# STRUCTURED EXERCISE VERSUS PHYSICAL ACTIVITY ON ENERGY EXPENDITURE AND SLEEP QUALITY IN COMMUNITY-DWELLING OLDER ADULTS

by

Ali Koster Wilcox

A thesis submitted to the faculty of
The University of North Carolina at Charlotte
in partial fulfillment of the requirements
for the degree of Master of Science in
Kinesiology

Charlotte

2018

Approved by:

_____
Dr. Michael J. Turner

_____
Dr. Trudy Moore-Harrison

_____
Dr. Jane F. Gaultney

# ABSTRACT

ALI KOSTER WILCOX. Structured Exercise versus Physical Activity on Energy Expenditure and Sleep Quality in Community-dwelling Older Adults. (Under the direction of DR. MICHAEL J. TURNER)

Regular physical activity is known to increase lifespan, prevent chronic diseases, improve cognitive maintenance, increase self-efficacy, decrease mortality, and reduce risk of falls in older adults. 60% of older adults report not participating in regular physical activity or exercise; however, new research is suggesting that older adults are meeting the American Heart Association physical activity recommendations throughout their daily activity. Sleep quality, quantity, and waking behaviors have been associated with increased quality of life, improved health, and increased overall energy expenditure. However, research has not looked at how structured versus unstructured physical activity affects sleep behaviors and perceived quality. This study examines current structural tendencies of physical activity in older adults to assess if they are meeting the American Heart Association recommendations through measuring daily energy expenditure (kcal/day). In addition, the study also examines how physical activity structure and sleep quality are correlated through direct and perceived assessments. Forty-five older adults from the Charlotte community volunteered and were divided into groups based on current structure of physical activity they engage in (i.e instructed exercise, independent exercise, physically active lifestyle, or control). Energy expenditure and sleep quality were measured through a wrist worn Fitbit Charge HR that was worn for 7 days. Perceived health status and sleep quality were assessed through surveys, SF-36 & PSQI,

respectively. No differences were observed between groups for energy expenditure, sleep quality, or sleep efficiency. Analysis of variance showed statistical significance between the physically active lifestyle group and the other groups for pain ($p = 0.002$), and physical functioning ($p = 0.01$). Trends toward statistical significance were observed with perceived health perception ($p = 0.07$) and steps ($p = 0.07$) between groups. The current study suggests that energy expenditure and sleep quality are not related to structure of physical activity in older adults.

TABLE OF CONTENTS

# LIST OF TABLES

# LIST OF ABBREVIATIONS

| | |
|---|---|
| BSLA | The Baltimore Longitudinal Study of Aging |
| CON | control |
| INDP | independent exercise |
| INST | instructed exercise |
| KCAL | kilocalorie |
| PAL | physically active lifestyle |
| PSQI | pittsburgh sleep quality index |

# CHAPTER 1: INTRODUCTION

Older adults, 65 years or older, are the least active age group in the US, engaging in 5 to 8 min/d of objectively measured moderate to vigorous activity. (1) In addition, the older adult population is the fastest growing age cohort globally; by 2060 it is projected that the number of people aged 65 years or older in the United States will reach 98 million. With the baby boomer generation reaching 65+ years of age, it is critical to maintain and improve overall health for the direct impact it has on quality of life, independence, and mortality in older adults. Physical activity is any bodily movement produced by skeletal muscles that requires energy expenditure and can be classified as structured or unstructured. Structured physical activity is planned and designed to increase the quality and/or intensity of a physical activity, whereas unstructured physical activity encompasses all free-living activity.

Perceived level of activity is a component of health that is key in behavior change and reporting. Older adults may perceive physical activity and exercise differently due to decreasing physiological mechanisms that are associated with aging, thus wrongly reporting activity level. Investigation of modifiable risk factors, such as physical activity, for disease or disability in older adults is important for this growing segment of the population that contributes disproportionately to increasing health care costs. (7)

The Center of Disease Control has reported physical inactivity as the second leading cause of preventable death across adults 18 years and older. (3) Physical inactivity has been correlated to negative health outcomes and is a key factor to

accelerating secondary aging, i.e. aging caused by disease and environmental factors. (4) Low activity level in older adults has been reported to be a result of concern for their safety, health status, and limited mobility in reference to moderate to vigorous intensity activities. (2) Adults who are classified as not meeting the physical activity recommendations are labeled "sedentary/inactive" due to lack of moderate physical activity. (5, 6) However, the negative health impact from sedentary behavior is more detrimental to overall health than simply a lack of moderate physical activity.

There is an inverse relationship between energy expenditure and all-cause mortality in adult men and women. (19) A minimum of 1000 kcal/wk must be expended to meet the physical activity recommendations, and is associated with a significant 20-30% reduction in risk of all-cause mortality. (20) However, the specific intensity and structure of physical activity required to achieve the energy expenditure needed has not been well researched. Light intensity activity contributes to a majority of daily energy expenditure, specifically in older adults, and has shown to provide health benefits but is not included in the physical activity guidelines. (6,9) By focusing programs and advocacy on nonexercise physical activity and reducing sedentary time by increasing light-intensity activities may be a more successful for older adults.

Though not well studied to date, a previous intervention designed to increase physical activity levels through a telephone-assisted physical activity promotion program for older adults showed that those who were initially sedentary increased their amount of light, but not moderate, intensity activity. (8) If this shift to light intensity activity were as beneficial as an increase of moderate or greater intensity activity for health benefits then

there would be justification to modify existing physical activity recommendations for older adults.

Age related declines in cognition, balance, and mood can lead to a lower quality of life, and have been shown to worsen with inadequate sleep. Lack of adequate sleep quality, especially in the older adult population, leads to an increased risk of falling, accidents, depression, and a decline in cognitive functioning. (10) For older adults, emerging evidence suggests poor sleep quality increases risk of developing cognitive impairment and dementia. (11, 12) Whereas, higher sleep quality has been associated with increased energy expenditure, increased quality of life, and improved health. Increasing the amount of physical activity is thought to improve subjective sleep quality and quantity. (13)

The primary purpose of this study was to investigate how perception of physical activity, structured or lifestyle, correlates to energy expenditure and perceived sleep quality. By comparing community-dwelling older adults, 65-85 years old, who self classify their physical activity as one of the following: instructed exercise (INST), independent exercise (INDP), physically active lifestyle (PAL), or control (CON). We hypothesized that older adults who engage in structured physical activity compared to those that do not will have a higher energy expenditure. Furthermore, those who have structured physical activity will perceive higher sleep quality compared to unstructured physical activity.

# CHAPTER 2: LITERATURE REVIEW

Meeting the national physical activity recommendations leads to increased quality of life, diminished development and progression of chronic diseases, and maintained independence in older adults. (14) However, many older adults do not meet the current physical activity guidelines, but that doesn't mean they should be categorized as completely sedentary either. Research suggests that over half (48.4%) of older adults participate in light intensity physical activity through their day which can lead to similar health benefits from higher intensity activity.

The literature on physical activity requirements in older adults is limited and it is uncertain how to appropriately define intensity, especially in the older population where there is large interindividual variation in the intensity associated with a given activity. (15) With a rapidly ageing population, there is a need to comprehensively assess physical activity patterns in older adults for public health strategies that target lifestyle modifications. Physical activity promotion is increasingly advocated for and should include not only increasing moderate-intensity physical activity, but also reducing sedentary time and increasing light intensity activity.

There has been a call for gerontological research in all areas of physical activity to assist the physical activity recommendations to continually evolve to reflect new knowledge. With the rapid advancement in physical activity monitoring there is now potential to explore free- living activity levels and patterns in more depth. By having older adults self-report if they participate in structured exercise or lead a physically active

lifestyle or neither, we can compare free- living activity measures across differing perceived activity levels.

## 2.1 Characteristics of Physical Activity and Older Adults

### *Defining Terms*

Physical activity is defined as any bodily movement produced by skeletal muscle that results in energy expenditure. (16) The amount of energy needed to complete the task is measured in kilocalories (kcal), which is a result of the quantity, intensity, duration, and frequency of muscle contraction. Physical activity is necessary to sustain life; however, the amount to which a person moves is a personal choice and often varies over time. (16) The terms “exercise” and “physical activity” often are used interchangeably; exercise is a subcategory of physical activity. It is planned, structured, repetitive, and intended to improve or maintain a component of physical fitness. There are four principal domains in which physical activity can be performed; leisure, work, transportation and domestic life, all of which have been shown to display independent associations with health outcomes. (17)

### *Current Trends*

Currently older adults are recommended to engage in either moderate or vigorous activity to achieve health benefits; however only 8% of older adults are meeting the recommendations. (1) The Baltimore Longitudinal Study of Aging (BLSA) showed through 7 day Actiheart activity monitoring that there is a 1.3% decrease per year in activity from mid- to- late life. Additionally, the BLSA reported a difference in the pattern of daily activity across age cohorts. Both younger and older participants were engaged in similar amounts of activity at the beginning of the day, older adults reach their

peak activity level earlier in the day and decreased activity amount as the day progressed. (21)

In the United States, Canada, and Europe walking is the most prevalent physical activity that is reported for older adults and duration has been shown to remain relatively consistent in physically capable adults. (22) Other forms of light intensity activity that are commonly reported by older adults are yardwork, golf, and bicycling. (23) Older adults spend their days doing greater amounts of light-intensity activities compared to other age cohorts. (24) Increasing time spent doing light-intensity activity to reduce time spent being sedentary would yield health benefits.

*Assessment*

Traditional subjective physical activity measurements indicate a biased and rough estimation of daily activity and is geared towards moderate-to-high intensity activities. (25) Studies have shown that older adults who report low physical activity levels are at elevated risk of mortality compared with those who report moderate or high levels of activity. These findings were based on questionnaire assessments of physical activity, which are subject to recall bias, are unable to account for free-living activity, and typically overestimate actual amounts of physical activity. (27, 28, 25) Furthermore, self-reported physical activity does not provide accurate estimates of absolute amounts of activity (kilocalories per day) and thus cannot be evaluated to determine whether levels of activity induced energy expenditure vary between groups. Objective measures in older adults are needed to examine the impact of engaging in structured physical activity and unstructured physical activity on total daily energy expenditure.

In recent years clinical trials and observational studies utilize accelerometers which provide objective and detailed measurements of physical activity intensity. Accelerometers capture a much wider range of activity intensities, including the light intensities characteristic of domestic and self-care tasks, which are essential for capturing an accurate measure of daily activity in older adults. Objective physical activity assessment methods, such as accelerometry, enable more accurate assessment of the entire movement intensity spectrum and may therefore have particular application in older populations. Wearable activity trackers are growing in popularity within both research and real world application to gain real-time assessment of activity level in daily life. Using both objective and subjective measurement measures in combination provides information on physical activity such as estimates of energy expenditure, duration, mode, and intensity as well as how the subjects perceives their activity levels. (17)

## 2.2 Energy Expenditure in Older Adults

Research that has shaped our current understanding between physical activity and lowering mortality risks generally quantify general activities such as walking, vigorous exercise, or regularity of activity, which does not capture the largest components of energy expenditure, daily activity. (26) Objectively measured free-living activity energy expenditure has been shown to be strongly associated with lower risk of mortality in healthy older adults. Simply expending energy through any activity may influence survival in older adults.

The effect of structured exercise training on energy expenditure is unclear in the literature specifically in older adults. Traditionally it is assumed that total daily energy expenditure increases with exercise training, however, this has been challenged with new

exercise training studies that report less weight loss than predicted given the energy cost of exercise participation. This suggests there is either a compensatory change in energy expenditure and/or energy intake. Wang et al found that participation in aerobic exercise interventions of two different doses did not result in changes in energy expenditure or nonexercise physical activity levels. (30) Interestingly they also found that exercise dose did not influence energy expenditure and total physical activity changes, but baseline physical activity levels might play an important mediating role. Conversely, other studies have suggested that structured physical exercise interventions increases energy expenditure compared with the non-exercising control groups. (31,32)

There is growing literature to support a model in which the transition from sedentary to light activity is associated with an increase in daily energy expenditure, but further increases in physical activity produce diminishingly small increments in daily energy expenditure. (33) Free-living activity energy expenditure has shown a strong association with lower mortality risk suggesting that previous self-reported measurements may have underestimated the benefits of higher levels of physical activity in older adults. (29) Suggesting that any activity energy expenditure in older adults can help lower mortality risks, seemingly contradicting reports that exercise needs to be performed at a specific intensity. Moreover, adherence to interventions that require participants to increase levels of non-exercise physical activity is likely to be higher than those interventions involving only MVPA, owing to fewer potential physical activity barriers.

## 2.3 Light-Intensity Physical Activity

Sedentary behavior has a negative impact on overall energy expenditure and health whereas light intensity activity has potential health benefits in older adults. (35,

36) Examples of light-intensity physical activities include, but are not limited to, stretching, casual walking, light yard work/ housework, and leisure sports. There is a strong inverse association between light-intensity activity and sedentary time suggesting that when light-intensity activity is increased sedentary time is reduced. (37)

Emerging research shows positive correlations between light-intensity activity and potentially beneficial health effects in older adults. (38) The importance of light intensity activity on metabolic health risk factors was first reported with by the Australian Diabetes, Obesity and Lifestyle Study (AusDiab) stating that light intensity activity was inversely associated with 2-hour post-glucose levels, waist circumference, and clustered metabolic risk. (37) Loprinzi and colleagues show that older adults who engage in greater than or equal to 300 min/wk (or more) of light intensity activity have fewer chronic diseases and favorable biological markers (body mass index (BMI), waist circumference, insulin resistance, etc) compared to those who engage in <300 min/wk. (38)

Nearly half, 48.4%, of older adults are engaged in more than 300 min/wk of light-intensity activity compared to less than 8% who meet current moderate to vigorous intensity recommendations. (1) The addition of light-intensity physical activity to physical activity recommendations and public health initiatives may be more palatable and practical for older adults due to decreased risk of injury, increased self-confidence, and increased willingness; all in promotion of increased adherence.

Due to decreased physiological mechanisms, it is possible that activities which are generally thought to be lighter intensity may achieve a beneficial health training effects for older adults. By encouraging regular incorporation of lifestyle light-intensity activity, older adults will reduce sedentary time and gain health benefits associated with physical

activity. Importantly, there is little research that compares kilocalories used per day, health benefits, and how older older adults self-report their physical activity levels.

2.4 Sleep Quality & Sleep Efficiency

Eighty percent of the people 65 years and older report sleep complaints which are associated with a variety of sleep-related health conditions. (36) Sleep problems have a significant negative effect on mental and physical health, impair quality of life, and increase healthcare costs. (39) Although research has found pharmacological treatment to be an effective treatment for sleep concerns, there is little evidence of its sustained efficacy. The potential risks of tolerance and dependency, along with the large number of prescriptions that older individuals frequently take in conjunction with sleep medication, make an evidence-based, non-drug approach of interest. Using exercise as a non-pharmacological treatment option provides an effective and low cost alternative that may provide long lasting improvements in sleep quality and overall health.

Currently, it is accepted that exercise is an important component of sleep treatment for poor sleep but the intensity of activity needed to improve sleep quality is still unclear. Physical activity is usually considered as beneficial in aiding sleep although this link may be subject to multiple factors such as sex, age, fitness level, sleep quality, and the characteristics of the activity. Naylor et al, were the first to publish a study showing low- intensity exercise intervention improving sleep quality and memory functioning after 14 days of intervention. (40)

The use of light- intensity exercise interventions in assisted living populations suggests that stretching exercises in conjunction with low impact exercise can improve subjective sleep quality. (40) Vaz Fragoso et al. studied the effect of structured physical

activity on sleep-wake behaviors in sedentary community-dwelling in older adults between the age of seventy and eighty-nine years old. (55) They found that structured physical activity over 24-30 months contributed to a lower likelihood of developing poor sleep quality for new cases over intervention period but does not resolve prevalent cases of poor sleep quality.

Scheduled physical activity of any intensity and mode can act as a synchronizing agent for the circadian system. An inverse relationship has been found between decreasing sleep latency and adherence to the exercise program. (41) Activity energy expenditure and physical activity level are equally affected by sleep duration because those who sleep less have a greater opportunity to expend more kilocalories through activity. (42)

Age related changes to the circadian system include the period, phase, and amplitude of sleep; all of which directly affect sleep quality and efficiency. (43) Age has varying and specific effects on different aspects of sleep quality and it does not worsen uniformly across the lifespan; the strongest age-related decline is sleep efficiency. (44) Sleep efficiency refers to percentage of total time in bed actually spent in sleep and is calculated as sum of each stage of sleep, divided by the total time in bed and multiplied by 100. Lack of adequate sleep leads to an increased risk of falling, accidents, depression, and a decline in cognitive functioning. (45, 10)

In older adults, small to moderate improvements in sleep quality have been found after exercise interventions like walking, yoga, Tai-Chi, and resistance training. (46,47,48) Body restoration and energy conservation theories suggest that a greater metabolic rate during wakeful hours elicits a compensatory shift toward a state of a lower

metabolic rate; which is associated with better sleep quality. (48, 49) Most of the sleep quality improvement studies focus on moderate-intensity activity, respectively on the current physical activity guidelines for adults and older adults worldwide. More research is needed to investigate how structure of physical activity correlates to sleep quality in the older adult population in their everyday setting.

# CHAPTER 3: METHODS

## 3.1 Participants

Community-dwelling persons aged 65-85 were recruited from the Charlotte Mecklenburg Park and Recreations Senior Nutrition Program and local senior health and wellness businesses. Eligibility criteria were being aged 65-85 years old, able to complete written surveys and informed consent in English. Out of 67 eligible participants recruited to participate, 45 (67%) participants had sufficient activity accelerometry data (i.e., greater than or equal to 4 days out of 7) and survey data to monitor habitual activity patterns. 43 participants returned perceived sleep quality survey and 32 had sleep quality measured by the Fitbit.

The activity levels were determined using an interview process. First participants were asked “Do you currently regularly exercise?” If the response was “yes,” then the participant was asked “Is it instructed or independent exercise?” Instructed exercisers were placed in group INST ($n$ = 13), and independent exercisers in group INDP ($n$ = 13). If the response was “no” to the first question, the participant was not currently participating in regular exercise, then they were asked “Do you lead a physically active lifestyle as a substitute to exercise?” If the response was “yes,” they were placed in PAL ($n$ = 10). Subjects who did not exercise nor have active lifestyles were placed in CON ($n$ = 9).

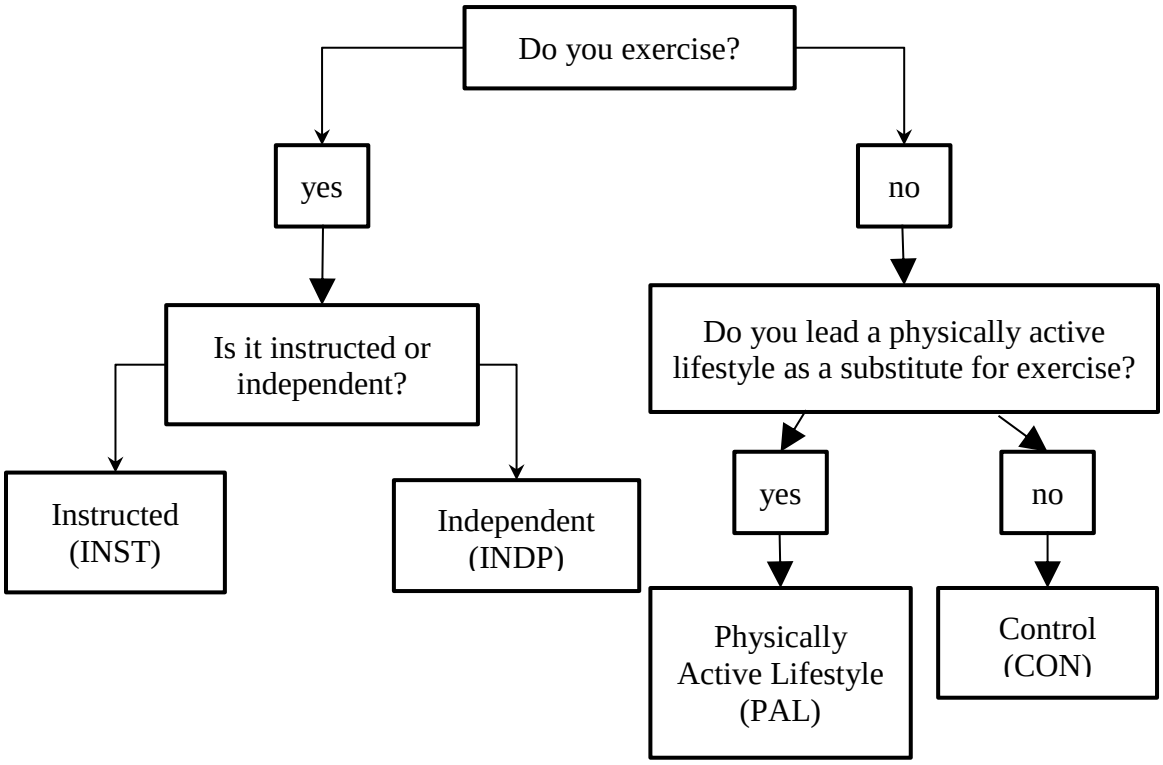


Figure 1

3.2 Study Design

This was a cross-sectional study to determine if structure of physical activity in older adults, 65-85 years of age, influenced daily energy expenditure measured through a wrist-worn Fitbit Charge HR. Furthermore, this study was designed to examine the relationship between energy expenditure and perceived sleep quality. Energy expenditure was defined as the amount of estimated kilocalories an individual expends in any activity per day. A consult with a certified personal trainer was offered to all subjects upon completion of the study to share subject's personal data and provide professional feedback. This consult did not produce any data for the study; it was offered as a benefit of completing the study. IRB approval was obtained by the UNCC Institutional Review Board.

3.3 Dependent Variables

Personal satisfaction with physical and mental health was assessed using the Short Form Health Survey (SF-36). The SF-36 survey has been shown to be valid and reliable for assessing eight dimensions of life quality. (51) Vitality, physical functioning, bodily pain, general health perceptions, physical role functioning, emotional role functioning, social role functioning, and mental health are the dimensions that are addressed in the survey. The SF-36 has been a part of the International Quality of Life Assessment project in over 50 countries to differentiate health benefits resulting from treatments in a wide range of fields. Scoring is based off a score of 100, questions are weighted equally, and a lower the score represents more disability or health concerns.

Perceived sleep quality was measured by the Pittsburgh Sleep Quality Index (PSQI) which assesses sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. (52) The seven component scores are also summed to generate a global PSQI score ranging from 0 to 21; higher scores indicate worse sleep quality and a score of more than 5 indicates a clinical sleep impairment. (52) It is a standard sleep questionnaire used in clinical and research settings. It has been shown to be reliable and valid in when testing general population and those with self-reported sleep problems. (52)

The Fitbit Charge HR is a triaxial accelerometer–based device that provides estimates of heart rate, steps, calories expended, and sleep quality. The wrist worn device uses photoplethysmography (PPG) to measure heart rate through the detection of blood volume changes in the microvascular bed of the tissue. The FitBit HR has been shown as a reliable and valid measure of energy expenditure and sleep quality in community

dwelling older adult. (53) Using the FitBit in free daily living in the senior population has been shown to be more accurate than using a pedometer due to shuffling, altered, or slow gaits. (54) A weekly average of the activity measures was exported from the Fitbit account was compared between groups.

*Procedure*

Eligibility was determined at the first session, during which informed consent and Fitbit return agreements were reviewed and signed. Participants were self-placed into groups according to current structure of physical activity, and given a study ID that was used for all records to ensure confidentiality. Subjects then randomly selected a Fitbit Charge HR and the serial number was recorded in order to ensure device randomization. The devices were individualized for age, gender, and anthropometric data following manufacturer instruction. Devices were synchronized via Bluetooth to a laptop to assist with data collection.

3.4 Protocol

Initially, subjects were interviewed to identify the appropriate activity group, see figure 1. Afterward, the SF-36 was completed and reviewed for completion. Subjects were then given copies of the Pittsburgh Sleep Quality Index (PSQI) and instructed to complete the index each morning and return the completed form at the second session. The PSQI was modified to assess previous night's sleep by referring to the night before rather than to the past week. Subjects were also instructed to wear the Fitbit for 7 consecutive days and charge it with the provided portable battery. Each subject was shown how to wear the device placing it 3 finger widths above the wrist bone where Fitbit suggests for maximum accuracy. All instructions were reviewed individually and

each participant was provided a written set of instructions. Participants were asked to not alter their daily activity levels or sleeping patterns from their normal lifestyle. The second session was scheduled 8-10 days after the first session to collect FitBits, charging equipment, and PQSI surveys.

### 3.5 Statistical Analysis

All data were analyzed using JMP (version 13.0.0) and MS Excel. Analysis of variance was performed to compare group means for all SF-36, physical activity, and PSQI data. An alpha level of 0.05 was set for significance. Since subject groups were found to differ by age, an additional analysis was performed to covary for age. This additional analysis was performed for all SF-36, physical activity, and PSQI data to determine differences between groups, by correcting for this age difference between groups.

# CHAPTER 4: RESULTS

## 4.1 Descriptive Subject Characteristics

Participant characteristics by group are detailed in Table 1. Sixty- seven subjects initially volunteered for the study with 45 subjects ($n$ = 45) completing the study (nine men and thirty-six women). Thirteen subjects were in each of the instructed exercise (INST) and independent exercise (INDP) groups, ten subjects were in the physically active lifestyle (PAL) group, and nine subjects were in the control (CON) group. No significant differences were found between groups for height ($p$ = 0.32), weight ($p$ = 0.47), and sex ($p$ = 0.6). There were significant differences of age ($p$ = 0.02) between the groups, CON was significantly younger than the other 3 groups and INST was younger than PAL and INDP. The mean age of the study sample was 75.2 (± 7.5, range 65-85) years.

Table 1: Mean ± SD Descriptive Subject Characteristics

| | CON | PAL | INDP | INST |
|---|---|---|---|---|
| Age (yr) | 69.78 ± 5.76** | 79.9 ± 9.55 | 76.46 ± 6.12 | 73.92 ± 6.6** |
| Height (cm) | 161.43 ±10.71 | 170.69 ± 13.16 | 162.17 ± 13.35 | 165.26 ± 11.31 |
| Weight (lbs) | 193 ± 60.19 | 190 ± 48.48 | 173.77 ± 50.62 | 165.23 ± 29.96 |
| Subjects (n) | 9 | 10 | 13 | 13 |

**= $p \leq 0.05$, * = $p \leq 0.07$, ∧ = $p \leq 0.05$ after correcting for age

## 4.2 Short Form - 36

Table 2 illustrates the means and standard deviations for all health constructs measured in the SF- 36. There were no significant differences between groups for the

following concepts: limitations due to physical health ($p = 0.26$), limitations due to emotional problems ($p = 0.6$), energy/fatigue ($p = 0.25$), social functioning ($p = 0.24$), and general health ($p = 0.24$). There were significant differences in physical functioning ($p = 0.01$) and pain ($p = 0.002$). For physical functioning PAL reported lesser values relative to all other groups. Pain was significantly lower in PAL compared to all other groups, and INDP and INST are greater other two groups. Perceived health measured from the SF-36 ($p = 0.07$) showed a trend towards PAL group reporting lower than all other groups and instructed physical activity reporting higher than all other groups.

Table 2: Means ± SD Short Form- 36

| | CON | PAL | INDP | INST |
|---|---|---|---|---|
| Total | 60.69 ± 27.12 | 54.04±26.66* | 67.67±25.22 | 79.36±10.92* |
| Physical Function | 737.50±195.94 | 488.89±279.26** | 729.17±216.86 | 811.54±160.93 |
| Role Limit (Phys Health) | 287.50±180.78 | 211.11± 183.33 | 326.00±121.54 | 330.77±118.21 |
| Role Limit (Emotional Problem) | 225.00± 70.71 | 222.22±109.29 | 250.00±67.42 | 261.54±65.04 |
| Energy/Fatigue | 215.00±104.61 | 246.67±63.25 | 260.00±58.47 | 275.38±41.76 |
| Social Function | 165.63±42.13 | 177.78±29.17 | 181.25±32.2 | 210.38±77.36 |
| Emotional Well-being | 360±74.83 | 395.56±86.47 | 378.33±113.92 | 427.69±28.91 |
| Pain | 132.5±25.07 | 102.78±46.04** | 157.08±36.27** | 160.77±30.81** |
| General Health | 334.38±68.06 | 316.67±79.06 | 358.33±78.58 | 378.85±67.58 |

| | | | | |
|---|---|---|---|---|
| Subjects (*n)* | 8 | 9 | 12 | 13 |

**= p ≤ 0.05, * = p ≤ 0.07, ∧ = p≤ 0.05 after correcting for age

4.3 Activity Data from Fitbit

There were no significant differences between groups for kcal/day ($p$ =0.38) and activity kcals ($p$ = 0.79), exhibited in Table 3. Steps ($p$ = 0.07) showed a trend towards PAL being lower than other groups. However, when corrected for group differences in age, steps ($p$ =0.04) were significantly lower in PAL than the other groups when analyzed by student t-test post-hoc test.

Table 3: Means ± SD Activity Data from Fitbit Daily Average

| | CON | PAL | INDP | INST |
|---|---|---|---|---|
| Kilocalorie/ day | 2170 ± 440 | 1948 ± 364 | 2051 ± 301 | 1903 ± 397 |
| Steps | 5561 ± 3195 | 2548 ± 1581*∧ | 4606 ± 1699 | 5000 ± 3332 |
| Activity kilocalories | 450 ± 157 | 304 ± 327 | 503 ± 417 | 445 ± 166 |
| Subjects (*n)* | 9 | 10 | 13 | 13 |

**= p ≤ 0.05, * = p ≤ 0.07, ∧ = p≤ 0.05 after correcting for age

4.4 Sleep Measures

No significant relationships were found between structuring of physical activity in older adults and sleep quality ($p$ = 0.64), exhibited in Table 4. Also, no significant relationships were found between structure of physical activity and sleep efficiency measured through the Fitbit Charge HR ($p$ = 0.72).

Table 4: Means ± SD Sleep Measures

| | CON | PAL | INDP | INST |
|---|---|---|---|---|
| PSQI | 5.90±2.91 | 7.79±4.67 | 6.14±3.30 | 6.71±2.62 |
| Subjects (*n*) | 8 | 9 | 13 | 13 |
| Sleep Efficiency | 51.63±41.26 | 43.41±43.73 | 63.13±26.93 | 46.22±45.63 |
| Subjects (*n)* | 6 | 7 | 10 | 9 |

**= $p \leq 0.05$, * = $p \leq 0.07$

# CHAPTER 5: DISCUSSION

The purpose of this current research study was to investigate the effects of structured physical activity on energy expenditure, perceived health status, sleep quality, and sleep efficiency in a community-dwelling geriatric population. The first hypothesis stated that structured physical activity with this population would lead to an higher energy expenditure when compared to non-structured. I reported a trend towards significance in steps when adjusted for age but that was the only activity measure that showed significance difference between groups. There were no significant differences for energy expenditure. The second hypothesis suggested that structured physical activity would improve perceived sleep quality and sleep efficiency. We reported that there were no differences between groups for either sleep measure, but all groups scored poor sleep quality reported by the PSQI.

## 5.1 Findings relative to the hypotheses

### *Energy Expenditure*

Results from the current study exhibited no significant differences between groups for daily energy expenditure. Literature on energy expenditure is mixed; some studies suggest increased or unchanged energy expenditure from exercise interventions, while others suggest a decrease potentially due to a compensatory decrease in non-exercise physical activity.

The non-significant difference in energy expenditure may have reflected non-measured differences in activity not identified as exercise. Manini et al, examined whether free-living activity energy expenditure is associated with all-cause mortality risk among older adults. (29) Free-living activity energy expenditure was assessed in 302 high-functioning, community-dwelling older adults (aged 70-82 years) over 2 weeks using doubly labeled water and indirect calorimetry. They reported that the proportion of individuals who indicated high-intensity exercise and walking for exercise in surveys had similar measures of free-living activity energy expenditure. This study found that energy expenditure has no differences between individuals who reported different structures of physical activity. The mode and intensity of activity done was not collected in my study and may be a variable to further examine. Manini et al, suggests that the accumulation of energy expenditure is from usual daily activities that expend energy and not necessarily from volitional exercise.

Wang et al. studied the effect of a four month structured exercise intervention on energy expenditure in older women between sixty and seventy-five years old. (30) They divided participants into lower and higher dose supervised aerobic exercise training

groups to see if energy expenditure assessed by doubly labeled water changed. They found that there were no significant differences between groups for energy expenditure. This study suggested that older adults who have structured physical activity are not expending more calories compared to individuals who are active or report engaging in no physical activity.

The current literature suggested that the lack of significant energy expenditure difference in the current study could be a result of not accounting for intensity of activity or the sample groups being homogeneous. Our sample came from senior centers and community groups that regularly offer exercise classes; this coupled with the eligibility criteria of being an independent older adult may have contributed to the lack of significant difference between groups.

*Sleep Quality*

There were no significant main effects of physical activity structure on perceived sleep quality or objective sleep efficiency. The literature suggests that structured physical activity results in better perceived sleep quality and can act as a synchronizing agent for the circadian system, therefore, those who report engaging in regular physical activity should report better sleep quality and sleep efficiency compared to those who do not. (40, 41, 55) We reported no differences in energy expenditure thus no differences were expected with sleep quality.

Youngstedt et al conducted a study to investigate correlations between sleep and total daily physical activity levels, both between and within subject. (56) They used activity diaries and wrist worn Actillume to assess energy expenditure over a 7 day period. They reported no correlations between physical activity level and objectively

measured sleep parameters for older adults. Additionally, they found no significant difference in sleep between the most active and least active days, which is consistent with the current study. Their results indicated however, that the number of steps and the duration of physical activity was significantly related to the improvement in subjective sleep measures. The present study did not exhibit significant correlation between steps and sleep measures.

Another epidemiological study by Loprinzi and Cardinal analyzed the data of 3081 adults (age: 18–85 years) who wore an accelerometer for 7 days. (38) Results showed an association between the objectively measured physical activity and self-reported sleeping-related parameters. The present study did not demonstrate a correlation between objectively measured energy expenditure and self reported sleep quality.

For objective sleep data, Edinger and colleagues showed that the sleep profile of 12 older fit men compared to inactive men of the same age revealed shorter sleep latency and shorter sleep interruptions, more deeper sleep and increased sleep efficiency. (57) Previous studies have found significant improvements in sleep quality in older adults through physical activity interventions, but the same effects may not transfer outside of a research setting. Sleep efficiency values also differ in physical activity studies based on mode of testing, so it is difficult to compare values between previously done studies and the current study.

## 5.2 Limitations

Certain limitation to this study should be noted. A small sample size ($n$ = 45) and incomplete data are the greatest limitations. We did not perform a power analysis prior to the study; however, due to an overall lack of significance we thought it might be

beneficial to determine how many subjects would be needed to find statistical significance. We ran a power analysis for SF-36 and activity data and found that 49 subject overall would be needed to show significance. For sleep quality and efficiency a power analysis showed that 250 more subjects would be needed to show significance.

Incomplete data was another limitation to this study. There were 17 participants who had incomplete data from the Fitbit Charge HR, either from not wearing the device for at least 4 days or device malfunctioning. The Fitbit Charge HR did not properly read and/or record sleep efficiency parameters in 24 participants. This could be due to participants not following protocol of wearing the device throughout the night or from the device not registering the activity.

The demographics of the population strengthened this study, based on the lack of observational research in structure of physical activity in community dwelling older adults. This study was predominately female, so sex representation may be considered a limitation. Also there was a significant difference between groups for age, all subjects were between 65-85, the control group was significantly younger than the other groups and the instructed exercise group was younger than the independent exercise and physically active lifestyle groups. However, this was addressed by using age as a covariate reducing this potential confound.

### 5.3 Future Research

Future research in the area of physical activity structure in older adults looking at energy expenditure and sleep parameters is necessary. Currently, the literature reports inconsistent findings on whether structuring physical activity in late life correlates to energy expenditure, sleep quality, and sleep efficiency. Physical activity interventions

have shown to benefit older adults who were previously sedentary in increasing perceived sleep quality; however the dose and structure of physical activity needed to provide changes for previously active older adults is unclear.

The current study did not observe modes of physical activity or measure dose of physical activity. This might be a good area to research in the future. Unfortunately, the method of ascertaining free-living activity energy expenditure in this study does not provide guidance on the intensity or type of activity that may be important for public health recommendations.

Future research could replicate this same study and increase the sample size and include a representative gender sample to see if more significant differences in activity data and sleep parameters would result. Future research should also utilize sleep efficiency measures that are more effective with older adults for home based studies. It might be beneficial to utilize devices that don't need charging for this population.

## 5.4 Conclusion

The data from the current research exhibited significant differences in activity data and perceived health status between structure of physical activity in older adults. The current study suggested that older adults who engage in a physically active lifestyle reported lower perceived health status, lower pain, and lower steps compared to older adults who exercise. Additionally that there are no significant difference in energy expenditure, perceived sleep quality, and sleep efficiency for those who report different structures of physical activity. More research is needed to determine if structure of physical activity produces significant differences of energy expenditure and sleep quality.

# References


1. Troiano RP, Berrigan D, Dodd KW, Mâsse LC, Tilert T, & McDowell, M. (2008). Physical Activity in the United States Measured by Accelerometer. *Medicine and Science in Sports and Exercise*. 40(1), 181-188.

2. Gardener EA, Huppert FA, Guralnik JM, & Melzer D. (2006). Middle-Aged and Mobility-Limited: Prevalence of Disability and Symptom Attributions in a National Survey. *Journal of General Internal Medicine*. 21(10), 1091-1096.

3. Nichols P, Ussery-Hall A, Griffin-Blake S, & Easton A. (2010). The Evolution of the Steps Program, 2003-2010: Transforming the Federal Public Health Practice of Chronic Disease Prevention..*Preventing Chronic Disease*. 9, E50.

4. Chodzko-Zajko WJ, Proctor D N, Fiatarone Singh MA, Minson CT, Nigg CR, Salem GJ, & Skinner JS. (2009). American College of Sports Medicine Position Stand: Exercise and Physical Activity for Older Adults. *Med Science Sports Exercise*. 41, 1510–1530.

5. Pollock M L, Gaesser G A, Butcher J D, Després J P, Dishman RK, Franklin BA, & Garber CE. (1998). American College of Sports Medicine Position Stand: the Recommended Quantity and Quality of Exercise for Developing and Maintaining Cardiorespiratory and Muscular Fitness, and Flexibility in Healthy Adults. *Med Science Sports Exercise*.30, 975-991.

6. Physical Activity Guidelines Advisory Committee. (2008). Physical Activity Guidelines for Americans. Washington, DC: *US Department of Health and Human Services*.15-34.

7. Rice DP, Fineman N. (2004). Economic implications of increased longevity in the United States. *Annual Review Public Health*. 25, 457-473.

8. Hooker SP, Seavey W, Weidmer CE, Harvey DJ, Stewart AL, Gillis DE, & King AC. (2005). The California Active Aging Community Grant Program: Translating Science Into Practice To Promote Physical Activity In Older Adults. *Annals of Behavioral Medicine*. 29, 155-165.

9. Buman MP, Hekler EB, Haskell WL, Pruitt L, Conway TL, Cain KL, & King AC. (2010). Objective Light-Intensity Physical Activity Associations with Rated Health in Older Adults. *American Journal of Epidemiology*. 172, 1155-1165.

10. Perlis ML, Giles DE, Buysse DJ, Tu X, & Kupfer DJ. (1997). Self-Reported Sleep Disturbance as a Prodromal Symptom in Recurrent Depression. *Journal of Affective Disorders*. 42, 209-212.

11. Landry GJ, Best JR, & Liu-Ambrose T. (2015). Measuring Sleep Quality in Older Adults: a Comparison Using Subjective and Objective Methods. *Frontiers in Aging Neuroscience*. 7.

12. Lim AS, Kowgier M, Yu L, Buchman AS, & Bennett DA. (2013). Sleep Fragmentation and the risk of Incident Alzheimer's Disease and Cognitive Decline in Older Persons. *Sleep*. 36(7), 1027-1032.

13. Taylor SR. (2001). The Influence of Exercise on Sleep Quality. *International SportMed Journal*. 2, 1-10.

14. Garber CE, Blissmer B, Deschenes MR, Franklin BA, Lamonte MJ, Lee IM, & Swain DP. (2011). Quantity and Quality Of Exercise For Developing and Maintaining Cardiorespiratory, Musculoskeletal, and Neuromotor Fitness In Apparently Healthy Adults: Guidance For Prescribing Exercise. *Medicine & Science in Sports & Exercise*. 43, 1334-1359.

15. Wareham NJ, Rennie KL. (1998). The assessment of physical activity in individuals and populations: why try to be more precise about how physical activity is assessed? *International Journal Obesity Related Metabolic Disorders.* 22(2), S30–8.

16. Caspersen CJ, Powell KE, & Christenson GM. (1985). Physical Activity, Exercise, and Physical Fitness: Definitions and Distinctions for Health-Related Research. *Public Health Reports*. 100, 126-131.

17. Golubic R, Martin KR, Ekelund U, Hardy R, Kuh D, Wareham N, & Brage S. (2014). Levels of Physical Activity Among a Nationally Representative Sample of People in Early Old Age: results of objective and self-reported assessments. *International Journal of Behavioral Nutrition and Physical Activity.* 11(1), 58.

18. McAuley E, Wraith S, & Duncan TE. (1991). Self-Efficacy, Perceptions of Success, and Intrinsic Motivation For Exercise. *Journal of Applied Social Psychology.* 21, 139-155.

19. Manini TM, Everhart JE, Patel KV, Schoeller DA, Colbert LH, Visser M, & Harris TB. (2006). Daily Activity Energy Expenditure and Mortality Among Older Adults. *Journal of American Medical Associatoin*, 296(2), 171-179.

20. Lee IM, & Skerrett PJ. (2001). Physical Activity and All-cause Mortality: What is the Dose-Response Relation?. *Medicine & Science in Sports and Exercise*, 33, S459-S471.

21. Schrack JA, Zipunnikov V, Goldsmith J, Bai J, Simonsick EM, Crainiceanu C, & Ferrucci L. (2013). Assessing the "Physical Cliff": Detailed Quantification of Age-Related Differences in Daily Patterns of Physical Activity. *Journals of Gerontology Series A: Biomedical Sciences and Medical Sciences*, 69, 973-979.

22. DiPietro L. (2001). Physical Activity in Aging: Changes in Patterns and Their Relationship to Health and Function. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences*, 56, 13-22.

23. Verbrugge LM, Gruber-Baldini AL, & Fozard JL. (1996). Age Differences and Age Changes in Activities: Baltimore Longitudinal Study Of Aging. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 51, S30-S41.

24. Westerterp KR. (2008). Physical Activity as Determinant of Daily Energy Expenditure. *Physiology and Behavior*, 93, 1039-1043.

25. Sallis JF, & Saelens BE. (2000). Assessment of Physical Activity by Self-Report: Status, Limitations, and Future Directions. *Research Quarterly for Exercise and Sport*, 71, 1-14.

26. Weller I, & Corey P. (1998). The Impact of Excluding Non-leisure Energy Expenditure on the Relation Between Physical Activity and Mortality in Women. *Epidemiology*, 9(6), 632-635.

27. Levin S, Jacobs DR, Ainsworth BE, Richardson MT, & Leon AS. (1999). Intra-Individual Variation and Estimates of Usual Physical Activity. *Annals of Epidemiology*, 9, 481-488.

28. LaMonte MJ, & Ainsworth BE. (2001). Quantifying Energy Expenditure and Physical Activity in the Context of Dose Response. *Medicine and Science in Sports and Exercise*, 33, S370-378.

29. Manini TM, Everhart JE, Patel KV, Schoeller DA, Colbert LH, Visser M, & Harris TB. (2006). Daily Activity Energy Expenditure and Mortality Among Older Adults. *Journal of the American Medical Association*, 296, 171-179.

30. Wang X, Bowyer KP, Porter RR, Breneman CB, & Custer SS. (2017). Energy Expenditure Responses to Exercise Training in Older Women. *Physiological Reports*, 5, 1-11.

31. Hollowell RP, Willis LH, Slentz CA, Topping JD, Bhakpar M, & Kraus WE. (2009). Effects of Exercise Training Amount on Physical Activity Energy Expenditure. *Medicine and Science in Sports and Exercise*, 41(8), 1640-1644.

32. Turner JE, Markovitch D, Betts JA, & Thompson D. (2010). Non-prescribed Physical Activity Energy Expenditure is Maintained with Structured Exercise and Implicates a Compensatory Increase in Energy Intake. *The American Journal of Clinical Nutrition*, 92(5), 1009-1016.

33. O'Neal TJ, Friend DM, Guo J, Hall KD, & Kravitz AV. (2017). Increases in Physical Activity Result in Diminishing Increments in Daily Energy Expenditure in Mice. *Current Biology*, 27(3), 423-430.

34. Copeland JL, & Esliger DW. (2009). Accelerometer Assessment of Physical Activity in Active, Healthy Older Adults. *Journal of Aging and Physical Activity*, 17(1), 17-30.

35. Owen N, Sparling PB, Healy GN, Dunstan DW, & Matthews CE. (2011). Sedentary Behavior: Emerging Evidence For a New Health Risk. *Mayo Clinic Proceedings*, 85, 1138-1141.

36. Buman MP, Hekler EB, Bliwise DL, & King AC. (2011). Exercise Effects on Night-To-Night Fluctuations in Self-Rated Sleep Among Older Adults with Sleep Complaints. *Journal of Sleep Research*, 20, 28-37.

37. Dunstan DW, Zimmet PZ, Welborn TA, Cameron AJ, Shaw J, Courten de M, & AusDiab Steering Committee. (2002). The Australian Diabetes, Obesity and Lifestyle Study (AusDiab)—methods and response rates. *Diabetes Research and Clinical Practice*, 57(2), 119-129.

38. Loprinzi PD, Lee H, & Cardinal BJ. (2015). Evidence to Support Including Lifestyle Light-Intensity Recommendations in Physical Activity Guidelines for Older Adults. *American Journal of Health Promotion*, 29, 277-284.

39. Jean-Louis G, Kripke DF, Elliott JA, Zizi F, Wolintz AH, & Lazzaro DR. (2005). Daily Illumination Exposure and Melatonin: Influence of Ophthalmic Dysfunction and Sleep Duration. *Journal of Circadian Rhythms*, 3(1), 13.

40. Naylor, E., Penev, P. D., Orbeta, L., Janssen, I., Ortiz, R., Colecchia, E. F & Zee, P. C. (2000). Daily Social and Physical Activity Increases Slow-Wave Sleep and Daytime Neuropsychological Performance in the Elderly. *Sleep*, 23, 1-9.

41. Kline, C. E. (2014). The Bidirectional Relationship Between Exercise and Sleep: Implications for Exercise Adherence and Sleep Improvement. *American Journal of Lifestyle Medicine*, 8, 375-379.

42. Schutz Y., Weinsier RL, Hunter GR. (2001). Assessment of free-living physical activity in humans: an overview of currently available and proposed new measures. *Obesity Res*. 9, 368-379.

43. Weitzman, E. D., Moline, M. L., Czeisler, C. A., & Zimmerman, J. C. (1982). Chronobiology of Aging: Temperature, Sleep-Wake Rhythms and Entrainment. *Neurobiology of Aging*, 3, 299-309.

44. Gadie, A., Shafto, M., Leng, Y., & Kievit, R. A. (2017). How are age-related difference in sleep quality associated with health outcomes? An epidemiological investigation in a UK cohort of 2406 adults. *bioRxiv*, 060145.

45. Foley, D. J., Monjan, A. A., Brown, S. L., Simonsick, E. M., Wallace, R. B., & Blazer, D. G. (1995). Sleep Complaints Among Elderly Persons: An Epidemiologic Study Of Three Communities. *Sleep*, 18, 425-432.

46. Chen, K. M., Chen, M. H., Chao, H. C., Hung, H. M., Lin, H. S., & Li, C. H. (2009). Sleep Quality, Depression State, and Health Status of Older Adults After Silver Yoga Exercises: Cluster Randomized Trial. *International Journal of Nursing Studies*, 46(2), 154-163.

47. Li, F., Fisher, K. J., Harmer, P., Irbe, D., Tearse, R. G., & Weimer, C. (2004). Tai Chi and Self-Rated Quality Of Sleep And Daytime Sleepiness In Older Adults: A Randomized Controlled Trial. *Journal of the American Geriatrics Society*, 52(6), 892-900.

48. Ferris, L. T., Williams, J. S., Shen, C. L., O'Keefe, K. A., & Hale, K. B. (2005). Resistance Training Improves Sleep Quality in Older Adults a pilot study. *Journal of Sports Science & Medicine*, 4(3), 354.

49. Adam, K., & Oswald, I. A. N. (1983). Protein Synthesis, Bodily Renewal and the Sleep-Wake Cycle. *Clinical Science*, 65, 561-567.

50. Berger, R. J., & Phillips, N. H. (1988). Comparative Aspects of Energy Metabolism, Body Temperature and Sleep. Acta physiologica Scandinavica. *Supplementum*, 574, 21-27.

51. Ware, J. E., Kosinski, M., Dewey, J. E., & Gandek, B. (2000). SF-36 Health Survey: Manual and Interpretation Guide. Quality Metric Inc..

52. Buysse, D. J., Reynolds, C. F., Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry Research*, 28(2), 193-213.

53. Adam Noah, J., Spierer, D. K., Gu, J., & Bronner, S. (2013). Comparison of Steps and Energy Expenditure Assessment in Adults of Fitbit Tracker and Ultra to the Actical and Indirect Calorimetry. *Journal of Medical Engineering & Technology*, 37(7), 456-462.

54. Fulk, G. D., Combs, S. A., Danks, K. A., Nirider, C. D., Raja, B., & Reisman, D. S. (2014). Accuracy of 2 Activity Monitors in Detecting Steps in People with Stroke and Traumatic Brain Injury. *Physical Therapy*, 94(2), 222-229.

55. Vaz Fragoso, C. A., Miller, M. E., King, A. C., Kritchevsky, S. B., Liu, C. K., Myers, V. H., & Gill, T. M. (2015). Effect of Structured Physical Activity on Sleep–Wake Behaviors in Sedentary Elderly Adults with Mobility Limitations. *Journal of the American Geriatrics Society*, 63(7), 1381-1390.

56. S.D. Youngstedt, M.L. Perlis, P.M. O'Brien, C.R. Palmer, M.T. Smith, H.J. Orff, et al. (2003). No association of sleep with total daily physical activity in normal sleepers. *Physiological Behavior*, 78, 395-401

57. J.D. Edinger, M.C. Morey, R.J. Sullivan, M.B. Higginbotham, G.R. Marsh, D.S. Dailey, et al. (1993). Aerobic fitness, acute exercise and sleep in older men. *Sleep*, 16, 351-359

APPENDIX A.1: PARTICIPANT CONSENT FORM

UNC CHARLOTTE

**Informed Consent for**

**Structured Exercise versus Physical Activity on Energy Expenditure and Sleep Quality in Community-dwelling Older Adults**

You are invited to participate in a research study entitled "Structured Exercise versus Physical Activity on Energy Expenditure and Sleep Quality in Community-dwelling Older Adults" This study is to investigate if the structure of activity you do has an impact on your energy expenditure and sleep quality.

**Investigator(*s*)**
This study is being conducted by Ali Wilcox in the Department of Kinesiology at UNC Charlotte, under the supervision Dr. Mike Turner.

**Eligibility**
To participate in the study, you must be between 65-85 years old, able to provide history of physical activity, and be able to provide 7 days of normative behavior data.

**Overall Description of Participation**
If you are interested in participating in the study you will be determined if eligible. After we go over the study protocol with you informed consent will be obtained.

- We will ask you to complete surveys where physical activity ability and a recall of physical activity will be addressed by the SF-36 and Yale Physical Activity Survey (YPAS), respectfully.
- You will choose a Fitbit HR at random that has its serial number assigned to in order to ensure confidentiality and privacy.
- Height, weight, stride length, age, and gender will be recorded and edited in each Fitbit account.
- Then you will receive instruction on how to function, charge, and use the Fitbit HR.
- You will be asked to wear the Fitbit for 7 consecutive days and charge it three times during the week.
- Also, you will be given 7 copies of the Pittsburg Sleep Quality Index to complete upon waking each day.
- You will be instructed not to change your physical activity levels or sleeping patterns and to wear the Fitbit HR at all times.

Starting with the second session, where we will meet to collect the Fitbits, turn in sleep diary, and complete the Yale physical activity survey (YPAS). A personal training consult will be offered to you upon completion of the study to share personal data and provide professional feedback.

**Length of Participation**
You will have to meet at a fitness center of choice for two sessions. Both session will take 60 minutes. You will be one of 100 study participants if you agree to be in this study.

**Risks and Benefits of Participation**
Risks: You will be asked to recall and disclose emotional information as well as have qualitative information about your daily activity monitored, both of these may cause distress or embarrassment. During informed consent you will be asked to not change your normal activity thus minimizing risk of injury to performing new activity to improve activity that is monitored. If the Fitbit HR is lost or damaged a replacement will be the responsibility of the subject. Costs will be $129.95 + tax and will need to be replaced within one week of second testing session.

Benefits: This study will help researchers develop better recommendation for physical activity for older adults. Additionally, this study allows participants to meet with a certified personal trainer about your current physical activity and sleep behavior.

**Alternatives**
If at any point a study wishes to no longer participate in the study they are free to do so.

**Possible Injury Statement**
If you are hurt during this study, we will make sure you get the medical treatment you need for your injuries. However, the university will not pay for the medical treatment or repay you for those expenses.

**Volunteer Statement**
You are a volunteer. The decision to participate in this study is completely up to you. If you decide to be in the study, you may stop at any time. You will not be treated any differently if you decide not to participate in the study or if you stop once you have started.

**Confidentiality Statement**
Any information about your participation, including your identity, is completely confidential. The following steps will be taken to ensure this confidentiality: You will be assigned a code number and all questionnaires and step logs will contain your number.

The master sheet with your name and assigned number will be kept separate from the data locked in a filing cabinet in the investigators office. All data collection sheets will be stored in a locked filing cabinet in the primary investigator's personal office (224 Belk Gym). Only the investigators will have access to your information.

**Statement of Fair Treatment and Respect**
UNC Charlotte wants to make sure that you are treated in a fair and respectful manner. Contact the university's Research Compliance Office (704-687-1871) if you have questions about how you are treated as a study participant. If you have any questions about the actual project or study, please contact Ali Wilcox (awilcox7@uncc.edu) or Dr. Mike Turner (miturner@uncc.edu)

**Approval Date:**
This form was approved for use on *Month, Date, 2016* for one year

**Participant Consent**
I have read the information in this consent form. I have had the chance to ask questions about this study, and those questions have been answered to my satisfaction. I am at least 18 years of age, and I agree to participate in this research project. I understand that I will receive a copy of this form after it has been signed by me and the principal investigator of this research study.

_____ _____
Participant Name (PRINT) Date

_____
Participant Signature

_____ _____
Investigator Signature Date

APPENDIX A.2: FITBIT RETURN AGREEMENT


Welcome to a *Kinesiology* study that assesses the energy expenditure and sleeping habits of the aging population. Before taking part in this study, please read the FitBit Return Agreement form below and sign if you consent to wearing and returning your assigned FitBit

**FitBit Return Agreement Form**

Taking part in this study involves wearing a FitBit Flex wristwatch for seven consecutive days. The FitBit will measure daily caloric expenditure and sleep behavior. You will be asked to keep the FitBit on your wrist at all times.

All participants will be required to schedule a Day 2 testing session within 10 days from today in order to return the FitBit in good condition. You must sign and date this form in order to this study. By signing this form, you agree to return the FitBit and charging cable during your scheduled Day 2 testing session with no damage. If the FitBit is not returned, you will be required to pay for a replacement, purchased through fitbit.com will be $129.95+tax.

If you have further questions or concerns about your rights as a participant in this study regarding use of the FitBit device, please contact the principal investigator, Ali Wilcox, at (xxx) xxx-xxxx or awilcox7@uncc.edu or the responsible faculty member, Dr. Mike Turner, at (xxx) xxx-xxxx or miturner@uncc.edu.

I have read the information in this FitBit Return Agreement Form. I have had the chance to ask questions about this study, and those questions have been answered to my satisfaction. I am at least 18 years of age, and I agree to return my assigned FitBit during my follow-up session one week from today. I understand that failure to return the FitBit will result in myself having to replace the Fitbit. I understand that I will receive this signed agreement form as a receipt upon returning the FitBit.

_____ _____

Participant Name (PRINT) Date

_____

Participant Signature

_____ _____

Investigator Signature Date

---

----------The above referenced FitBit has been returned in good working order.

_____ _____

Investigator Signature Date

# APPENDIX A.3: SHORT FORM 36

## SF-36 QUESTIONNAIRE

**Name:**_____ **Ref. Dr:**_____ **Date:** _____

**ID#:** _____ **Age:** _____ **Gender: M / F**

Please answer the 36 questions of the **Health Survey** completely, honestly, and without interruptions.

**GENERAL HEALTH:**
**In general, would you say your health is:**
Excellent Very Good Good Fair Poor

**Compared to one year ago, how would you rate your health in general now?**
Much better now than one year ago
Somewhat better now than one year ago
About the same
Somewhat worse now than one year ago
Much worse than one year ago

**LIMITATIONS OF ACTIVITIES:**
The following items are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?

**Vigorous activities, such as running, lifting heavy objects, participating in strenuous sports.**
Yes, Limited a lot Yes, Limited a Little No, Not Limited at all

**Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf**
Yes, Limited a Lot Yes, Limited a Little No, Not Limited at all

**Lifting or carrying groceries**
Yes, Limited a Lot Yes, Limited a Little No, Not Limited at all

**Climbing several flights of stairs**
Yes, Limited a Lot Yes, Limited a Little No, Not Limited at all

**Climbing one flight of stairs**
Yes, Limited a Lot Yes, Limited a Little No, Not Limited at all

**Bending, kneeling, or stooping**
Yes, Limited a Lot Yes, Limited a Little No, Not Limited at all

**Walking more than a mile**
Yes, Limited a Lot Yes, Limited a Little No, Not Limited at all

**Walking several blocks**
Yes, Limited a Lot Yes, Limited a Little No, Not Limited at all

**Walking one block**
Yes, Limited a Lot Yes, Limited a Little No, Not Limited at all

**Bathing or dressing yourself**
◯Yes, Limited a Lot ◯Yes, Limited a Little ◯No, Not Limited at all

**PHYSICAL HEALTH PROBLEMS:**
During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of your physical health?

**Cut down the amount of time you spent on work or other activities**
◯Yes ◯No

**Accomplished less than you would like**
◯Yes ◯No

**Were limited in the kind of work or other activities**
◯Yes ◯No

**Had difficulty performing the work or other activities (for example, it took extra effort)**
◯Yes ◯No

**EMOTIONAL HEALTH PROBLEMS:**
During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?

**Cut down the amount of time you spent on work or other activities**
◯Yes ◯No

**Accomplished less than you would like**
◯Yes ◯No

**Didn't do work or other activities as carefully as usual**
◯Yes ◯No

**SOCIAL ACTIVITIES:**
**Emotional problems interfered with your normal social activities with family, friends, neighbors, or groups?**

◯Not at all ◯Slightly ◯Moderately ◯Severe ◯Very Severe

**PAIN:**
**How much bodily pain have you had during the past 4 weeks?**

◯None ◯Very Mild ◯Mild ◯Moderate ◯Severe ◯Very Severe

**During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework)?**

◯Not at all ◯A little bit ◯Moderately ◯Quite a bit ◯Extremely

**GENERAL HEALTH:**
**How true or false is each of the following statements for you?**

**I seem to get sick a little easier than other people**
◯Definitely true ◯Mostly true ◯Don't know ◯Mostly false ◯Definitely false

**I am as healthy as anybody I know**
◯Definitely true ◯Mostly true ◯Don't know ◯Mostly false ◯Definitely false

**I expect my health to get worse**
◯Definitely true ◯Mostly true ◯Don't know ◯Mostly false ◯Definitely false

**My health is excellent**
◯Definitely true ◯Mostly true ◯Don't know ◯Mostly false ◯Definitely false

**ENERGY AND EMOTIONS:**
These questions are about how you feel and how things have been with you during the last 4 weeks. For each question, please give the answer that comes closest to the way you have been feeling.

**Did you feel full of pep?**
- ◯ All of the time
- ◯ Most of the time
- ◯ A good Bit of the Time
- ◯ Some of the time
- ◯ A little bit of the time
- ◯ None of the Time

**Have you been a very nervous person?**
- ◯ All of the time
- ◯ Most of the time
- ◯ A good Bit of the Time
- ◯ Some of the time
- ◯ A little bit of the time
- ◯ None of the Time

**Have you felt so down in the dumps that nothing could cheer you up?**
- ◯ All of the time
- ◯ Most of the time
- ◯ A good Bit of the Time
- ◯ Some of the time
- ◯ A little bit of the time
- ◯ None of the Time

**Have you felt calm and peaceful?**
- ◯ All of the time
- ◯ Most of the time
- ◯ A good Bit of the Time
- ◯ Some of the time
- ◯ A little bit of the time
- ◯ None of the Time

**Did you have a lot of energy?**
- ◯ All of the time
- ◯ Most of the time
- ◯ A good Bit of the Time
- ◯ Some of the time
- ◯ A little bit of the time
- ◯ None of the Time

**Have you felt downhearted and blue?**

- ◯ All of the time
- ◯ Most of the time
- ◯ A good Bit of the Time
- ◯ Some of the time
- ◯ A little bit of the time
- ◯ None of the Time

**Did you feel worn out?**

- ◯ All of the time
- ◯ Most of the time
- ◯ A good Bit of the Time
- ◯ Some of the time
- ◯ A little bit of the time
- ◯ None of the Time

**Have you been a happy person?**

- ◯ All of the time
- ◯ Most of the time
- ◯ A good Bit of the Time
- ◯ Some of the time
- ◯ A little bit of the time
- ◯ None of the Time

**Did you feel tired?**

- ◯ All of the time
- ◯ Most of the time
- ◯ A good Bit of the Time
- ◯ Some of the time
- ◯ A little bit of the time
- ◯ None of the Time

**SOCIAL ACTIVITIES:**
**During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting with friends, relatives, etc.)?**

- ◯ All of the time
- ◯ Most of the time
- ◯ Some of the time
- ◯ A little bit of the time
- ◯ None of the Time

APPENDIX A.4: PSQI

Name_____ Date_____

# Sleep Quality Assessment (PSQI)

### What is PSQI, and what is it measuring?

The Pittsburgh Sleep Quality Index (PSQI) is an effective instrument used to measure the quality and patterns of sleep in adults. It differentiates "poor" from "good" sleep quality by measuring seven areas (components): subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medications, and daytime dysfunction over the last month.

## INSTRUCTIONS:

The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month. Please answer all questions.

## During the past month,

1. When have you usually gone to bed? _____
2. How long (in minutes) has it taken you to fall asleep each night? _____
3. What time have you usually gotten up in the morning? _____
4. A. How many hours of actual sleep did you get at night? _____
   B. How many hours were you in bed? _____

| 5. During the past month, how often have you had trouble sleeping because you | Not during the past month (0) | Less than once a week (1) | Once or twice a week (2) | Three or more times a week (3) |
|---|---|---|---|---|
| A. Cannot get to sleep within 30 minutes | | | | |
| B. Wake up in the middle of the night or early morning | | | | |
| C. Have to get up to use the bathroom | | | | |
| D. Cannot breathe comfortably | | | | |
| E. Cough or snore loudly | | | | |
| F. Feel too cold | | | | |
| G. Feel too hot | | | | |
| H. Have bad dreams | | | | |
| I. Have pain | | | | |
| J. Other reason (s), please describe, including how often you have had trouble sleeping because of this reason (s): | | | | |
| 6. During the past month, how often have you taken medicine (prescribed or "over the counter") to help you sleep? | | | | |
| 7. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity? | | | | |
| 8. During the past month, how much of a problem has it been for you to keep up enthusiasm to get things done? | | | | |
| 9. During the past month, how would you rate your sleep quality overall? | Very good (0) | Fairly good (1) | Fairly bad (2) | Very bad (3) |

## Scoring

| | | |
|---|---|---|
| **Component 1** | #9 Score | C1 _____ |
| **Component 2** | #2 Score (<15min (0), 16-30min (1), 31-60 min (2), >60min (3)) + #5a Score (if sum is equal 0=0; 1-2=1; 3-4=2; 5-6=3) | C2 _____ |
| **Component 3** | #4 Score (>7(0), 6-7 (1), 5-6 (2), <5 (3) | C3 _____ |
| **Component 4** | (total # of hours asleep) / (total # of hours in bed) x 100 >85%=0, 75%-84%=!, 65%-74%=2, <65%=3 | C4 _____ |
| **Component 5** | # sum of scores 5b to 5j (0=0; 1-9=1; 10-18=2; 19-27=3) | C5 _____ |
| **Component 6** | #6 Score | C6 _____ |
| **Component 7** | #7 Score + #8 score (0=0; 1-2=1; 3-4=2; 5-6=3) | C7 _____ |

***Add the seven component scores together*** _____ ***Global PSQI*** _____

***A total score of "5" or greater is indicative of poor sleep quality.***
***If you scored "5" or more it is suggested that you discuss your sleep habits with a healthcare provider***