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Association between Biopsychosocial Factors and Physical Activity among U.S. Stroke Survivors

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This is to certify that the doctoral dissertation by

Claire Johnson

has been found to be complete and satisfactory in all respects,
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Abstract

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by

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Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

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Abstract

Stroke causes substantial morbidity and mortality, and physical activity can reduce the risk of stroke occurrence. The purpose of this study was to test the association between biopsychosocial factors and levels of physical activity and to develop a model to predict inactivity for US stroke survivors. A quantitative, cross-sectional analysis was performed of the 2013 National Health Interview Survey (NHIS), which is a representative sample of US households. Association for 1,077 stroke survivors was tested with chi-square between physical activity and independent variables: biological factors (age, sex, race, body mass index, musculoskeletal conditions, and cardiovascular diseases), psychological factors (mental distress, perception of health), and sociological factors (income, health provider contact, family structure, neighborhood, region, marriage, and education). Multiple variable logistic regression was weighted and adjusted for a complex sampling design. Independent associations were found among biopsychosocial variables. A multiple logistic regression model demonstrated statistically significant variables of older age (OR 6.1, 95% CI 2.1 to 17.6), poor perceived health (OR 4.6, 95% CI 3.0 to 6.8), lower levels of education (OR 2.8, 95% CI 1.5 to 5.0) and living in the Northwest (OR 2.2, 95% CI 1.2 to 4.1) or Midwest region (OR 1.6, 95% CI 1.0 to 2.7), predicting the likelihood of inactivity for stroke survivors. This biopsychosocial model may contribute to positive social change by identifying stroke survivors at risk for inactivity and directing interventions and supportive care. Targeting those most at risk and increasing activity could help to reduce morbidity and mortality among stroke survivors, which could improve their lives and the lives of their families and communities.

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Dedication

I dedicate this dissertation to all who have survived a stroke. For most, having a stroke can be life-changing and each person will experience, and is affected by, these changes in a different manner. In spite of these changes, our minds and bodies can be amazingly resilient. We must remember that as individuals, we are greater than the sum of the parts of our bodies, especially when considering health and healing. Our minds and spirits, friends and family, communities and cultures, also contribute to how our bodies heal and can greatly influence us on our healing journeys. I humbly hope that the findings of this study will contribute to positive social change and will ultimately improve the health and wellness of those who have ever experienced a stroke.

Acknowledgments

I would like to acknowledge Drs. Ji Shen, Georjean Stoodt, and Peter Anderson for their wonderful guidance, and for helping and mentoring me throughout this project. I thank Monica Smith, DC, PhD for her assistance with SPSS. I thank my many friends who have helped and supported me with my progress and growth along my professional path. To those who have gone above and beyond to support me, I thank Bart Green, DC, my husband, for joining me on this learning journey; Louis Sportelli, DC for being an inspiration by demonstrating persistence and perseverance; Joe Keating, Jr., PhD for inspiring me to begin this PhD program; and my father Bruce Johnson, MD and mother Vicki Johnson for always challenging me to strive to become better.

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Chapter 1: Introduction to the Study

Introduction

Stroke is the second leading cause of death in the world, the third most common cause of disability-adjusted life years (DALYs) worldwide (Feigin et al., 2014), and the fourth leading cause of death in the United States (US) (Roger et al., 2012b). Stroke survivors are at greater risk for recurrent stroke (Hu et al., 2000), have nine times the risk of recurrence within five years compared to those without stroke (Burn et al., 1994) and the risk of recurrent stroke over ten years has been reported as six times greater than first stroke for those without stroke (Hardie, Hankey, Jamrozik, Broadhurst, & Anderson, 2004). Physical activity has been shown to have a protective effect to prevent first ever stroke (Wendel-Vos et al., 2004), and physical activity has improved outcomes, such as aerobic capacity, for stroke survivors (Pang, Eng, Dawson, & Gylfadottir, 2006). Recommendations by the American Heart Association (AHA) and American Stroke Association (ASA) include increased physical activity for prevention of stroke in patients with ischemic stroke (Sacco et al., 2006). Even though these guidelines are established, at least 50% of American adults do not follow these recommendations (Mozaffarian et al., 2015).

Barriers to physical activity are complex and multifactorial (Bauman et al., 2012; Bauman, Sallis, Dzewaltowski, & Owen, 2002). Whereas some studies have reported the most common barriers are biologically based, such as with pain or health conditions (Brawley, Rejeski, & King, 2003; Cohen-Mansfield J., 2003), others have focused on psychological or sociological factors (Booth, Owen, Bauman, Clavisi, & Leslie, 2000; J.

Morris, Oliver, Kroll, & Macgillivray, 2012). Thus, evaluating the relationships among biological, psychological, and sociological factors using a biopsychosocial approach may help us to improve our understanding of who is more at risk for inactivity. Knowing what factors most influence the level of physical activity in stroke survivors may contribute to reducing barriers to physical activity and at the same time reduce rates of recurrent stroke and associated morbidity and mortality.

Physical activity is a recognized modifiable risk factor for stroke (Goldstein et al., 2006; Mozaffarian et al., 2015; Wolf et al., 1999). The cost of participation in physical activity is relatively inexpensive, and most of the population can participate at some level, thereby improving their cardiovascular risk factors (Ekelund et al., 2012; Nelson, Rejeski, Blair, Duncan, Judge, King, Macera, & Castaneda-Sceppa, 2007). If we focus limited healthcare resources on factors associated with reduced physical activity, we can reduce death and suffering for those at risk of recurrent stroke (Mozaffarian et al., 2015; Sacco et al., 2006). Knowing which factors most influence level of physical activity is important. People who have already had a stroke are at greater risk of another stroke (Hu et al., 2000; Sacco et al., 2006). If we can identify the factors associated with inactivity among stroke survivors, we may be able to develop plans and programs using this information to decrease morbidity and mortality, thus addressing the social and economic burdens associated with stroke.

There is pronounced social, economic, and personal cost associated with stroke and recurrent stroke (Heidenreich et al., 2011; Ma, Chan, & Carruthers, 2014; Mozaffarian et al., 2015). It is imperative that we find feasible solutions to solve this public health burden (Mozaffarian et al., 2015). This chapter focuses on the background of the research study, the problem statement, purpose of study, research questions, theoretical framework, nature of the study, definitions, assumptions, scope, limitations, and significance.

Background

Stroke causes substantial disability and adds to social and economic burden (Di Carlo, 2009; Mozaffarian et al., 2015). Some portions of the population suffer more than others. Racial minorities, older adults, and women have higher stroke prevalence and suffer a greater health burden than others in the population suffer (Mozaffarian et al., 2015). Ma et al. (2014) summarized the incidence, prevalence, costs, and impact of conditions that require rehabilitation; including stroke. They reported that in the US stroke is the leading cause of serious, long-term disability and that the overall lifetime cost was over $140,000 per individual (Ma et al., 2014). This burden of disability contributes to an estimated $28.3 billion for direct and $25.6 billion for indirect costs in the US for stroke-related care per year (Heidenreich et al., 2011).

Physical inactivity in the general US population is an important modifiable risk factor for many non-communicable diseases including stroke (Artinian et al., 2010; Mozaffarian et al., 2015; Parks, Housemann, & Brownson, 2003). Physical inactivity is responsible for 5.3 million deaths per year (Wen & Wu, 2012). Authors of a previous study suggested that eliminating physical inactivity would remove 6% to 10% of the major non-communicable diseases (I. M. Lee et al., 2012). Over half of the adults in the

US do not meet minimum physical activity requirements (Centers for Disease & Prevention, 2005; Kilmer et al., 2008; Li et al., 2011).

There is evidence that those with stroke have reduced physical activity and that physical inactivity has been identified with initial and recurrent stroke risk (S. Nicholson et al., 2013; Saunders, Greig, & Mead, 2014).Identifying risk factors associated with decreased physical activity for stroke survivors could help reduce morbidity and mortality thereby contributing to positive social change.

Physical activity can reduce stroke burden (Mozaffarian et al., 2015; Sacco et al., 2006), stroke incidence (Hu et al., 2000; Hu et al., 2005; Pang et al., 2006; Wendel-Vos et al., 2004), and there are biological, psychological, and social factors that can influence levels of physical activity (Bauman et al., 2012; Bauman et al., 2002; Booth et al., 2000; Brawley et al., 2003; Cohen-Mansfield J., 2003). Currently, it is unknown which specific biopsychosocial or combinations of factors are most associated with levels of physical activity in US stroke survivors. Further discussion of these factors will be offered in Chapter 2.

Problem Statement

Stroke is a major contributor to morbidity and mortality (Mozaffarian et al., 2015; Sacco et al., 2006). The association between level of physical activity and National Health Interview Survey (NHIS) biopsychosocial factors among adult US stroke survivors is unknown. People who already have had a stroke are at greater risk of having another stroke (Burn et al., 1994; Hardie et al., 2004); therefore, measures should be taken to prevent recurrence. Physical activity can help to reduce the risk of recurrent stroke (F. B. Hu et al., 2000; Sacco et al., 2006) and may improve overall health and well-being (Okoro et al., 2014; Penedo & Dahn, 2005). However, painful conditions, such as arthritis, joint pain, low back, and neck pain, or cardiovascular conditions, may possibly prevent necessary physical activity putting stroke survivors at greater risk of another stroke (Booth, Bauman, Owen, & Gore, 1997; Brittain, Gyurcsik, McElroy, & Hillard, 2011). Other factors that can negatively influence the level of physical activity include psychological distress and social factors (Booth et al., 1997; Chinn, White, Harland, Drinkwater, & Raybould, 1999; Costello, Kafchinski, Vrazel, & Sullivan, 2011; Damush, Plue, Bakas, Schmid, & Williams, 2007; S. L. Nicholson et al., 2014). Understanding the combination of these factors may help to identify who is most at risk of recurrent stroke. In order to improve physical activity in stroke survivors, it is important to understand what biological, psychological, or sociological factors may be associated with levels of physical activity in stroke survivors.

Previous studies have investigated the levels of activity in stroke survivors. Butler and Evenson (2014) performed a prevalence study comparing the level of physical activity among US stroke survivors to those without stroke (Butler & Evenson, 2014). Their study used data from the National Health and Nutrition Examination Survey (NHANES) and found that those with stroke were less likely to follow activity recommendations compared to those without stroke. However, they did not evaluate the association of other risk factors to physical activity for those with stroke. Morris et al. (2014) looked at interventions that promoted physical activity for stroke survivors. Of the 11 studies they identified, none showed definitive results and only tailored home exercises provided higher participation after 12 months (J. H. Morris, Macgillivray, & McFarlane, 2014). The authors recommended that diverse approaches are needed and that future research should include studying the amount of physical activity and a broad range of measures such as behavioral and physiological outcomes (J. H. Morris et al., 2014).

The AHA recommends that all adults obtain target levels of physical activity each week. These physical activity guidelines were originally published in 1995 and were updated in 2007 (Haskell et al., 2007). Since that time, these guidelines have been recognized by the US government and are included in the publication: 2008 Physical Activity Guidelines for Americans (http://health.gov/paguidelines/).

The AHA recommended that stroke survivors follow the same 2007 recommendations for physical activity (Haskell et al., 2007), however, in a following report, emphasized that modifications should be made for individuals' needs (Billinger et al., 2014). Thus, the guideline for recommended levels of activity for adults is the same regardless of age or condition. The 2014 AHA guideline recommended that future research should include stroke characteristics and that individual/social factors be evaluated to understand barriers to activity in stroke survivors (Billinger et al., 2014).

At present, no population-based studies utilizing data from the NHIS to assess biopsychosocial factors associated with physical activity in US stroke survivors have been published. Therefore, given that physical activity is a modifiable risk factor that can potentially reduce the risk of recurrent stroke in stroke survivors, a population-based study evaluating these relationships is needed.

Purpose of the Study

The purpose of this quantitative, cross-sectional, secondary data analysis was to identify if any biopsychosocial factors in the NHIS were associated with US stroke survivors following the recommended levels of physical activity according to the AHA recommendations. A multivariable logistic regression model is proposed for predicting the likelihood of a stroke survivor reaching recommended levels of physical activity. The independent variables include: (a) biological variables consisting of biological individual characteristics (i.e., age, body mass index (BMI), race/ethnicity, and sex) and biological conditions (i.e., musculoskeletal conditions (i.e., joint pain, arthritis, neck pain, and back pain) and cardiovascular conditions (i.e., hypertension, coronary heart disease, angina pectoris, myocardial infarction, and ‘other’ heart diseases); (b) psychological variables consisting of perceived health and the Kessler scale for mental distress (i.e., sadness, nervousness, restless, hopeless, effort, and worthlessness); and (c) sociological variables (i.e., education, family structure, income, marital status, region, neighborhood, and contact with a health care professional in the past 12 months).

Research Questions and Hypotheses

The following research questions and hypotheses were analyzed in this study:

Research Question 1

1. Is there a significant association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and individual NHIS biological individual characteristics (age, BMI, race/ethnicity, and sex), among US stroke survivors?

Hypothesis 1

$H_0$1: There is no association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and individual NHIS biological individual characteristics (age, BMI, race/ethnicity, and sex), among US stroke survivors.

Ha1: There is an association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and individual NHIS biological individual characteristics (age, BMI, race/ethnicity, and sex), among US stroke survivors.

Research Question 2

2. Is there a significant association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and NHIS biological conditions (musculoskeletal conditions (i.e., joint pain, arthritis, neck pain, and back pain) and cardiovascular conditions (i.e., hypertension, coronary heart disease, angina pectoris, myocardial infarction, and 'other' heart diseases), among US stroke survivors?

Hypothesis 2

$H_0$2: There is no association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and NHIS biological conditions (musculoskeletal conditions (i.e., joint pain, arthritis, neck pain, and back pain) and cardiovascular conditions (i.e., hypertension, coronary heart disease,

angina pectoris, myocardial infarction, and 'other' heart diseases), among US stroke survivors.

Ha2: There is an association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and NHIS biological conditions (musculoskeletal conditions (i.e., joint pain, arthritis, neck pain, and back pain) and cardiovascular conditions (i.e., hypertension, coronary heart disease, angina pectoris, myocardial infarction, and 'other' heart diseases), among US stroke survivors.

Research Question 3

3. Is there a significant association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and NHIS psychological variables, which includes perceived health and the Kessler scale for mental distress (i.e., sadness, nervousness, restless, hopeless, effort, and worthlessness), among US stroke survivors?

Hypothesis 3

$H_0 3$: There is no association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and NHIS psychological variables, which includes perceived health and the Kessler scale for mental distress (i.e., sadness, nervousness, restless, hopeless, effort, and worthlessness), among US stroke survivors.

Ha3: There is an association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and NHIS psychological variables, which includes perceived health and the Kessler scale for mental distress (i.e., sadness, nervousness, restless, hopeless, effort, and worthlessness), among US stroke survivors.

Research Question 4

4. Is there a significant association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and NHIS sociological variables (i.e., education, family structure, income, marital status, region, neighborhood (i.e., neighborhood help, neighborhood count on, neighborhood trusted, and neighborhood close-knit), contact with a health care professional in the past 12 months (i.e., mental health professional, eye doctor, foot doctor, chiropractor, physical therapist, nurse, women's health doctor, other medical specialist, and general practitioner), among US stroke survivors?

Hypothesis 4

$H_0 4$: There is no association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and NHIS sociological variables (i.e., education, family structure, income, marital status, region, neighborhood (i.e., neighborhood help, neighborhood count on, neighborhood trusted, and neighborhood close-knit), contact with a health care professional in the past 12 months (i.e., mental health professional, eye doctor, foot doctor, chiropractor, physical therapist, nurse, women's health doctor, other medical specialist, and general practitioner), among US stroke survivors.

Ha4: There is an association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and NHIS sociological variables (i.e., education, family structure, income, marital status, region, neighborhood (i.e., neighborhood help, neighborhood count on, neighborhood trusted, and neighborhood close-knit), contact with a health care professional in the past 12 months (i.e., mental health professional, eye doctor, foot doctor, chiropractor, physical therapist, nurse, women's health doctor, other medical specialist, and general practitioner), among US stroke survivors.

Research Question 5

5. Is there a biopsychosocial, multivariable logistic regression model based on the NHIS variables identified by the answers to questions one through four that can predict the level of activity for US stroke survivors?

Hypothesis 5

$H_0 5$: There is no viable biopsychosocial, multivariable logistic regression model based on NHIS variables that can predict the level of activity for US stroke survivors.

Ha5: There is a viable biopsychosocial, multivariable logistic regression model based on NHIS variables that can predict the level of activity for US stroke survivors.

Theoretical Framework for the Study

The biopsychosocial model may be an appropriate theoretical framework to assist in addressing stroke risk factors by prevention and treatment (Engel, 1980; Gatchel, Peng, Peters, Fuchs, & Turk, 2007; Pincus et al., 2013). The biopsychosocial model was first proposed by Engel (Engel, 1977, 1980) as a reaction to approaches in research that at that time were primarily biomedically based (Borrell-Carrio, Suchman, & Epstein, 2004). Since that time, this model has been used extensively in biomedical and psychological research, and it has been suggested that it can also be applied to studies in public health and epidemiology (Green & Johnson, 2013).

Research that has been performed on factors associated with levels of physical activity has included biological, psychological, and sociological approaches (Bauman et al., 2012; Bauman et al., 2002). Biological causes may include individual characteristics such as age, sex, or BMI. Biological barriers to physical activity may also include health conditions, such as musculoskeletal pain, arthritis, or cardiovascular conditions (Bauman et al., 2002; Brittain et al., 2011). Psychological causes may include perceived health or fitness or other psychological barriers such as mental distress (Bauman et al., 2002). Sociological causes may include lack of social support or socioeconomic status (Bauman et al., 2002). The biopsychosocial model recognizes that these factors interrelate and are integral to understanding the barriers to physical activity for stroke survivors. Further details pertaining to the use of the biopsychosocial model in this research are presented in Chapter 2.

Nature of the Study

The quantitative, cross-sectional study design was selected for this study because the cross-sectional design is useful in determining associations between characteristics in large populations. A cross-sectional design evaluates characteristics of a population at one point in time and determines prevalence (Friis & Sellers, 2009; Rothman, 2002). This study design can measure the magnitude of a problem; however, because the data are not connected in time, longitudinal associations cannot be suggested (Friis & Sellers, 2009). Because this study aims to measure the association between physical activity and multiple factors, the cross-sectional design allows the examination of a large number of variables from individuals in relation to an outcome variable.

The key study variables for the population of stroke survivors include the dependent variable physical activity, and the independent variables biopsychosocial factors that are present in NHIS. Biological factors included age, sex, BMI, race, musculoskeletal disorders, and cardiovascular disorders. Psychological factors included psychological stress as measured by the Kessler scale (i.e., sadness, nervousness, restlessness, hopelessness, burden of effort, worthlessness), and perceived health. Sociological factors included marital status, family structure, income, neighborhood, region, contact with healthcare professionals, and level of education.

This quantitative cross-sectional study utilized a secondary data analysis from the NHIS (Blackwell, Lucas, & Clarke, 2014). The NHIS database is open access and available to scientists interested in public health and population studies (CDC, 2015a; NCHS, 2014). Chi-square evaluated the relationship between individual independent variables and the dependent variable (Portney & Watkins, 2009). Multiple logistic regression was selected for this study because it helps to test hypothesis between categorical independent and dependent variables (Portney & Watkins, 2009). The variables were analyzed using SPSS software.

Definitions

Stroke: The AHA and the ASA define stroke as:

> … brain, spinal cord, or retinal cell death attributable to ischemia, based on
>
> 1. pathological, imaging, or other objective evidence of cerebral, spinal cord, or retinal focal ischemic injury in a defined vascular distribution; or
>
> 2. clinical evidence of cerebral, spinal cord, or retinal focal ischemic injury based on symptoms persisting ≥24 hours or until death, and other etiologies excluded. (Sacco et al., 2013)

There are three different categories of stroke. These three types include ischemic (87%), intracerebral (10%), and subarachnoid hemorrhage (3%) (Roger et al., 2011; Roger et al., 2012b). For the purposes of this study, a stroke survivor was someone who responded in the affirmative to the NHIS survey question "Have you ever been told by a doctor or other health professional that you had a stroke?"

*Physical Activity***:** According to the physical activity guidelines *2008 Physical Activity Guidelines for Americans,* physical activity is "bodily movement that enhances health" (www.health.gov/paguidelines). Physical activity is distinguished from subsets of physical activity such as "exercise" that is a planned activity or physical fitness regimens that specifically focuses on health benefits (Caspersen, Powell, & Christenson, 1985).

For the purposes of this study, physical activity was defined and identified by participant responses to NHIS survey questions. These questions include the self-reported level of activity (e.g., vigorous) and frequency (e.g., how often). More details about these variables are described in Chapter 3.

*Age***:** The age of the survey respondents was recorded based on self-reported number by year. For the purposes of this study, age was recognized as a biological variable.

Arthritis: According to the Centers for Disease Control and Prevention (CDC), the term "arthritis" encompasses multiple joint diseases (http://www.cdc.gov/arthritis/basics/general.htm). These include rheumatoid arthritis, lupus, fibromyalgia, gout and the most common, osteoarthritis. Arthritis may or may not have an inflammatory component and may or may not have persistent pain. For the purposes of this study, arthritis was recognized as a biological variable and was defined as a respondent who answered that they have ever been told by a doctor of health professional that they have arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia.

Back Pain: The area for low back pain is typically considered the general region of the upper back, low back, to include the buttock area, however, many studies will not point out an anatomical description and instead rely on the participants' interpretation of the meaning of back pain (Hoy, Brooks, Blyth, & Buchbinder, 2010). For the purposes of this study, back pain was considered a biological variable and was defined as someone responding that they have had "low back pain" in the past three months.

BMI: The BMI of the survey respondents was recorded and calculated based on self-reported height and weight using the equation BMI = weight /height^2 (Keys, Fidanza, Karvonen, Kimura, & Taylor, 1972). For the purposes of this study, BMI was recognized as a biological variable.

Cardiovascular diseases: Cardiovascular diseases are conditions that affect the cardiovascular system (Mozaffarian et al., 2015). Guidelines mainly focus on how physical activity may be used to treat or prevent cardiovascular diseases (Perk et al., 2012; Thompson et al., 2003), instead of how cardiovascular disease may prevent activity. The NHIS survey includes a list of cardiovascular diseases that respondents report being told that they have that particular condition. For the purposes of this study, cardiovascular diseases were considered a biological variable.

Education: The level of education is defined as the self-reported highest level of education that a person has completed. The NHIS survey includes a list of typical educational levels that one would expect to find in the US educational system. For the purposes of this study, education levels were considered a social factor.

Family structure: Family structure in the NHIS survey relates to who is living in the household. People may include spouse, children, other family members, or others such as roommates. Family structure has been shown to have an effect on health (Blackwell, 2010; Montgomery, Kiely, & Pappas, 1996).

Health professional contact: Health professional contact relates to an interaction that one has with a member of the healthcare community. For the NHIS, contact is counted within the last 12 months (Graham et al., 2005; Hewitt & Rowland, 2002). For the purposes of this study, health professional contacts were considered a social variable.

Income: Income designates household income. Income is related to overall health and access to care but may also be a contributing factor to accessing other resources and sociological status (Chinn et al., 1999; Fiscella & Franks, 1997). Income was considered a social variable for this study.

Joint Pain: Joint pain was defined as any perceived pain in joints in the past 30 days and for the purposes of this study was recognized as a biological variable. Symptoms were identified as "pain" including aching or stiffness around a joint. Joints may include any joint other than in the neck or back.

K6: Non-Specific Distress Battery (Kessler6): Kessler described a series of questions that help to identify psychological distress (Kessler et al., 2002). The set of six questions, often referred to as K6, identify the amount of time a person has experienced in the past 30 days: sadness, nervousness, restlessness, hopelessness, feeling that everything is an effort, and worthlessness. The K6 uses a Likert scale, and the combined score suggests if a person has mental distress.

Married: Support from significant others is an influencing factor on health and may have a role in determining levels of physical activity (Booth et al., 2000). The married status variable identifies those who report that they are living with a married spouse or partner.

Neck Pain: Neck pain is not a clinical diagnosis but a subjective symptom. For this study, neck pain was defined as someone responding that they have had neck pain in the past three months.

Neighborhood: Support from others (Booth et al., 2000) and perception of safety may influence amounts of physical activity (Humpel, Owen, & Leslie, 2002). Neighborhood is defined by four factors that define a person's perception of their neighbors, including whether they: provide help, can be counted on, are trusted, and are close-knit.

Perceived health: A person's perception of his or her overall health identifies the psychological state and may determine willingness to participate in physical activity. The perception of health is a global outcome that asks if the person perceived that their health was excellent, very good, good, fair, or poor.

Race: Race is a characteristic that is typically included in epidemiologic studies. However, the categorization of race and ethnicity as a biological, psychological, or social factor is not necessarily clear (Caulfield et al., 2009; J. B. Kaplan & Bennett, 2003; Risch, Burchard, Ziv, & Tang, 2002). Race is typically used in the biological sciences when referring to physical characteristics (R. Bhopal, 2004; Senior & Bhopal, 1994), whereas ethnicity typically refers to social or cultural characteristics (R. Bhopal, Rankin, J., Bennett, T. , 2000), such as language, religion, and values (C. Lee, 2009). It has been recommended that researchers should state the context of how the variable is being used when describing methods and reporting results (Comstock, Castillo, & Lindsay, 2004).

Recent reviews of the literature that focus on barriers to physical activity have categorized race as a demographic and biological variable (Bauman et al., 2012; Bauman et al., 2002). Race categories were determined by categories that are included in the 2013 NHIS survey and were considered a biological variable.

Region: Region is the general location where one lives in a country or state. There are regional variations in health outcomes throughout the US (Obisesan, Vargas, &

Gillum, 2000; Pickle, Mungiole, & Gillum, 1997). This variable identifies the region (Northeast, South, Midwest, and West) of the participant.

Sex: For the purposes of this study, sex was recognized as a biological variable and categorized into either male or female options (Caspersen, Pereira, & Curran, 2000). The respondent of the NHIS survey was free to choose which response based on self-identified sexuality.

Biopsychosocial Model: The biopsychosocial model combines three domains and suggests that each has an influence on health (Engel, 1980). Although each domain (i.e., biological, psychological, and social) can be measured alone and may run as a continuum, each area may also have an influence on each other as seen in Figure 1. The biopsychosocial model was selected for this study because this model can be applied to cross-sectional studies, whereas other models, such as behavioral models, would be more appropriate for other types of studies such as qualitative or intervention studies.

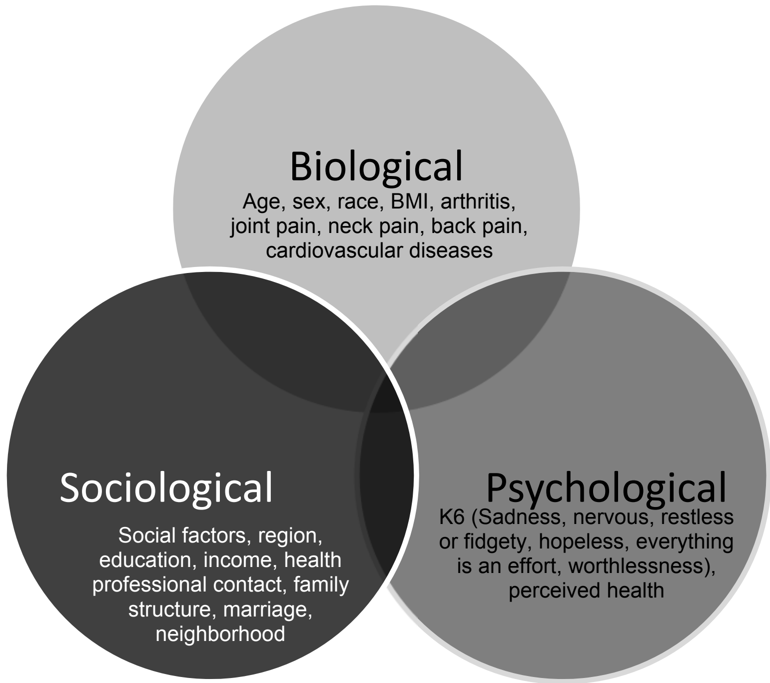

Figure 1. Biopsychosocial model using NHIS relevant variables. This figure is modified from the biopsychosocial Venn diagram in Natale-Pereira, A., Enard, K. R., Nevarez, L., & Jones, L. A. (2011). The role of patient navigators in eliminating health disparities. *Cancer, 117*(15 Suppl), 3543-3552. doi: 10.1002/cncr.26264 (Natale-Pereira, Enard, Nevarez, & Jones, 2011)

Determinants of health: Determinants of health are those factors that influence health and disease (Marmot & Allen, 2014; Marmot et al., 2008). These factors include social networks, culture, race, religion, education, environment, and individual biological characteristics such as sex, age, and genetics. Determinants of health can be addressed from individual or population health paradigms (Johnson & Green, 2009). Determinants of health fit the biopsychosocial theoretical model and consider the individual as a whole as seen in figure 2.

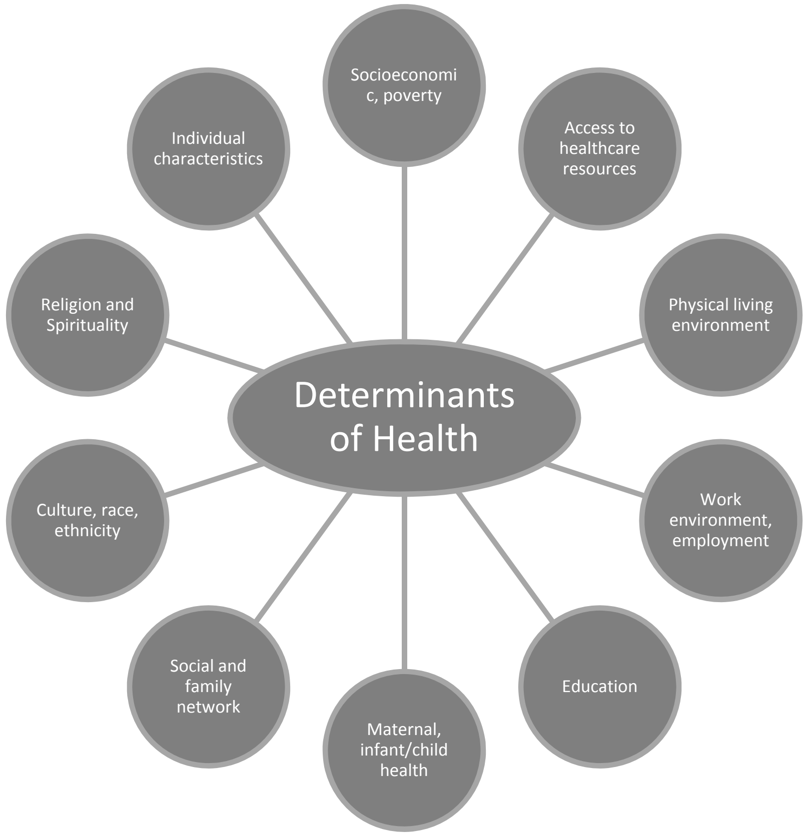

Figure 2. Determinants of Health. (Reprinted with permission from Johnson CD, Green BN. (2009). Public health, wellness, prevention, and health promotion: considering the role of chiropractic and determinants of health. Journal of Manipulative and Physiological Therapeutics, 32,405-12).

Assumptions

This study was based on several assumptions. I assumed that there was a potential association between biopsychosocial factors and levels of physical activity in US stroke survivors. It was assumed that the NHIS includes a representative sample of the US population and that this dataset was large enough to identify associations. It was assumed that those implementing the NHIS performed appropriate data collection and consent procedures. It was assumed that the sampling of stroke survivors was independent and random so that it represented the US population. It was assumed that respondents to the survey answered truthfully and that their answers were accurate (Blackwell et al., 2014; CDC, 2015a; NCHS, 2014). It was also assumed that the NHIS survey is a reliable and valid instrument.

Scope and Delimitations

The scope of this study was a quantitative secondary data analysis of information from the 2013 NHIS. Delimitations of this study were focused to findings that related to adult US civilians who were eligible for the NHIS survey. The NHIS was selected for this study because it provided a representative sample of the US population. Only adults were included in this study since stroke in children is relatively rare (Mozaffarian et al., 2015).

The NHIS normally has a good return rate (around 70%), thus is suggested to be a good representation of the US population (Carlson, Densmore, Fulton, Yore, & Kohl, 2009). Due to the nature of the survey, findings from this study are not necessarily applicable to people in other countries, those who are ineligible to participate in the NHIS survey (e.g., active duty military, incarcerated people), or those under the age of 18 (Blackwell et al., 2014; CDC, 2015a; NCHS, 2014). Chapter 3 includes additional information about the study population.

The NHIS survey is an established survey with predetermined questions, and no follow-up questions are collected. Therefore, this study is limited to only the data that were collected by NHIS and no information about the rationale for responses can be included.

The survey was offered in two languages, English and Spanish (CDC, 2015a), therefore, those whose primary languages were not English or Spanish may have been missed. Due to the data being collected by a survey, direct measures were not taken and findings can only be estimated. This study may be generalizable to the US population of stroke survivors, especially those who are similar to those who answered the NHIS survey.

Limitations

This study analyzed the association of biopsychosocial factors with the level of physical activity in US adult stroke survivors. The findings are limited to only the variables selected and only those people who report having had a stroke. Thus, the findings cannot be applied to other variables or to those without stroke. This study was not able to determine motivators for why a participant selected a specific response.

The NHIS survey questions did not specifically relate to stroke or physical activity and did not include some of the health conditions that may relate to stroke risk, such as atrial fibrillation (Mozaffarian et al., 2015), or that relate to physical activity such as specific neurological conditions and balance disorders (Anens, Emtner, & Hellstrom, 2015). Questions about social function are limited and do not include environmental factors such as accessibility, safety, or social connections. Therefore, some potentially relevant biopsychosocial factors were not included in this study.

The cross-sectional survey design is not longitudinal, which does not allow for determination of cause and effect. Therefore, the findings of this study are limited to association and do not imply cause. It is also possible that certain minority groups are not proportionally represented, which may limit the study findings. The data are from the US population for one year, therefore the findings are not necessarily generalizable to populations in other countries or to other points in time.

Several biases are inherent in the NHIS survey. The survey is biased to those who are willing to respond to surveys and who are accessible. The construct of the survey is primarily biomedically oriented, so other potentially relevant factors that might be associated with psychosocial barriers to physical activity in stroke survivors were not identified. The survey questions are structured in a closed-ended format, which may result in response bias due to limited options. There is a risk of recall bias for response participants. They might report their height to be taller, their weight lower, or their activity to be higher than it actually is.

The NHIS has processes to help minimize some of these limitations. The NHIS oversamples minority groups, thereby insuring that these groups have representation. Limitations of response bias may be addressed by the NHIS being given as an in person interview, therefore responses may be more accurate based on these collection methods. Limitations of accuracy can be mitigated by the size of the survey responses, in that more responses help to reduce errors of inaccuracy of one response.

Significance

The findings of this study contribute to current knowledge of the relationship between selected biopsychosocial variables and levels of activity in people who report having had a stroke. This is the first study of its kind using the NHIS dataset to evaluate associations and to develop a model that may drive future research and models of care. A better understanding of the relationship between risk factors that influence physical activity for stroke survivors may help guide policy decisions, stroke management guidelines, and daily practices in healthcare and long-term care facilities.

Implications for Social Change

This study provides several implications for positive social change. Understanding what biopsychosocial factors might limit physical activity in stroke survivors may help target those with stroke for specialized programs to increase physical activity. Programs and policies could be created that address these barriers, which might increase physical activity. The increase in physical activity for this at-risk population would hopefully result in improved function, improved quality of life, and longer lifespan, thereby decreasing morbidity and mortality for US adults who have had a stroke. Findings from this study include the potential for reducing morbidity and mortality especially for those subgroups that are most at risk of recurrent stroke.

Summary

Stroke is a leading cause of death in the US, and increased levels of physical activity can reduce the risk of stroke. People who already have had a stroke are at greater risk of having another stroke; therefore, measures should be taken to prevent recurrence. The biopsychosocial model is an appropriate theoretical framework to assist in addressing stroke risk factors as they relate to both prevention and treatment.

Identifying biopsychosocial factors that are most associated with stroke could reduce morbidity and mortality due to stroke. At present, the association between level of physical activity and biopsychosocial factors among adult US stroke survivors is unknown. Therefore, the purpose of this quantitative, cross-sectional analysis of the 2013 NHIS was to identify if biopsychosocial factors are associated with levels of physical activity for US stroke survivors. For biopsychosocial factors that were found to be associated with levels of physical activity for US stroke survivors, a multivariable logistic regression model was proposed. The findings of this study may produce positive social change by informing healthcare policy and prevention practices for groups at risk of recurrent stroke. The implications for positive social change in this study include the potential for reducing morbidity and mortality especially for those subgroups that are most at risk of recurrent stroke.

This chapter has introduced the study. Chapter 2 presents a review of the literature of stroke and physical activity, the biopsychosocial model and the variables that are used in the statistical analysis.

Chapter 2: Literature Review

Introduction

Stroke is a major health burden (Feigin et al., 2014; C. D. Lee, Folsom, & Blair, 2003; Roger et al., 2012b). Physical activity may prevent stroke (Wendel-Vos et al., 2004) and improve outcomes in aerobic capacity for stroke survivors (Pang et al., 2006). The AHA and ASA include recommendations for increased physical activity for the prevention of stroke in patients with ischemic stroke (Sacco et al., 2006). However, at present, the association between levels of physical activity and biopsychosocial factors among adult US stroke survivors is not well understood. Biopsychosocial factors, such as chronic musculoskeletal conditions, psychological distress, and social factors may prevent recommended levels of physical activity, thus putting stroke survivors at greater risk of another stroke. In order to improve physical activity in stroke survivors, it is important to understand what factors are related to physical activity in stroke survivors.

Currently, no population- based studies utilizing the NHIS to assess factors associated with physical activity in US stroke survivors has been published. The purpose of this quantitative, cross-sectional, secondary data analysis was to measure the association of biopsychosocial factors with levels of physical activity for US stroke survivors. The findings of this study may produce positive social change by informing healthcare policy and prevention practices for groups at risk of secondary or recurrent stroke. This study assessed if levels of physical activity were associated with biopsychosocial factors for stroke survivors and proposed a biopsychosocial multivariable logistic regression model.

This chapter will review the literature related to the topics of stroke and physical activity. The chapter will also provide information on the literature search strategy, theoretical foundations, recent studies evaluating barriers to physical activity, and previous population studies related to physical activity.

Literature Search Strategy

A literature review was completed using a structured electronic search of Medline using the PubMed search engine for all publications from inception through March 2015 and updated May 2015. Search terms were clustered into four searches: a) stroke survivor, physical activity, or exercise; b) stroke survivor, physical activity, or exercise, and prevention; c) stroke survivor, physical activity, or exercise, and barriers; and d) stroke, physical activity, and NHIS. Additional literature was identified through the references from the retrieved articles and other searches.

Studies were selected if they were related to the dependent and independent variables as they relate to physical activity in stroke survivors, barriers to physical activity, and how physical activity in stroke survivors may prevent recurrent stroke. The inclusion criteria for papers in the search were that they were full papers published in peer-reviewed journals and were published in English. Due to heterogeneity of the literature, a narrative summary was performed on the topics of stroke and physical activity.

Theoretical Foundation

The theoretical foundation for this study is the biopsychosocial model. Whereas the biomedical model focuses on disease processes coming from biological mechanisms, the biopsychosocial model combines three characteristics of biological, psychological, and social factors to explain or address the context of disease. Engel first described the biopsychosocial model as a response from the field of psychology to the reductionist model of biomedicine at the time (Engel, 1977, 1980). Instead of focusing on only the factors that relate to biological mechanisms, the model combines additional determinants of health: psychological and social factors. In the 1970s, the argument in favor of the biomedical model was that it was scientific, whereas psychology and sociology were not as rigorously tested. However, over the past several decades, other methods such as population-based studies have contributed to developing complex models to study the multifactorial nature of health. Thus, scientific approaches have been recognized as viable for testing complex models. In summary, the biopsychosocial model can be a useful multifactorial means of analyzing disease and addressing health (Keefe et al., 2002; Penney, 2010; Smith, Fortin, Dwamena, & Frankel, 2013).

The biopsychosocial model is well suited to evaluate factors associated with levels of physical activity. In order to engage in regular physical activity, one needs to have a functioning body, in other words, intact biological mechanisms. For example, muscles and joints must move freely, the cardiovascular system must perform efficiently, and the body must not be too severely restricted by pain to move about. Biological factors include sex, age, race, (Bauman et al., 2002) and functioning biological systems (Brittain et al., 2011; Flynn et al., 2009).

Psychological factors associated with physical activity include motivation and positive behaviors to completing activities (Bauman et al., 2002; Bauman et al., 2012).

Psychological health may include a person's mental state such as if they are sad, nervous, restless, hopeless, or feeling worthless (Andersen et al., 2011; Dhingra, Strine, Holt, Berry, & Mokdad, 2009; Fushimi et al., 2012; S. Lee et al., 2012; Prochaska, Sung, Max, Shi, & Ong, 2012). Social factors may include support from family or friends, knowledge about the importance of exercise, and access to facilities that support activity (Bauman et al., 2002). Psychosocial constructs have been evaluated in adults with physical disabilities as they relate to physical activity. A study of adults with physical disabilities showed that psychosocial factors had influence on the amount of physical activity people participated in over time (Kosma, Ellis, & Bauer, 2012; Kosma, Ellis, Cardinal, Bauer, & McCubbin, 2009). Psychosocial factors have also been linked to the prevalence of back pain (Clays et al., 2007) and levels of physical activity (Lewis, Marcus, Pate, & Dunn, 2002; Lewis, Williams, Martinson, Dunsiger, & Marcus, 2013). Psychosocial distress in the stroke survivor population has been documented. A longitudinal study found that increased levels of psychosocial distress increased the risk of stroke in older adults (Henderson et al., 2013). Thus, psychosocial factors should be included when studying stroke prevention.

Literature Review Related to Key Variables and Concepts

The Condition of Stroke

In the US, stroke is a leading cause of death and disability (C. D. Lee et al., 2003) and the leading cause of long-term disability (Roger et al., 2012b). Stroke is estimated to affect over 7 million adults in the US with an estimated prevalence of 3.0% (Roger et al., 2011; Roger et al., 2012b). Annually it is estimated that 795,000 people will experience a new or recurrent stroke, with 23% of these being a recurrent stroke (Roger et al., 2011; Roger et al., 2012b). In the US, stroke is responsible for one out of 18 deaths and ranks fourth among all causes of death (Roger et al., 2012b).

It is estimated that 54% of deaths due to stroke occur outside of the hospital (Roger et al., 2012b). People who are older (average age 79.6 years), and female, are more likely to die from stroke (Roger et al., 2012a). The thirty-day mortality rate after stroke differs by age group: 65 to 74 years (9%), 74 to 84 years (13.1%), and over 85 years (23%) (Roger et al., 2012b).

Those who have had a stroke are at greater risk for recurrent stroke, having nine times the risk of recurrence within five years compared to those without stroke (Burn et al., 1994). The risk of recurrent stroke over 10 years has been reported as six times greater than the risk of a first stroke (Hardie et al., 2004). Evidence has shown that increased physical activity is associated with reduced rates of stroke and recurrent stroke (F. B. Hu et al., 2000) and is protective to prevent first ever stroke (Wendel-Vos et al., 2004). Recommendations by the AHA and ASA include increased physical activity in their guidelines for prevention of stroke in patients with ischemic stroke (Sacco et al., 2006).

Race and stroke

The prevalence of stroke among races in the US varies (Attenello et al., 2014; Cruz-Flores et al., 2011; Kwon et al., 2015). Compared to those without stroke, stroke survivors more likely to report stroke symptoms include minorities and those with lower income, lower education, higher Framingham stroke risk score (i.e., relating to race and geographic differences), and poor perceived health status (Roger et al., 2012b). Racial minorities, especially Blacks, have greater activity limitations after stroke (Burke et al., 2014). According to the CDC 2013 data, US adults who reported a history of stroke included: non-Hispanic Blacks (4.0%), non-Hispanic Whites (2.5%), Asians (1.3%), Hispanics (2.3%), American Indian/Alaskan Natives (4.6%), and others/multiracial (4.6%) (Mozaffarian et al., 2015). Therefore, those who are a minority may be at greater risk for recurrent stroke.

Future burden

Although stroke has moved from third to fourth place as the leading cause of death in US adults (Towfighi & Saver, 2011), an estimated additional four million people (which is an increased prevalence of 25%) will have had a stroke by 2030 (Heidenreich et al., 2011). It is estimated that the direct medical cost of stroke will rise by 238% in 2030 compared to 2010, which translates to $95.6 billion in 2008 dollars (Heidenreich et al., 2011). An estimated increase in indirect costs by 73% represents $44.4 billion in 2008 dollars. The sum is estimated to be $140 billion (Heidenreich et al., 2011). Therefore, investigating cost-effective measures to reduce stroke prevalence and finding ways to reduce barriers to physical activity for stroke survivors is warranted.

Physical Activity

Increased physical activity is associated with reducing rates of stroke and recurrent stroke (F. B. Hu et al., 2000). Physical inactivity is one of the modifiable risk factors associated with reducing approximately 80% of the risk for stroke (O'Donnell et al., 2010), so knowing what might affect participation in physical activity may have the potential to positively influence stroke outcomes (Billinger et al., 2014). Therefore, physical activity should be further evaluated to determine what factors may be associated with the level of physical activity.

As of July 2015, the most current physical activity guidelines available in the US are those endorsed by the AHA (www.heart.org/HEARTORG/), the Office of Disease Prevention and Health Promotion (http://www.health.gov/paguidelines/), and the American College of Sports Medicine (Garber et al., 2011). These guidelines are currently used to determine levels of activity in the 2015 update from the AHA (Mozaffarian et al., 2015). Physical activity recommendations made by the AHA and the ACSM outline levels of physical activity needed to promote and maintain health (Haskell et al., 2007). The AHA recommendation for adults 18 to 65 years includes the following criteria: 30 minutes of moderate level of physical activity five days per week (150 minutes of moderate activity per week) or 20 minutes of vigorous activity three days per week (60 minutes of vigorous activity per week). These recommendations suggest that levels of activity can be combined to meet the requirements. Moderate (e.g., brisk walking) and vigorous (e.g., jogging) intensity are encouraged compared to light activity or inactivity (Haskell et al., 2007).

In 2008, the updated physical activity guidelines *2008 Physical Activity Guidelines for Americans* were published to update the 2007 guidelines (www.health.gov/paguidelines). These evidence-based recommendations provide additional information and update the level of vigorous activity to 25 minutes three days per week. This study determines activity as defined by the 2008 US Department of

Health and Human Services recommendation for physical. The 2008 AHA guidelines provide additional suggestions for adults over the age of 65 and for those who have chronic conditions or disabilities. The guidelines suggest that people of all ages follow 150 minutes of moderate activity or 75 minutes of vigorous activity but modifications should be made based on ability and if there are any concerns for personal safety.

Physical activity is measured by the NHIS to determine what percentage of the general US population is following AHA requirements. According to Mozaffarian et al. (2015), only one-half of adults responding to the 2013 NHIS survey reported meeting the minimum criteria of activity. They found that more men than women met the recommendations (54.2% vs. 46.1% respectively). As well, White non-Hispanics (53.4%) were more likely to follow activity requirements than Black non-Hispanics or Hispanics (41.4% vs. 42.9%). And as age increased, fewer people met the physical activity guidelines (Mozaffarian et al., 2015). However, these findings were for the US population in general. It is unknown what percent of stroke survivors follow physical activity requirements.

Trends in physical activity of US adults have been measured. In 2008, only 43.5% of adults were active using the AHA 2008 criteria (Carlson, Fulton, Schoenborn, & Loustalot, 2010). When compared to prior years, the authors note that negligible improvement had been made for the level of physical activity among US adults. A following comparative study examined the mortality risk of US adults who met physical activity recommendations. This study found that those following the 2008 US Department of Health and Human Services Physical Activity Guidelines (USDHHS,

2008) had a statistically significant reduction in all-cause mortality (Schoenborn & Stommel, 2011).

Physical activity has shown benefit to stroke survivors. A large population study evaluated physical activity frequency and risk of incident stroke in US adults (McDonnell et al., 2013). They found that low levels of activity were associated with increased risk for stroke incident. A systematic review and meta-analysis of controlled cohort studies using exercise training programs for stroke patients found beneficial outcomes (Stoller, de Bruin, Knols, & Hunt, 2012). These included improved peak oxygen uptake and improved walking endurance. The authors suggest that these outcomes may improve long-term physical functioning and quality of life. A randomized controlled trial of stroke survivors compared water exercises to exercises performed while sitting. Those performing water-based exercises for eight weeks showed improved cardiovascular function (Chu et al., 2004). Thus, even short periods of increased exercise can result in measurable physiological gains. A randomized clinical trial evaluated the effects of therapeutic exercise on stroke survivors, comparing those treated with exercise sessions to those receiving usual care. Although both groups improved in cardiovascular function, the group receiving supervised care from health professionals showed improvement in endurance, balance, and mobility compared to the control group (Duncan et al., 2003). Therefore, the addition of a structured program may be beneficial in improving multiple physical outcomes. A randomized study evaluated progressive aerobic exercise and its effect on insulin sensitivity in stroke survivors. The study findings were that those participating in structured exercise had improved glucose tolerance at two hours compared to controls (Ivey, Ryan, Hafer-Macko, Goldberg, & Macko, 2007). This study showed that exercise for stroke survivors can be beneficial for metabolism and various body systems. A controlled trial was performed on stroke survivors that measured a community-based fitness program for older adults. After 19 weeks, the intervention group showed significant improvements in cardiovascular health compared to the control group receiving sitting exercises (Pang, Eng, Dawson, McKay, & Harris, 2005). Thus, sitting exercise alone may not be as beneficial as including other components such as focusing on reaching a target heart rate. A randomized study of stroke survivors who were hemi-paretic evaluated the effects of vigorous training compared to passive exercises for the same amount of time and duration. The findings were that cardiovascular outcomes results in significant improvement compared to the control group, such as aerobic capacity and blood pressure (Potempa et al., 1995). This suggests that those with stroke could benefit from regular vigorous exercise and can improve their cardiovascular health in a short amount of time (i.e., ten weeks). A clinical trial that recruited African-American stroke survivors compared exercise to no treatment. Significant differences were found for the exercise intervention, which improved cardiovascular endurance, strength, and body composition (Rimmer, Riley, Creviston, & Nicola, 2000). Thus, exercise can be improved in a 12-week period for stroke survivors. A non-controlled trial measured the peak exercise capacity of stroke survivors who participated in a treadmill training program. Thus, physiological improvements can be achieved after three months of training (Macko et al., 2005). The authors also found that exercise may also be accomplished with treadmill training.

A meta-analysis by Lee et al. (2003) identified 23 studies that measured the association between physical activity and risk of stroke. The authors found that there is an association of reduced risk of stroke with moderate and high levels of physical activity (C. D. Lee et al., 2003). The 2015 update on heart disease and stroke statistics states that physical inactivity is a major risk factor for stroke (Mozaffarian et al., 2015). As well, those who have had a stroke are more likely to be physically inactive than those without stroke, creating an even greater risk of future stroke (Butler & Evenson, 2014).

Biopsychosocial Model of Disease and Health

The biopsychosocial model was first proposed by Engel in 1977. He proposed the model in an attempt to go beyond the traditional biomedical model of treating mental illness, which at the time was struggling with research methods and perceived "unscientific opinions" to address research of mental health issues (Engel, 1977). At the time, biomedicine addressed disease through biological variables and did not account for potential psychological or sociological factors. Engel's suggestion was to include other factors to explain disease and that this better understanding may help in treatment and prevention (Engel, 1977). Although initially developed for the field of psychiatry, the biomedical model has been used in other fields such as musculoskeletal and cardiovascular health (Adler, 2009; Deyo, 2015; Stone & Baker, 2014; Wright & Kirby, 2003).

The biopsychosocial model can be depicted using a Venn diagram of overlapping circles to demonstrate the influence that each domain has on the other (Figure 1). When considered separately, each approach has a different manner of looking at disease. The biological model represents disease as the dysfunction of cells, tissues, and systems. Thus, treatment and prevention in the biological model would focus on directing therapy to the specific tissue or injured body part (e.g., pharmaceuticals or physical therapy). The psychological model represents disease as coming from the mind, such as a person's behaviors, feelings, or ways of thinking. Thus, treatment and prevention in the psychological model would focus on modifying behaviors or mood. The sociological model represents disease generated from interactions with others, such as family and society. Thus, treatment and prevention in the sociological model focuses on social constructs and group behaviors (Dilts, 2000). Engel proposed a continuum that included these three components to explain disease, which ranged from a subatomic particle level, to molecular, cellular, tissue, organ, systems, person, family, community, and society (Adler, 2009; Frankel, Quill, & McDaniel, 2003). Applying the biopsychosocial model may help us better understand the association between barriers and levels of physical activity.

Factors Associated with Physical Inactivity

Physical inactivity in US adults is persistent (Mozaffarian et al., 2015). Mozaffarian et al. (2015) reported that 30.5% of US adults report that they are inactive and that inactivity is higher in women, older adults, and racial minorities. (Mozaffarian et al., 2015). Others report that although some activity is being performed, US adults are not meeting the 2008 Physical Activity Guidelines for Americans (USDHHS, 2008), in that only 43.5% of adults were active using the AHA 2008 criteria (Carlson et al., 2010).

There are multiple factors associated with adult physical activity that have been measured (Bauman et al., 2002; Bauman et al., 2012). Bauman et al. (2002, 2012) completed literature reviews that summarized the correlates that were associated with physical activity. In the Bauman et al. 2002 study, the factors that had the highest inverse associations with physical activity were age, race, barriers to exercise, mood disturbance, perceived effort, and climate. The factors reported in 2002 that had the highest positive associations with physical activity were education, sex, genetic factors, income, expected positive benefits, enjoyment of exercise, personality variables, self-efficacy, self-motivation, self-schemata for exercise, stage of change, activity history during adulthood, quality diet, processes of change, physician influence, and social support from friends or spouse (Bauman et al., 2002). The 2012 literature review by Bauman et al. described individual correlates most associated with physical activity including age, sex, health status, self-efficacy, and activity as an adult. However, of the studies included, there were inconsistencies across study designs. None of the studies evaluated NHIS data, and the summary did not approach physical activity specifically using a biopsychosocial approach (Bauman et al., 2012).

It is not clear what percentage of stroke survivors are following physical activity guidelines. A systematic review of 26 studies about physical activity in stroke survivors revealed several gaps in the literature (English, Manns, Tucak, & Bernhardt, 2014). This 2014 study found no studies that measured inactivity in people with stroke. They also noted that little is known about the intensity of community-dwelling people with stroke. They emphasized that more information is needed about those who have had a stroke and are engaged in moderate to vigorous activity; thus, it is not clear what factors influence those people who engage in greater physical activity.

If we are to help stroke survivors increase physical activity, we need to identify the most impactful associated factors. Barriers to physical activity are multifactorial. A systematic review of literature reporting perceived physical activity barriers and motivators for those with stroke summarized six articles (S. Nicholson et al., 2013). The authors summarize that common barriers include lack of motivation, the environment, health concerns, and discouragement from stroke impairments.

Biological factors associated with inactivity include age, sex, race, and body mass index. A study of 2003 to 2004 National Health and Nutrition Examination Survey data showed that in the US women were less physically active than men at a younger age (below 30) and more active after 60 years (Matthews et al., 2008). They also found that Hispanic adults were more physically active than other groups and that White and Black females had similar levels of inactivity. A study compared the activity of White and African American adults in the Southeastern US (S. S. Cohen et al., 2013). A cross-sectional survey studied a large US population of White and Black adults and controlled for social context (i.e., income and region) (Wilson-Frederick et al., 2014). These authors found that Blacks had higher odds of physical activity compared with Whites. A cross-sectional survey found similar findings for the race variable. Crespo et al. (2000) evaluated the amount of leisure-time inactivity and found that Whites had more activity compared to Blacks and Hispanics. In their study they controlled for factors of social class, suggesting that race has an influence on the amount of physical activity, minorities showing less physical activity compared to Whites(Crespo, Smit, Andersen, Carter-Pokras, & Ainsworth, 2000).

Additional biological factors associated with inactivity include health conditions and pain. Arthritis is one musculoskeletal barrier that limits movement and may include pain. However, conversely, movement and activity have been suggested to be protective to further disability due to arthritis. A study of the Behavioral Risk Factor Surveillance System (BRFSS) showed that adults with arthritis and obesity were more likely to have limited physical activity than those who were obese without arthritis (Centers for Disease & Prevention, 2011). Thus, joint pain and arthritis may be barriers to physical activity. A study that measured barriers to physical activities in older adults found that pain were significant barriers (Baert, Gorus, Mets, & Bautmans, 2015). Other studies include a systematic review of barriers and motivators to physical activity in stroke survivors identified physical impairments as primary factors (S. Nicholson et al., 2013) and a study of Australians in which older adults (aged 60 to 78) there was reduced activity for those with injury or poor health (Booth et al., 1997).

The role of cardiovascular disease as a barrier to physical activity has not been studied at a population level. As well, national data on cardiorespiratory fitness has not been measured (Mozaffarian et al., 2015). Cardiovascular diseases can influence physical activity but they are typically studied with the relationship of physical activity as a treatment or solution to cardiovascular problems (Kohl, 2001; Thompson et al., 2003) or physical inactivity as an implied cause of cardiovascular disease (Chomistek, Chasman, Cook, Rimm, & Lee, 2013; Chomistek, Chiuve, Jensen, Cook, & Rimm, 2011;

Chomistek, Cook, Flint, & Rimm, 2012; Chomistek, Manson, et al., 2013), instead of cardiovascular problems being reported as a barrier to activity.

Psychological barriers to physical activity include mental distress and perception of health. A large cross-sectional study of US adults measured the association between physical activity and mental distress using the Kessler scale of nonspecific psychological distress (Okoro et al., 2014). The authors found that those with mental distress were less likely to reach physical activity recommendations. A systematic review of barriers and motivators to physical activity in stroke survivors identified psychological factors, such as fear and embarrassment as a primary factor to low levels of activity (S. Nicholson et al., 2013). A summary of barriers to exercise of older adults reported that perception of poor health was reported as a barrier to physical activity (Schutzer & Graves, 2004)

Sociological barriers to physical activity include socioeconomic factors such as income, education, family structure, marital status, region, neighborhoods, and social interaction with people who support activity (i.e., health professionals). An observational study evaluated community-level physical activity (Powell, 2004). The authors found that those communities with lower income had fewer environmental factors associated with physical activity. A study in the United Kingdom of people aged 16 to 74 showed that there was a socioeconomic relationship between physical activity and income (Chinn et al., 1999). A review of the literature identified environmental factors associated with levels of physical activity (Humpel et al., 2002). They found that environmental factors that were associated included access, aesthetic attributes as well as weather and safety. A population-based study of barriers, enjoyment, and preference to physical activity evaluated Australian adults (Salmon, Owen, Crawford, Bauman, & Sallis, 2003). The authors found that factors of cost, weather, and personal barriers were associated with levels of physical activity. Thus, a combination of social factors may influence levels of physical activity.

A study that evaluated a combination of psychological and sociological factors measured predictor variables for physical activity of older Canadian adults (M. S. Kaplan, Newsom, McFarland, & Lu, 2001). The authors found that social factors of lower education, being married, lower social support, and region were associated with lower levels of activity. A survey of Australians found that a majority of older adults wanted advice from healthcare professionals (Booth et al., 1997). A similar study of Australian adults showed that participation in physical activity with friends and family was associated with greater levels of activity (Booth et al., 2000). A study that measured physical activity in older adults found that "receiving medical advice from a medical doctor" and social contacts were motivators to being more active (Baert et al., 2015). As well, Schutzer et al. (2004) suggest that physicians play an important role in encouraging activity in older adults. A systematic review of barriers and motivators to physical activity in stroke survivors identified social support as a primary factor to being physically active (S. Nicholson et al., 2013). The focus groups revealed that both healthcare provider advice and the availability of programs were desired to increase activity. A study compared the activity of White and African American adults in the Southeastern US (S. S. Cohen et al., 2013). They found that in this region, that there were no differences between races. This is a different finding when compared to the Matthews et al. (2008) study that showed racial differences across the US population. Thus, it is possible that regional differences play a role in the level of physical activity.

The NHIS has questions that can address various biopsychosocial variables. However, there are many other possible barriers to physical activity that NHIS does not include since the NHIS has a limited set of questions. For example, questions about neighborhood safety, access to facilities or programs, are not part of the NHIS survey; therefore, they cannot be measured in this study. For the purpose of this study, only those factors that are included in the NHIS dataset were used.

Example of Factors in the Biopsychosocial Model

Identifying significant barriers to physical activity through a model may be one way to address how these factors are interrelated with physical activity in stroke survivors. For example, the biopsychosocial model includes selected examples of biological, psychological, or sociological factors in figure 3. Once specific factors are identified, programs could be developed to identify those most at risk and intervention measures could be developed to address the specific risk factors.

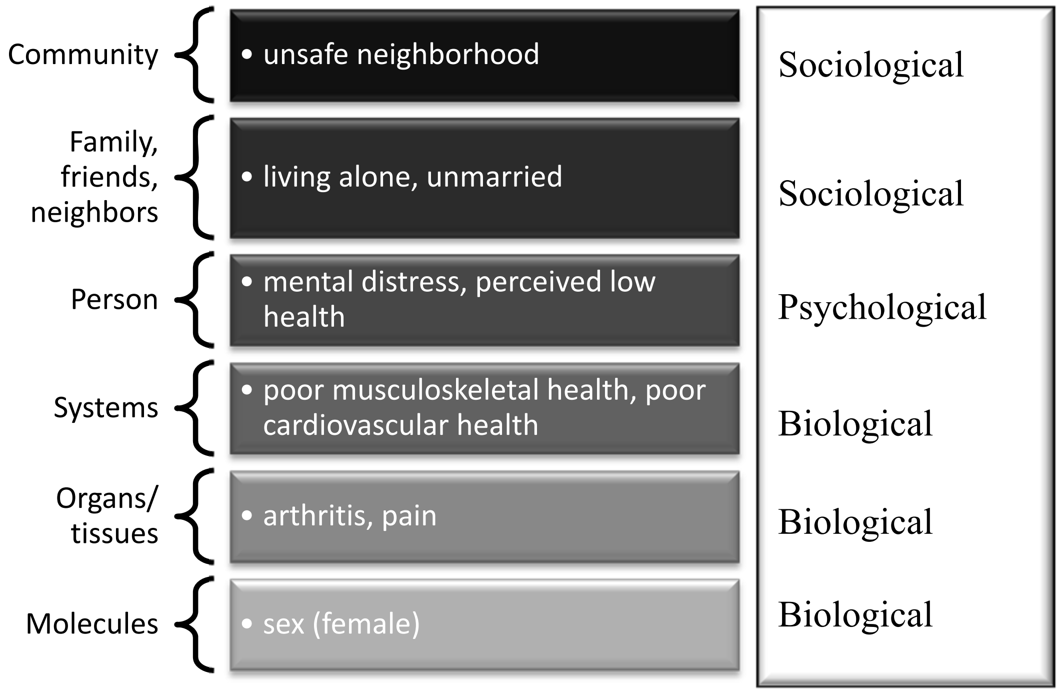

Figure 3. Examples of the continuum of factors associated with physical activity. These examples are based on Engel's biopsychosocial model of disease. Engel, G. L. (1980). The clinical application of the biopsychosocial model. Am J Psychiatry, 137(5), 535-544. doi: 10.1176/ajp.137.5.535

Previous National Studies on Stroke or Physical Activity

At present, there have been no published population-based studies utilizing the NHIS to assess factors associated with physical activity in US stroke survivors. The NHIS is a useful source of information and there have been studies of the NHIS database that have evaluated the relationship of other health outcomes. For example, a study of the NHIS 2002 was performed to estimate the factors associated with physical activity for adults with arthritis. The authors found that those with arthritis had significantly reduced activity compared to those without arthritis (Shih, Hootman, Kruger, & Helmick, 2006). The covariates they selected were previously associated with physical activity: sex; education (high school or less, beyond high school); body mass index; age (i.e., 18–44, 45–64, 65+ years); race/ethnicity (i.e., non-Hispanic White, non-Hispanic Black, Hispanic, non-Hispanic other/multiple race), and anxiety/depression. Shih et al. (2006) also adjusted for comorbidities and health status. The authors selected 16 self-reported medical conditions, nine functional limitations, three social/leisure limitations, and need for special equipment. The authors noted that when testing the multivariable model, comorbidity was not significant.

A study of NHIS data evaluated the association between self-reported sleep and prevalence of stroke. The authors found by using a logistic regression model that there was a higher stroke prevalence of stroke for those who were not sleeping within the normal range of seven to eight hours (Fang, Wheaton, & Ayala, 2014). A sample of the variables that they selected were age (i.e., 18-44, 45-64, and greater than 65 years); race/ethnicity (i.e., Hispanic, non-Hispanic White, non-Hispanic Black, and non-Hispanic other); sex; education (less than high school graduate, high school graduate or equivalent, some college, and college graduate), BMI), and conditions of diabetes, hypertension, coronary heart disease, angina pectoris, and heart attack. The authors added different variables in a stepwise fashion including age, sex, race/ethnicity, and education in the first step; smoking status, alcohol intake, and physical activity in the second step; and, BMI, hypertension, coronary heart disease, and diabetes status in the third step (Fang et al., 2014).

Estimation of the prevalence of chronic diseases and the association with physical activity has been measured using the NHIS. Authors of one study found that those with disabilities were more likely to have low levels of physical activity (Carroll et al., 2014). The variables they studied respondent disability, which was identified through a series of questions on functional limitations. The variables for chronic disease status were self-reported if they had been told they had diabetes, cancer, stroke, or heart disease. The functional limitations they included were: hearing, vision, cognitive, or mobility (i.e., walking or climbing stairs). Because those with a functional limitation may have additional difficulty with physical activity, Carroll et al. included them in the mobility limitation subgroup, even if the subjects reported other limitations (Carroll et al., 2014).

Questions in the NHIS for functional limitation for chronic diseases or complaints include factors for which the respondent is stating that they have limited mobility or activity. For example, the questions “What condition or health problem causes you to have difficulty with (names of up to 3 specified activities/these activities)?” “Arthritis/rheumatism causes difficulty with activity” or “Back or neck problem causes difficulty with activity” have an implied association with activity. If included, they would distort the relationship between the tested independent variables and the dependent of physical activity. Therefore, these confounding factors were not included in this study. Instead, the questions related directly to the diagnosis of the disease itself were included in this study. Examples of these questions include: “Have you EVER been told by a doctor or other health professional that you have some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia?” and “During the PAST THREE MONTHS, did you have ...Low back pain?” (CDC, 2015a).

The above studies show that relationships can be identified by analyzing the NHIS database, and these findings can be applied to informing policy or changing social norms. If we wish to track health indicators and trends in the US population over time, we must consider using population studies of large and consistent databases so that important factors and outcomes can be measured over time (Hallal et al., 2012). Given that physical activity is a modifiable risk factor and that it can have a large influence on potentially reducing the risk of recurrent stroke in stroke survivors, a study evaluating these relationships is needed.

Other studies have investigated activity in stroke survivors. For example, a study was performed to measure the prevalence of physical activity among stroke survivors compared to those without stroke in the US using the National Health and Nutrition Examination Survey (NHANES) (Butler & Evenson, 2014). This study included the self-report of levels of activity in addition to physical activity monitored by accelerometers in order to compare activity between groups. The authors found that those with stroke were less likely to follow activity recommendations compared to those without stroke. This study did not evaluate the association of other risk factors to physical activity; however, it did provide a baseline to estimate expected levels of physical activity for those with stroke. The authors found that 18% of those with stroke met activity guidelines compared to those without stroke (25%). They also found that compared to those without stroke, those with stroke performed less moderate (46% vs 55%) and vigorous (9% vs. 20%) activity (Butler & Evenson, 2014).

A systematic review by Morris et al. (2014) looked at interventions that promoted physical activity for stroke survivors. Of the 11 studies they identified, none showed definitive results and only tailored home exercises provided higher participation after 12 months (J. H. Morris et al., 2014). The authors reinforced that diverse approaches are needed and that future research should include dose of activity and a broad range of outcomes should be used including “behavioral, health, physical, and physiological outcomes” (J. H. Morris et al., 2014). These findings support the need for a study that will provide a multifactorial biopsychosocial approach and one that includes levels of physical activity.

The AHA recommends that all adults obtain a certain level of physical activity each week. These physical activity guidelines were originally published in 1995 and then were updated in 2007 (Haskell et al., 2007). Since that time, these guidelines have been recognized by the US government and are included in the publication 2008 Physical Activity Guidelines for Americans (http://health.gov/paguidelines/). The 2014 physical activity and exercise recommendations for stroke survivors endorsed by the AHA (Billinger et al., 2014), is an update to an earlier set of recommendations (Gordon et al., 2004) and support the 2008 Physical Activity Guidelines. These guidelines recommend that stroke survivors follow recommendations for activity, however, emphasize that modifications should be made for individuals’ needs. The 2014 AHA guideline recommended that future research should include stroke characteristics, and that individual/social factors be evaluated to understand barriers to activity in stroke survivors.

Selection of Dataset

Several national health surveys are used in the US to collect data about the health of its population. The NHIS was selected for this study for the following reasons. The NHIS is used as a major source of health information for the US population by the

National Center for Health Statistics (NCHS), which is a component of the Centers for Disease Control and Prevention (CDC). The criteria for selecting participants are that they are US civilians who are noninstitutionalized. Exclusion criteria include patients in long-term care, inmates in correctional facilities, active duty military, and U.S. citizens living outside of the country. Annually, a representative sample of households is selected to be surveyed by trained interviewers. The interview questions are standardized and are included in the NHIS field manual (Blackwell, 2015).

The National Health Survey Act of 1956 initiated the NHIS, which calls for a yearly survey to collect information on health and disability factors in the US (CDC, 2015a; NCHS, 2014). The NHIS findings are used by the Department of Health and Human Services (DHHS), public health, and epidemiological researchers to measure health trends and national health objectives. Thus, the NHIS is a recognized source for public health data, which is beneficial when communicating study results. If trends are to be measured over time, instrument consistency is essential. As well, this is a preferred instrument since it is recognized as a valid instrument and is used in health policy decisions at a national level.

The NHIS has been performed annually since 1957 (CDC, 2015a; Schiller, Lucas, & Peregoy, 2012) therefore can be used to track outcomes over time. The survey is a cross-sectional household interview survey of the US population that is done throughout the year. Each US region is sampled to ensure proper geographic distribution, and oversampling is done for some demographic groups to ensure proper representation. The survey is performed as an interview, which is done in person, and includes a battery of standardized questions and responses with follow-up questions. Households that are selected are sent a letter prior to the interview, which explains the purpose of the survey, that participation is voluntary, details about the procedures, and how the data will be used.

The questionnaire is divided into sections that group the questions into categories. The Family Core questions are given to each family in the household if there is more than one family present. A representative adult from the family is identified as the respondent who answers the questions for the family. The Sample Adult questionnaire includes questions that are directed to one randomly selected adult per family. In the sample adult file, a comprehensive battery of health-related questions has potential as independent variables for the proposed study. All information is processed in a confidential manner, no identifiers are made public, thus protecting the confidentiality of the participants (NCHS, 2014).

Other survey instruments, such as the National Health and Nutrition Examination Survey (NHANES) and the Behavioral Risk Factor Surveillance System (BRFSS) have also been used to collect information related to physical activity and stroke. A study by Carlson et al. (2009), suggests that each survey instrument has a different method of assessing physical activity and may result in different prevalence estimates thus caution should be taken if trying to compare one to the other (Carlson et al., 2009). The NHANES combines physical examinations with in person surveys, and the BRFSS is a state-based telephone survey. The NHANES focuses primarily on physical health and behavior questions (CDC, 2015c) thus is limited in mental health, psychological and sociological questions and therefore was not selected for the present study for these reasons. The BRFSS (CDC, 2015b) includes some questions about psychological and sociological factors however questions rotate, may not be consistent across years, and there is reportedly a lower response rate for BRFSS compared to NHIS (around 50% compared to around 70%) (Carlson et al., 2009). Due to the desire to have a large and representative sample for the present research, BRFSS was not selected for use in this study.

Selection of Variables

Based on the literature search, the variables for biological, psychological, and social factors that had the highest positive or negative associations related to physical activity as noted by Bauman et al. (2002) were compared to 2013 NHIS survey items. The files used to identify variables were the “2013 NHIS Public Use Variable Summary” and the “2013 NHIS Public Use Variable Layout” files that are found at http://www.cdc.gov/nchs/nhis.htm. All variables that related to adults were reviewed. Variables that were available in the 2013 NHIS were included if they were marked as high on the association list from Bauman et al. (2002) (Table 1). In addition, cardiovascular and musculoskeletal factors were also included since biological factors were not emphasized in the study by Bauman et al. (2002). The musculoskeletal and cardiovascular variables are justified to be included because of evidence that shows these may have an association with physical activity (Brittain et al., 2011; Gyurcsik et al., 2009; Lin et al., 2011; Wood, Connelly, & Maly, 2009). Variables were then arranged in congruence with the biopsychosocial theoretical foundation informing this research.

Table 1

Factors Associated with Barriers to Physical Activity

Biopsychosocial Factor	Correlates of physical activity that have had strong positive or negative associations	Variables from the 2013 NHIS Survey that match or are similar
Biological factors		
	Age	Age
	Gender	Sex
	Race/ethnicity	Race
	Pain	Joint pain, neck pain, back pain, arthritis Hypertension, coronary heart disease, angina pectoris, myocardial infarction, other heart disease
Psychological factors		
	Mood disturbance	Sadness, nervousness, restless, hopeless, effort, worthlessness
	Perceived health or fitness	Perceived health
Sociological factors		
	Physician influence	Health professional contact
	Social support from friends/peers	Neighborhood
	Social support from spouse/family	Married
	Income/socioeconomic status	Income, Region
	Education	Education

(Bauman et al., 2002; Brittain et al., 2011; Gyurcsik et al., 2009; Lin et al., 2011; Wood et al., 2009) compared to factors available in 2013 NHIS (CDC, 2015a; NCHS, 2014).

Summary and Conclusions

The literature shows that physical activity can have a preventive influence on the risk of stroke, including recurrent stroke for stroke survivors. Physical activity is a protective and modifiable behavior, but it is unknown which biopsychosocial factors may be associated with levels of physical activity in stroke survivors. The findings of this study aims to fill the research gap by identifying associations between the independent variables of NHIS biopsychosocial factors, including age, sex, BMI, race, musculoskeletal conditions, cardiovascular conditions, psychological distress, perceived health and sociological factors (i.e., income, education, family structure, marital status, region, neighborhood, healthcare professional contact) and the dependent variable physical activity. The following chapter will describe the research methods for this study. This includes the research design, methodology, population, data collection, operationalization, research questions, data analysis plan, threats to validity, and ethical procedures.

Chapter 3: Research Method

Introduction

The purpose of this quantitative cross-sectional study was to identify if selected NHIS biopsychosocial factors are associated with recommended levels of physical activity in US adult stroke survivors. This study aimed to produce positive social change by informing healthcare policy and prevention practices for groups at risk of recurrent stroke.

This chapter reviews the primary components of the research design and methods. These include the population, sampling, data collection, data analysis plan, operationalization of variables, threats to validity, and ethical procedures.

Research Design and Rationale

The study variables that were selected were biopsychosocial factors and the level of physical activity for those who reported that they had been told that they had a stroke. The dependent variable was based on the self-reported amount of physical activity. The independent variables were biological, psychological, and social factors that have an association with the level of physical activity, with particular relevance to stroke survivors. Biological independent variables included age, sex, BMI, race, musculoskeletal conditions (i.e., back pain, neck pain, joint pain, and arthritis), and cardiovascular conditions (i.e., hypertension, coronary heart disease, angina pectoris, myocardial infarction, and other heart disease). Psychological independent variables included psychological distress factors (i.e., sadness, nervousness, restlessness, feelings of hopelessness, amount of effort, and feelings of worthlessness) and perceived health.

Sociological factors included income, level of education, family structure, marital status, region, neighborhood, and contact with a healthcare provider in the past 12 months. For those who are reported that they were stroke survivors, this study measured if there was any association between the respondents' reported level of physical activity and the biopsychosocial factors that were included in the 2013 NHIS.

This cross-sectional quantitative epidemiological study uses secondary data analysis of the 2013 NHIS. A cross-sectional design is an appropriate epidemiological research design to use to explore the associations between biopsychosocial factors and levels of physical activity in stroke survivors (Katz, 2006). The purpose of this study was to measure association therefore a cross-sectional design was selected (Aschengrau & Seage, 2008; Katz, 2006; Rothman, 2002).

This study was a secondary data analysis; thus, the advantage was that data were in existence and the completion of the project would be feasible (Boslaugh, 2007). The advantage of the cross-sectional design is that data may be collected from large groups of people and will help identify relational hypotheses (Rothman, 2002). Cross-sectional designs are appropriate when time is limited and when the disease or disorder under study is of higher prevalence (Katz, 2006). As one of the leading global causes of mortality (Feigin et al., 2014) and the fourth leading cause of death in the US (Roger et al., 2012b), stroke may be considered a disease of high prevalence (Centers for Disease & Prevention, 2007; Muntner, Garrett, Klag, & Coresh, 2002). In that physical inactivity is prevalent in at least 50% of US adults (Mozaffarian et al., 2015), it should be considered highly prevalent and a cross-sectional design would be well suited to study these conditions

(Katz, 2006). Case-controlled studies are best suited for diseases of low prevalence. Case-controlled and cohort studies require many years to complete and are expensive; thus, time and resource limitations support the use of the cross-sectional design (Katz, 2006; Rothman, 2002). A disadvantage of a secondary data analysis design is that the data for the NHIS study have been previously collected (Boslaugh, 2007). Questions cannot be modified to meet different needs of the study, which limited the number of hypotheses that were tested.

Methodology

Population

The population for this study includes adults in the US who report having been diagnosed with a stroke. It is estimated that approximately 3% of the US population has been told they have had a stroke (Mozaffarian et al., 2015). There are approximately nine million stroke survivors in the US.

Sampling and Sampling Procedures

The annual NHIS questionnaire selects a representative sample of households using a multistage cluster sample design. This cross-sectional survey does sampling and interviewing throughout the year and uses a multistage area probability design to obtain a representative sampling. The Sample Adult Core section of the NHIS selects one randomly selected adult from the family being interviewed (NCHS, 2014). The questions relate to health information, physical activity, health behaviors, health services, and demographic information (e.g., age, sex, and race).

The NHIS is an annual survey that measures and monitors health of a representative sample of this population (Blackwell et al., 2014).

For this study, the sampling frame included adults who responded affirmatively that they had been told by a doctor or other healthcare professional that they had had a stroke. Based on the data from years 2011 and 2012, it was estimated that the total number of participants for the 2013 NHIS survey was between 33,000 and 35,000 respondents. Based on years 2011 and 2012, it was estimated that the total number of participants responding that they have been told they had a stroke would be between 1050 and 1100 participants http://www.cdc.gov/nchs/nhis.htm.

G*Power 3.1.9.2 for Windows (Universität Düsseldorf, Germany) was used to perform a power analysis to determine the minimal number of subjects needed for the regression analysis. Cohen's *a priori* method (J. Cohen, 1988) was used using a medium effect size. Alpha was set at 0.05 (two-tailed) and the recommended power of 0.95 was chosen (Faul, Erdfelder, Buchner, & Lang, 2009). A conservative odds ratio of 1.3 was calculated into the power analysis. Thus, G*Power suggested 777 subjects were required for the logistic regression (Figure 4). Given that previous NHIS datasets contained more than 1,000 respondents who were stroke survivors (n = 1,113 in 2012), the 2013 dataset contained the minimum number of subjects necessary to determine an effect between variables.

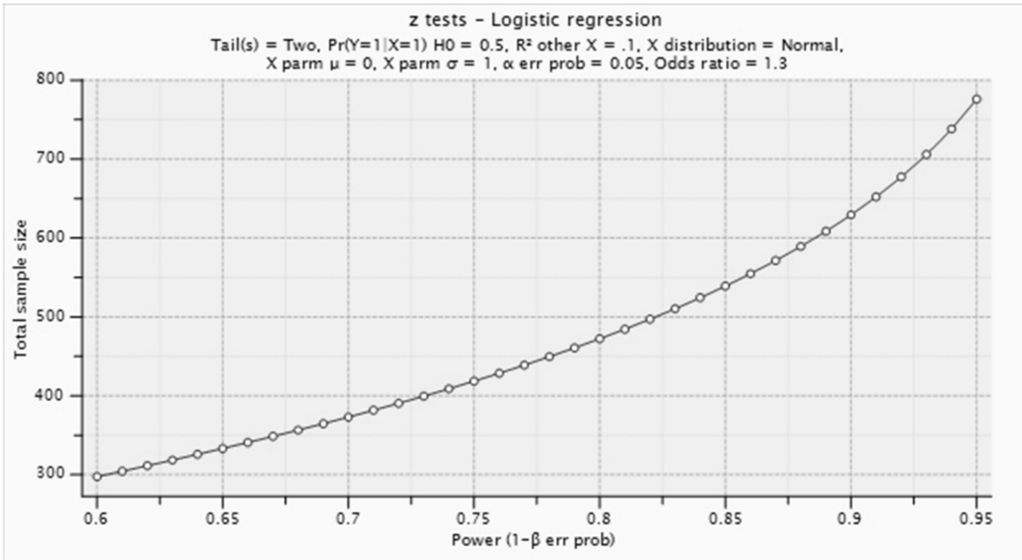

Figure 4. Analysis to determine the number of subjects for this study. Figure printed using Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. Behavior Research Methods, 41, 1149-1160.

Data Collection Procedures

There was no direct recruitment for this study, as the data had already been collected from the participants, and all responses had been de-identified. The NHIS is an open source set of annual data; therefore, no permissions were required. The surveys were organized by year. The reason that the 2013 dataset was selected is that this was the most recent collection of NHIS data at the time of this study.

The Walden Institutional Review Board approved this study (09-03-15-0117020).

Source files

There were three sources for the selected variables for this study, each of them from the 2013 NHIS materials. After Walden IRB approved the proposal, the groups of descriptive files and data files were downloaded from the CDC website.

http://www.cdc.gov/nchs/nhis.htm. The Adult Sample and Person files were downloaded as compressed data files. The three files that house the selected variables include: Sample Adult, Person, and Family files. The data are available in various formats. The SPSS version was downloaded for this study. Once the files were downloaded, they were merged so that all selected variables could be evaluated.

Operationalization of Constructs

Details regarding the selected variables from the 2013 NHIS survey are included in Table 2. The dependent variable is the level of physical activity that individuals report. Levels of activity include amount of vigorous or light/moderate physical activity per week and were calculated to identify if the individual was following or was not following the AHA recommendations for levels of physical activity per week (Billinger et al., 2014; Nelson, Rejeski, Blair, Duncan, Judge, King, Macera, Castaneda-Sceppa, et al., 2007). The AHA recommendations include activity of moderate intensity for at least 30 minutes five days per week (i.e., 150 minutes of moderate exercise), or at least 25 minutes of vigorous activity for at least three days per week (i.e., 75 minutes of vigorous exercise). These figures were calculated from the survey items that frequency, duration, and level of physical activity per week. Physical activity was coded as either adequate or inadequate.

Independent variables were selected because they were shown to be risk factors or have been identified as potential confounders based on published research. The biological independent variables include the individual characteristics age, sex, BMI, and race. These variables were selected as they have been shown to be associated with levels of physical activity (Mozaffarian et al., 2015).

The biological independent variables for individual characteristics are age, sex, BMI, and race. Age data are collected as a continuous variable reported by year. Age was re-coded to the following categories: (a) 18 to 44, (b) 45 to 54, (c) 55 to 64, (d) 65 to 74, (e) 75 to 84, and (f) 85 and older. Sex information is a nominal variable and collected as either male or female. Body mass index as described by Keys et al. was calculated from the height and weight variables (i.e., BMI = weight /height^2) (Keys et al., 1972). Height was reported in inches and weight was reported in pounds. The BMI was categorized into the following categories: (a) underweight BMI < 18.5, (b) healthy weight is BMI 18.5 to <25, and (c) overweight is BMI > = 25 to <30; obese is BMI > = 30. Race data were collected through two questions that asked for self-identified race. These two questions included if the person considered themselves of Hispanic or Latino origin and the other asks specifically for race labels (i.e., White, Black/African American, Indian (American), Alaska Native, Asian Indian, Chinese, Filipino, Other Asian, Primary race not releasable, Multiple race). Race resulted in the following categories: (a) White, (b) non-Hispanic, (c) Black, (d) non-Hispanic, (e) Hispanic, and (f) Other/multiple race.

Musculoskeletal biological independent variables that were condition and symptom related included: (a) joint pain, (b) arthritis, (c) back pain, and (d) neck pain. Musculoskeletal pain and arthritis are recognized as contributing factors to reduced physical activity (Brittain et al., 2011). The biological independent variables were condition and symptom related variables. The joint pain variable identified if the individual experienced any pain or stiffness around a joint in the past 30 days, except in the neck or back. The neck and back pain variables identified if the individual experienced neck or back pain in the past 30 days. The arthritis variable was obtained through the response to the question "Have you ever been told by a doctor or other health professional that you have some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia?" The categorical responses for joint pain, arthritis, back pain and neck pain included: (a) yes, (b) no, (c) refused, (d) do not know, or (e) not ascertained and were re-coded for statistical analysis.

The biological independent variables related to cardiovascular diseases included: (a) hypertension, (b) coronary heart disease, (c) angina pectoris, (d) myocardial infarction, and (e)other heart disease. Each of these variables identified if the individual had been diagnosed by a doctor or other health professional for one or more of these conditions. The cardiovascular disease variables were re-coded so that no disease was identified as "none" and one or more were identified as "present."

Psychological factors have been linked with the level of physical activity in adults (Booth et al., 2000; Brawley et al., 2003; Lim & Taylor, 2005; Vahlberg, Cederholm, Lindmark, Zetterberg, & Hellstrom, 2013). The psychological independent variables included the Non-Specific Distress Battery of six questions, known as the K6, which have been included in the NHIS since 1997 (Kessler et al., 2002; Kessler et al., 2003) and are considered a valid instrument to measure psychological distress (Khan, Chien, & Burton, 2014). The 2013 NHIS includes the K6, which asked "During the PAST 30 DAYS, how often did you feel..." (a) "So sad that nothing could cheer you up?", (b) "Nervous?", (c) "Restless or fidgety?", (d) "Hopeless?", (e) "That everything was an effort?", and (f) "Worthless?" The responses to these six questions were based on a

Likert scale and rated as follows: (a) “all of the time, (b) most of the time, (c) some of the time, (d) a little of the time, and (e) none of the time.” The K6 was re-coded as a categorical variable using pre-published thresholds for mental health (Andrews & Slade, 2001; Kessler et al., 2003). For rating, I used a cut-off score of 13 that represents severe mental distress (Kessler et al., 2010; Prochaska et al., 2012). The psychological factor of perceived health was a global score and was measured by asking if the person perceived their “health in general is excellent, very good, good, fair, or poor?”

The sociological independent variables related to living status (e.g., living alone, divorced), education, neighborhood factors, contact with health professionals, region, and income. The family status variable captures information about others that were living with the individual, such as if the person was living alone, with relatives, or roommates. This variable was re-coded into two variables: living alone and living with others. The marriage status variable identified if the person had a significant other or spouse by asking the question “Are/Is, you/person now married, widowed, divorced, separated, never married, or living with a partner?” These responses were re-coded into categories: with spouse/partner and without spouse/partner. Region where the participant was located was recorded in the survey as: (a) Northeast, (b) Midwest, (c) South, or (d) West. The educational variable was recorded on a continuous scale and asked the respondents for their highest level of education. For the purposes of this study, the level of education was re-coded into four categories: (a) less than high school, (b) high school, (c) some college, and (d) college graduate or higher. The income variable captured the reported amount of income for the family home. The responses were categorized into ranges of income and was re-coded and to address missing or unreported data. Interaction with a healthcare professional in the past 12 months was measured through the question that asked if the respondent had seen one or more of the following healthcare providers: (a) mental health professional, (b) eye doctor, (c) foot doctor, (d) chiropractor, (e) physical therapist, (f) nurse, (g) women's health doctor, (h) other medical specialist, and (i) general practitioner. These were re-coded using the following method; if no health specialist was seen in the past 12 months, the response was re-coded as "0" and if one or more were seen in the past 12 months, the response was re-coded as "1". The set of neighborhood variables identified if the participant perceived that the people in the neighborhood in which they lived could: (a) provide help, (b) can be counted on, (c) can be trusted, and (d) if the neighborhood is close-knit. The neighborhood variables were re-coded so that a negative response was identified as "none" and one or more was identified as "present."

Table 2

Variable Description Table; Variables from the National health Interview Survey 2013

NHIS Variable	NHIS Code	NHIS File Location, Question #	Data Scale	Survey Question	Response Options
POPULATION: PEOPLE WITH STROKE WHO RESPONDED TO 2013 NHIS					
Stroke	STREV	Sample Adult, ACN.031_05.000	Categorical	Have you EVER been told by a doctor or other health professional that you had...A stroke?	Yes, No, Refused, Not ascertained, Don't know
PHYSICAL ACTIVITY: DEPENDENT VARIABLE (OUTCOME)					
Physical activity level was calculated from the variables using the AHA 2008 criteria (i.e., criteria = 150 minutes of moderate activity or 75 minutes of vigorous activity, or a combination of the above). Those who reported participating in moderate physical activity for 150 minutes per week were considered compliant, whereas those who reported 149 minutes or less per week were considered non-compliant according to the guidelines. The calculation of activity level used the following equation: [(VIGFREQW)*(VIGMIN)*2] +[(MODFREQW)*(MODMIN)] = minutes This was transformed into 149 or less = non-compliant and 150 or more = compliant.					
NHIS Variable	**NHIS Code**	**NHIS File Location, Question #**	**Data Scale**	**Survey Question**	**Response Options**
Vigorous Physical Activity Frequency	VIGFREQW	Sample Adult, AHB.090_02.000	Continuous	How often do you do VIGOROUS leisure-time physical activities for AT LEAST 10 MINUTES that cause HEAVY sweating or LARGE increases in breathing or heart rate?	Less than once per week, 1-28 times per week, Never, Unable to do vigorous activity, Refused, Not ascertained, Don't know
Vigorous Physical Activity Duration	VIGMIN	Sample Adult, AHB.100_02.000	Continuous	About how long do you do these vigorous leisure-time physical activities each time?	10-720 minutes, Refused, Not ascertained, Don't know
Light or Moderate Physical Activity Frequency	MODFREQW	Sample Adult, AHB.110_02.000	Continuous	How often do you do LIGHT OR MODERATE leisure-time physical activities for AT LEAST 10 MINUTES that cause ONLY LIGHT sweating or a SLIGHT to MODERATE increase in breathing or heart rate?	Less than once per week, 1-28 times per week, Never, Unable to do vigorous activity, Refused, Not ascertained, Don't know
Light or Moderate Physical Activity Duration	MODMIN	Sample Adult, AHB.120_02.000	Continuous	About how long do you do these light or moderate activities each time?	10-720 minutes, Refused, Not ascertained, Don't know
BIOLOGICAL INDIVIDUAL CHARACTERISTICS: INDEPENDENT VARIABLES					
NHIS Variable	**NHIS Code**	**NHIS File Location, Question #**	**Data Scale**	**Survey Question**	**Response Options**
Age	AGE_P	Sample Adult, HHC.420_00.000	Continuous.	How old are you?	Under 1 year, 1-84 years, 85+ years This variable was transformed into categorical (18 to 44, 45 to 54, 55 to 64, 65 to 74, 75 to 84, and 85+ over)
Sex	SEX	Sample Adult, HHC.110_00.000	Nominal	Are you male or female?	Yes, No

BMI	BMI	Sample Adult, AHB.200_02.000	Categorical	How much do you weigh without shoes? How tall are you without shoes?	Calculated from height and weight underweight is BMI < 18.5; healthy weight is BMI 18.5 to <25; overweight is BMI > = 25 to <30; obese is BMI > = 30.
Race/Ethnicity	HISCODI3	Person, HHC.200_01.000	Categorical	Recode from Sources: HHC.200; HHC.220	Hispanic Non-Hispanic White Non-Hispanic Black Non-Hispanic Asian Non-Hispanic All other race groups

BIOLOGICAL CONDITIONS: INDEPENDENT VARIABLES

NHIS Variable	NHIS Code	NHIS File Location, Question #	Data Scale	Survey Question	Response Options
Joint Pain	JNTSYMP	Sample Adult, ACN.250_00.000	Categorical	The next questions refer to your joints. Please do NOT include the back or neck. DURING THE PAST 30 DAYS, have you had any symptoms of pain, aching, or stiffness in or around a joint?	Yes, No, Refused, Not ascertained, Don't know
Arthritis	ARTH1	Sample Adult, ACN.290_00.000	Categorical	Have you EVER been told by a doctor or other health professional that you have some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia?	Yes, No, Refused, Not ascertained, Don't know
Neck Pain	PAINECK	Sample Adult, ACN.300_00.000	Categorical	During the PAST THREE MONTHS, did you have ...Neck pain? Please refer to pain that LASTED A WHOLE DAY OR MORE.	Yes, No, Refused, Not ascertained, Don't know
Back Pain	PAINLB	Sample Adult, ACN.310_00.000	Categorical	During the PAST THREE MONTHS, did you have ...Low back pain? Please refer to pain that LASTED A WHOLE DAY OR MORE.	Yes, No, Refused, Not ascertained, Don't know
Hypertension	HYPEV	Sample Adult, ACN.010_00.000	Categorical	Have you EVER been told by a doctor or other health professional that you had... Hypertension, also called high blood pressure?	Yes, No, Refused, Not ascertained, Don't know
Coronary heart disease	CHDEV	Sample Adult, ACN.031_01.000	Categorical	Have you EVER been told by a doctor or other health professional that you had ... Coronary heart disease?	Yes, No, Refused, Not ascertained, Don't know
Angina pectoris	ANGEV	Sample Adult, ACN.031_02.000	Categorical	Have you EVER been told by a doctor or other health professional that you had ... Angina, also called angina pectoris?	Yes, No, Refused, Not ascertained, Don't know

Myocardial infarction	MIEV	Sample Adult, ACN.031_03.000	Categorical	Have you EVER been told by a doctor or other health professional that you had ...A heart attack (also called myocardial infarction)	Yes, No, Refused, Not ascertained, Don't know
Other heart disease	HRTEV	Sample Adult, ACN.031_04.000	Categorical	Have you EVER been told by a doctor or other health professional that you had ...Any kind of heart condition or heart disease (other than the ones I just asked about)?	Yes, No, Refused, Not ascertained, Don't know
		PSYCHOLOGICAL: INDEPENDENT VARIABLES			
NHIS Variable	**NHIS Code**	**NHIS File Location, Question #**	**Data Scale**	**Survey Question**	**Response Options**
Sadness	ASISAD	Sample Adult, ASI.390_01.000	Categorical	DURING THE PAST 30 DAYS, how often did you feel…so sad that nothing could cheer you up?	ALL of the time, MOST of the time, OME of the time, A LITTLE of the time, NONE of the time, Refused, Not ascertained, Don't know
Nervousness	ASINERV	Sample Adult, ASI.390_02.000	Categorical	During the PAST 30 DAYS, how often did you feel...nervous?	ALL of the time, MOST of the time, OME of the time, A LITTLE of the time, NONE of the time, Refused, Not ascertained, Don't know
Restless	ASIRSTLS	Sample Adult, ASI.390_03.000	Categorical	During the PAST 30 DAYS, how often did you feel... restless or fidgety?	ALL of the time, MOST of the time, OME of the time, A LITTLE of the time, NONE of the time, Refused, Not ascertained, Don't know
Hopeless	ASIHOPLS	Sample Adult, ASI.390_04.000	Categorical	During the PAST 30 DAYS, how often did you feel... hopeless?	ALL of the time, MOST of the time, OME of the time, A LITTLE of the time, NONE of the time, Refused, Not ascertained, Don't know
Effort	ASIEFFRT	Sample Adult, ASI.390_05.000	Categorical	During the PAST 30 DAYS, how often did you feel... that everything was an effort?	ALL of the time, MOST of the time, OME of the time, A LITTLE of the time, NONE of the time, Refused, Not ascertained, Don't know
Worthless	ASIWTHLS	Sample Adult, ASI.390_06.000	Categorical	During the PAST 30 DAYS, how often did you feel... worthless?	ALL of the time, MOST of the time, OME of the time, A LITTLE of the time, NONE of the time, Refused, Not ascertained, Don't know
Perceived Health	PHSTAT	Person, FHS.500_00.000	Categorical	Would you say (your/ALIAS's) health in general is excellent, very good, good, fair, or poor?	Excellent Very good Good Fair Poor Refused Not ascertained Don't know

SOCIOLOGICAL: INDEPENDENT VARIABLES

Family Structure	FM_STRP	Family, MFM.000_00.000	Categorical	Recode by NHIS from FM_TYPE; FMOTHER1; FFATHER1; MOM_DEG; DAD_DEG; FRRP; R_MARITL	Living alone Living with roommate(s) Married couple Unmarried couple All other adult-only families Mother and biological or non-biological child(ren) only Father and biological or non-biological child(ren) only All other single-adult and child(ren) families Married parents with biological/adoptive child(ren) only Cohabiting parent(s) with child(ren) only Parent (biological or adoptive), step parent, and child(ren) only At least 1 (biological or adoptive) parent and 1+ child(ren), and other related adults Other related and/or unrelated adults, 1+ child(ren), no biological or adoptive parent(s) Unknown
Marital Status	R_MARITL	Sample Adult, FID.250_00.000	Categorical	Are/Is, you/person now married, widowed, divorced, separated, never married, or living with a partner?	Under 14 years Married - spouse in household Married - spouse not in household Married -spouse in household unknown Widowed Divorced Separated Never married Living with partner Unknown marital status
Region	REGION	Sample Adult, UCF.000_00.000	Categorical	Data from Unit Control File	Northeast Midwest South West
Neighborhood Help	ASINHELP	Sample Adult, ASI.160_00.000	Categorical	How much do you agree or disagree with the following statements about your neighborhood? People in this neighborhood help each other out.	Definitely agree Somewhat agree Somewhat disagree Definitely disagree Refused Not ascertained Don't know
Neighborhood Count On	ASINCNTO	Sample Adult, ASI.170_00.000	Categorical	How much do you agree or disagree with the following statements about your neighborhood? There are people I can count on in this neighborhood.	Definitely agree Somewhat agree Somewhat disagree Definitely disagree Refused Not ascertained Don't know
Neighborhood Trusted	ASINTRU	Sample Adult, ASI.180_00.000	Categorical	How much do you agree or disagree with the following statements about your neighborhood? People in this neighborhood can be trusted.	Definitely agree Somewhat agree Somewhat disagree Definitely disagree Refused Not ascertained Don't know
Neighborhood	ASINKNT	Sample Adult,	Categorical	How much do you	Definitely agree

Close-knit		ASI.190_00.000		agree or disagree with the following statements about your neighborhood? This is a close-knit neighborhood.	Somewhat agree Somewhat disagree Definitely disagree Refused Not ascertained Don't know
Income	INCGRP3	Family, FIN.250_00.000	Categorical	Did [you/any family members living here] receive income in [the last calendar year] from ...	$0 - $34,999 $35,000 -$49,999 $50,000 -$74,999 $75,000 -$99,999 $100,000 and over $0 - $49,999 (no further detail) $50,000 and over (no further detail) $50,000 - $99,999 (no further detail) Unknown
Education	EDUC1	Person File, FSD.010_00.000	Categorical	What is the HIGHEST level of school [fill: you have/ALIAS has] completed or the highest degree [fill: you have/ALIAS has] received?	Never attended/kindergarten only 1st grade 2nd grade 3rd grade 4th grade 5th grade 6th grade 7th grade 8th grade 9th grade 10th grade 11th grade 12th grade, no diploma GED or equivalent High School Graduate Some college, no degree Associate degree: occupational, technical, or vocational program Associate degree: academic program Bachelor's degree (Example: BA, AB, BS, BBA) Master's degree (Example: MA, MS, MEng, MEd, MBA) Professional School degree (Example: MD, DDS, DVM, JD) Doctoral degree (Example: PhD, EdD) Child under 5 years old Refused Don't know
Mental health professional	AHCSYR1	Sample Adult, AAU.141_01.000	Categorical	DURING THE PAST 12 MONTHS, have you seen or talked to any of the following health care providers about your own health? ..... A mental health professional such as a psychiatrist, psychologist, psychiatric nurse, or clinical social worker	Yes, No, Refused, Not ascertained, Don't know
Eye doctor	AHCSYR2	Sample Adult, AAU.141_02.000	Categorical	DURING THE PAST 12 MONTHS, have you seen or talked to any of the following health care providers about your own health? ..... An	Yes, No, Refused, Not ascertained, Don't know

				optometrist, ophthalmologist, or eye doctor (someone who prescribes eyeglasses)	
Foot doctor	AHCSYR3	Sample Adult, AAU.141_03.000	Categorical	DURING THE PAST 12 MONTHS, have you seen or talked to any of the following health care providers about your own health? ..... A foot doctor	Yes, No, Refused, Not ascertained, Don't know
Chiropractor	AHCSYR4	Sample Adult, AAU.141_04.000	Categorical	DURING THE PAST 12 MONTHS, have you seen or talked to any of the following health care providers about your own health? ..... A chiropractor	Yes, No, Refused, Not ascertained, Don't know
Physical therapist	AHCSYR5	Sample Adult, AAU.141_05.000	Categorical	DURING THE PAST 12 MONTHS, have you seen or talked to any of the following health care providers about your own health? ..... A physical therapist, speech therapist, respiratory therapist, audiologist, or occupational therapist	Yes, No, Refused, Not ascertained, Don't know
Nurse	AHCSYR6	Sample Adult, AAU.141_06.000	Categorical	DURING THE PAST 12 MONTHS, have you seen or talked to any of the following health care providers about your own health? ..... A nurse practitioner, physician assistant, or midwife	Yes, No, Refused, Not ascertained, Don't know
Women's health doctor	AHCSYR7	Sample Adult, AAU.200_00.000	Categorical	DURING THE PAST 12 MONTHS, have you seen or talked to any of the following health care providers about your own health? ..... A doctor who specializes in women's health (an obstetrician/gynecologist)?	Yes, No, Refused, Not ascertained, Don't know
Other medical specialist	AHCSYR8	Sample Adult, AAU.211_01.000	Categorical	DURING THE PAST 12 MONTHS, have you seen or talked to any of the following health care providers about your own health? ..... A medical doctor who specializes in a particular medical disease or problem (other than obstetrician/gynecologist, psychiatrist or ophthalmologist)?	Yes, No, Refused, Not ascertained, Don't know

General practitioner	AHCSYR9	Sample Adult, AAU.211_02.000	Categorical	DURING THE PAST 12 MONTHS, have you seen or talked to any of the following health care providers about your own health? ..... A general doctor who treats a variety of illnesses (a doctor in general practice, family medicine, or internal medicine)	Yes, No, Refused, Not ascertained, Don't know

There were several assumptions that were held to be true for the study variables. These include the following. It was assumed that observations were independent. It was assumed that the natural log of the odds ratio and the measurement variables had a linear relationship. There were no assumptions that the variables were normally distributed.

Research Questions and Hypotheses

This study aimed to identify if recommended levels of physical activity are associated with 2013 NHIS biopsychosocial factors for stroke survivors. The purpose of this study was to assess the association between recommended levels of physical activity and the available NHIS biopsychosocial factors among stroke survivors. The following research questions and hypotheses were analyzed in this study:

Research Question 1

1. Is there a significant association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and individual NHIS biological individual characteristics (age, BMI, race/ethnicity, and sex), among US stroke survivors?

Hypothesis 1

$H_0 1$: There is no association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and individual NHIS biological individual characteristics (age, BMI, race/ethnicity, and sex), among US stroke survivors.

Ha1: There is an association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and individual NHIS biological individual characteristics (age, BMI, race/ethnicity, and sex), among US stroke survivors.

Research Question 2

2. Is there a significant association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and NHIS biological conditions (musculoskeletal conditions (i.e., joint pain, arthritis, neck pain, and back pain) and cardiovascular conditions (i.e., hypertension, coronary heart disease, angina pectoris, myocardial infarction, and 'other' heart diseases), among US stroke survivors?

Hypothesis 2

H_02: There is no association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and NHIS biological conditions (musculoskeletal conditions (i.e., joint pain, arthritis, neck pain, and back pain) and cardiovascular conditions (i.e., hypertension, coronary heart disease, angina pectoris, myocardial infarction, and 'other' heart diseases), among US stroke survivors.

Ha2: There is an association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and NHIS biological conditions (musculoskeletal conditions (i.e., joint pain, arthritis, neck pain, and back pain) and cardiovascular conditions (i.e., hypertension, coronary heart disease, angina pectoris, myocardial infarction, and 'other' heart diseases), among US stroke survivors.

Research Question 3

3. Is there a significant association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and NHIS psychological variables, which includes perceived health and the Kessler scale for mental distress (i.e., sadness, nervousness, restless, hopeless, effort, and worthlessness), among US stroke survivors?

Hypothesis 3

$H_0 3$: There is no association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and NHIS psychological variables, which includes perceived health and the Kessler scale for mental distress (i.e., sadness, nervousness, restless, hopeless, effort, and worthlessness), among US stroke survivors.

Ha3: There is an association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and NHIS psychological variables, which includes perceived health and the Kessler scale for mental distress (i.e., sadness, nervousness, restless, hopeless, effort, and worthlessness), among US stroke survivors.

Research Question 4

4. Is there a significant association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and NHIS sociological variables (i.e., education, family structure, income, marital status, region, neighborhood (i.e., neighborhood help, neighborhood count on, neighborhood trusted, and neighborhood close-knit), contact with a health care professional in the past 12 months (i.e., mental health professional, eye doctor, foot doctor, chiropractor, physical therapist, nurse, women's health doctor, other medical specialist, and general practitioner), among US stroke survivors?

Hypothesis 4

$H_0$4: There is no association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and NHIS sociological variables (i.e., education, family structure, income, marital status, region, neighborhood (i.e., neighborhood help, neighborhood count on, neighborhood trusted, and neighborhood close-knit), contact with a health care professional in the past 12 months (i.e., mental health professional, eye doctor, foot doctor, chiropractor, physical therapist, nurse, women's health doctor, other medical specialist, and general practitioner), among US stroke survivors.

Ha4: There is an association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and NHIS sociological variables (i.e., education, family structure, income, marital status, region, neighborhood (i.e., neighborhood help, neighborhood count on, neighborhood trusted, and neighborhood close-knit), contact with a health care professional in the past 12 months (i.e., mental health professional, eye doctor, foot doctor, chiropractor, physical therapist, nurse, women's health doctor, other medical specialist, and general practitioner), among US stroke survivors.

Research Question 5

5. Is there a biopsychosocial, multivariable logistic regression model based on the NHIS variables identified by the answers to questions one through four that can predict the level of activity for US stroke survivors?

Hypothesis 5

$H_0$5: There is no viable biopsychosocial, multivariable logistic regression model based on NHIS variables that can predict the level of activity for US stroke survivors.

Ha5: There is a viable biopsychosocial, multivariable logistic regression model based on NHIS variables that can predict the level of activity for US stroke survivors.

Data Analysis Plan

Inclusion of Covariates

Table 3 summarizes the proposed biopsychosocial variables from the 2013 NHIS survey. Variables for biological, psychological, and social factors that had the highest positive or negative associations related to physical activity as noted by Bauman et al. (2002) that were included in the 2013 NHIS survey items were selected for this study. Variables were arranged in congruence with the biopsychosocial theoretical foundation informing this research.

Table 3

Variables Selected Based Upon Items in the 2013 NHIS

	POPULATION: PEOPLE WITH STROKE WHO RESPONDED TO 2013 NHIS			
	NHIS Variable	**NHIS Code**	**NHIS File Location**	**Data Scale**
Population	**Stroke**	**STREV**	**Sample Adult**	**Categorical**
	PHYSICAL ACTIVITY: DEPENDENT VARIABLE (OUTCOME)			
	NHIS Variable	**NHIS Code**	**NHIS File Location**	**Data Scale**
Physical activity	**Vigorous Physical Activity Frequency**	**VIGFREQW**	**Sample Adult**	**Continuous**
	Vigorous Physical Activity Duration	**VIGMIN**	**Sample Adult**	**Continuous**
	Light or Moderate Physical Activity Frequency	**MODFREQW**	**Sample Adult**	**Continuous**
	Light or Moderate Physical Activity Duration	**MODMIN**	**Sample Adult**	**Continuous**
	BIOLOGICAL INDIVIDUAL CHARACTERISTICS: INDEPENDENT VARIABLES			
	NHIS Variable	**NHIS Code**	**NHIS File**	**Data Scale**
	Age	AGE_P	Sample Adult	Continuous
	BMI	BMI	Sample Adult	Categorical
	Race/Ethnicity	HISCODI3	Person	Categorical
	Sex	SEX	Sample Adult	Nominal
	BIOLOGICAL CONDITIONS: INDEPENDENT VARIABLES			
	NHIS Variable	**NHIS Code**	**NHIS File**	**Data Scale**
Musculoskeletal (one or more)	**Joint Pain**	JNTSYMP	Sample Adult	Categorical
	Arthritis	ARTH1	Sample Adult	Categorical
	Neck Pain	PAINECK	Sample Adult	Categorical
	Back Pain	PAINLB	Sample Adult	Categorical
Cardiovascular (one or more)	**Hypertension**	HYPEV	Sample Adult	Categorical
	Coronary heart disease	CHDEV	Sample Adult	Categorical
	Angina pectoris	ANGEV	Sample Adult	Categorical
	Myocardial infarction	MIEV	Sample Adult	Categorical
	Other heart disease	HRTEV	Sample Adult	Categorical
	PSYCHOLOGICAL: INDEPENDENT VARIABLES			
	NHIS Variable	**NHIS Code**	**NHIS File**	**Data Scale**
	Perceived Health	PHSTAT	Person	Categorical
Mental distress (Kessler scale)	**Sadness**	ASISAD	Sample Adult	Categorical
	Nervousness	ASINERV	Sample Adult	Categorical
	Restless	ASIRSTLS	Sample Adult	Categorical
	Hopeless	ASIHOPLS	Sample Adult	Categorical
	Effort	ASIEFFRT	Sample Adult	Categorical
	Worthless	ASIWTHLS	Sample Adult	Categorical
	SOCIOLOGICAL: INDEPENDENT VARIABLES			
	NHIS Variable	**NHIS Code**	**NHIS File**	**Data Scale**
	Education	EDUC1	Person	Categorical
	Family Structure	FM_STRCP	Family	Categorical
	Income	INCGRP3	Family	Categorical
	Marital Status	R_MARITL	Sample Adult	Categorical
	Region	REGION	Sample Adult	Categorical
Neighborhood (two or more)	**Neighborhood Help**	ASINHELP	Sample Adult	Categorical
	Neighborhood Count On	ASINCNTO	Sample Adult	Categorical
	Neighborhood Trusted	ASINTRU	Sample Adult	Categorical
	Neighborhood Close-knit	ASINKNT	Sample Adult	Categorical
Health profession contact (one or more)	**Mental health professional**	AHCSYR1	Sample Adult	Categorical
	Eye doctor	AHCSYR2	Sample Adult	Categorical
	Foot doctor	AHCSYR3	Sample Adult	Categorical
	Chiropractor	AHCSYR4	Sample Adult	Categorical
	Physical therapist	AHCSYR5	Sample Adult	Categorical
	Nurse	AHCSYR6	Sample Adult	Categorical
	Women's health doctor	AHCSYR7	Sample Adult	Categorical
	Other medical specialist	AHCSYR8	Sample Adult	Categorical
	General practitioner	AHCSYR9	Sample Adult	Categorical

Statistical software. The statistical software that was used to analyze the data was SPSS (IBM SPSS Statistics V21.0).

Data cleaning and screening. The data were reviewed. Variables were examined for correct frequencies that matched NHIS reported frequencies. Data that were missing were re-coded in SPSS as "system missing." Data entry or coding errors were searched for. Outliers were sought by using descriptive functions in SPSS (e.g. histograms, boxplots).

Verification of assumptions for statistical tests. The variables were evaluated prior to logistic regression analysis. The relationship between independent variables was evaluated to identify if there was multicollinearity between variables. If multicollinear variables had been found, Katz (2011) recommended several approaches. The variables could be omitted, combined using an "and/or" clause, or a scale could be created (Katz, 2011a). It was assumed that the variables for chi-square had a minimum of five results in each category and that a minimum of 15 independent variables would be present for logistic regression. This study met these criteria.

Statistical tests. Baseline characteristics of self-reported biopsychosocial variables were initially calculated to show the distribution of characteristics of the study population. The statistical tests conducted for each research question are shown in Table 4. The chi-square test for association was used to determine whether categorical independent variables were associated with the dependent variable. For chi-square with multiple comparisons, to protect against type I errors, a Bonferroni correction was completed (Munro, 2005). Statistical significance was set as $\alpha < .05$. Multiple logistic regression was used to predict the probability of the dependent variable based on one or more independent variables (Katz, 2011b).

Table 4

Statistical Analyses Conducted: Research Question and Corresponding Null Hypothesis

Research Question	Null Hypothesis	Dependent Variable	Independent Variables (underline indicates a score calculated from multiple variables)	Statistical Procedure
1. Is there a significant association between physical activity and individual biological characteristics among US stroke survivors?	Ho1: There is no association between physical activity and individual biological factors among US stroke survivors.	Follow AHA physical activity recommendations Dichotomous	Age (categorical) BMI (categorical) Race/ethnicity (categorical) Sex (categorical)	chi-square with Bonferroni correction
2. Is there a significant association between physical activity and biologically-based health conditions among US stroke survivors?	Ho2: There is no association between physical activity and biologically-based health conditions among US stroke survivors.	Follow AHA physical activity recommendations Dichotomous	Musculoskeletal (categorical) Cardiovascular (categorical)	chi-square
3. Is there a significant association between physical activity and psychological factors among US stroke survivors?	Ho3: There is no association between physical activity and psychological factors among US stroke survivors.	Follow AHA physical activity recommendations Dichotomous	Kessler scale (K6) (categorical) Perceived health (categorical)	chi-square
4. Is there a significant association between physical activity and sociological factors among US stroke survivors?	Ho4: There is no association between physical activity and sociological factors among US stroke survivors.	Follow AHA physical activity recommendations Dichotomous	Education (categorical) Family structure (categorical) Health professional contact (categorical) Income (categorical) Married (categorical) Neighborhood (categorical) Region (categorical)	chi-square with Bonferroni correction
5. Is there a biopsychosocial, multivariable logistic model that can predict the level of activity for	Ho5: There is no viable biopsychosocial, multivariable logistic model that can predict	Follow AHA physical activity recommendations Dichotomous	Age Angina pectoris Arthritis Back pain BMI	multivariable logistic regression

US stroke survivors?	the level of activity for US stroke survivors.		Coronary heart disease Education Family structure Health professional contact Hypertension Income Joint pain K6 Married Myocardial infarction Neck pain Neighborhood Other heart disease Perceived health Race/ethnicity Region Sex

Note. US = United States, BMI = body mass index, AHA = American Heart Association, K6 = Kessler 6 Psychological Distress Scale.

Interpretation of results. The statistical tests were run using SPSS. Chi–square was used to test the association of the categorical variables to identify if the variables were independent or not. The expectation was that there would be greater than five responses in each category. Measures of effect size were calculated using Phi (for two by two tables) and Cramer's V (for those associations with more variables). These measured strength of association. The results of chi-square were reported in a symmetric measures table for each of the variable relationships. For those with multiple pairwise comparisons, a Bonferroni correction was made (Munro, 2005).

Logistic regression evaluated the probability of a dependent variable given the independent variables, where the dependent variable was dichotomous (physical activity) and the independent variables were categorical (biopsychosocial variables). The independent variables that showed association in chi-square were included in a logistic regression model. Results were presented in a classification table showing percentages each variable contributed, degrees of freedom and significance. The results reported the percent that the model explains the presence of physical activity (Munro, 2005).

Threats to Validity

The threats to validity include bias of the survey, survey methods, and interpretation of the findings. The NHIS aims to select a representative sample of households in the U.S. However, it is possible that the survey under-samples households that are difficult to reach. Those who are institutionalized were not included in the survey; therefore, more severely disabled people with stroke may have been omitted from this analysis. Respondents to the survey were likely to have sound verbal and motor skills; thus, those who were not functioning as well may not have been represented adequately. Thus, response and recall bias must be considered.

The data were from a survey; thus, this analysis must rely on self-reported data for stroke and physical activity. Some authors have suggested that individuals may report levels of physical activity higher than actually performed (Mozaffarian et al., 2015). However, others have reported that self-reported stroke from a survey is adequate to identify stroke prevalence (Engstad, Bonaa, & Viitanen, 2000). Other threats to validity include that not all relevant variables may have been included in this analysis or variables were included that were irrelevant; either of these threats may result in inaccurate findings. Potentially missing factors include variables that the 2013 NHIS survey does not measure, such as cultural, environmental, and other sociological variables. As this is a cross-sectional study, no causal relationship can be concluded. As well, disease causal inference is not possible with a cross-sectional design, only a measure of association between variables can be made.

The threats to external validity are that the survey is not generalizable to those populations under the age of 18, those who do not speak English or Spanish, and those from other countries. As each individual with stroke has unique characteristics, findings from this population-based study may not necessarily apply to a specific individual.

Ethical Procedures

This study was a secondary analysis of the 2013 NHIS survey. No primary data were obtained for this study. The data were de-identified and were open access. Each participant household received a letter in advance informing the participant about the parameters of the interview, that the survey was voluntary, and how the results will be used. At the time of the interview, verbal consent was obtained for survey participation. For the purposes of this study, all data were housed within my own work environment, which has two physical (two locked doors) and two technical security features (security alarm system and password protected computer).

Summary

This quantitative cross-sectional study of adult stroke survivors was a secondary data analysis from a large nationally representative sample of US non-institutionalized adults from the 2013 NHIS publicly accessible dataset. The study used chi-square test for association and multiple logistic regression modeling to evaluate the association between the independent variables, which included biopsychosocial factors (i.e., biological factors, psychological factors, and sociological factors) and levels of physical activity.

Chapter 4 will report data analysis results. These include descriptive and demographic data and the results of the chi-square and multiple regression analysis.

Chapter 4: Results

Introduction

The purpose of this quantitative, cross-sectional, secondary data analysis was to identify if there were any biopsychosocial factors for US stroke survivors in the NHIS associated with following the AHA recommendations for levels of physical activity. Tests of association were applied to identify if there were any relationships among these variables. A multivariable logistic regression model was completed for predicting the likelihood of reaching recommended levels of physical activity.

The research questions and hypotheses in this study included:

Research Question 1

1. Is there a significant association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and individual NHIS biological individual characteristics (age, BMI, race/ethnicity, and sex), among US stroke survivors?

Hypothesis 1

$H_0 1$: There is no association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and individual NHIS biological individual characteristics (age, BMI, race/ethnicity, and sex), among US stroke survivors.

Ha1: There is an association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and individual NHIS biological individual characteristics (age, BMI, race/ethnicity, and sex), among US stroke survivors.

Research Question 2

2. Is there a significant association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and NHIS biological conditions (musculoskeletal conditions (i.e., joint pain, arthritis, neck pain, and back pain) and cardiovascular conditions (i.e., hypertension, coronary heart disease, angina pectoris, myocardial infarction, and 'other' heart diseases), among US stroke survivors?

Hypothesis 2

$H_0 2$: There is no association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and NHIS biological conditions (musculoskeletal conditions (i.e., joint pain, arthritis, neck pain, and back pain) and cardiovascular conditions (i.e., hypertension, coronary heart disease, angina pectoris, myocardial infarction, and 'other' heart diseases), among US stroke survivors.

Ha2: There is an association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and NHIS biological conditions (musculoskeletal conditions (i.e., joint pain, arthritis, neck pain, and back pain) and cardiovascular conditions (i.e., hypertension, coronary heart disease, angina pectoris, myocardial infarction, and 'other' heart diseases), among US stroke survivors.

Research Question 3

3. Is there a significant association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and NHIS psychological variables, which includes perceived health and the Kessler scale for mental distress (i.e., sadness, nervousness, restless, hopeless, effort, and worthlessness), among US stroke survivors?

Hypothesis 3

$H_0$3: There is no association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and NHIS psychological variables, which includes perceived health and the Kessler scale for mental distress (i.e., sadness, nervousness, restless, hopeless, effort, and worthlessness), among US stroke survivors.

Ha3: There is an association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and NHIS psychological variables, which includes perceived health and the Kessler scale for mental distress (i.e., sadness, nervousness, restless, hopeless, effort, and worthlessness), among US stroke survivors.

Research Question 4

4. Is there a significant association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and NHIS sociological variables (i.e., education, family structure, income, marital status, region, neighborhood (i.e., neighborhood help, neighborhood count on, neighborhood

trusted, and neighborhood close-knit), contact with a health care professional in the past 12 months (i.e., mental health professional, eye doctor, foot doctor, chiropractor, physical therapist, nurse, women's health doctor, other medical specialist, and general practitioner), among US stroke survivors?

Hypothesis 4

$H_0$4: There is no association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and NHIS sociological variables (i.e., education, family structure, income, marital status, region, neighborhood (i.e., neighborhood help, neighborhood count on, neighborhood trusted, and neighborhood close-knit), contact with a health care professional in the past 12 months (i.e., mental health professional, eye doctor, foot doctor, chiropractor, physical therapist, nurse, women's health doctor, other medical specialist, and general practitioner), among US stroke survivors.

Ha4: There is an association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and NHIS sociological variables (i.e., education, family structure, income, marital status, region, neighborhood (i.e., neighborhood help, neighborhood count on, neighborhood trusted, and neighborhood close-knit), contact with a health care professional in the past 12 months (i.e., mental health professional, eye doctor, foot doctor, chiropractor, physical therapist, nurse, women's health doctor, other medical specialist, and general practitioner), among US stroke survivors.

Research Question 5

5. Is there a biopsychosocial, multivariable logistic regression model based on the NHIS variables identified by the answers to questions one through four that can predict the level of activity for US stroke survivors?

Hypothesis 5

$H_0 5$: There is no viable biopsychosocial, multivariable logistic regression model based on NHIS variables that can predict the level of activity for US stroke survivors.

Ha5: There is a viable biopsychosocial, multivariable logistic regression model based on NHIS variables that can predict the level of activity for US stroke survivors.

This chapter revisits the research questions and hypotheses. The following sections will describe the data collection, provide the descriptive statistics for the sample, and present results from the statistical analysis of this study.

Data Collection

Time frame. The data were collected in the year 2013 and made publically available in 2014. The data were uploaded into SPSS (IBM SPSS Statistics V21.0). Three data files were obtained in order to answer all of the research questions. The files included: (a) sample adult file, (b) family file, and (c) person file. Once the data were entered, each of the variables were checked for frequency against the NHIS reported numbers in the frequency report in order to include full data capture. Once the data were confirmed to be accurate, the selected variables were merged into a master file so that they could be analyzed with statistics.

The variables in the master file were re-coded for the purpose of this study. Bivariate variables were re-coded so that the baseline was “0” which indicated either a healthy state or the state which is most associated with increased physical activity according to the previous literature review. The dependent variable was set to “0” as reaching the required level of physical activity and “1” as not meeting required levels of physical activity. Variables that did not have any hierarchical order were not changed.

The dependent variable, level of physical activity, was created in SPSS by multiplying the frequency by minutes with a modifier for vigorous activity using the following equation: [(VIGFREQW)*(VIGMIN)*2] +[(MODFREQW)*(MODMIN)] = minutes. This standardized the data to compare the results so that those with 149 or less would be considered non-compliant and those with 150 or more would be compliant with the AHA guidelines. Of the 1,077 stroke survivors, 228 did not respond to all items that were in the multiple logistic regression were excluded, resulting in 849 participants included in the logistic model for this study.

There was one modification to the variables. The variable of health professionals was modified to include only those health professionals that see both sexes, thus the variable “woman doctor” was not included in the analysis. The reason for this is that if this variable was left in, it would reduce the viable number of subjects in the sample to only women and would drop the sample size to below accepted power.

Description of data. No discrepancies in the data collection were identified and 100% of the data were downloaded from the NHIS website. Those selected for this study (adult stroke survivors) were in the adult data group (18+ years of age). The data were collected throughout the year (Quarter 1 = 8,241, Quarter 2 = 8,363, Quarter 3 = 9,192, Quarter 4 = 8,761), resulting in a total of 34,557 respondents for this study.

Baseline descriptive demographic characteristics. The overall sample population included those who replied that they were 18 years or older for this survey.

Representative sample. For the specific population for this study, those who answered the survey question “Have you EVER been told by a doctor or other health professional that you had...A stroke?” with a “yes” response were included in the analysis. There were 1,077 (3.12%) who replied “yes”, 14 (.04%) refused, 18 (.05%) replied “don’t know” and 33,448 replied “no” (96.79%). This appears to be a representative sample of stroke survivors in the US as it has been estimated that stroke prevalence is approximately 2.6% and can range from 1.3% to 4.6% depending upon race (Mozaffarian et al., 2015). Of the 34,557 respondents, 5,645 (16.34%) were from the Northeast region, 7,070 (20.46%) were from the Midwest region, 12,813 (37.08%) were from the South region, and 9,029 (26.13%) were from the West region.

Results Summary

Descriptive statistics. Table 5 presents all of the demographic data and range of values for each variable category but a brief overview is provided here for context. Biological individual characteristics are reported here. The unweighted count of stroke survivors in the 2013 NHIS was 1,077, which provides a weighted population estimate of 6,552,271. Of these, 25.5% met the recommended number of minutes per week of physical activity and 74.5% did not follow the recommendations. The sex of this sample was evenly distributed between men (48.7%) and women (51.3%) and a minority of the sample was obese (33.3%). The distribution of age favored those in the middle to older age groups: 18 to 44 (7.8%), 45 to 54 (11.9%), 55 to 64 (23.6%), 65 to 74 (24.9%), 75 to

84 (20.8%), and 85 and above (11.0%). Race distribution of the sample showed Hispanic (9.5%), Non-Hispanic White (72%), Non-Hispanic Black (14.3%), and Non-Hispanic All Others (4.2%). For biological conditions, the majority reported having one or more musculoskeletal conditions (78.5%) and one or more cardiovascular conditions (79.8%). See Table 5 for all values for each variable.

Psychological condition was reported using the outcomes of perceived health as measured by a global rating scale. Psychological distress was reported by the Kessler scale. There was an almost even distribution of stroke survivors who reported having good to excellent health (48.3%) compared to those with fair to poor health (51.7%). Those reporting a Kessler scale of 13 or more, which indicates severe mental distress, were in the minority (10.3%).

The sociological conditions included that the majority of stroke survivors had education as a high school graduate or equivalent or some college (47.8%), those with less than high school graduate (25.2%) and college degree or higher (27%) made up the other portion. A majority of stroke survivors (72.5%) reported living with someone else. The percentage of people who reported living with a spouse or partner (51%) was nearly equal to those who were not living with a spouse or partner (49%). This suggests that the people that they were living with may be family, friends, or roommates. Those who reported positive attributes about their neighborhood (responded definitely agree or up to two agree of four neighborhood attributes) were approximately half (47.4%). The majority of stroke survivors reported seeing one or more health professionals in the past year (94.2%). Table 5 provides a description of the study sample.

Table 5.

Frequency and Distribution of Demographics in the Population of Stroke Survivors from the 2013 NHIS, Including the Biological, Psychological, and Social Characteristics

Stroke survivors

		Weighted Population Estimate	Unweighted Count	
Population Size	Total	6,552,271	1077	
Physical Activity 150 minutes or greater				
	activity 150 minutes or more per week	1,633,994	263	25.5%
	less than 150 minutes	4,776,395	789	74.5%
	Total	6,410,389	1,052	100.0%
Biological individual characteristics				
Sex				
		Weighted Population Estimate	Unweighted Count	%
	male	3,191,310	490	48.7%
	female	3,360,961	587	51.3%
	Total	6,552,271	1,077	100.0%
Age				
	18 to 44	510,653	86	7.8%
	45 to 54	780,869	119	11.9%
	55 to 64	1,546,258	245	23.6%
	65 to 74	1,632,024	283	24.9%
	75 to 84	1,362,517	224	20.8%
	85 and above	719,950	120	11.0%
	Total	6,552,271	1,077	100.0%
Obesity (BMI)				
	less than obese	4,246,099	688	66.7%
	obese	2,121,793	354	33.3%
	Total	6,367,892	1,042	100.0%
Hispanic Black White other groups				
	Hispanic	620,787	121	9.5%
	Non-Hispanic White	4,718,249	685	72.0%

		Weighted Population Estimate	Unweighted Count	%
	Non-Hispanic Black	936,424	228	14.3%
	Non-Hispanic All Others	276,811	43	4.2%
	Total	6,552,271	1,077	100.0%
Biological conditions				
Musculoskeletal conditions				
		Weighted Population Estimate	**Unweighted Count**	**%**
	no MSK conditions	1,400,251	225	21.5%
	one or more MSK conditions	5,100,046	846	78.5%
	Total	6,500,297	1,071	100.0%
Cardiovascular conditions				
	no cardiovascular diseases	1,313,880	191	20.2%
	one or more cardiovascular diseases	5,176,002	875	79.8%
	Total	6,489,882	1,066	100.0%
Psychological conditions				
Perceived Health				
		Weighted Population Estimate	Unweighted Count	%
	good, very good, excellent health	3,159,360	513	48.3%
	fair and poor health	3,383,173	563	51.7%
	Total	6,542,533	1,076	100.0%
Serious Psychological Distress				
	no to moderate distress	5,495,910	907	89.7%
	severe distress	633,996	107	10.3%
	Total	6,129,906	1,014	100.0%
Sociological conditions				
Education				
		Weighted Population Estimate	Unweighted Count	%
	college degree or higher	1,759,815	251	27.0%
	high school grad or equivalent or some college	3,109,842	531	47.8%

	less than high school graduate	1,639,009	285	25.2%
	Total	6,508,666	1,067	100.0%
Living alone				
	living with someone	4,747,995	607	72.5%
	living alone	1,804,276	470	27.5%
	Total	6,552,271	1,077	100.0%
Living with married spouse or partner				
	living with spouse or partner	3,337,200	404	51.0%
	not living with spouse or partner	3,203,834	670	49.0%
	Total	6,541,034	1,074	100.0%
Income below $35, 000				
	income above $35, 000	2,663,513	353	44.2%
	income below $35, 000	3,355,925	655	55.8%
	Total	6,019,438	1,008	100.0%
Region				
	Northeast	1,160,533	181	17.7%
	Midwest	1,461,443	231	22.3%
	South	2,627,498	432	40.1%
	West	1,302,797	233	19.9%
	Total	6,552,271	1,077	100.0%
Neighborhood				
	definitely agree or up to 2 agree	2,804,612	450	47.4%
	3 or more agree or less	3,113,141	520	52.6%
	Total	5,917,753	970	100.0%
Seen one or more health professionals				
	seen one or more health professionals in past 12 months	6,031,519	988	94.2%
	seen no health professionals	374,507	66	5.8%
	Total	6,406,026	1,054	100.0%

Statistical Assumptions For chi-square, all data were re-coded to categorical variables. The sample size was adequate in that there were greater than five subjects in each cell. All subjects were independent of each other; no subject was included more than once. All variables were selected in advance prior to analysis, thus there was a theoretical basis for inclusion of each variable. Thus all assumptions for chi-square were met (Munro, 2005). The chi-square test identifies association but cannot identify strength of association or the direction of the relationship. Therefore, no strength of association or direction was reported. Multiple logistic regression followed the individual chi-square tests, which included odds ratios, therefore direction of association was determined using this method.

All assumptions for logistic regression were met. All relevant variables were included. Linear relationships are not required for logistic regression and thus normality of the data was not ascertained. The range of values for the dependent variable was 0 or 1 (Katz, 2011b). To test for multicollinearity, variance inflation factor (VIF) and tolerance were tested. This was done by performing a linear regression in SPSS using physical activity as the dependent variable and loading all of the independent variables in the model at once. From the data output, only the tests for multicollinearity were used for interpretation. For all independent variables, VIF ranged from 1.0 to 2.2. Thus, VIF was lower than 10 which indicated lack of multi-collinearity between variables. Tolerance ranged from .46 to .98. Because tolerance was greater than .10, this indicates there are no significant issues with multi-collinearity between the variables (H. Lee, 2013).

Research question one. For research question one, “Is there a significant association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and individual NHIS biological individual characteristics (age, BMI, race/ethnicity, and sex), among US stroke survivors?” the following null hypothesis was tested: “There is no association between level of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and individual NHIS biological individual characteristics (age, BMI, race/ethnicity, and sex), among US stroke survivors.” This was accomplished with a chi-square test for independence, which explored the relationship between categorical variables, and a Bonferroni correction was applied to account for multiple comparisons.

A chi-square test for association was conducted between age and physical inactivity for stroke survivors. There was a statistically significant association between age and physical inactivity in stroke survivors, χ^2 (5, n = 1,052, N = 6,410,389) = 42, $p <$ .001, Bonferroni $p <$ .001. A chi-square test for association was conducted between obesity (BMI = 30 or greater is obese) and physical inactivity for stroke survivors. There was no statistically significant association between obesity and physical inactivity in stroke survivors, χ^2 (1, n = 1,021, N = 6,255,143) = .11, p = .745.A chi-square test for association was conducted between race (non-Hispanic White being the reference value) and physical inactivity for stroke survivors. There was no statistically significant association between race and physical inactivity in stroke survivors, χ^2 (3, n = 1,052, N = 6,410,389) = 4.43, p = .219, Bonferroni p = .388. A chi-square test for association was conducted between sex (male versus female) and physical inactivity for stroke survivors. There was no statistically significant association between men and women for physical inactivity in stroke survivors, χ^2 (1, *n* = 1,052, *N* = 6,410,389) = 1.2, *p* = .274. The null hypothesis for question one was rejected because a statistically significant association was found for the relationship between levels of age (category of years ranges were 18 to 44, 45 to 54, 55 to 64, 65 to 74, 75 to 84, and 85 and above) and inactivity, particularly in age categories of 55 and above.

Research question two. For research question two, "Is there a significant association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and NHIS biological conditions (musculoskeletal conditions (i.e., joint pain, arthritis, neck pain, and back pain) and cardiovascular conditions (i.e., hypertension, coronary heart disease, angina pectoris, myocardial infarction, and 'other' heart diseases), among US stroke survivors?" the following null hypothesis was tested: "There is no association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and NHIS biological conditions (musculoskeletal conditions (i.e., joint pain, arthritis, neck pain, and back pain) and cardiovascular conditions (i.e., hypertension, coronary heart disease, angina pectoris, myocardial infarction, and 'other' heart diseases), among US stroke survivors."

A chi-square test for association was conducted between cardiovascular conditions (one or more of the following: hypertension, coronary heart disease, angina pectoris, myocardial infarction, or 'other' heart diseases) and physical inactivity for stroke survivors. There was a statistically significant association between cardiovascular conditions and physical inactivity in stroke survivors, χ^2 (1, *n* = 1,041, *N* = 6,348,000) = 7.24, *p* = .007. A chi-square test for association was conducted between musculoskeletal conditions (one or more of the following: joint pain, arthritis, neck pain, or back pain) and physical inactivity for stroke survivors. There was no statistically significant association between having one or more musculoskeletal conditions and physical inactivity in stroke survivors, χ^2 (1, *n* = 1,046, *N* = 6,358,415) = .00, *p* = .985. The null hypothesis for question two was rejected because there was a statistically significant association between having one or more cardiovascular conditions and physical inactivity.

Research question three. For research question three, "Is there a significant association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and NHIS psychological variables, which includes perceived health and the Kessler scale for mental distress (i.e., sadness, nervousness, restless, hopeless, effort, and worthlessness), among US stroke survivors?" the following null hypothesis was tested: "There is no association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and NHIS psychological variables, which includes perceived health and the Kessler scale for mental distress (i.e., sadness, nervousness, restless, hopeless, effort, and worthlessness), among US stroke survivors." This was accomplished with a chi-square test for independence, which explored the relationship between these categorical variables.

A chi-square test for association was conducted between perceived health (those who report fair or poor health vs those reporting good, very good or excellent health) and physical inactivity for stroke survivors. There was a statistically significant association between perceived health and physical inactivity in stroke survivors, χ^2 (1, *n* = 1,051, *N* = 6,400,651) = 68, $p < .001$. A chi-square test for association was conducted between serious psychological distress (Kessler scale score of 13 or more indicating serious psychological distress) and physical inactivity for stroke survivors. There was a statistically significant association between serious psychological distress as measured by the Kessler scale and physical inactivity in stroke survivors, χ^2 (1, *n* = 994, *N* = 6,024,047) = 4.99, $p = .026$. The null hypothesis for question three was rejected because a statistically significant association between reporting serious psychological distress and physical inactivity as well as stating one's perceived health was fair or poor and physical inactivity.

Research question four. For research question four, "Is there a significant association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and NHIS sociological variables (i.e., education, family structure, income, marital status, region, neighborhood (i.e., neighborhood help, neighborhood count on, neighborhood trusted, and neighborhood close-knit), contact with a health care professional in the past 12 months (i.e., mental health professional, eye doctor, foot doctor, chiropractor, physical therapist, nurse, other medical specialist, and general practitioner), among US stroke survivors?" the following null hypothesis was tested: "There is no association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and NHIS sociological variables (i.e., education, family structure, income, marital status, region, neighborhood (i.e., neighborhood help, neighborhood count on, neighborhood trusted, and neighborhood close-knit), contact with a health care professional in the past 12 months (i.e., mental health professional, eye doctor, foot doctor, chiropractor, physical therapist, nurse, other medical specialist, and general practitioner), among US stroke survivors." This was accomplished with a chi-square test for independence and Bonferroni correction, which explored the relationship between these categorical variables.

A chi-square test for association was conducted between levels of education (three categories: college degree or higher; high school graduate or equivalent or some college; less than high school graduate) and physical inactivity for stroke survivors. There was a statistically significant association between levels of education and physical inactivity in stroke survivors, χ^2 (2, n = 1,042, N = 6,366,784) = 17.9, $p < .001$, Bonferroni $p < .001$. A chi-square test for association was conducted between family structure (living alone or with another) and physical inactivity for stroke survivors. There was a statistically significant association between family structure and physical inactivity in stroke survivors, χ^2 (1, n = 1,052, N = 6,410,389) = 4.4, $p = .037$. A chi-square test for association was conducted between marital status (defined as living with a married spouse or partner) and physical inactivity for stroke survivors. There was a statistically significant association between marital status and physical inactivity in stroke survivors, χ^2 (1, n = 1,050, N = 6,401,818) = 11, $p < .001$. A chi-square test for association was conducted between income (poverty level income defined as below $35,000) and physical inactivity for stroke survivors. There was a statistically significant association between poverty level income and physical inactivity in stroke survivors, χ^2 (1, *n* = 987, *N* = 5,899,554) = 22.5, *p* < .001. A chi-square test for association was conducted between region (in the Northeast, Midwest, and South, compared to living in the West region of the US) and physical inactivity for stroke survivors. There was a statistically significant association between region and physical inactivity in stroke survivors, χ^2 (3, *n* = 1,052, *N* = 6,410,389) = 12 1, *p* = .007, Bonferroni *p* < .009. A chi-square test for association was conducted between positive perception of neighborhood (defined as definitely agreeing or up to two agrees for neighborhood perception questions) and physical inactivity for stroke survivors. There was no statistically significant association between positive perception of neighborhood and physical inactivity in stroke survivors, χ^2 (1, *n* = 952, *N* = 5,825,215) = .002, *p* = .964. A chi-square test for association was conducted between seeing a health professional (defined as seeing one or more health professional in the past 12 months) and physical inactivity for stroke survivors. There was no statistically significant association between seeing a health professional and physical inactivity in stroke survivors, χ^2 (1, *n* = 1,034, *N* = 6,300,167) = 1.0, *p* = .315. The null hypothesis for question four was rejected because a statistically significant association was found between physical inactivity and being married or not married, living or not living with others, level of income, and region of the US.

Research question five. For research question five, “Is there a biopsychosocial, multivariable logistic regression model based on the NHIS variables identified by the answers to questions one through four that can predict the level of activity for US stroke survivors?" the following null hypothesis was tested: "There is no viable biopsychosocial, multivariable logistic regression model based on NHIS variables that can predict the level of activity for US stroke survivors." This was accomplished with logistic regression which tested models to predict categorical outcomes. The logistic regression used complex sampling technique and the forced entry method. This method controls for confounding variables.

There were 849 cases with no missing values, representing a population of 5,126,718. The sample size estimate conducted before the study commenced suggested that 777 subjects would be needed for the logistic regression analysis (see Chapter 3). Thus, the final number of valid cases exceeded this minimum estimate for power. Direct, or forced entry, logistic regression was used to assess the impact association of independent biopsychosocial variables (Education, Marital status, Family structure, Income, Region, Neighborhood, Seen Health Professional, Sex, Age, Obese, Race/ethnicity, Musculoskeletal conditions, Cardiovascular conditions, Perceived Health, Serious Psychological Distress) on the likelihood of physical inactivity in stroke survivors. The full model containing all predictors was statistically significant χ^2 (24, n = 849, N = 5,126,718) = 128.2, $p < .001$. This indicated that the model was able to distinguish between those who were physically inactive and those who were active. The model explained between 19.0% (Cox and Snell R squared) and 27.8% (Nagelkerke R squared) of the variance and correctly classified 78% of cases. As shown in the tests of model effects table (Table 6), four independent variables provided unique statistically significant contribution to the model. These included age, perceived health, region, and education. Those who live in the Midwest were 1.7 and those in the Northeast were 2.2 times more likely to be inactive compared to those in the West. Those who had less than high school level education were 2.8 times more likely to be physically inactive compared to those with a college degree or higher. The strongest predictors were age and perceived health. Individuals between 75 and 85 years of age were 5.7 times and those above 85 years old were 6.1 times more likely to be physically inactive than those who were 18 to 44 years of age. Those who perceived their health to be fair or poor, regardless of age, were 4.6 more likely to be physically inactive.

Table 6.

Model Resulting From Direct Logistic Regression of Biopsychosocial Variables on the Likelihood of Stroke Survivors Following Physical Activity Recommendations

Sample Design Information

		N
Unweighted Cases	Valid	849
	Invalid	228
	Total	1077
Population Size		5126718

Tests of Model Effects

Source	df	Wald Chi-Square	Sig.	Bonferroni Sig.
(Corrected Model)	**24.000**	**128.190**	**.000**	**.000**
(Intercept)	1.000	21.531	.000	.000
Age	**5.000**	**29.403**	**.000**	**.004**
Sex	1.000	.079	.778	.778
Obese	1.000	1.175	.278	.278
Race/ethnicity	3.000	14.402	.002	.211
Musculoskeletal conditions	1.000	3.328	.068	.068
Cardiovascular conditions	1.000	1.300	.254	.254
Perceived Health	**1.000**	**54.741**	**.000**	**.000**
Serious Psychological Distress	1.000	2.177	.140	.140
Education	**2.000**	**11.506**	**.003**	**.002**
Region	**3.000**	**9.532**	**.023**	**.040**
Marital status	1.000	2.862	.091	.091
Family structure	1.000	1.181	.277	.277
Income	1.000	3.625	.057	.057
Neighborhood	1.000	.025	.875	.875
Seen Health Professional	1.000	1.748	.186	.186

Dependent Variable: Physical Activity 150 minutes or greater (reference category = activity 150 minutes or more per week)

Model: (Intercept), Education, Marital status, Family structure, Income, Region, Neighborhood, Seen Health Professional, Sex, Age, Obese, Race/ethnicity, Musculoskeletal conditions, Cardiovascular conditions, Perceived Health, Serious Psychological Distress

Odds ratios were calculated to compare the relative odds of physical inactivity given the occurrence of the independent variable. The odds ratios were used to determine if the independent variable is a risk factor for physical inactivity and to compare the magnitude of risk factors among themselves (Szumilas, 2010).

For the biological individual characteristics sex, obesity, and race, the confidence interval included 1.0, therefore there was no statistical significance for these odds ratios. For age, the odds ratio of those aged 45 to 54 years old compared to those who were younger (18 to 44) was 1.479, however the confidence interval crossed over 1.0, thus there was no significant association for that age group. The 55 to 64 years old group had an odds ratio of 2.409, the 65 to 74 year old group had an odds ratio of 2.285, and the 75 to 84 year old group had an odds ratio of 5.720 indicating increased odds of inactivity compared to the 18 to 44 year old group. Those who were 85 and above had the largest odds ratio of 6.104 compared to 18 to 44 year olds. The confidence intervals of the odds for age categories above 55 years old (Table 7) indicated that the odds for physical inactivity are statistically higher than for those who were older compared to the younger age groups. Since these confidence intervals did not contain 1.0, these odds were statistically significant. For the biological conditions musculoskeletal conditions and cardiovascular diseases, the confidence interval included 1.0, therefore this was not statistically significant.

For the psychological conditions of serious psychological distress as measured by the Kessler scale, the confidence interval included 1.0, therefore there was no significant association. For the self-reported perception of health, the odds ratio was 4.561 and the confidence interval was 3.040 to 6.843, indicating that those who perceived that their health was poor or fair were 4.56 times more likely to be physically inactive than those who perceived that their health was good to excellent.

For the sociological conditions of living with spouse or partner, living alone, income below $35,000, neighborhood and seeing a health professional, the confidence intervals included 1.0, therefore these were not statistically significant. The odds ratio for education was 2.757 for those who had less than a high school degree compared to those with a college degree or higher, indicating that those who had less than a high school education were more likely to be physically inactive compared to those who had completed a college degree. The odds ratio for comparing the South with the West was 1.095 but the confidence intervals included 1.0, therefore these were not statistically significant. The odds of inactivity for those living in the Northeast compared to the West was 2.196 and was 1.654 for those living in the Midwest compared to the West, indicating that those who lived in the Northeast and Midwest were more likely to be physically inactive than those who live in the West.

Table 7.

Odds Ratios and Confidence Intervals for Independent Variables

Odds Ratios [a]

Physical Activity less than 150 minutes		Odds Ratio	95% Confidence Interval Lower	Upper
Biological individual characteristics				
Sex	female vs. male	1.058	.713	1.570
Age	**45 to 54 vs. 18 to 44**	**1.479**	**.617**	**3.543**
	55 to 64 vs. 18 to 44	**2.409**	**1.064**	**5.453**
	65 to 74 vs. 18 to 44	**2.285**	**1.049**	**4.977**
	75 to 84 vs. 18 to 44	**5.720**	**2.629**	**12.445**
	85 and above vs. 18 to 44	**6.104**	**2.115**	**17.614**
BMI obese or greater	obese vs. less than obese	1.231	.842	1.799
Race/ethnicity	Hispanic vs. Non-Hispanic White	.350	.194	.629
	Non-Hispanic Black vs. Non-Hispanic White	1.139	.605	2.145
	Non-Hispanic All Others vs. Non-Hispanic White	1.253	.340	4.626
Biological conditions				
MSK 1 or more	one or more MSK conditions vs. no MSK conditions	.623	.374	1.041
one or more cardiovascular diseases	one or more cardiovascular diseases vs. no cardiovascular diseases	1.324	.814	2.153
Psychological conditions				
Perceived Health Good or better	**fair and poor health vs. good, very good, excellent health**	**4.561**	**3.040**	**6.843**
Serious Psychological Distress	serious distress vs. no to moderate distress	1.809	.817	4.006
Sociological conditions				
Education	**less than high school graduate vs. college degree or higher**	**2.757**	**1.508**	**5.039**
	high school grad or equivalent or some college vs. college degree or higher	1.307	.814	2.097
Region	**Northeast vs. West**	**2.196**	**1.170**	**4.122**
	Midwest vs. West	**1.654**	**1.011**	**2.706**
	South vs. West	**1.095**	**.700**	**1.712**
Living with married spouse or partner	not living with spouse or partner vs. living with spouse or partner	1.565	.927	2.644
Living alone	living alone vs. living with someone	.729	.410	1.296
Income below 35K	income below 35k vs. income above 35k	1.521	.984	2.352
Neighborhood	3 or more agree or less vs. definitely agree or up to 2 agree	.971	.670	1.406
Seen one or more health professionals	seen no health professionals vs. seen one or more health professionals	1.600	.792	3.230

Variables That are in bold are statistically significant for being more likely to be inactive. Dependent Variable: Physical inactivity (reference category = activity 150 minutes or more per week) Model: (Intercept), Education, Marital status, Family structure, Income, Region, Neighborhood, Seen Health Professional, Sex, Age, Obese, Race/ethnicity, Musculoskeletal conditions, Cardiovascular conditions, Perceived Health, Serious Psychological Distress
a. Factors and covariates used in the computation are fixed at the following values: Education =less than high school graduate; Marital status=not living with spouse or partner; Family structure=living alone; Income=income below 35k; Region=West; Neighborhood=3 or more agree or less; Seen Health Professional=seen no health professionals; Sex=female; Age =85 and above; Obese=obese; Race/ethnicity=Non-Hispanic All Others; Musculoskeletal conditions =one or more MSK conditions; Cardiovascular conditions =one or more cardiovascular diseases; Perceived Health =fair and poor health; Serious Psychological Distress=serious distress

The null hypothesis for question five was rejected because the logistic regression showed statistical significance. These findings show that there was a viable biopsychosocial, multivariable logistic regression model based on NHIS variables, which can predict a portion of the level of activity for US stroke survivors.

Summary

The results of this study showed that there are certain biopsychosocial factors that have a statistically significant association with levels of physical activity in stroke survivors and that a multivariable logistic regression model of these factors predicted the likelihood of stroke survivors reaching recommended levels of physical activity.

A chi-square test for association was conducted between the independent biopsychosocial variables and the dependent variable physical inactivity. For biological individual characteristics, there was a statistically significant association for the relationship between levels of age and inactivity. However, no statistically significant association was found between obesity, race, and sex and physical inactivity in stroke survivors. For presence of association between biological conditions, there was a statistically significant association between having one or more cardiovascular condition and physical inactivity. However, no statistically significant association was found between having one or more musculoskeletal conditions and inactivity. For psychological variables, there was a statistically significant association between levels of perceived health and physical inactivity in stroke survivors and serious psychological distress as measured by the Kessler scale and physical inactivity in stroke survivors. For sociological variables, there was a statistically significant association between several of these variables. Those that showed association with physical inactivity were levels of education, family structure, income, marital status, and region. No statistically significant association was observed between physical inactivity and perception of neighborhood or seeing a health professional. Thus, a statistically significant association was found independently between physical inactivity and being married or not married, living or not living with others, level of income, and region of the US.

Multiple logistic regression resulted in a model that contained all predictor variables that were statistically significant. This model was able to distinguish between those stroke survivors who were physically inactive and those who were active. The model explained between 19.0% (Cox and Snell R squared) and 27.8% (Nagelkerke R squared) of the variance and correctly classified 78% of cases. Four independent variables provided unique statistically significant contribution to the model: age, perceived health, region, and education. People living in the Midwest region were 1.7

times and those living in the Northeast region were 2.2 times more likely to be inactive compared to those in the West. Those who had less than high school level education were 2.8 times more likely to be physically inactive compared to those with a college degree or higher. The strongest predictors for inactivity were age and perceived health. Individuals between 75 and 85 years of age were 5.7 times and those above 85 years old were 6.1 times more likely to be physically inactive than those in the youngest age group of 18 to 44 year olds. Those who perceived their health to be fair or poor, regardless of age, were 4.6 more likely to be physically inactive than those who considered their health to be good, very good, or excellent.

Chapter 5 will provide a discussion of the research findings. An interpretation of the findings will be placed in context of the current literature. Chapter 5 will also present limitations, recommendations for future studies, and implications for social change and application of findings from this study.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

Following physical activity guidelines is associated with reducing rates of stroke (McDonnell et al., 2013; Williams, 2009), which is a leading cause of death and disability in the US (Feigin et al., 2014; C. D. Lee et al., 2003; Roger et al., 2012b). Understanding the associated factors may help to reduce this health burden. Previously, no population-based studies have assessed factors associated with inactivity in US stroke survivors using the NHIS. This quantitative, cross-sectional data analysis, measured the association of biopsychosocial factors with levels of physical activity for US stroke survivors. A multivariable logistic regression model included statistically significant biopsychosocial variables that could predict the likelihood of inactivity for stroke survivors.

This chapter will discuss the interpretation of the findings of this study. The chapter will present limitations, recommendations for future research, and social change implications of these findings.

Interpretation of the Findings

This study provides insight into the characteristics of stroke survivors in the US and how these factors are associated with levels of physical activity. In this study, the overall percentage of inactive stroke survivors in the 2013 NHIS was 25.5%, this can be compared to the proportion of general US adults that met physical activity guidelines being 50.0% (Mozaffarian et al., 2015). Compared to the study by Butler et al. (2014), only 18% of stroke survivors from the NHANES 2003 to 2006 data met the recommended levels of physical activity, compared to 25.5% of stroke survivors in the present study of 2013 NHIS data. It is not known if there were baseline differences between groups or if there were trends in activity over the past decade.

Interpretation of research question one. Question one states, "Is there a significant association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and individual NHIS biological individual characteristics (age, BMI, race/ethnicity, and sex), among US stroke survivors?" A chi-square test for independence explored the relationship between these categorical variables. A statistically significant association between age and physical inactivity was found. The chi-square test that was conducted for obesity, race, and sex and physical inactivity showed no statistically significant association. Therefore, the null hypothesis for question one was rejected since age showed an association with level of physical activity. This test showed that there is an association between level of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and age as the specific individual biological characteristic, among US stroke survivors.

Increasing age has been shown to be associated with diminishing levels of physical activity in the general population (Shaw & Spokane, 2008). As people age, regular work and leisure activities reduce and can result in decreased fitness and is a risk factor for chronic diseases (DiPietro, 2001). As the body ages, speed, flexibility, balance, and strength decrease. Mental and social factors also change and may result in less activity (DiPietro, 2001). Mozaffarian et al. (2015) reported that in the general population of the 2013 NHIS, the percentage of people engaging in activity decreased as age increased. The findings from the present study support these outcomes in this group of stroke survivors.

For sex, previous studies have shown that in the general population, men are more likely than women to follow physical activity recommendations (Haskell et al., 2007). Haskell et al. (2007) reported the prevalence of leisure-time physical activity among men and women in the US and found that men (50.7%) are more likely than women (47.9%) to be active. However, in the present study, there was no statistically significant difference in following activity recommendations between men and women stroke survivors.

Obesity has been shown to be associated with low levels of activity. In the literature, increased BMI is usually conceptualized as being a consequence of physical inactivity and not as a barrier to it. The recent report by Bauman et al. (2012) suggests that obesity might be a contributing factor to inactivity in addition to being a result. For the present study, there was no association between obesity and physical inactivity in stroke survivors. This finding suggests that regardless of other factors, BMI may not necessarily be a barrier to activity for some people with stroke.

Race has been shown to be associated with physical inactivity. Haskell et al. (2007) reported that White non-Hispanics (51.1%) were more likely to be physically active in the general population compared to Hispanics (44%), and Black non-Hispanics (41.8%). Crespo et al. (2000) found similar results in that Black and Hispanic US citizens were less active than those who were White regardless of age, education, income, or marital status (Crespo et al., 2000). In the present study, there was no statistically significant difference between racial groups for physical inactivity. It is possible that those with stroke experienced similar barriers to activity, which may have reduced the influence of race on physical activity.

Age is an important factor when considering physical activity in stroke survivors. Race, sex, and BMI did not show a statistically significant association in the stroke survivor population, which suggests that these factors may be less important in identifying those most at risk for low activity.

Interpretation of research question two. Question two stated, "Is there a significant association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and NHIS biological conditions (musculoskeletal conditions (i.e., joint pain, arthritis, neck pain, and back pain) and cardiovascular conditions (i.e., hypertension, coronary heart disease, angina pectoris, myocardial infarction, and 'other' heart diseases), among US stroke survivors?" A chi-square test for independence tested the relationship between the categorical variables. A statistically significant association between having one or more cardiovascular conditions and physical inactivity was found. However, there was no statistically significant association for having one or more musculoskeletal conditions and physical inactivity in stroke survivors. Therefore, the null hypothesis for question two was rejected since cardiovascular conditions showed an association with level of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and specific biological conditions (cardiovascular conditions), among US stroke survivors.

Musculoskeletal conditions have been associated with levels of physical activity in the general population. A study of Canadians showed that arthritis and back pain were significantly associated with reduced physical activity (Slater, Perruccio, & Badley, 2011). A qualitative study of stroke survivors with arthritis identified arthritis as a barrier to activity (Wood et al., 2009). For the present study, no statistical significance was found for having one or more musculoskeletal conditions. Thus, in spite of having musculoskeletal pain, there were stroke survivors who regularly engaged in recommended levels of physical activity.

Cardiovascular diseases are strongly associated risk factors for stroke (Mozaffarian et al., 2015). However, there are insufficient studies that evaluate if cardiovascular diseases act as barriers to physical activity. Studies have shown greater risk for cardiovascular disease for those who are inactive (Chomistek, Manson, et al., 2013). For the present study, although there was an association, it was not clear if cardiovascular disease inhibited activity or if inactivity increased the likelihood of cardiovascular disease because of the nature of the cross-sectional study design.

Interpretation of research question three. Question three stated, “Is there a significant association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and NHIS psychological variables, which includes perceived health and the Kessler scale for mental distress (i.e., sadness, nervousness, restless, hopeless, effort, and worthlessness), among US stroke survivors?” A chi-square test for independence explored the relationship between these categorical variables. A statistically significant association was found between both perceived health and serious psychological distress with physical inactivity for stroke survivors. Therefore, the null hypothesis for question three was rejected as this test showed that there is an association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and the two NHIS psychological variables (perceived health and serious psychological distress), among US stroke survivors.

Mental distress is associated with physical inactivity (Okoro et al., 2014). For example, Okoro et al. (2014) assessed 2009 BRFSS data and showed that those with severe psychological distress according to the Kessler scale were less likely to be active compared to those without severe distress. The authors suggested that physical activity could be used as a treatment for distress and, therefore, activity could be used as an intervention for mental distress. In the present study, I evaluated this relationship from the reverse viewpoint by looking at mental distress as a risk factor for inactivity. As causation cannot be conferred from either study, it is possible that there was a bidirectional influence of these factors, such that increased mental distress may have caused someone to be physically inactive or that physical inactivity may cause greater mental distress.

Perceived health is a global outcome measure that is non-specific but may help in identifying health issues (Bergner & Rothman, 1987; McDowell, 2006; Shields & Shooshtari, 2001). Various studies have shown a statistically significant association between physical activity and perceived health (Eifert, Wideman, Oberlin, & Labban, 2014; McHugh & Lawlor, 2013; Kaleta, Polanska, Dziankowska-Zaborszczyk, Hanke, &

Drygas, 2009). In the present study, I found a statistically significant relationship between perception of health and following physical activity recommendations. It is not clear which direction the influence may be. For example, those who perceived that they were healthy may have felt more motivated to exercise. On the other hand, those who were physically active may have had elevated mood and, therefore, felt better about their health. Another interpretation may be that if someone was healthier than another, he or she was able to perform more activity. The converse may also be considered, in that by increasing physical activity, one was healthier and, therefore, perceived oneself to be healthier overall. Without doing additional studies, the direction of influence of this relationship is yet to be determined.

Interpretation of research question four. Question four asked, “Is there a significant association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and NHIS sociological variables (i.e., education, family structure, income, marital status, region, neighborhood (i.e., neighborhood help, neighborhood count on, neighborhood trusted, and neighborhood close-knit), contact with a health care professional in the past 12 months (i.e., mental health professional, eye doctor, foot doctor, chiropractor, physical therapist, nurse, other medical specialist, and general practitioner), among US stroke survivors?” A chi-square test for association was conducted to test these relationships. A statistically significant association was shown for each of the following variables and levels of physical activity: levels of education, family structure (living alone or with another) income (poverty level income defined as below $35,000), marital status (defined as living with a married spouse or partner), and region (in the Northeast, Midwest, South, compared to living in the West region of the US). There was no statistically significant association between positive the perception of one's neighborhood, or seeing a health professional (defined as seeing one or more health professional in the past 12 months). Therefore, the null hypothesis for question four was rejected since this test showed that there is a statistically significant association between levels of physical activity, according to the AHA recommendations, as measured by self-reported frequency and duration and selected NHIS sociological variables (i.e., education, region, family structure, living alone, and income) among US stroke survivors.

Education level has been shown to be a risk factor for physical inactivity in the general population. In a review by DiPietro (2001), she stated that there was a positive association between years of education and physical activity. The supposition is that those who are highly educated may be more likely to have the means to exercise regularly, have the knowledge of why exercise is important for health, have healthier influences from a social network, and have more resources to support physical activity (Shaw & Spokane, 2008). As well, Haskell et al (2007) reported in the general population that there is a higher proportion of those with a college degree or higher meeting activity recommendations (53.2%) compared to those who have not completed high school (37.8%). The findings of the present study reflect the same trend in that those who had less than a high school level education were more inactive compared to those with a college degree or higher. These findings suggest that those with a higher level of education may have had greater means and knowledge about physical activity and were more prone to participate in exercise.

Income has been implicated as a contributor to barriers to physical activity for the general population (Chinn et al., 1999). Chinn et al. (1999) evaluated data from a health and lifestyle survey in the United Kingdom and found that barriers varied by age, marital status, and social class. They also found a positive association between income and lack of motivation and lack of time for activity (Chinn et al., 1999). These authors suggested that income and social status are complex when considering how they influence levels of physical activity. For the present study, those who had income below $35,000 were less likely to be physically active.

Family structure (i.e., for the present study this identified whether one was living with another or living alone) and marital status (i.e., for this study this recognized within a marriage or with a partner) may have an influence on the level of activity. A strong social support group may assist or motivate people to be more active through exercise or social activities. Lindstrom et al. (2001) suggested that social participation was strongly associated with physical activity (Lindstrom, Hanson, & Ostergren, 2001). A majority of stroke survivors live with someone (72.5%) and half live with a spouse or partner (51%). For this study, living with someone and marital status showed significant association with physical activity. It is possible that stroke survivors were motivated by social interactions, such as with care givers or spouses. People who lived with stroke survivors may have encouraged stroke survivors to participate or offered a sense of security during physical activity.

There is a regional variation of participation in exercise or levels of physical activity in the US (Kachan et al., 2014; Kirtland, Zack, & Caspersen, 2012). For example, Kachan et al. (2014) evaluated health-related quality of life of older adults in different regions of the US. They found that there were regional differences, such as that those in the Midwest and Northeast were less likely to follow physical activity recommendations compared to those in the South. These findings are similar to what was found in the present study, in that those in the Midwest and Northeast were less likely to follow physical activity recommendations compared to those in the West. In the present study, region was statistically significant for inactivity in stroke survivors after controlling for other variables. There are possible contributing factors to these findings. It is possible that weather contributed to the amount of activity that someone could engage in, such as there may have been reduced activity in the winter when snow and ice were present. It is possible that built communities in various regions of the country promoted or inhibited activity. As well, there may have been regional culture or programs that promoted or prevented healthy exercise and activity.

Neighborhood environment may influence activity levels. For example, a study of how the neighborhood social environment influenced physical activity showed an association that included a mediator of personal safety (Timperio, Veitch, & Carver, 2015). Another research team investigated the influence of neighborhood safety and activity levels in older adults. Those who perceived that their neighborhood was safe were more likely to be active compared to those who thought their neighborhood was unsafe, however when perceived health was included in this study, the association was not present (Tucker-Seeley, Subramanian, Li, & Sorensen, 2009). The findings of the present study were similar to the Tucker-Seeley study in that there was no significant association between neighborhood factors and levels of activity. However, due to the substantial difference in question items that were measured, these studies cannot be compared directly. In the present study, I was not able to measure neighborhood safety. Instead, I used the measurement of perception of the neighborhood being supportive (i.e., neighborhood help, neighborhood count on, neighborhood trusted, and neighborhood close-knit).

Health professional interaction was suspected to be associated with increased physical activity. A study of the 1999 Behavioral Risk Factor Surveillance System showed that those with stroke who received advice from their health care provider were nearly twice as likely to exercise compared to those who did not receive advice (Furie et al., 2011; Greenlund, Giles, Keenan, Croft, & Mensah, 2002). In the present study, provider contact acted as a proxy for health advice, thus, it is uncertain what percentage of providers may have offered exercise advice. Thus, it is possible that preventive counseling from health care providers was low and this may have contributed to these results. For the stroke survivors measured in this study, a majority were seeing one or more healthcare providers in the past 12 months (94.2%). This finding suggests that there may have been many opportunities for health care providers to intervene by giving advice and counseling to increase activity in stroke survivors.

Overall, these findings show that there were several sociological factors that influenced the level of physical activity in stroke survivors. Some of these factors are modifiable, but more importantly, they can be used to help identify groups that are more at risk for inactivity. These factors include region, level of education, marital status, living with others, and income.

Interpretation of research question five. Question five stated, “Is there a biopsychosocial, multivariable logistic regression model based on the NHIS variables identified by the answers to questions one through four that can predict the level of activity for US stroke survivors?” A logistic regression using complex sampling technique and forced entry method was performed. The full model containing all predictors was statistically significant, which indicates that the proposed model was able to distinguish between those who were physically inactive and those who were active based on the included biopsychosocial characteristics. Four of the independent variables provided unique statistically significant contributions to the model. These include a biological variable, a psychological variable, and two sociological variables. To better understand how each of these variables contributed to the model, odds ratios were calculated to compare the magnitude of risk factors among themselves (Szumilas, 2010).

Age contributed significantly to the model for the older age groups. There was an increase in the odds ratio for being inactive as people aged, when compared to the youngest age group: the 55 to 64 years old group OR = 2.4, the 65 to 74 year old group OR = 2.3, and the 75 to 84 year old group OR = 5.7 and for those 85 and above had the largest OR = 6.1. As stroke survivors, age, there seems to be a gradient related to activity. Those who were between 55 and 74 years of age were over two times more likely to be inactive than the younger group (e.g., 18 to 44). This finding nearly tripled to between 5.7

and 6.1 times more likely to be inactive for the eldest groups (e.g., 75 and older), suggesting that there may be a gradient in the association between activity and age for stroke survivors. After the musculoskeletal and cardiovascular conditions were analyzed with other factors in this model, the odds ratios were no longer statistically significant for these variables. In the category of psychological conditions, the self-reported perception of health had a statistically significant odds ratio of 4.6. This finding indicates that those who perceived that their health was poor or fair were 4.6 times more likely to be physically inactive than those who perceived that their health was good to excellent.

The odds ratio for education was 2.8 for those who had less than a high school degree compared to those with a college degree or higher, indicating that those who had less than a high school education were almost three times more likely to be physically inactive compared to those who had completed a college degree. The odds ratio for regional association of inactivity showed that for those with stroke who lived in the Northeast and Midwest were 2.2 and 1.7 more likely to be physically inactive than those who lived in the West living in the Northeast compared to the West. For the sociological conditions of living with spouse or partner, living alone, income below $35,000, neighborhood and seeing a health professional, the odds ratios were not statistically significant.

The model that resulted from the multiple logistic regression showed that there was representation from each component of the biopsychosocial model (Figure 5). This finding indicates that the influences on physical activity are complex and multifactorial. This model has identified factors that can be easily tracked over time with populations.

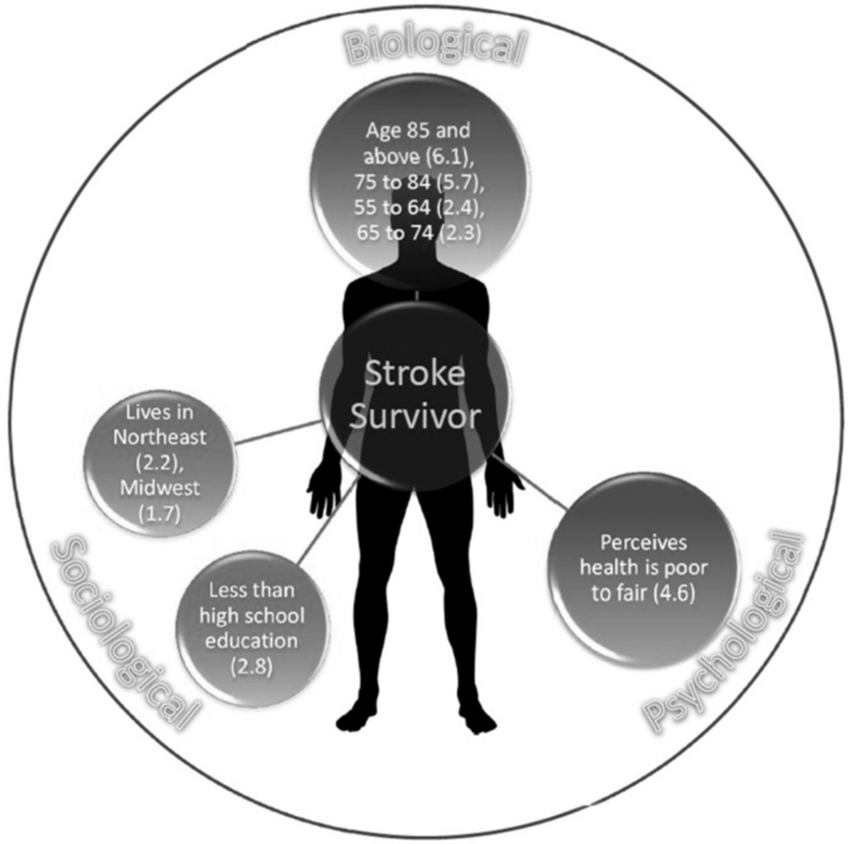

Figure 5. Biopsychosocial model for physical inactivity among U.S. stroke survivors. The biopsychosocial model showing statistically significant characteristics associated with stroke survivors who do not follow recommended levels of physical activity. The data represent 2013 NHIS variables showing the odds ratios in parentheses. Stroke survivors who are older, live in the Northeast or Midwest, and who perceive that their health is poor to fair are at greatest risk for physical inactivity.

Limitations of the Study

This study has several limitations. It is important to note that causality cannot be determined from this cross-sectional study. Those with stroke may have multiple factors that decreased physical activity or it may be that decreased physical activity resulted in physical, mental, and social consequences. The influence may also go in both directions.

The characteristics that were selected as independent variables were based on the literature and what items were available in the NHIS. Several factors that may influence level of physical activity were not measured in this study. These include physiological conditions such as work status, level of disability, fatigue, and other health conditions. Other items that are not measured by the NHIS include additional environmental factors that may have a substantial role in activity levels (Humpel et al., 2002). The dependent variable of 150 minutes per week was determined by the 2008 AHA activity guidelines (Haskell et al., 2007) . Other activity targets or reduced levels of activity for stroke survivors may result in different findings.

Inherent to a large nationwide survey is the reliance on self-reported information. It is possible that some respondents who reported that they had a stroke were incorrect and had never had a stroke. It is also possible that some who had a stroke did not respond correctly when asked if they previously had a stroke or they could have been unaware that they had stroke. Thus, some who should have been included in the analysis may not have been included. Similarly, it is possible that some respondents may have over or underreported the amount of physical activity they performed each week. Some people may have had difficulty remembering how many minutes or may not have been able accurately recall the intensity of their activity.

Recommendations

There are several recommendations for future research. Future studies could perform the same analysis as this study but focus on the association for non-stroke responders compared to the stroke survivors to see if characteristics differ between groups.

A more detailed analysis should be performed on the subsections of the biopsychosocial categories. For the musculoskeletal conditions of back pain, neck pain, joint pain, and arthritis, one or more of these conditions may have an influence on activity. For example, it has been shown that arthritis can be a barrier to level of physical activity in women (Brittain et al., 2011). Certain cardiovascular conditions may have a greater influence on the ability to perform physical activity than other conditions. Other investigations may include the further evaluation of the relationship of psychological distress variables individually rather than as a single score. Thus, taking a more detailed look at these factors may help better identify those at risk.

A subgroup analysis may also provide interesting information. For example, if large enough groups could be obtained, such as through combining multiple years, identifying which factors are associated with activities for racial groups, economic levels, or region, may be fruitful. It is possible that Hispanics in the West have different influencing factors than Black non-Hispanics in the South as they relate to following physical activity recommendations. The inverse may be true in that there may be no difference between races. For example, a study in the Southeastern US evaluated levels of activity in low-income Black and White adults and found similar patterns in physical activity (S. S. Cohen et al., 2013). A similar study could be performed but with a focus on stroke survivors. Alternate analyses for association could be performed that would analyze if stroke survivors who are participating in physical activity have health benefits (e.g., less cardiovascular disease, better mental status, greater number of social activities).

There have been a few focus group studies and systematic reviews to identify how associated factors may interfere with physical activity in the general population and stroke survivors (Cohen-Mansfield J., 2003; Damush et al., 2007; S. Nicholson et al., 2013; S. L. Nicholson et al., 2014; Salmon et al., 2003; Schutzer & Graves, 2004). More focus groups and systematic reviews may help to guide larger, population-based studies that focus on increasing levels of activity on stroke survivors.

As I have observed the increase in literature over the past 10 years, there is a greater awareness of the importance of non-communicable diseases and recognition that physical activity plays a substantial role in many aspects of health. A continued call for measuring physical activity of populations at a global level emphasizes the need for more epidemiological studies (Bauman et al., 2012; Hallal et al., 2012; Heath et al., 2012; I. M. Lee et al., 2012).

Implications

The findings of this study have potential impact for positive social change. These findings can help to identify groups that have a higher risk for physical inactivity and, therefore, we will be able to better target interventions (J. H. Morris et al., 2014).

Intervention studies for stroke survivors show that tailored counseling with or without supervised exercise may improve physical activity over the long term (J. H. Morris et al., 2014). Health care professionals should engage and educate patients on multiple levels. These include not only focusing on prescribed exercise programs but also incorporating behavioral change (J. H. Morris et al., 2014).

The model from this study identifies statistically significant factors that can be tracked over time in populations. Data about these characteristics are easily available to public health departments, healthcare providers, and to those who may develop intervention programs. The characteristics of age, perceived health, region of the US, and education level are commonly measured during surveys or health visits.

Through intervention and educational programs targeted at these populations, physical activity could be encouraged early, even during the sub-acute stage of stroke rehabilitation, in order to improve physiological outcomes and potentially decrease the risk of additional stroke (Stoller et al., 2012). Thus, by identifying those at risk who are not following physical activity guidelines, early intervention could potentially reduce disability and save lives, thereby contributing to positive social change.

Conclusion

Stroke causes devastating consequences for both individuals and society. Yet, simple measures can reduce the chances of having a stroke, such as by participating in regular moderate to rigorous levels of physical activity on a weekly basis. Even though physical activity is a simple prevention measure, it is not well understood. I completed this study of a high risk population (i.e., stroke survivors) to identify which factors may influence physical activity and to develop a predictive model to help identify stroke survivors at risk for inactivity. This quantitative cross-sectional study of a large, representative sample of US adult stroke survivors found that age, perceived health, educational level, and geographic region had statistically significant association with physical activity. In this model, stroke survivors with increasing age, poorer perceived health, lower level of education and living in Northeast or Midwest were more likely to be physically inactive.

This model has great potential for implementing prevention and intervention measures. It may be used to identify stroke survivors who are at higher risk for inactivity to whom prevention measures could be offered. For example, educational programs could target caregivers, family members, and health providers and others who are watching over those who have recently had a stroke. Community educational programs could be developed to target regions, age groups, educational status, and psychological status thus providing prevention measures to groups of people who recently had a stroke and who are most at risk for inactivity. This model may also be used to inform intervention programs to increase physical activity in those stroke survivors who are currently inactive. Collaborative efforts could engage family, health care providers, and communities to identify at-risk groups and create intervention programs to increase physical activity. Therefore, the model developed by this study may help to identify stroke survivors who are at risk for inactivity, for whom early intervention could potentially reduce disability and save lives, thereby contributing to positive social change.

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