, Native Hawaiians experience an unequal burden of chronic illnesses and have a much lower life expectancy than Chinese, Japanese, Filipino, and Caucasian populations in Hawaii. [59,149–152] They are also more likely to fill blue collared occupations and report the lowest mean family income compared to other major ethnicities in Hawai'i. [153]

It is well established across the globe that social and economic adversities are associated with poor health outcomes.[120] A sustained lifetime of low socioeconomic status is independently associated with poor physical, psychological, and cognitive health outcomes during older adulthood.[121] However, the reason behind this relationship may be unique within the Native Hawaiian population. The forced assimilation of Native Hawaiians by their colonizers is theorized to be the root of current socioeconomic and health disparities.[85,154,155] This concept of historical trauma stems from the disregard of cultural values by the dominant culture, the loss of traditional lifestyles, interpersonal and institutional discrimination (resulting in the lack of opportunity for education and socioeconomic advancement), and lack of access to health care systems faced by colonized indigenous people, including Native Hawaiians.[156] Therefore, this study will only explore Native Hawaiian perspectives on how childhood experiences, especially adversity, influence older adult lifestyle behaviors.

Research on older adults suggests that an individual's biological risk increases and years of life decrease as his/her poverty experiences accumulate over time. This may

explain why certain demographic groups age less successfully than others.[122] Of the many health outcomes examined in older adults, declines in physical activity (PA) and functional status are important indicators because they impact quality of life for both the affected individuals and their families by increasing the older adult's risk of falls, risk for subsequent overall health decline, need for assistance, and cost for both health care and daily living. [124]

In 2012, only 38.6% of Native Hawaiians in the United States met CDC's PA recommendations compared to 45.8% of the total population.[157] A limitation to promoting PA among Native Hawaiians is that PA is only appealing when culturally relevant. [158] A study conducted by Moy et al. attempted to identify PA correlates among Native Hawaiians using a quantitative cross-sectional design. The authors concluded that PA interventions need to be culturally tailored.[159] Unfortunately, quite a few epidemiological studies in the United States aggregate Native Hawaiians with Other Pacific Islanders and/or Asians. Since there is a large variation in culture across Pacific Islander and Asian groups, findings from studies that aggregate Pacific Islanders and Asians will not yield enough specificity to inform the tailoring of programs to the Native Hawaiian context. [160,161] Further, deeply understanding the interactions between ethnic, historical, and other demographical features can inform researchers on the receptivity, durability, and maintenance of public health efforts.[162]

Previous studies have shown that early life exposures, or childhood adversity, may play a role in PA behavior, physical performance outcomes, and life expectancy in high and middle income countries. [163–166] Similarly, the author posits that early life exposures experienced by Native Hawaiians may play in their PA behavior and health

outcomes in later life. Thus, the purpose of this study is to explore early life exposures experienced by Native Hawaiians and how they may affect their perceptions, attitudes, and behaviors toward PA.

Methods
Design

The community of Waimanalo, Hawaii was chosen as the site of the research. Waimanalo is a town that lies along the windward coastline beside the Koolau Mountains on Oahu, Hawaii. Prior to colonization, Waimanalo extended from present day Olomana to present day Hawaii Kai. During the 1960s, Henry J. Kaiser dredged part of the original Waimanalo and converted it to a series of luxury condominiums and homes now known as Hawaii Kai ('Kai' for Kaiser). [167] In 2010, Waimanalo was home to approximately 5,451 residents, 23.3% of whom are Native Hawaiian, compared to 9.9% in the entire state of Hawaii. [168] The average annual family income in Waimanalo (at $43,347) is 31% less than that of the state (at $56,961). [169] The Waimanalo community has a limited commercial center, approximately 10 fast food restaurants, and one small locally-owned grocery store.

This community was selected because the author has established solid relationships with key community members through volunteering at a prominent community program, God's Country Waimanalo. This is a grassroots, non-profit organization in Waimanalo that provides cost-free, cultural preservation programs for all ages with the goal of improving Native Hawaiian health through cultural learning. The University of Hawaii College of Tropic Agriculture and Human Resources maintains an agricultural station in the community, and God's Country Waimanalo uses space

associated with the station. God's Country has collaborated with the Office of Public Health Studies on research projects and student service learning opportunities since 2009. Key stakeholders in the community were interested in exploring the role of childhood events, historical trauma, and resilience on health of its members.

The director and staff of God's Country Waimanalo were consulted throughout the process to ensure that the procedures were culturally sensitive and community-based. Previous qualitative studies in Native Hawaiian elder health have successfully utilized the listening study format to understand cultural beliefs, values, and motivations related with health. [170,171] Similar format was used to understand Native Hawaiian elder PA practices and beliefs with a focus on early life events.

Sample

Community dwelling, self-identified Native Hawaiian older adults, age 55 years or older who were cognitively alert were recruited through GCW's list of participants and allies. Individuals with four or more errors on Leganes Cognitive Test orientation scale [94] were excluded from the study. Participants completed a written consent form. Twenty-two elders were approached, and 20 were recruited for this study. All 20 individuals consented, passed the cognitive test, and were therefore interviewed. Interviews were held at the Waimanalo Agriculture Station.

Measures

Key informant interviews were semi-structured. A set of pre-determined opened ended questions was developed to understand how early life events affected their current perceptions on PA and PA behavior. What was life like growing up? What types PA have you done growing up? What types of PA do you do now? Do you enjoy it? How satisfied

are you with your health, and the amount and types of PA you currently do? Do you feel

that being Native Hawaiian affects your PA behaviors? If so, why/how? If your loved one

asks you, "do you think I should be physically active? How should I start?", what would

you say to him/her? Interviews closed with thanking the participants for their time and

asking them if they had any additional comments and/or questions for the interviewer.

Each session was approximately 60-120 minutes long. All interviews were audio

recorded and transcribed for analysis.

Participants also were asked to complete a brief demographic questionnaire to

describe the sample and to correlate variables like age, gender, and community in which

they grew up with the qualitative data. This questionnaire asked about sex

(male/female/other), the community in which they grew up, current living arrangement

(alone/not alone), ethnicity (free response), age (free response), highest education

attained (haven't graduated high school/high school or GED equivalent/2 years college/4

years college/graduate/professional or doctorate), and physical functioning or limitation

of activity (ability to climb and walk, assistive technology usage). [172]

Analysis

Transcripts were analyzed using constant comparative method. [173] Transcripts

from interviews were read multiple times to identify any early life course events and PA

perceptions, attitudes, and behaviors. Based on initial ideas from this reading, two

researchers independently coded transcripts using open, axial, then selective coding

similar to analysis methods used in Browne et al's study. [170] Researchers first created a

list of open codes, or tentative labels from the transcripts. Next, axial codes were

developed by identifying any relationships between the open codes. Quotes were

identified as axial codes were developed. Finally, researchers reread the transcript to identify core variables of the axial coding. Themes were developed from common axial codes that occurred throughout participants. Demographical data from the interviews were also coded, summed, and linked to qualitative data results. Results were presented to the participants and their friends and family at a community meeting. Individuals present at the community meeting validated the results. Because qualitative findings revealed very interesting differences in childhood experiences by community in which the elder was raised, demographic data and qualitative themes were further analyzed by community of upbringing.

Human Subjects

An exempt application was submitted and approved by the University of Hawaii Institutional Review Board (IRB) prior to start of study. All participants remained anonymous and non-identifiable throughout in all audio recordings and notes.

Results
Demographics

Demographic characteristics of the sample by neighborhood are shown in Table 11. Participant age ranged from 55 to 76 years old, and the mean age was 66.4 years. Most of the elders interviewed were female (60%). The majority of elders (40%) had completed some college. The majority also had a low level of physical limitations, and only 10% reported needing an assistive device to climb stairs and/or walk 400 meters.

Additional demographic information gathered from the interview transcripts are displayed in Table 12. Eight of the 20 participants spent most of their childhood in more urban and population dense areas such as Papakolea, Kalihi, Punchbowl, or Ala Moana. The rest spent most of their childhood in rural Waimanalo. Overall, PA behavior

decreased from childhood (75% were active) to adulthood (55% were active), and then increased drastically during older adulthood (95% were active). One elder was unable to be physically active due to physical limitations. Only one elder was satisfied with his health and amount of PA performed. All other elders reported poor health and expressed their desire to exercise more. The percentage of individuals who experienced adversity (poverty, discrimination, violence, physical abuse, or mental abuse) was 35% during childhood, to 6% during adulthood, and 1% older adulthood. All 20 elders reported having children, and 18 of the 20 had grandchildren.

Both Tables 11 and 12 were stratified by neighborhood to compare differences in characteristics. A higher proportion of elders from urban Honolulu seemed to have more difficulty with climbing stairs and walking, and more used assistive devices compared to elders from Waimanalo neighborhood. Although during childhood, 75% of both urban and rural elders were physically active, more elders raised in Waimanalo were physically active in adulthood (58.3%) and older adulthood (100.0%) than Honolulu-raised elders (50.0% adulthood, 87.5% older adulthood). Elders raised in Waimanalo perceived less life course adversity (childhood, adulthood, and older adulthood) compared to Honolulu neighborhood elders.

Two elders mentioned that being Native Hawaiian influenced their current PA behavior because they chose to do activities that were culturally relevant such as surfing, making board and stone to pound taro, and farming native plants. "[My name] means water. I feel more connected to the water. So swimming, surfing, diving makes me feel me." All other 18 elders did not feel that being Native Hawaiian specifically affected their current PA behavior. When asked what advice they would give to loved ones to help

them be physically active, elders suggested starting slow, finding an activity that is of

personal interest, and participating in a group activity with friends.

Table 11. Characteristics of participants by neighborhood, *N=20*

	Waimanalo/rural (n=12)	Honolulu/urban (n=8)	Total (n=20)
Sex, *n(%)*			
Female	8(66.7)	4(50.0)	12(60.0)
Male	4(33.3)	4(50.0)	8(40.0)
Age, *mean(SD)*	64.5(6.8)	69.3(4.3)	66.4(6.3)
Education, *n(%)*			
Haven't completed high school/G.E.D.	0(0.0)	1(12.5)	1(5.0)
High school/G.E.D.	2(8.3)	4(50.0)	6(30.0)
Some college	7(58.3)	1(12.5)	8(40.0)
Graduate or higher	3(25.0)	2(25.0)	5(25.0)
Difficulty with stair climb[b], *n(%)*			
None	12(100.0)	6(75.0)	18(90.0)
A little/Some	0(0.0)	1(12.5)	1(5.0)
A lot	0(0.0)	1(12.5)	1(5.0)
Uses assistive devices for stair climb[b], *n(%)*			
Yes	0(0.0)	2(25.0)	2(10.0)
No	12(100.0)	6(75.0)	18(90.0)
Difficulty with walking[b], *n(%)*			
None	11(91.7)	5(62.5)	16(80.0)
A little/Some	0(0.0)	3(37.5)	3(15.0)
A lot	1(8.3)	0(0.0)	1(5.0)
Uses assistive devices for walking[b], *n(%)*			
Yes	0(0.0)	2(25.0)	2(10.0)
No	12(100.0)	6(75.0)	18(90.0)

[a]*All participants were Native Hawaiian, some reported ethnicities in addition to Native Hawaiian*
[b]*Physical functioning were measured using Nagi Questionnaire*

Table 12. Additional characteristics gathered from semi-structured interviews by neighborhood, *N=20*

	Waimanalo/rural (n=12) *n*(%)	Honolulu/urban (n=8) *n*(%)	Total (n=20) *n*(%)
Physically active[a] during childhood	9(75.0)	6(75.0)	15(75.0)
Physically active[a] during adulthood	7(58.3)	4(50.0)	11(55.0)
Physically active[a] during older adulthood	12(100.0)	7(87.5)	19(95.0)
Experienced adversity[b] during childhood	0(0.0)	7(87.5)	7(35.0)
Experienced adversity[b] during adulthood	0(0.00)	6(75.0)	6(30.0)
Experienced adversity[b] during older adulthood	1(8.3)	0(0.0)	1(5.0)

[a]Participants were considered physically active if they participated in leisure, sports, occupational, or transportational physical activity.
[b]Adversity is defined as poverty, discrimination, or abuse observed or experienced.

Themes

Three major themes emerged from the data. First, most elders were engaged in PA post-retirement, but PA type varied by neighborhood. Second, childhood PA behaviors and adult PA perspectives were contextual, based on neighborhood. Third, PA perspectives and behaviors were influenced by gender expectations.

Most elders were engaged in PA post-retirement, but PA type varied by neighborhood. As noted above, 15 (75%) of elders in the sample were physically active during childhood, 55% (n=11) were physically active during adulthood, and 95% (n=19) were active during older adulthood. Table 2). During childhood, all PA was done for leisure, social, and functional purposes. For example, four elders from Waimanalo recalled that, growing up, families often had eight or more children. Parents would entertain children by taking all of them to play softball. "There were enough kids [per family] to make one softball team! So we would play against each other." Outdoor activities were affordable activities done to pass the time and included camping out on the beach all summer, swimming, fishing, hiking, and softball.

During adulthood, only six of the 15 elders who were active during childhood continued to be physically active for leisure purposes on a regular basis, and five of the six were raised in Waimanalo. The other five who were still active in adulthood were active for occupational purposes. For example, several of the males worked labor-intensive jobs during their adulthood, which helped maintain their physical performance. "I worked in the firehouse, I worked all kine stuff. And that's how you expand

everything. You expand your lungs. You expand your life, life expectancy." All women, regardless of physical activity levels, were occupied with childcare and, for some, work.

During older adulthood, 17 elders reported being engaged in some type of leisure PA. The most commonly reported PA during older adulthood for all elders was walking. Although 19 elders reported to be physically active, the type and number of PA seemed to varied by neighborhood. Waimanalo-raised elders seemed more enthusiastic about the PA they were performing because it was an activity they grew up with and felt passionate about and, therefore, had integrate into their everyday lives. Every Waimanalo elder (n=12) consistently performed at least two different types of activities during older adulthood. Examples of PA that Waimanalo elders participated in were: yard work, farm work, building aquaponics systems, building canoe, hula, and beach activities (swimming, diving, surfing, and fishing). Honolulu elders on the other hand, did not seem as passionate about the activities they were doing during older adulthood. Further, only one Honolulu elder performed more than one different type of physical activity at a time. The rest only performed one physical activity at a time. Examples of PA that Honolulu elders participating in were: physical therapy, water exercises, and community senior classes (like bon dance and tai chi).

PA perspectives were contextual by neighborhood. Differences in life course PA behavior were observed between Honolulu-raised and Waimanalo-raised elders. All except for one Waimanalo-raised elder recalled hiking, picking fruits, diving, swimming, fishing, camping, and/or playing softball as children. "We get to go hiking in the mountains. Pick your own fruit, Roller skating from one end of Waimanalo to the other. Playing softball. Baseball." Outdoor activity was common in Waimanalo because of the

rural environment. The beach and mountains were less than ten minutes away by foot (albeit in different directions), therefore it was easy to access these resources. "During the summer time, back in the 60s, we would move and camp for 3 months on the beach in Waimanalo." Several Waimanalo-raised elders also mentioned that these pastimes were "free and fun and convenient to do." Some of these PA pastimes, such as picking fruits and fishing, were a necessary part of daily survival. "My dad was a fisherman, so I learned everything I needed to know as a young person about fishing. So we worked hard, we did a lot of trading growing up because the bay area was right there."

Honolulu-raised elders on the other hand, recalled growing up in crowded places with no place to play. A Honolulu-raised elder recalled working to save money to catch the bus to the beach to surf. "From Lanakila, we needed to work to catch bus to beach. If no money, we walk to the harbor, ask them [tourist] to throw coins at us. They watched and we dived for the coins." Work and chores seemed to be a priority for all Honolulu-raised elders during childhood. The lack of money forced some of the elders to work at an early age. One elder mentioned that he started working at nine years old in Waikiki "We got into trouble because we were in the projects for a while. And kids there become all kinds stuff. So my grandma's husband taught me how to make a nickel. What I needed to do. I needed to make money."

In addition to PA behavior, discrimination and poverty were perceived differently dependent on childhood neighbor. All seven of eight elders who grew up in urban Honolulu recalled experiencing discrimination, poverty, or both during their childhood. However, most elders who grew up in rural Waimanalo did not. When asked to recall their childhoods, Honolulu-raised elders naturally spoke of discrimination in schools

"because I was Hawaiian" or of poverty by comparing themselves with children of other ethnicities. "The hoale (Caucasian) kid always got the new backpack every year. But me, I get my brother's old backpack, and I use it until it can't be used no more." In contrast, elders from Waimanalo did not complain about discrimination or poverty as the Honolulu-raised elders did. An elder from Waimanalo mentioned that, "Growing up [in Waimanalo] I never knew I was poor. It wasn't till later, when I start work outside [in Honolulu], I realized, wow, we were poor!" indicating that moving to urban areas made him feel poor. Three of the seven elders who grew up in urban Honolulu and experienced adversity, described discrimination in the classroom during elementary and intermediate school. "When I first went to my first school, I thought I was being discriminated against. And I didn't want to go to that school. I used to run away every day. Cuz I felt at that time that my teacher, because we were Hawaiians, never bothered to help us." "I had a bad experience [in school] growing up…I get called stupid, this and that." This caused the elders to have negative views of education and de-motivated them to finish secondary school or pursue a higher education to present day.

Further, it seemed that the elders who readily spoke of living through poverty and discrimination did not bring up leisure activities, or activities they would do for fun growing up. For example, six participants who recalled not having enough to eat as a child, talked about having to work during childhood. If PA was done, it was for occupational purposes. In contrast, none of the elders from rural Waimanalo mentioned experiencing poverty during childhood; instead, they describing all the games and activities they and their friends would play.

During adulthood, the six Honolulu-raised elders continued to experience adversity, whereas no Waimanalo-raised elders reported experiencing discrimination and poverty during adulthood. However, during older adulthood, only one elder (Waimanalo-raised) of the 20 elders experienced some type of adversity. Thus, inferences regarding adversity transitions (RQ2) could not be made because 12 elders were in the no adversity group, 7 were in the improved, and 1 was in worsened (refer to RQ2). None of the elders were in the severe category, which was found to have the lowest physical performance compared to the other three groups.

PA perspectives and behaviors were contextual based social gender expectations. Gender-specific roles and expectations affected PA behavior. For example, a female elder recalled not playing sports because her father did not want her to have scars. Her father told her that, "girls are not supposed to have scars." During the interviews, the females spoke in detail about their children and/or grandchildren and how it was common for females to cease PA to care for children and family. In contrast, all but one male spoke about themselves, their personal adventures, and careers.

Discussion

It is well documented in literature that early-life exposures influence later-life health behaviors and outcomes. Prevalence studies show that fewer Native Hawaiians engage in recommended levels of PA compared other major ethnicities in Hawaii. The purpose of this study was to explore perceptions of how early-life experiences affected PA behaviors of Native Hawaiian elders.

Even with a sample homogenous in age and ethnicity, we observed a difference in how early-life environment and social conditions affected PA behavior and perspectives throughout life. Rural-dwelling elders were more physically active in childhood

66

compared to urban-dwelling elders. An explanation could be the physical environment. As other researchers have found, urban areas tend to have higher population density and less safe outdoor places for leisure activity compared to urban dwelling areas, thus limiting PA behaviors. [174]

Findings from this study also suggest that elders who were raised in urban areas perceived discrimination and poverty more deeply than elders raised in rural areas. For example, discrimination as a result of social stigma occurred in a school setting and dissuaded urban Native Hawaiians from finishing secondary school. Other studies have shown that social stigma based on race or socioeconomic status have negative implications for one's educational outcomes (decreasing one's opportunities for well-paying) as well as for one's social identity, and these factors are all associated with greater stress and poorer health outcomes.[175 176 177]

Findings also that crude ethnic classifications may not be sufficient in understanding health disparities. Within the Native Hawaiian population, there is a difference in the way environmental factors affect how social factors are perceived and how that, ultimately, influenced their health behaviors.

In addition to discrimination, perceived poverty was dependent on area of residence. Rural-dwelling elders did not perceive themselves as being impoverished during childhood whereas urban-dwelling elders did. Interestingly, 19 of the 20 elders seem to have similar type blue collared occupations and mentioned that their income level was low or middle. Poverty is a well-documented predictor of poor health behaviors and outcomes. [178,179] However, oftentimes studies utilize absolute income to indicate poverty. Relative poverty, on the other hand, compares actual income to the amount

needed in the community (based on cost of living), thus making it a closer to accurate measure of poverty. [180] This study captured another dimension of poverty in addition to absolute and relative—perceived wealth or poverty in relation to their peers. For example, an elder who moved from a rural to an urban area recalled feeling impoverished after moving to the urban area. Future studies should consider examining the effects of perceived poverty compared the absolute and relative poverty.

Our findings that females tended to be less active throughout their lives corroborate with other studies examining PA behavior and gender, as well as findings from RQ1 and RQ2. [56,181,182] An explanation to the relationship between gender and PA behavior can be social expectations and norms. A study conducted by Sriram et al showed that rural adults tended to be deeply affected by social norms and inter-personal relationships. Further, the need to conform to social norms has a negative impact on health behavior. [183] Our findings indicated that gender specific norms affected elder PA-behaviors during childhood and adulthood, and PA perceptions throughout their life course. Females were expected to be caretakers of the household, therefore they held the responsibility to rear children, and take care of children, spouse, parents, and even grandchildren. Gender norms and expectations have been previously identified as barriers to elder PA. [182] Females are less active due to higher levels of perceived social and physical barriers, and the need to conform to gender expectations (that women are less active). [184] Therefore, targeting social norms, such as gender expectations, may be required to increase PA overall. [185]

Limitations

Several limitations exist for this study. The first is social desirability bias. Interviews were conducted in person, therefore increasing the potential of participants to respond based on their perceived notions about the interviewer and what she wanted to hear. The second limitation is the lack of an objective measure of PA. Since this was a qualitative study, the purpose was to examine in-depth perceptions of the participants. Although some data about PA and level of physical functioning were summarized from interviews, population-based statistical inferences cannot be made from small and qualitative studies. Lastly, the participants mainly consisted of females and therefore might be biased to experiences specific to the females.

Conclusion

Early life environmental exposures, as well as gender expectations, affected Native Hawaiian elders' PA behavior in childhood, and this appears to affect later life PA behaviors. Perceived discrimination and poverty had a negative impact on PA behaviors for participants who grew up in urban neighborhoods, but not for those who grew up in rural neighborhoods. Women tended to be less PA due to gender expectations. Although not all elders recalled being physically active during their child and adulthood, all but one was active during older adulthood. However, the rural dwelling elders were more passionate about their PA and were consistently engaged in more types of PA compared to urban dwelling elders, and fewer reported physical limitations in older adulthood. Understanding how life course events affect elders' perceptions towards PA and PA behaviors may provide deeper insight on developing context-based PA interventions.

CHAPTER 5. CONCLUSION

Summary of Findings

This dissertation examined the effects of life course factors and older adult physical performance and physical activity (PA) behavior disparities. Two global quantitative studies and one local (Hawaii) qualitative study were conducted.

The first utilized data from a global health study, the International Mobility in Aging Study (IMIAS), to examine the relationship between childhood adversity and leisure time PA (LTPA) among community-dwelling older adults from Kingston, Canada; St. Hyacinthe, Canada; Tirana, Albania; Manizales, Colombia; and Natal, Brazil. Although childhood adversity was not associated with older adult LTPA, findings suggest that site location specific effects of socio-demographic factors exist. For example, high-income sites had higher LTPA prevalence compared to middle-income sites. Females were less likely to engage in LTPA compared to males in Tirana, but were more likely to engage in LTPA in Manizales. Low income participants were less likely than high income participants to engage in LTPA in St. Hyacinthe and Manizales. However, the opposite was true in Tirana. Results from this study further support the importance of upstream socio-demographic factors that affect PA behavior and suggest that a one-size fits all approach to PA promotion is ill-advised.

The second study used data from IMIAS to examine the relationship between economic adversity transitions from childhood to older adulthood, and older adulthood physical performance. Results from the total sample suggest that economic adversity transitions associated with highest to lowest physical performance outcomes in older adulthood were as follows: no adversity in childhood and older adulthood, improved

(adversity only in childhood), worsened (adversity only in older adulthood), and severe (adversity in both childhood and older adulthood). In sex-stratified models, the same gradient was observed to be significant for females but not males. Findings from this study indicate that persistent economic adversity has a negative cumulative effect on older adult physical performance, especially among women.

The third study used qualitative methods to explore how early life exposures experienced by Native Hawaiians may affect their perceptions and behaviors toward PA. This study found that perceived discrimination and poverty have a negative impact on PA behaviors for participants who grew up in urban neighborhoods, but not for those who grew up in rural neighborhoods. Women tend to be less physically active due to social gender expectations. Although not all elders recalled being physically active during their child and adulthood, all but one was active during older adulthood. However, the rural dwelling elders were more passionate about their PA, were consistently engaged in more types of PA compared to urban dwelling elders, and fewer reported physical limitations in older adulthood. Understanding how life course events affect elders' perceptions towards PA and their PA behaviors may provide deeper insight on developing contextually informed PA interventions. Evidence from this dissertation observes strong associations between PA behavior, ethnic minorities status, neighborhood, and demography and thus, calls for a more nuanced discussion of the synergistic effects of these multi-level and multi-disciplinary PA correlates [186].

Implications to Practice and Policy

Findings from this dissertation suggest that context and gender play a large role in predicting later life physical performance and PA behavior. For example, RQ1 and RQ2

demonstrated that sex influenced the association between childhood adversity and PA behavior, and physical performance. RQ3 shed light on a possible reason why—social gender expectations and neighborhood, or context. Since context and gender are social constructs, for maximal impact, practice and policy should focus on the importance of social level changes rather than individual.

There are two public health practice and policy recommendations that can be made based on the findings from this dissertation. First, using an ecological perspective, target social norms to improve older adult PA and physical performance. As mentioned above, results show that social constructs such as gender, played a role in late life PA behavior and physical performance. One method to address upstream determinants of health behaviors and outcomes is through social norms campaigns, which draw out individual desired behavior, and are the opposite of using scare tactics. [187] A successful gender based campaign is the Dove's Real Beauty Campaign. This campaign aimed at re-establishing beauty norms around females of all ages to improve their self-esteem and rectify unrealistic and unhealthy beauty standards set by media. [188] Not all social norm changing marketing techniques need to be a planned campaign such as Dove's. Other established corporations such as Pantene, Pot Noodle, Whisper, and Airtel have utilized their influence by dispelling several harmful gender-based stereotypes in their public commercials. [189] Beside applying the considerable financial resources of large business corporations, other low-cost social norm campaigns can start at the grass roots level using social media, such as Twitter, Instagram, and Facebook. Another method of changing social norms is through institutional level policy change. For example, the Title IX Education Amendments Act forbade exclusion and gender discrimination in sports

participation. The downfall of policies is that they only become social norms when implemented. In most cases, institutional level policies require time and facilitation for them to be normalized in the target population.[190] In RQ2, poverty played a significant role in lowering physical performance in women and not men. In RQ3, women had distinctive roles in society compared to men. They were expected to care for the rest of the family. Thus, having sufficient finances may alleviate their roles and responsibilities. However, an interesting finding in RQ3 was that although all women spent time caring for their families, women from the rural site were relatively healthy compared to the rest of the participants. This may demonstrate that the rural site somehow incorporated PA into their established norms around women's responsibilities, thus, even without poverty alleviation, PA behavior and physical performance was not low. Based on results from this study, I recommend that we change society's gender stereotypes surrounding a woman's responsibilities around childcare and family member care at home by utilizing a combination of bottom-up (social marketing) and top-down (institutional policy change) approach. Perhaps if we suggest that men have equal responsibility as women to care for children and other family members as well.

Second, at the community level, interventions to improve PA levels and physical performance should be tailored to the target population based on region. Results from the qualitative study showed that differences in early life exposures and PA perceptions exist in a relatively small geographical area such as Oahu, Hawaii due to social norms and the natural environment. Elders living in Waimanalo (near the coast) had access to natural resources (mountains for hiking and beach for swimming) within walking or biking distance. Whereas, elders living Honolulu (central Oahu) needed some type of

transportation to get the nearest mountain or beach. Groups of older adults, based on neighborhood and gender, experienced different social norms and events in life, and therefore their perceptions towards PA are framed differently. Currently in Hawaii, interventions are tailored to Native Hawaiians as a whole rather than Native Hawaiians by neighborhoods. Future interventions should tailor their approach based on the context of the neighborhoods.

Future Research Needs

To build on findings from this dissertation, future research is needed to further examine how childhood adversity and perceived discrimination plays a role in older adult physical performance and PA behaviors. The quantitative global studies confirmed the impact of socio-demographic factors on PA behavior, and the impact of life course economic adversity transition on older adult physical performance. The in-depth qualitative study revealed that certain adversities (discrimination and poverty) throughout the life course is experienced differently by each individual based on regional context. A proposal has been submitted to the RMATRIX pilot grant 2017-2019 to conduct the first population-based quantitative study that examine how Native Hawaiians perceived-discrimination and resilience influences the established relationship between early childhood adversity and PA and physical performance. Findings from this project will further elucidate the role of resilience to inform the development of interventions that promote Native Hawaiian health. In the past, public health efforts focused on infectious diseases affecting the younger population. However, with the world's aging populations on a constant increase, it is crucial to begin prioritizing elder health. Further, since connections between childhood exposures and elder health outcomes have been made,

results from the proposed project can potentially advocate for both childhood and elder

health efforts.

References

1. Glascock AP, Feinman SL. A holocultural analysis of old age. *Comp Soc Res*. 1980;3(31):1-332.

2. WHO | Proposed working definition of an older person in Africa for the MDS Project. WHO. http://www.who.int/healthinfo/survey/ageingdefnolder/en/. Accessed March 13, 2017.

3. World Population Prospects - Population Division - United Nations. https://esa.un.org/unpd/wpp/. Accessed March 13, 2017.

4. World Development Indicators | Data. http://data.worldbank.org/data-catalog/world-development-indicators. Accessed March 13, 2017.

5. Oeppen J, Vaupel JW. Broken limits to life expectancy. *Science*. 2002;296(5570):1029-1031.

6. Christensen K, Doblhammer G, Rau R, Vaupel JW. Ageing populations: the challenges ahead. *The lancet*. 2009;374(9696):1196-1208.

7. World Health Organization. Global health and aging. http://www.who.int/ageing/publications/global_health.pdf. Published 2009. Accessed March 13, 2017.

8. Taylor AH, Cable NT, Faulkner G, Hillsdon M, Narici M, Van Der Bij AK. Physical activity and older adults: a review of health benefits and the effectiveness of interventions. *J Sports Sci*. 2004;22(8):703-725.

9. Kramarow E, Lubitz J, Lentzner H, Gorina Y. Trends in the health of older Americans, 1970–2005. *Health Aff (Millwood)*. 2007;26(5):1417-1425.

10. Caspersen CJ, Powell KE, Christenson GM. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. *Public Health Rep*. 1985;100(2):126.

11. Braith RW, Stewart KJ. Resistance exercise training. *Circulation*. 2006;113(22):2642-2650.

12. Laaksonen DE, Lindström J, Lakka TA, et al. Physical activity in the prevention of type 2 diabetes. *Diabetes*. 2005;54(1):158-165.

13. Lam T-H, Ho S-Y, Hedley AJ, Mak K-H, Leung GM. Leisure time physical activity and mortality in Hong Kong: case-control study of all adult deaths in 1998. *Ann Epidemiol*. 2004;14(6):391-398.

14. Haley C, Andel R. Correlates of physical activity participation in community-dwelling older adults. *J Aging Phys Act*. 2010;18(4):375-389.

15. Hackney ME, Hall CD, Echt KV, Wolf SL. Dancing for Balance: Feasibility and Efficacy in Oldest-Old Adults With Visual Impairment. *Nurs Res*. 2013;62(2):138-143. doi:10.1097/NNR.0b013e318283f68e.

16. Mazzeo RS, Cavanagh P, Evans WJ, et al. Exercise and physical activity for older adults. *Med Sci Sports Exerc*. 1998;30(6):992-1008. doi:10.1097/00005768-199806000-00033.

17. Fisher KL, Harrison EL, Reeder BA, Sari N, Chad KE. Is self-reported physical activity participation associated with lower health services utilization among older adults? Cross-sectional evidence from the Canadian Community Health Survey. *J Aging Res*. 2015;2015. https://www.hindawi.com/journals/jar/aa/425354/. Accessed March 13, 2017.

18. Ford ES, Kohl HW, Mokdad AH, Ajani UA. Sedentary behavior, physical activity, and the metabolic syndrome among U.S. adults. *Obes Res*. 2005;13(3):608-614. doi:10.1038/oby.2005.65.

19. van Baak MA, van Mil E, Astrup AV, et al. Leisure-time activity is an important determinant of long-term weight maintenance after weight loss in the Sibutramine Trial on Obesity Reduction and Maintenance (STORM trial). *Am J Clin Nutr*. 2003;78(2):209-214.

20. National Center for Health Statistics. *Health, United States, 2013: With Special Feature on Prescription Drugs*. Hyattsville, MD; 2014. https://www.cdc.gov/nchs/data/hus/hus13.pdf. Accessed March 13, 2017.

21. Caspersen CJ, Pereira MA, Curran KM, others. Changes in physical activity patterns in the United States, by sex and cross-sectional age. *Med Sci Sports Exerc*. 2000;32(9):1601-1609.

22. Caspersen CJ, Merritt RK, Stephens T. International physical activity patterns: a methodological perspective. *Adv Exerc Adherence Champaign IL Hum Kinet*. 1994;73.

23. Korea Ministry of Health. Korea Ministry of Health and Welfare Guidelines for health life projects. http://mchp.hp.go.kr/hpMchp/board.dia?method=downFile&FI_FID=884. Published 2011.

24. Smith L, Gardner B, Fisher A, Hamer M. Patterns and correlates of physical activity behaviour over 10 years in older adults: prospective analyses from the English Longitudinal Study of Ageing. *BMJ Open*. 2015;5(4):e007423.

25. Physical Activity Guideline Advisory Committee. 2008 Physical activity guideline for Americans. https://health.gov/paguidelines/pdf/paguide.pdf. Accessed March 13, 2017.

26. Guralnik JM, Simonsick E, Ferrucci L, et al. A short physical performance batter assessing lower extremity function: Association with self-reported disability and prediction of mortalit and nursing home admission. *J Gerontol*. 1994;49(2):85-94.

27. Studenski S, Perera S, Wallace D, et al. Physical Performance Measures in the Clinical Setting. *J Am Geriatr Soc*. 2003;51(3):314-322. doi:10.1046/j.1532-5415.2003.51104.x.

28. Elosua R, Bartali B, Ordovas JM, Corsi AM, Lauretani F, Ferrucci L. Association between physical activity, physical performance, and inflammatory biomarkers in an elderly population: the InCHIANTI study. *J Gerontol A Biol Sci Med Sci*. 2005;60(6):760-767.

29. Fried LP, Tangen CM, Walston J, et al. Frailty in Older AdultsEvidence for a Phenotype. *J Gerontol Ser A*. 2001;56(3):M146-M157. doi:10.1093/gerona/56.3.M146.

30. Gill TM, Williams CS, Tinetti ME. Assessing risk for the onset of functional dependence among older adults: the role of physical performance. *J Am Geriatr Soc*. 1995;43(6):603-609.

31. Verbruge L, Jette A. The disablement process. *Soc Sci Med*. 1994;38(1):1-14.

32. Sallis JF, Owen N. *Physical Activity and Behavioral Medicine*. SAGE Publications; 1998.

33. Bauman AE, Reis RS, Sallis JF, et al. Correlates of physical activity: why are some people physically active and others not? *The lancet*. 2012;380(9838):258-271.

34. Ruchlin HS, Lachs MS. Prevalence and correlates of exercise among older adults. *J Appl Gerontol*. 1999;18(3):341-357.

35. Sternfeld B, Ainsworth BE, Quesenberry CP. Physical activity patterns in a diverse population of women. *Prev Med*. 1999;28(3):313-323.

36. Booth ML, Owen N, Bauman A, Clavisi O, Leslie E. Social–cognitive and perceived environment influences associated with physical activity in older Australians. *Prev Med*. 2000;31(1):15-22.

37.   Brenes GA, Strube MJ, Storandt M. An application of the theory of planned behavior to exercise among older adults. *J Appl Soc Psychol*. 1998;28(24):2274-2290.

38.   Clark DO, Nothwehr F. Exercise self-efficacy and its correlates among socioeconomically disadvantaged older adults. *Health Educ Behav*. 1999;26(4):535-546.

39.   Burton LC, Shapiro S, German PS. Determinants of physical activity initiation and maintenance among community-dwelling older persons. *Prev Med*. 1999;29(5):422-430.

40.   Trost SG, Owen N, Bauman AE, Sallis JF, Brown W. Correlates of adults' participation in physical activity: review and update. *Med Sci Sports Exerc*. 2002;34(12):1996-2001.

41.   Huang DL, Park M. Socioeconomic and racial/ethnic oral health disparities among US older adults: oral health quality of life and dentition. *J Public Health Dent*. 2015;75(2):85-92.

42.   Wallace SP, Villa VM. Equitable health systems: cultural and structural issues for Latino elders. *Am J Law Med*. 2003;29(2-3):247.

43.   Ralph NL. Multiple chronic conditions and limitations in activities of daily living in a community-based sample of older adults in New York City, 2009. *Prev Chronic Dis*. 2013;10. https://www.cdc.gov/pcd/issues/2013/13_0159.htm. Accessed March 14, 2017.

44.   Guerra RO, Alvarado BE, Zunzunegui MV. Life course, gender and ethnic inequalities in functional disability in a Brazilian urban elderly population. *Aging Clin Exp Res*. 2008;20(1):53-61.

45.   Fragala MS, Clark MH, Walsh SJ, et al. Gender differences in anthropometric predictors of physical performance in older adults. *Gend Med*. 2012;9(6):445-456.

46.   August KJ, Sorkin DH. Racial/ethnic disparities in exercise and dietary behaviors of middle-aged and older adults. *J Gen Intern Med*. 2011;26(3):245-250.

47.   Ball K, Timperio A, Salmon J, Giles-Corti B, Roberts R, Crawford D. Personal, social and environmental determinants of educational inequalities in walking: a multilevel study. *J Epidemiol Community Health*. 2007;61(2):108-114.

48.   Wilcox S, Castro C, King AC, Housemann R, Brownson RC. Determinants of leisure time physical activity in rural compared with urban older and

ethnically diverse women in the United States. *J Epidemiol Community Health*. 2000;54(9):667-672.

49.   Ross CE. Walking, exercising, and smoking: does neighborhood matter? *Soc Sci Med*. 2000;51(2):265-274.

50.   MacDougall C, Cooke R, Owen N, Willson K, Bauman A. Relating physical activity to health status, social connections and community facilities. *Aust N Z J Public Health*. 1997;21(6):631-637.

51.   King AC, Castro C, Wilcox S, Eyler AA, Sallis JF, Brownson RC. Personal and environmental factors associated with physical inactivity among different racial–ethnic groups of US middle-aged and older-aged women. *Health Psychol*. 2000;19(4):354.

52.   Control C for D, (CDC P, others. Neighborhood safety and the prevalence of physical inactivity–selected states, 1996. *MMWR Morb Mortal Wkly Rep*. 1999;48(7):143.

53.   Ashworth NL, Chad KE, Harrison EL, Reeder BA, Marshall SC. Home versus center based physical activity programs in older adults. *Cochrane Libr*. 2005. http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD004017.pub2/full. Accessed July 27, 2016.

54.   Van Der Bij AK, Laurant MG, Wensing M. Effectiveness of physical activity interventions for older adults: a review1 1The full text of this article is available via AJPM Online at www. elsevier. com/locate/ajpmonline. *Am J Prev Med*. 2002;22(2):120-133.

55.   Chao D, Foy CG, Farmer D. Exercise adherence among older adults: challenges and strategies. *Control Clin Trials*. 2000;21(5):S212-S217.

56.   Caspersen CJ, Pereira MA, Curran KM, others. Changes in physical activity patterns in the United States, by sex and cross-sectional age. *Med Sci Sports Exerc*. 2000;32(9):1601-1609.

57.   Ben-Shlomo Y, Kuh D. A life course approach to chronic disease epidemiology: conceptual models, empirical challenges and interdisciplinary perspectives. *Int J Epidemiol*. 2002;31(2):285-293.

58.   Kuh D, Hardy R, Langenberg C, Richards M, Wadsworth ME. Mortality in adults aged 26-54 years related to socioeconomic conditions in childhood and adulthood: post war birth cohort study. *Bmj*. 2002;325(7372):1076-1080.

59.   Kuh D, Ben-Shlomo Y, Lynch J, Hallqvist J, Power C. Life course epidemiology. *J Epidemiol Community Health*. 2003;57(10):778.

60.   Ben-Shlomo Y, Kuh D. A life course approach to chronic disease epidemiology: conceptual models, empirical challenges and interdisciplinary perspectives. *Int J Epidemiol*. 2002;31(2):285-293. doi:10.1093/ije/31.2.285.

61.   Richter M, Blane D. *The Life Course: Challenges and Opportunities for Public Health Research*. Springer; 2013. http://link.springer.com/article/10.1007/s00038-012-0436-z. Accessed March 14, 2017.

62.   Adverse Childhood Experiences (ACEs). https://www.cdc.gov/violenceprevention/acestudy/. Accessed March 14, 2017.

63.   Anda RF, Croft JB, Felitti VJ, et al. Adverse childhood experiences and smoking during adolescence and adulthood. *JAMA*. 1999;282(17):1652-1658.

64.   Brown DW, Anda RF, Felitti VJ, et al. Adverse childhood experiences are associated with the risk of lung cancer: a prospective cohort study. *BMC Public Health*. 2010;10(1):1.

65.   Corso PS, Edwards VJ, Fang X, Mercy JA. Health-related quality of life among adults who experienced maltreatment during childhood. *Am J Public Health*. 2008;98(6):1094-1100.

66.   Dong M, Dube SR, Felitti VJ, Giles WH, Anda RF. Adverse childhood experiences and self-reported liver disease: new insights into the causal pathway. *Arch Intern Med*. 2003;163(16):1949-1956.

67.   Dong M, Giles WH, Felitti VJ, et al. Insights into causal pathways for ischemic heart disease adverse childhood experiences study. *Circulation*. 2004;110(13):1761-1766.

68.   Dube SR, Anda RF, Felitti VJ, Edwards VJ, Croft JB. Adverse childhood experiences and personal alcohol abuse as an adult. *Addict Behav*. 2002;27(5):713-725.

69.   Dube SR, Felitti VJ, Dong M, Chapman DP, Giles WH, Anda RF. Childhood abuse, neglect, and household dysfunction and the risk of illicit drug use: the adverse childhood experiences study. *Pediatrics*. 2003;111(3):564-572.

70.   Felitti VJ, Anda RF, Nordenberg D, et al. Relationship of childhood abuse and household dysfunction to many of the leading causes of death in adults: The Adverse Childhood Experiences (ACE) Study. *Am J Prev Med*. 1998;14(4):245-258.

71. Williamson DF, Thompson TJ, Anda RF, Dietz WH, Felitti V. Body weight and obesity in adults and self-reported abuse in childhood. *Int J Obes*. 2002. http://psycnet.apa.org/psycinfo/2002-17922-002. Accessed July 27, 2016.

72. Gustafsson PE, San Sebastian M. When does hardship matter for health? Neighborhood and individual disadvantages and functional somatic symptoms from adolescence to mid-life in the Northern Swedish Cohort. *PloS One*. 2014;9(6):e99558.

73. Wickrama KK, O'Neal CW, Lee TK, Wickrama T. Early socioeconomic adversity, youth positive development, and young adults' cardio-metabolic disease risk. *Health Psychol*. 2015;34(9):905.

74. Kajeepeta S, Gelaye B, Jackson CL, Williams MA. Adverse childhood experiences are associated with adult sleep disorders: a systematic review. *Sleep Med*. 2015;16(3):320-330.

75. Kelly-Irving M, Mabile L, Grosclaude P, Lang T, Delpierre C. The embodiment of adverse childhood experiences and cancer development: potential biological mechanisms and pathways across the life course. *Int J Public Health*. 2013;58(1):3-11.

76. Cowan CSM, Callaghan BL, Kan JM, Richardson R. The lasting impact of early-life adversity on individuals and their descendants: potential mechanisms and hope for intervention. *Genes Brain Behav*. 2016;15(1):155-168.

77. Ranchod YK, Headen IE, Petito LC, Deardorff JK, Rehkopf DH, Abrams BF. Maternal childhood adversity, prepregnancy obesity, and gestational weight gain. *Am J Prev Med*. 2016;50(4):463-469.

78. Friedman EM, Montez JK, Sheehan CM, Guenewald TL, Seeman TE. Childhood adversities and adult cardiometabolic health: does the quantity, timing, and type of adversity matter? *J Aging Health*. 2015;27(8):1311-1338.

79. Slopen N, McLaughlin KA, Dunn EC, Koenen KC. Childhood adversity and cell-mediated immunity in young adulthood: Does type and timing matter? *Brain Behav Immun*. 2013;28:63-71.

80. Lee LO, Aldwin CM, Kubzansky LD, et al. Do cherished children age successfully? Longitudinal findings from the Veterans Affairs Normative Aging Study. *Psychol Aging*. 2015;30(4):894.

81. Levine ME, Cole SW, Weir DR, Crimmins EM. Childhood and later life stressors and increased inflammatory gene expression at older ages. *Soc Sci Med*. 2015;130:16-22.

82. King AC, Stokols D, Talen E, Brassington GS, Killingsworth R. Theoretical approaches to the promotion of physical activity: forging a transdisciplinary paradigm. *Am J Prev Med*. 2002;23(2):15-25.

83. Prohaska T, Belansky E, Belza B, et al. Physical activity, public health, and aging: critical issues and research priorities. *J Gerontol B Psychol Sci Soc Sci*. 2006;61(5):S267-S273.

84. Woolf SH, Husten CG, Lewin LS, Marks JS, Fielding JE, Sanchez EJ. The economic argument for disease prevention: distinguishing between value and savings. *Partnersh Prev*. 2009. http://blog.renakrebsbach.com/wp-content/uploads/2013/04/economicargumentfordiseaseprevention.pdf. Accessed March 14, 2017.

85. Danieli Y. *International Handbook of Multigenerational Legacies of Trauma*. Springer Science & Business Media; 1998. https://books.google.com/books?hl=en&lr=&id=thoNwuDmHEQC&oi=fnd&pg=PA1&dq=Danieli,+Y.+(1998).+International+handbook+of+multigenerational+legacies+of+trauma.+New+York,+Plenm+Press:+1-20.&ots=Lz5xrdf4pl&sig=JOtO1EM78Bdr_xdDVUaFAxBHH9k. Accessed January 6, 2017.

86. Leroux JS, Moore S, Richard L, Gauvin L. Physical inactivity mediates the association between the perceived exercising behavior of social network members and obesity: a cross-sectional study. *PLoS One*. 2012;7(10):e46558.

87. Montero-Fernandez N, Serra-Rexach JA. Role of exercise on sarcopenia in the elderly. *Eur J Phys Rehabil Med*. 2013;49(1):131-143.

88. Caspersen CJ, Pereira MA, Curran KM, others. Changes in physical activity patterns in the United States, by sex and cross-sectional age. *Med Sci Sports Exerc*. 2000;32(9):1601-1609.

89. Hillis SD, Anda RF, Felitti VJ, Marchbanks PA. Adverse childhood experiences and sexual risk behaviors in women: a retrospective cohort study. *Fam Plann Perspect*. 2001:206-211.

90. Okechukwu C, Davison K, Emmons K. Changing health behaviors in a social context. *Soc Epidemiol*. 2014;365. https://books.google.com/books?hl=en&lr=&id=DgzVAwAAQBAJ&oi=fnd&pg=PA365&dq=Okechukwu,+C.,+Davison,+K.,+%26+Emmons,+K.+(2015).+Changing+health+behaviors+in+a+social+context+Social+Epidemiology.+Boston,+MA:+Oxford+University+Press.&ots=M2T6sgsKd2&sig=4pfTki_bShxdOIyplNcix6uEnyo. Accessed July 27, 2016.

91. Rose GA, Khaw K-T, Marmot MG. *Rose's Strategy of Preventive Medicine: The Complete Original Text*. Oxford University Press, USA; 2008.

https://books.google.com/books?hl=en&lr=&id=BQDXQI8n7qQC&oi=fnd&pg=PR17&dq=Rose,+G.+(2008).+Rose%27s+strategy+of+preventive+medicine.+Boston,+MA:+Oxford+University+Press.&ots=Ro3qPPYT7H&sig=1kuagTDOrH5qS-roVa7rwKmfFow. Accessed July 27, 2016.

92. Zunzunegui MV, Alvarado BE, Guerra R, et al. The mobility gap between older men and women: The embodiment of gender. *Arch Gerontol Geriatr*. 2015;61(2):140-148.

93. For the IMIAS Research Group, Pirkle CM, de Albuquerque Sousa ACP, Alvarado B, Zunzunegui M-V. Early maternal age at first birth is associated with chronic diseases and poor physical performance in older age: cross-sectional analysis from the International Mobility in Aging Study. *BMC Public Health*. 2014;14(1). doi:10.1186/1471-2458-14-293.

94. de Yébenes MJG, Otero A, Zunzunegui MV, Rodríguez-Laso A, Sánchez-Sánchez F, Del Ser T. Validation of a short cognitive tool for the screening of dementia in elderly people with low educational level. *Int J Geriatr Psychiatry*. 2003;18(10):925-936.

95. Gomes MMF, Turra CM, Fígoli MGB, Duarte YA, Lebrão ML. Past and present: conditions of life during childhood and mortality of older adults. *Rev Saude Publica*. 2015;49. http://www.scielosp.org/article_plus.php?pid=S0034-89102015000100271&tlng=pt&lng=en. Accessed July 27, 2016.

96. Fuller-Thomson E, Stefanyk M, Brennenstuhl S. The robust association between childhood physical abuse and osteoarthritis in adulthood: findings from a representative community sample. *Arthritis Care Res*. 2009;61(11):1554-1562.

97. de Albuquerque Sousa ACP, Guerra RO, Tu MT, Phillips SP, Guralnik JM, Zunzunegui M-V. Lifecourse adversity and physical performance across countries among men and women aged 65-74. *PloS One*. 2014;9(8):e102299.

98. Marmot M. Social determinants of health inequalities. *The Lancet*. 2005;365(9464):1099-1104.

99. WHO | Physical activity. WHO. http://www.who.int/topics/physical_activity/en/. Published 2016. Accessed July 27, 2016.

100. Sports | List of Summer and Winter Olympic Sports. International Olympic Committee. https://www.olympic.org/sports. Published July 8, 2016. Accessed July 27, 2016.

101. Mazzeo RS, Cavanagh P, Evans WJ, et al. ACSM Position Stand: Exercise and Physical Activity for Older Adults: *Med Sci Sports Exerc*. 1998;30(6):992-1008. doi:10.1097/00005768-199806000-00033.

102. Shonkoff JP, Garner AS, Siegel BS, et al. The lifelong effects of early childhood adversity and toxic stress. *Pediatrics*. 2012;129(1):e232-e246.

103. Willson AE, Shuey KM, Elder Jr GH. Cumulative advantage processes as mechanisms of inequality in life course health1. *Am J Sociol*. 2007;112(6):1886-1924.

104. Andersen O, Laursen L. Health and Factors causing disease-in a social perspective. *Dan Stat*. 1998.

105. Cohen O, Geva D, Lahad M, et al. Community Resilience throughout the Lifespan–The Potential Contribution of Healthy Elders. *PLoS One*. 2016;11(2):e0148125.

106. Hallal PC, Andersen LB, Bull FC, et al. Global physical activity levels: surveillance progress, pitfalls, and prospects. *The lancet*. 2012;380(9838):247-257.

107. Arredondo EM, Elder JP, Ayala GX, Campbell N, Baquero B, Duerksen S. Is parenting style related to children's healthy eating and physical activity in Latino families? *Health Educ Res*. 2006;21(6):862-871.

108. Joseph RP, Keller C, Affuso O, Ainsworth BE. Designing Culturally Relevant Physical Activity Programs for African-American Women: A Framework for Intervention Development. *J Racial Ethn Health Disparities*. 2016:1-13.

109. Chen D-R, Lin Y-C. Social identity, perceived urban neighborhood quality, and physical inactivity: A comparison study of China, Taiwan, and South Korea. *Health Place*. 2016;41:1-10.

110. Chick GE. The cross-cultural study of games. *Exerc Sport Sci Rev*. 1984;12:307-337.

111. Roberts JM, Arth MJ, Bush RR. Games in culture. *Am Anthropol*. 1959;61(4):597-605.

112. Deaner RO, Geary DC, Puts DA, et al. A sex difference in the predisposition for physical competition: Males play sports much more than females even in the contemporary US. *PLoS One*. 2012;7(11):e49168.

113. De Block A, Dewitte S. Darwinism and the cultural evolution of sports. *Perspect Biol Med*. 2009;52(1):1-16.

114. Lombardo MP. On the evolution of sport. Evol Psychol. 2012; 10: 1–28. doi: 10.1556. *JEP*. 10(1.1).

115. Archer J. Does sexual selection explain human sex differences in aggression? *Behav Brain Sci*. 2009;32(3-4):249-266.

116. Measurement of Physical Activity and Sedentary Behaviour | Alberta Centre for Active Living. https://www.centre4activeliving.ca/services/measurement-physical-activity/. Accessed July 15, 2016.

117. Forget M-F. Étude sur la validité et la fiabilité d'un questionnaire sur l'activité physique de personnes âgées de 65 à 74 ans, du Québec et du Brésil. 2012. https://papyrus.bib.umontreal.ca/xmlui/handle/1866/7133. Accessed July 27, 2016.

118. Juneau CE, Benmarhnia T, Poulin AA, Côté S, Potvin L. Socioeconomic position during childhood and physical activity during adulthood: a systematic review. *Int J Public Health*. 2015;60(7):799-813. doi:10.1007/s00038-015-0710-y.

119. Keegan R, Middleton G, Henderson H, Girling M. Auditing the socio-environmental determinants of motivation towards physical activity or sedentariness in work-aged adults: a qualitative study. *BMC Public Health*. 2016;16(1):1.

120. Leon DA, Walt G, others. *Poverty, Inequality, and Health: An International Perspective.* Oxford University Press; 2001. http://www.cabdirect.org/abstracts/20023007902.html. Accessed December 8, 2016.

121. Lynch JW, Kaplan GA, Shema SJ. Cumulative impact of sustained economic hardship on physical, cognitive, psychological, and social functioning. *N Engl J Med*. 1997;337(26):1889-1895.

122. Crimmins EM, Kim JK, Seeman TE. Poverty and Biological Risk: The Earlier "Aging" of the Poor. *J Gerontol A Biol Sci Med Sci*. 2009;64A(2):286-292. doi:10.1093/gerona/gln010.

123. Câmara SMA, Pirkle C, Moreira MA, Vieira MCA, Vafaei A, Maciel ÁCC. Early maternal age and multiparity are associated to poor physical performance in middle-aged women from Northeast Brazil: a cross-sectional community based study. *BMC Womens Health*. 2015;15:56. doi:10.1186/s12905-015-0214-1.

124. Functional Decline in Older Adults - American Family Physician. http://www.aafp.org/afp/2013/0915/p388.html. Accessed December 8, 2016.

125. Fukagawa NK, Brown M, Sinacore DR, Host HH. The Relationship of Strength to Function in the Older Adult. *J Gerontol A Biol Sci Med Sci*. 1995;50A(Special Issue):55-59. doi:10.1093/gerona/50A.Special_Issue.55.

126. Grundy E, Sloggett A. Health inequalities in the older population: the role of personal capital, social resources and socio-economic circumstances. *Soc Sci Med*. 2003;56(5):935-947. doi:10.1016/S0277-9536(02)00093-X.

127. Haas S. Trajectories of functional health: The "long arm" of childhood health and socioeconomic factors. *Soc Sci Med*. 2008;66(4):849-861. doi:10.1016/j.socscimed.2007.11.004.

128. Lif EF, Brannstrom L, Vinnerljung B, Hjern A. Childhood adversities and later economic hardship among Swedish child welfare clients: cumulative disadvantage or disadvantage saturation? *Br J Soc Work*. 2016. doi:10.1093/bjsw/bcw167.

129. Evans GW, Chen E, Miller G, Seeman T. How Poverty Gets Under the Skin: A Life Course Perspective. May 2012. http://www.oxfordhandbooks.com/view/10.1093/oxfordhb/978019976910 0.001.0001/oxfordhb-9780199769100-e-1. Accessed December 7, 2016.

130. Barros AJD, Hirakata VN. Alternatives for logistic regression in cross-sectional studies: an empirical comparison of models that directly estimate the prevalence ratio. *BMC Med Res Methodol*. 2003;3:21. doi:10.1186/1471-2288-3-21.

131. Galobardes B, Lynch JW, Smith GD. Childhood socioeconomic circumstances and cause-specific mortality in adulthood: systematic review and interpretation. *Epidemiol Rev*. 2004;26(1):7-21.

132. Yeung WJ, Hofferth SL. Family adaptations to income and job loss in the US. *J Fam Econ Issues*. 1998;19(3):255-283.

133. Harper C, Marcus R, Moore K. Enduring Poverty and the Conditions of Childhood: Lifecourse and Intergenerational Poverty Transmissions. *World Dev*. 2003;31(3):535-554. doi:10.1016/S0305-750X(03)00010-X.

134. Cawthorne A. The straight facts on women in poverty. *Cent Am Prog*. 2008;8. https://cdn.americanprogressaction.org/wp-content/uploads/issues/2008/10/pdf/women_poverty.pdf. Accessed January 22, 2017.

135. Hernandez DC, Pressler E. Accumulation of childhood poverty on young adult overweight or obese status: race/ethnicity and gender disparities. *J Epidemiol Community Health*. 2014;68(5):478-484. doi:10.1136/jech-2013-203062.

136. Entwisle DR, Alexander KL, Olson LS, Ross K. Paid work in early adolescence: Developmental and ethnic patterns. *J Early Adolesc*. 1999;19(3):363-388.

137. LIFE Study Investigators, Pahor M, Blair SN, et al. Effects of a physical activity intervention on measures of physical performance: Results of the lifestyle interventions and independence for Elders Pilot (LIFE-P) study. *J Gerontol A Biol Sci Med Sci*. 2006;61(11):1157-1165.

138. Glasier A, Gülmezoglu AM, Schmid GP, Moreno CG, Van Look PF. Sexual and reproductive health: a matter of life and death. *The Lancet*. 2006;368(9547):1595-1607.

139. da Conceição Chagas de Almeida M, Aquino EM. The role of education level in the intergenerational pattern of adolescent pregnancy in Brazil. *Int Perspect Sex Reprod Health*. 2009:139-146.

140. Kiernan KE. Becoming a young parent: a longitudinal study of associated factors. *Br J Sociol*. 1997:406-428.

141. Hardy R, Lawlor DA, Black S, Mishra GD, Kuh D. Age at birth of first child and coronary heart disease risk factors at age 53 years in men and women: British birth cohort study. *J Epidemiol Community Health*. 2009;63(2):99-105.

142. Tu MT, Zunzunegui M-V, Guerra R, Alvarado B, Guralnik JM. Cortisol profile and depressive symptoms in older adults residing in Brazil and in Canada. *Aging Clin Exp Res*. 2013;25(5):527-537.

143. Motl RW, Learmonth YC, Wójcicki TR, et al. Preliminary validation of the short physical performance battery in older adults with multiple sclerosis: secondary data analysis. *BMC Geriatr*. 2015;15(1):157.

144. Gómez JF, Curcio C-L, Alvarado B, Zunzunegui MV, Guralnik J. Validity and reliability of the Short Physical Performance Battery (SPPB): a pilot study on mobility in the Colombian Andes. *Colomb Medica*. 2013;44(3):165-171.

145. Guilley E, Bopp M, Faeh D, Paccaud F. Socioeconomic gradients in mortality in the oldest old: A review. *Arch Gerontol Geriatr*. 2010;51(3):e37-e40. doi:10.1016/j.archger.2009.12.009.

146. World Bank. Life expectancy at birth, total (years) | Data. http://data.worldbank.org/indicator/SP.DYN.LE00.IN. Accessed September 6, 2016.

147. Office of Hawaiian Affairs. The disparate treatment of Native Hawaiian in the criminal justice systen. http://www.justicepolicy.org/uploads/justicepolicy/documents/10-

09_exs_disparatetreatmentofnativehawaiians_rd-ac.pdf. Accessed January 6, 2017.

148. Osorio JK. *Dismembering Lahui: A History of the Hawaiian Nation to 1887*. http://www.uhpress.hawaii.edu/p-9780824825492.aspx/. Accessed January 6, 2017.

149. Flegal KM, Carroll MD, Ogden CL, Curtin LR. Prevalence and Trends in Obesity Among US Adults, 1999-2008. *JAMA*. 2010;303(3):235-241. doi:10.1001/jama.2009.2014.

150. Grandinetti A, Chang HK, Chen R, et al. Prevalence of overweight and central adiposity is associated with percentage of indigenous ancestry among native Hawaiians. *Int J Obes*. 1999;23(7):733-737.

151. Kaʻopua LS, Braun KL, Browne CV, Mokuau N, Park C-B. Why Are Native Hawaiians Underrepresented in Hawai"i"s Older Adult Population? Exploring Social and Behavioral Factors of Longevity. *J Aging Res*. 2011;2011:e701232. doi:10.4061/2011/701232.

152. Mau MK, Sinclair K ʻimi, Saito EP, Kauʻi NB, Kaholokula JK. Cardiometabolic health disparities in native Hawaiians and other Pacific Islanders. *Epidemiol Rev*. 2009;31(1):113-129.

153. KA ʻOHANA KWO. Income Inequality and Native Hawaiian Communities in the Wake of the Great Recession: 2005 to 2013. 2014. http://19of32x2yl33s8o4xza0gf14.wpengine.netdna-cdn.com/wp-content/uploads/2014/05/Income-Inequality-and-Native-Hawaiian-Communities-in-the-Wake-of-the-Great-Recession-2005-2013.pdf. Accessed February 25, 2017.

154. Marshall WE. Remembering Hawaiian, transforming shame. *Anthropol Humanism*. 2006;31(2):185-200.

155. Sotero M. A conceptual model of historical trauma: Implications for public health practice and research. *J Health Disparities Res Pract*. 2006;1(1):93-108.

156. Braun KL, Kim BJ, Kaʻopua LS, Mokuau N, Browne CV. Native Hawaiian and Pacific Islander Elders: What Gerontologists Should Know. *The Gerontologist*. 2015;55(6):912-919. doi:10.1093/geront/gnu072.

157. Kruger J, Ham SA, Kohl III HW, Sapkota S, others. Physical activity among Asians and Native Hawaiian or Other Pacific Islanders-50 states and the District of Columbia, 2001-2003. *Morb Mortal Wkly Rep*. 2004;53(33):756-760.

158. Maskarinec GG, Look M, Tolentino K, et al. Patient Perspectives on the Hula Empowering Lifestyle Adaptation Study Benefits of Dancing Hula for Cardiac Rehabilitation. *Health Promot Pract*. 2015;16(1):109-114.

159. Moy KL, Sallis JF, Ice CL, Thompson KM. Physical activity correlates for native Hawaiian and Pacific Islanders in the United States. *J Health Care Poor Underserved*. 2010;21(4):1203.

160. Madan A, Archambeau OG, Milsom VA, et al. More than black and white: differences in predictors of obesity among Native Hawaiian/Pacific Islanders and European Americans. *Obesity*. 2012;20(6):1325-1328.

161. Kaholokula JK, Townsend CK, Ige A, et al. Sociodemographic, behavioral, and biological variables related to weight loss in native Hawaiians and other Pacific Islanders. *Obesity*. 2013;21(3):E196-E203.

162. Liu JJ, Davidson E, Bhopal R, et al. Adapting health promotion interventions for ethnic minority groups: a qualitative study. *Health Promot Int*. 2016;31(2):325-334.

163. Hwang P, Gomes C, Auais M, Pirkle CM. Childhood adversity and leisure time physical and sports activity in older adults: a cross-sectional analysis from the International Mobility in Aging Study. October 2016.

164. Hwang P, Gomes C, Auais M, Pirkle CM. The effects of economic adversity life course transitions on leisure time physical activity in older adults: a cross-sectional analysis from the International Mobility in Aging Study. October 2016.

165. Sousa ACP de A, Guerra RO, Thanh Tu M, Phillips SP, Guralnik JM, Zunzunegui M-V. Lifecourse adversity and physical performance across countries among men and women aged 65-74. *PloS One*. 2014;9(8):e102299. doi:10.1371/journal.pone.0102299.

166. Wu Y, Braun K, Onaka AT, Horiuchi BY, Tottori CJ, Wilkens L. Life Expectancies in Hawai'i: A Multi-ethnic Analysis of 2010 Life Tables. *Hawaii J Med Public Health*. 2017;76(1):9.

167. Ho-Lastimosa I. Waimanalo's History. February 2014.

168. U.S. Census Bureau. Population estimates, July 1, 2016, (V2016). U.S. Census Bureau QuickFacts. //www.census.gov/quickfacts/table/PST045216/15. Accessed February 19, 2017.

169. Community Info for Waimanalo, HI - Demographics & Census Data - Trulia. Waimanalo, HI community information. Research crime statistics, income and home prices, demographics, Census data, commute times, and nearby homes.

https://www.trulia.com/real_estate/Waimanalo-Hawaii/community-info/. Accessed February 19, 2017.

170. Browne CV, Mokuau N, Lana S, Kim BJ, Higuchi P, Braun KL. Listening to the voices of Native Hawaiian Elders and 'Ohana Caregivers: discussions on aging, health, and care preferences. *J Cross-Cult Gerontol*. 2014;29(2):131-151.

171. NCAI Policy Research Center, MSU Center for Native Health Partnerships. Walk softly and listen carefully: Building research relationships with tribal communities. 2012. http://www.ncai.org/attachments/PolicyPaper_SpMCHTcjxRRjMEjDnPmesE NPzjHTwhOlOWxlWOIWdSrykJuQggG_NCAI-WalkSoftly.pdf. Accessed January 6, 2017.

172. NHIS - Questionnaire Redesign. https://www.cdc.gov/nchs/nhis/nhis_redesign.htm. Accessed January 7, 2017.

173. Khan SN. Qualitative Research Method: Grounded Theory. *Int J Bus Manag*. 2014;9(11). doi:10.5539/ijbm.v9n11p224.

174. Hakimian P, Lak A. Adaptation and reliability of neighborhood environment walkability scale (NEWS) for Iran: A questionnaire for assessing environmental correlates of physical activity. *Med J Islam Repub Iran*. 2016;30:427.

175. Reutter LI, Stewart MJ, Veenstra G, Love R, Raphael D, Makwarimba E. "Who Do They Think We Are, Anyway?": Perceptions of and Responses to Poverty Stigma. *Qual Health Res*. 2009;19(3):297-311. doi:10.1177/1049732308330246.

176. Bodkin-Andrews G, O'Rourke V, Grant R, Denson N, Craven RG. Validating racism and cultural respect: testing the psychometric properties and educational impact of perceived discrimination and multiculturation for Indigenous and non-Indigenous students. *Educ Res Eval*. 2010;16(6):471-493. doi:10.1080/13803611.2010.550497.

177. Hankonen N, Heino MTJ, Kujala E, et al. What explains the socioeconomic status gap in activity? Educational differences in determinants of physical activity and screentime. *BMC Public Health*. 2017;17(1):144. doi:10.1186/s12889-016-3880-5.

178. Murray S. Poverty and health. *Can Med Assoc J*. 2006;174(7):923-923.

179. Rowson M. Poverty and health. *Stud BMJ*. 2001;9. http://search.proquest.com/openview/59ad7a1c35657e5a12d45391d53209 5d/1?pq-origsite=gscholar&cbl=2041875. Accessed February 20, 2017.

180. Foster JE. Absolute versus Relative Poverty. *Am Econ Rev*. 1998;88(2):335-341.

181. Pratt M, Macera CA, Blanton C. Levels of physical activity and inactivity in children and adults in the United States: current evidence and research issues. *Med Sci Sports Exerc*. 1999;31(11 Suppl):S526-S533.

182. Sandlund M, Skelton DA, Pohl P, Ahlgren C, Melander-Wikman A, Lundin-Olsson L. Gender perspectives on views and preferences of older people on exercise to prevent falls: a systematic mixed studies review. *BMC Geriatr*. 2017;17(1):58. doi:10.1186/s12877-017-0451-2.

183. Sriram U, Morgan EH, Graham ML, Folta SC, Seguin RA. Support and Sabotage: A Qualitative Study of Social Influences on Health Behaviors Among Rural Adults. *J Rural Health Off J Am Rural Health Assoc Natl Rural Health Care Assoc*. January 2017. doi:10.1111/jrh.12232.

184. Allison KR, Dwyer JJM, Makin S. Perceived Barriers to Physical Activity among High School Students. *Prev Med*. 1999;28(6):608-615. doi:10.1006/pmed.1999.0489.

185. Wally CM, Cameron LD. A Randomized-Controlled Trial of Social Norm Interventions to Increase Physical Activity. *Ann Behav Med Publ Soc Behav Med*. February 2017. doi:10.1007/s12160-017-9887-z.

186. Maddox GL. Aging differently. *The Gerontologist*. 1987;27(5):557-564.

187. Riley A. Social Norms: Harnessing Positive Peer Pressure for Change. *Change Conversat*. February 2014. http://conversations.marketing-partners.com/2014/02/social-norms-harnessing-positive-peer-pressure-change/. Accessed April 5, 2017.

188. About Dove. Dove US. http://www.dove.com/us/en/stories/about-dove.html. Accessed April 5, 2017.

189. 5 Ad Campaigns That Shatter Gender Stereotypes. The Content Strategist. https://contently.com/strategist/2015/10/09/5-ad-campaigns-that-shatter-gender-stereotypes/. Published October 9, 2015. Accessed April 7, 2017.

190. Smith TB. The policy implementation process. *Policy Sci*. 1973;4(2):197-209.

Appendices

Appendix A. RQ3 Key informant interview questions
1. What is your name, what does it mean?
2. What was life like growing up? (before age 18, childhood)
   - Location, family structure, economic situation, education, historical events, cultural influences, adverse events
   - What did you do for fun?
   - Would you say that life was good growing up? Why?
3. What types of physical activity have you done growing up?
   - Why did you do it?
   - Use time specific events: elementary school, high school, college, marriage, pregnancy, first job, etc.
4. What types of physical activity do you do now?
   - Why did you do it?
   - What's keeping you from doing the PA you've done before?
   - Why are you doing different PA now?
5. How satisfied are you with your health and the amount and types of physical activity you are doing now?
   - Why or why not?
   - What would you like to be doing?
6. Do you feel that being Native Hawaiian affects your physical activity behaviors? If so, why/how?

7. If your loved one asks you, "do you think I should be physically active? How should I start?" what would you say to him/her?

8. Is there anything else you would like to share on this topic?

Appendix B. Pre-interview survey questions

1. What year were you born?	_____
2. What is your gender?	☐ Female ☐ Male ☐ Other
3. Do you live alone? a. If no, who do you live with?	☐ Yes. ☐ No. Who (If no): _____ _____

4. What is your ethnicity? (Please check all that apply.)	☐ African American/Black ☐ American Indian/Alaska Native ☐ Asian ☐ Hispanic/Latino ☐ Native Hawaiian/Other Pacific Islander ☐ White Caucasian ☐ Other: _____ ☐ Prefer not to answer
5. Highest Education Level	☐ Haven't graduate high school ☐ High school/G.E.D. ☐ 2 years of college ☐ 4 years of college ☐ Graduate ☐ Professional/Doctorate
6. Occupation (if retired, previous):	_____
7. Do you have difficulties climbing a single flight (10 steps) of stairs without resting?	☐ None at all ☐ A little ☐ Some ☐ A lot ☐ Unable to do
8. Do you use any assistive devices to help you walk up stairs?	☐ Yes (please specify): _____ ☐ No ☐ I don't know ☐ No response
9. Do you have difficulties walking 400 meters (1/4 mile)?	☐ None at all ☐ A little ☐ Some ☐ A lot ☐ Unable to do
10. Do you use any assistive devices to help you walk 400 meters (1/4 mile)?	☐ Yes (please specify): _____ ☐ No ☐ I don't know ☐ No response

Appendix C. RQ3 Consent form

Elder Physical Activity Perceptions, Attitudes, and Behaviors
Office of Public Health Studies
University of Hawaiʻi at Mānoa

-Data Assessment Questions Consent Form-

Purpose
The purpose of this project is to understand how your views towards physical activity and your current physical activity behaviors

Voluntary Participation
Your participation in this project is voluntary and you may withdraw from participation at any time.

Privacy and Confidentiality
All information that is collected is private and kept confidential. Throughout the research project, all data is always kept in a secure location. Only research team will have access to the data while although legally authorized agencies, including the UH Human Studies Program, can review research records. The data will be reported in a blended summary without any personally identifying information. The final report of findings will protect your privacy and confidentiality.

Activities and Time Commitment
The key informant interview will last about 60-120 minutes. The key informant interviews will be informal and conversational. Recording of the interviews will be recorded with a digital audio recorder and will be destroyed when the final report is completed.

Benefits and Risks
You may enjoy talking story about these issues, and your answers will help us understand views toward physical activity. There is no or little risk to you in participating in this research project. At any time, we can skip the question, take a break, stop the interview, or you can withdraw from the project altogether.

Questions
Please contact the lead researcher, Phoebe Hwang, at (808) 232-3223 or via email, pwnhwang@hawaii.edu, if you have any questions regarding this project.

If you have questions about your rights as a research participant, contact the UH Committee on Human Studies at (808) 956-5007 or via email at, uhirb@hawaii.edu

Agreement to Participate in
Elder Physical Activity Perceptions, Attitudes, and Behaviors

"I certify that I have read and that I understand the information in this consent form, that I have been given satisfactory answers to my questions concerning the project, and that I have been told that I am free to withdraw my consent and to discontinue participation in the project at any time without any negative consequences to me.

I herewith give my consent to participate in the following activities (check all activities below) in this project with the understanding that such consent does not waive any of my legal rights."

☐ To be audio recorded

☐ To participate in key informant interview

→_____   _____
Signature of Participant   Date

-OR-

☐ Yes, I give verbal consent.

_____   _____
Signature of Witness for Verbal Consent   Date

Offer/provide a copy of this consent form to the participant.