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The Impact of Physical Activity on Depressed Mood in Older Seventh-day Adventists

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by

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A dissertation submitted in partial satisfaction of
the requirements for the degree of
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Each person whose signature appears below certifies that this dissertation in his/her opinion is adequate, in scope and quality, as a dissertation for the degree Doctor of Philosophy.

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ABBREVIATIONS

AHS-2	Adventist Health Study-2
ANOVA	Analysis of Variance
BRHS	Biopsychosocial Religion & Health Study
CES-D	Center for Epidemiological Studies Depression Scale
DALY	Disability-Adjusted Life Years
HPA	Hypothalamic-Pituitary-Adrenal
IGF-I	Insulin-like growth factor-I
Kg	Kilogram
MDD	Major Depressive Disorder
MPH	Miles per Hour
OR	Odds Ratio
PA	Physical Activity
PHA	Phytohemagglutinin
PTSD	Post-traumatic Stress Disorder
$VO_{2\ max}$	Maximal Oxygen Uptake
WHO	World Health Organization
WRJ	Walk, Run, Jog

ABSTRACT OF THE DISSERTATION

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by

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Doctor of Philosophy, Graduate Program in Psychology
Loma Linda University, September 2014
Dr. Kelly R. Morton, Chairperson

Research has shown physical activity (PA) to result in a reduction in depressed mood. The effects have been examined for different age groups, however, it is unclear whether PA effects differ in older adults. A prospective cohort study (N = 6,463) examined duration and intensity of PA in relation to mood in the Biopsychosocial Religion and Health Study (BRHS). Depressed mood indices were expected to be predicted by lower levels of PA and individuals in younger age groups were expected to receive a greater reduction in depressed mood after PA than those in older age groups. Previous PA (minutes of vigorous PA per week) of all participants had a small protective effect against depressed mood 1-3 years later. A one hour daily increase in vigorous PA may result in a meaningful impact on depressive symptoms.

PA was protective of depressed mood in participants falling within the oldest quartile but not the three younger quartiles. Age was also a significant predictor of later depressed mood in older adults but not in younger adults indicating PA may be more important in an older population who could be more at risk for depressed mood.

CHAPTER ONE

LITERATURE REVIEW

Impact of Depression

Sometimes referred to as the "common cold" of mental health, depression remains one of the most frequent mental disorders in the United States and many other countries. International rates of depression have been found to range from 1.5% in Taiwan to 19% in Beirut (Weissman, et al., 1996). Studies conducted on community samples in the United States indicate that 10-25% of women and 5-12% of men will meet criteria for Major Depressive Disorder (MDD) during their lifetime (Kessler, McGonagle, Swartz, Blazer, & Nelson, 1992; Weissman, Bruce, Leaf, Florio, & Holzer, 1991; American Psychiatric Association, 2000). The consequences of any disorder impairing approximately 17% of a nation's adults are considerable (Kessler, et al., 1992). A growing body of research indicates that more work must focus on treatment for and prevention of depression.

In 2002, it was estimated that the economic cost of depressive disorders in American workplaces was $44 billion per year. This estimate did not include labor costs associated with short- and long-term disability and is thus likely an underestimate of total workplace costs (Stewart, Ricci, Chee, Hahn, & Morganstein, 2003). The First Chicago Study found that depression accounted for the greatest number of short-term disability days of absence of any disease or disorder including: anxiety disorders, lower back pain, heart disease, high blood pressure, and diabetes (Burton & Conti, 1990; Burton & Conti, 1992; Conti & Burton, 1992).

A recent development in the study and measurement of disease impact on human life is disability-adjusted life years (DALY; WHO, 2000). DALY is a general estimation of disease burden as measured by the combination of years lost to disability, poor health, and premature death by combining measures of mortality and morbidity into a single metric. Using a baseline WHO model across 47 countries, depression is predicted to rank as the second highest cause of DALYs worldwide by 2020 (after ischemic heart disease). It is further estimated that depression will be the highest ranking cause of DALYs in developing regions (Murray & Lopez, 1997). Approximately 15% of those struggling with MDD die of suicide (American Psychiatric Association, 2000). In addition, elderly adults with depression had a higher mortality rate than those who were not depressed, even when physical disability and health conditions were controlled (Murphy, Smith, Lindesay, & Slattery, 1988).

What about depression causes such widespread impairment? This is best explained through an explanation of its diagnosis. The diagnosis of MDD requires that an individual has met criteria for at least one Major Depressive Episode which is not better accounted for by another diagnosis and the Major Depressive Episode is not superimposed on Schizophrenia, Schizophreniform Disorder, Delusional Disorder, or Psychotic Disorder Not Otherwise Specified. The individual also must not have experienced a manic episode, mixed episode, or hypomanic episode (American Psychiatric Association, 2000). A Major Depressive Episode requires that "five (or more) of the following symptoms have been present during the same two-week period and represent a change from previous functioning; at least one of the symptoms is either (1)

depressed mood or (2) loss of interest or pleasure" (American Psychiatric Association, 2000, p. 356):

1. Depressed mood most of the day, nearly every day, as indicated by either subjective report or observation made by others.
2. Markedly diminished interest or pleasure in all, or almost all, activities most of the day, nearly every day.
3. Significant weight loss when not dieting or weight gain, or decrease or increase in appetite nearly every day.
4. Insomnia or hypersomnia nearly every day.
5. Psychomotor agitation or retardation nearly every day.
6. Fatigue or loss of energy nearly every day.
7. Feelings of worthlessness or excessive or inappropriate guilt nearly every day.
8. Diminished ability to think or concentrate, or indecisiveness, nearly every day.
9. Recurrent thoughts of death, recurrent suicidal ideation without a specific plan, or a suicide attempt or a specific plan for committing suicide.

The symptoms must cause clinically significant distress or impairment in social, occupational, or other important areas of functioning. Some studies examining MDD do not require the standard five or more symptoms for diagnosis as listed above. In such cases, researchers are examining depressed mood rather than MDD. Depressed mood according to the American Psychiatric Association is characterized by "subjective report (e.g., feels sad or empty) or observation made by others (e.g., appears tearful)" (2000, p. 356). The current study will examine depressed mood in relation to physical activity.

Despite the commonality of depression, it is often left untreated (Weissman, Myers, & Thompson, 1981; Hirschfeld, et al., 1997). Olfson, et al. (2002) found an increase in treatment for MDD from 0.73 per 100 persons in 1987 to 2.33 per 100 persons in 1997 indicating it is still undertreated since 5-9% of women and 2-3% of men meet the criteria for MDD (American Psychiatric Association, 2000). The majority of individuals who are treated for MDD receive anti-depressant medications (74.5%) and/or psychotherapy (60.2%), often from their primary care provider (87.3%; Olfson, et al., 2002). The prevalence of care by primary care providers is sobering given that primary care providers provide twice as many failed treatments to depressed patients than psychiatrists (Powers, Kniesner, & Croghan, 2002). Much less common in the treatment of depression, though perhaps of equal importance, is the effect of PA on mood.

Physical Activity and Depression

A growing body of evidence supports the inverse relationship between PA and depression. To understand this relationship, it is important to define PA and exercise. Both are frequently measured in depression research but may have different results due to distinctive differences between the two constructs. Exercise is a specific type of PA that is planned, structured, and repetitively done to improve or maintain physical fitness. For the purposes of the present paper, exercise will be defined as any activity in which the primary intention is at least mild physical exertion. Conversely, PA is any bodily movement produced by skeletal muscles that result in energy (or caloric) expenditure (Casperson, Powell, & Christenson, 1985). PA can therefore be defined as any activity requiring some physical action. Examples of exercise are consequently more narrow

(e.g., jogging, weight lifting, aerobics) than those of PA (e.g., raking leaves, moving boxes, walking two miles in a shopping center), though many activities will fall into either category depending on the context. For example, swimming is a PA which is often a form of casual recreation. If done regularly to stay in shape, swimming also functions as exercise. To summarize, exercise is intentional and structured while PA is less so. Although the present study includes measures of both PA and exercise, we will use the more inclusive term of PA throughout the manuscript.

A prospective study examined the relationship between PA and television watching with depression. Approximately 50,000 nondepressed U.S. women completed questionnaires in 1992, 1994, 1996, 1998, and 2000 (Lucas, et al., 2011). The multivariate risk of those in the highest PA quintile (≥ 90 minutes of PA per week) compared to those in the lowest PA quintile (< 10 minutes per week) was 0.80. Conversely, the multivariate risk of those in the highest quintile of television watching (≥ 21 hours per week) compared to those in the lowest television watching quintile (0 – 1 hour per week) was 1.13 (95% CI: 1.00, 1.27; $P_{trend} = 0.01$) after 20 controls. Furthermore, both PA and TV watching contributed to risk of depression independently. A cross sectional cohort study found that increased PA and decreased sedentary time were associated with lower depression risk (Vallance, et al, 2011). Those who were most sedentary (quartile 4) were more likely to be depressed than those who were least sedentary (quartile 1; OR = 3.09).

Longitudinal research in Alameda County determined that PA levels among non-depressed individuals in 1968 were predictive of depression in 1974 (Camacho, et al., 1991). Participants with low activity (OR = 4.22) were considerably more likely to be

depressed than those with moderate activity (OR = 2.14) when compared to the reference group of those with high activity. PA was a protective factor for depression. This study highlights a methodological concern for prospective research on depression as they found a higher attrition rate in depressed participants than non-depressed participants. This means that the effects may be underestimated as less depressed individuals were available for analyses.

A meta-analysis of 23 randomized controlled trials of exercise for treatment of depression (Mead, et al, 2010) compared exercise, placebo, and antidepressants. Exercise had a large clinical effect that was similar to cognitive behavioral therapy. In addition, 45% of depressed individuals participating in supervised exercise and 40% of those engaging in home based exercise went into remission for MDD after four months (Blumenthal, et al., 2009). This effect was comparable to antidepressants (47% for Sertraline) and was better than placebo (31%).

Babyak et al. (2000) examined depression relapse six months after the four month treatment program (Babyak, et al., 2000). Babyak et al. found that PA, Sertraline, and a combination of the two resulted in comparable remission rates (60.4%, 65.5%, and 68.8% respectively). However, after 6 months, the PA group had the lowest rate of depression (30%) while medication (52%) and the combined (PA/Sertraline) groups (55%) had much higher depression relapse rates. Those who were not depressed at 6 months were reassessed at 10 months. Relapse rates were: 8% in the PA group, 38% in the medication, and 31% in the combined groups. Those in the PA group were more likely to be fully recovered from depression than those in the medication group or the combined group. The authors hypothesize this is because medication leads to less empowering

attributions. For example, the participant may have received benefits from their hard work through physical activity/exercise but rather than feeling empowered and an increased sense of self-efficacy "I was dedicated and worked hard with the exercise program; it wasn't easy, but I beat this depression," the participants might endorse the belief that "I took an antidepressant and got better." When looking at long term treatment and relapse rates, medication may be less effective than PA. Furthermore, combining the two may be deleterious to patient progress, resulting in an inhibited therapeutic effect.

A study measured a PA dose response to treat mild to moderate depression. Evidence suggests that a "Public Health Dose" of PA (17.5 kcal/kg/week) was more effective in improving depressed mood than placebo (flexibility training three days per week; Dunn, et al., 2005). As an example, a PA public health dose would equate to moderate-intensity aerobic PA for a minimum of 30 minutes, five days each week or vigorous-intensity aerobic PA for a minimum of 20 minutes three days each week. The public health dose resulted in a 47% decrease in depression scores whereas the placebo group experienced a 29% decrease and a low dose PA group (7 kcal/kg/week) experienced only a 30% decrease. Interestingly, it appears that a low dose of PA is comparable to a placebo, further strengthening the importance of adhering to at least the public health dosage standard.

Selection of Physical Activity Measures

The literature typically examines the relationship between PA and other experimental variables by separating the effects of PA frequency, duration, intensity, and type. The general consensus suggests that PA frequency is consistently tied to reduced

depression (Legrand & Heuze, 2007; Hassmen, Koivula, Uutela, 2000). Duration of PA studies have mixed results with some studies finding duration to be an important factor and others not. PA intensity level studies consistently show strong effects on depression across studies with higher intensities resulting in greater improvements. Finally, when considering type of PA, a combination of aerobic and resistance training appears to be better than either alone or than aerobic activity combined with flexibility training (Beniamini, et al., 1997). It is for these reasons that the PA items utilized in the present study specifically examine durations of PA at high levels of intensity.

Physical Activity and Depression by Age

Although a great deal is known about the benefits of PA on mood and MDD, and a number of studies have looked at the impact of PA on mood with a variety of age groups, little has been done to compare the effects of PA on mood between these age groups. Thus, it is not clear whether PA has similar effects on depression across adulthood. Research has found PA to benefit individuals of all ages in a wide variety of domains with numerous studies focusing solely on geriatric populations. Such studies have found PA to improve cardiovascular status, fracture risk, functional ability, and mental processing (Elward & Larson, 1992) as well as blood pressure, diabetes, lipids, osteoarthritis, and osteoporosis (Nied & Franklin, 2002). However, some of these benefits decline considerably with age.

For example, older women (68.3 years) experience a greater decline in power following muscle contractions than younger women (25.1 years), 18% and 9% respectively (Power, Dalton, Rice, & Vandervoort, 2011). Older women were found to

experience a 50% reduction in the strength of their muscles' contractions while younger women experienced no reduction following activity. Furthermore, older men (70 years) experience blunted post-physical activity myofibrillar protein synthesis and reduced availability of essential amino acids compared to young men (24 years; Kumar, et al., 2009). Consequently, the production of new muscle fibers of older adults is considerably lower than younger adults despite similar training, physical activity, and body types. A final example pertains to bone density. Ex-tennis and squash athletes who started training before (10.5 years) menarche had a 1.3-2.2 times greater bone density of their dominant arm versus their nondominant arm when compared to athletes who began training after menarche (26.4 years; Kontulainen, et al., 2001). This amounted to a 22% in the humeral shaft versus 10% respectively. This suggests PA during critical periods in childhood can have a greater impact than PA at later stages of development.

Research also shows PA increases self-efficacy which in turn predicts PA adherence, enjoyment, and benefits (Dunn, Blair, Marcus, Carpenter, & Jaret, 2001). For example, middle aged and older adults' self-efficacy predicts exercise program adherence and subsequent benefits (e.g. weight loss, cardiovascular improvements; Howze, Smith, & DiGilo, 1989; Grembowski, et al., 1993; McAuley, 1992). In sum, those with the lowest self-efficacy are more likely to drop out, miss exercise sessions, and self-report lower perceived intensity of PA.

These findings are significant for the present study given evidence that age is negatively related to attitudes toward exercise, PA, and activity-specific self-efficacy (Wilcox & Storandt, 1996). Furthermore, the belief that PA would be enjoyable and beneficial decreases with age in nonexercisers. The impact of exercise on affect was

moderated by perceptions of efficacy as well as age in male veterans (McAuley, Shaffer, & Rudolph, 1995). Older veterans were less likely to endorse an elevated self-efficacy and had more negative responses to exercise. McAuley (1992) indicates self-efficacy was important for early commitment to exercise but became less important after five months and the program was in place. The literature suggests a variety of converging factors such as fear of exercise-related injury, perceptions of poor control of exercise behavior, and perceived poor health all impact PA self-efficacy (Stephens & Craig, 1990; Dishman, 1994; OBrien, 1997).

Thus, there are several ways PA and the impact of PA may differ by age. While considerable research demonstrates that older adults indeed receive benefits from PA and that they experience improvements in mood as a consequence of regular activity, the impact of PA on depression across age groups has not been specifically evaluated in a single study. The literature contains many studies which have evaluated the relationship between depression and PA, some of which have focused on specific age groups (geriatric populations, middle age adults, young adults, adolescents, etc) though generally age is only a control variable. The examination of the difference in how PA buffers depressed mood by age in a single study is needed since depression risk does increase with age.

The current study predicted that PA would have a reduced impact on depression with advancing age for several reasons. First, research indicates that self-efficacy is important for receiving the full benefits of exercise and PA. Self-efficacy is important, not only for the initiation of PA, but also for the maintenance of a PA program which is necessary for the individual to achieve a sense of mastery. Older adults are more likely to

perceive a lack of personal control over physical activities and fitness, often fearing the risks involved (Dishman, 1994). A psychological mechanism by which exercise and PA may benefit depression may be through an enhanced sense of control and mastery (Greist, Klein, & Eischens, et al., 1979; Martinsen, Hoffart, & Solberg, 1989). The mastery hypothesis suggests that by conquering a challenging pursuit such as exercise or improving in a physically active sport builds confidence. Individuals with depression often feel a loss of control and helplessness. Mastery of exercise/ PA serves to reduce this sense of helplessness and depressed mood. It may be therefore, that older adults will receive a lower benefit from mastery if they do not believe they are physically fit enough to exercise. Older adults have lower expectations about their exercise abilities and the benefits of exercise and physical activity and may therefore not be as physically active as often or as consistently as younger adults. It seems plausible that older adults will not typically receive the same mood-related benefits as younger individuals. In summary, older adults have lower activity-specific self-efficacy than younger adults on average that leads to less PA.

Second, improvements in body image associated with exercise may reduce depressed mood (McAuley, et al., 2000; Bosscher, 1999, Stice, et al., 2000). The importance of body shape, weight, and appearance diminish in women as they age (Tiggemann, 2004), suggesting that older adults may not receive the same self-esteem boost from exercise related body image changes as younger adults. It may be that individuals develop more facets of their identity, independent of appearance, with age. As such, research further indicates that physical features of the self are more highly regarded

and valued by younger adults again leading to less physical activity for older adults and then possibly fewer resulting mood benefits.

Third, there may be a physiological pathway by which PA ameliorates depressed mood. A major conduit by which these effects occur pertains to allostatic load. Traustadóttir, Bosch, and Matt (2005) found that older-unfit women had higher cortisol level responses than both older-fit and young-unfit participants. This suggests that fitness in older adults may serve as a protective buffer against stress responses. Further, older-fit and young-unfit participants had similar cortisol responses to stressors indicating a strong need for fitness with age to buffer stress responses that have a 'wear and tear' effect on the body. By extension, PA which is intense enough to result in increases in physical fitness will likely also lead to reduction in depressed mood.

Unfortunately, with advancing age, we become less capable of high intensity exercises and higher degrees of caloric expenditure that are protective of depression. In addition, activity requiring greater stress on the body expends more energy in young than older adults (Yue, Woo, Ip, Sum, Kwok, & Hui, 2007). The lower energy expense in older adults is a result of decreased VO_2 capacity, maximal heart rate, stroke volume, and arterio-venous oxygen difference (Visser, Deurenberg, van Staveren, & Hautvast, 1995). And, reductions in PA intensity in individuals over the age of 65 corresponded with greater depressive affect (Lampinen, Heikkinen, & Ruoppila, 2000). Because elderly adults are less capable of strenuous exercise, there is a reduction in PA related benefits. Older adults are also more susceptible to seasonally based fluctuations in PA (Merchant, Dehghan, & Akhtar-Danesh, 2007; Uitenbroek, 1993); all leading again to less PA in older adults.

Conversely, due to differences in functioning by age, PA may provide an even greater benefit to older adults with depression. Old age is associated with a number of risk factors (poor health, declining intellectual functioning, lack of social support, and loss of freedom, mobility, life purpose, and spouse) linked to depression (Valvanne, et al., 1996; Schoevers et al., 2006; Fiske, et al., 2009; Wongpakaran et al., 2012; Chang-Quan, et al., 2010). As such, the incidence of depression is higher in the elderly; higher risk offers more potential benefit from a PA effect moderator. According to the WHO report on the global burden of depressive disorders in 2000, the incidence of major depressive episodes in the Americas was 35 per 1,000 males and 56 per 1,000 females (Üstün, et al., 2004) with these rates increasing incrementally at ages 65, 70, 75, and 80 (Zhao, et al., 2012; Weyerer, et al., 2013). Pálsson, et al. (2001) have found the incidence of depression in individuals over the age of 85 to be roughly double that of the average adult. As a consequence, it may be older adults who receive the greatest benefit of PA.

A considerable body of evidence for both greater and reduced efficacy of PA on depression in older adults exists and deserve scientific investigation.

Hypotheses:

Hypothesis 1: Levels of PA will be associated with depressed mood after controls (age, gender, ethnicity, difficulty meeting expenses).

a. This will be examined cross-sectionally in 2006-7.
b. This will be examined longitudinally by predicting 2010-11 depressed mood with 2006-7 PA levels.

Hypothesis 2: Levels of PA will be negatively associated with depressed mood in each age quartile after controls (age, gender, ethnicity, difficulty meeting expenses).

a. The youngest quartile (quartile 1) will have stronger effects than in the oldest quartiles (quartiles 2-4)

    i. These age differences will be examined cross-sectionally in the 2006-7 wave.

    ii. These age differences will be examined longitudinally with 2006-7 PA predicting 2010-11 depressed mood.

CHAPTER TWO

METHODOLOGY

Participants

The Adventist Health Study-2 (AHS-2) assessed 96,194 Seventh-day Adventists (SDA) living in the United States and Canada on lifestyle, health and medical history. White and Black participants were primarily targeted in recruitment. Health behaviors are strongly featured in the Adventist lifestyle; few participants in the sample drink (less than 10% drink at all) or smoke (1.8%) and about half do not regularly eat meat with only 4% eating pork (Fraser, 2003). The inclusion criteria specified that the participant be Seventh-day Adventist, 30 years of age or older for Black participants, 35 years of age or older for White participants. Participants were recruited by church leaders and compensated with a pen and completion certificate, and $10 for Black participants (Butler, et al., 2007).

In 2006-7, a random sample of 20,000 U.S. AHS-2 participants was sent a 20 page questionnaire for the Biopsychosocial Religion and Health Study (BRHS; Lee, et al., 2009). Of these, 10,988 (54.9%) completed the questionnaire about religion, stress, lifestyle and health. Of these, 9,759 met the inclusion criteria for the BRHS 2010-11 follow-up questionnaire and 6,752 (69.2%) responded.

The Black and White participants of the BRHS were comparable to those of the larger AHS-2 pool with a mean age of 60.3; 65% female, 35% male, 68% White, and 32% Black. Similar to Camacho, et al. (1991), those who did not complete both waves of the BRHS had higher depression scores than those who did. Although the difference in depression scores between those who participated in both waves of the BRHS (Mean

CES-D = 3.48) and those who dropped out after the first wave (Mean CES-D = 4.30) was small, it was significant F (1, 9850) = 107.68, p = 0.000. A difference of less than one point may not result in an appreciable impact but is important when interpreting results as the most depressed may have been lost to follow-up.

Exclusion criteria for participants in the present study included incomplete data on variables of interest. Inclusion criteria for participants included being SDA, over the age of 35 years, and identifying as White or Black (because BRHS only surveyed these groups in 2010-11) resulting in 6,463 participants available for analyses.

Materials

Controls

A number of demographic variables were utilized as controls in data analyses: age, education (nine categories, ranging from grade school to doctoral degree), ethnicity (two categories coded as 1 = White, 2 = Black), and difficulty meeting expenses last year for basic needs like food, clothing and housing (rated on a 5 point scale: not at all, a little, somewhat, fairly, or very difficult). This 5 point rating scale (1= not at all to 5=very difficult) was recoded as 1 = Financial Difficulties Absent if they rated "not at all" on the Likert scale; or, 2 = Financial Difficulties Present if they rated between 2 (a little) to 5 (very difficult) on the Likert scale (Pudrovska, et al. 2005).

Depression

Both waves of the BRHS included the Center for Epidemiological Studies Depression Scale 11-item short form (CES-D) developed by Kohout, et al. (1993) which

is reliable (Cronbach's $\alpha = 0.81$) and has a strong association with the 20-item CES-D ($r = 0.95$). The scale measures symptoms of depression over the past week such as "I felt depressed, "I could not get 'going'," and "I did not feel like eating; my appetite was poor (see Appendix B)." Responses range from 0 (Rarely or none of the time, less than 1 day) to 3 (most or all of the time, 5-7 days) and scores are summed to create a total score. Higher scores suggest more depressed mood. The 20 item CES-D has been frequently studied using scores of 16 or greater to indicate depression. For the present study, an algorithm developed by Kohout (Kohout, Berkman, Evans, & Cornoni-Huntley, 1993) was used to convert scores to a 20 item scale equivalent.

Physical Activity

Baseline PA levels were assessed in 2006-2007 and again in 2010-2011 with two questions about engagement in an exercise or PA program and six items about the intensity, distance, frequency, and duration of PA or exercise engagement (see Appendix A). The data from these items were converted into either the speed at which the individual walked, ran, or jogged or the number of minutes engaged in vigorous PA per week. The conversion process for these variables is described in detail in a related study (Silber, Fraser, & Morton, 2010).

Though inter-item correlations may prove useful, transforming PA response indices provides additional information. A variable called WRJ MPH or "*walk-run-jog miles-per-hour*" was created using the frequency, duration, and length of distance performed by individuals in a PA program consisting of walking, jogging, and/or running. In order to determine whether the individual was engaging mostly in walking

versus jogging, mph was calculated using the distance and time variables (distance divided by time). The purpose of the *walk-run-jog index* was to estimate the amount of time and energy expenditure participants derived from regular running, jogging, and walking based exercise programs. Such PA would mostly consist of purposeful exercise.

A second PA variable, *Vigorous Activity Minutes*, was created by multiplying the number of times participants estimated they engaged in recreational activities which are vigorous enough to "work up a sweat" per week by the reported duration (in minutes) of activity. The primary function of this index is to give an estimation of the time participating in vigorous recreational activities.

Procedure

Data Cleaning

Several data screening processes were conducted before testing study hypotheses including analyzing missing data, outliers, the distribution, and any unexpected trends. Because of the importance of age, ethnicity, and other demographic variables, these items were also examined. Data was cleaned and screened such that participants were excluded if they had greater than two missing items on either CES-D administration or were missing items necessary to calculate the PA indices in 2006-7 or 2010-11. Further, participants who reported impossibly fast speeds of running (e.g. 20 MPH) were removed from the sample. Because data was only utilized for individuals who participated in each questionnaire and provided complete data, it was necessary to examine whether significant between-group differences existed between those who completed both questionnaires (N = 6,752) and those who did not (N = 3,007). ANOVAs were used to

test whether individuals who took the 2010-11 BRHS were similar in age, gender, ethnicity, and difficulties with expenses as well as whether they reported similar scores on the CES-D and similar levels of PA in the 2006-7 survey compared to those who did not complete the 2010-11 BRHS. Results are summarized in Table 1. In short, no differences were found for gender or age. More White participants completed the study than did Black participants. Small differences were found for all other variables.

Table 1

Participants Included vs. Excluded

Variables	Mean	F	*p*
Age		1.806	0.179
Included	61.88		
Excluded	62.25		
Gender [a]		0.001	0.974
Included	67.5% female		
Excluded	67.4% female		
Ethnicity [b]		254.843	0.000
Included	70.3% White		
Excluded	54.9% White		
Expense Difficulties		62.729	0.000
Included	1.48		
Excluded	1.64		
CES-D		107.676	0.000
Included	3.48		
Excluded	4.30		
Vigorous Minutes		33.439	0.000
Included	81.64		
Excluded	70.97		
WRJ MPH		7.573	0.006
Included	2.63		
Excluded	2.54		

[a] Gender: 1=female, 2=male
[b] Ethnicity: 1=White, 2=Black
Included n = 6,463, Excluded n = 3,296

CHAPTER THREE

RESULTS

To evaluate differences between age groups, the sample was divided into age-based quartiles. The sample characteristics of the quartiles can be seen in Table 2. A number of demographic differences between quartiles were observed. In particular, older quartiles (3, 4) contained more Whites, more males, were less educated, and had fewer expense difficulties and less depressed mood. Finally, those in the oldest quartile 4 reported less vigorous PA than the other quartiles but a faster average walk, run, or jog speed than the younger quartiles 1-3. Differences in frequency of reporting zero minutes of vigorous PA was observed between age quartiles with the older quartiles reporting more sedentary time (no activity).

The amount of vigorous PA the participants reported was skewed (1.3) with a standard deviation (SD = 91.0 minutes per week) greater than the mean (M = 77.2 minutes per week). Also of note, the mode was 0 and comprised 26.4% of the sample. When the Vigorous PA Minutes variable was divided into quartiles, the average of each activity-based quartile varied considerably (PA Quartile 1 = 0 minutes; PA Quartile 2 = 15.5 minutes, PA Quartile 3 = 81.3 minutes; PA Quartile 4 = 210.7 minutes).

Table 2

Sample Demographic Characteristics

Variables	Q1 Ages 35-52	Q2 Ages 53-61	Q3 Ages 62-72	Q4 Ages 73-106
Mean age (years)	44.89	56.10	65.92	79.22
Gender				
Males (%)	29.5	31.6	33.7	35.1
Females (%)	70.5	68.4	66.3	64.9
Education				
Grade School (%)	0.6	1.1	2.3	4.0
Some High School (%)	2.3	2.3	5.4	7.6
High School Diploma (%)	9.5	10.5	15.1	16.6
Trade School Diploma (%)	5.4	4.8	5.8	3.7
Some College (%)	19.2	21.2	24.3	23.8
Associate Degree (%)	14.4	12.4	10.3	7.3
Bachelors Degree (%)	28.0	25.0	17.9	17.5
Masters Degree (%)	14.9	16.6	13.4	12.3
Doctoral Degree (%)	5.9	6.0	5.4	7.2
Mean BMI (kg/m^2)	27.22	28.22	27.89	26.06
Ethnicity				
White (%)	52.9	58.8	65.1	77.1
Black (%)	47.1	41.2	34.9	22.9
Expense Difficulty [a]				
Absent (%)	60.3	67.7	75.9	77.6
Present (%)	39.7	32.3	24.1	22.4
Mean CES-D Score	4.15	3.89	3.50	3.77
Mean Vigorous PA Min/Week	81.60	82.36	80.80	64.80
# of Participants Reporting 0				
Min of Vigorous PA/Week	410	506	702	1009
Mean WRJ MPH	2.93	2.74	2.57	3.0

Hypothesis 1a stated that concurrent levels of PA would be associated with decreased depressed mood. This was measured by a linear multivariate regression model

where 2006-7 PA variables, WRJ MPH and Vigorous Activity (after controls: age, gender, ethnicity, and difficulty with expenses) was associated with 2006-7 depressed mood (see Table 3) using standardized beta weights. All beta weights used in the present study for all analyses were standardized. All variables were significant predictors of concurrent depressed mood with the exception of ethnicity. Both PA variables had a negative relationship with depressed mood. Further, age had a negative association with depressed mood; suggesting that with increasing age there is less depressed mood.

Table 3

Linear Multivariate Regression of Concurrent 2006-7 PA with Depressed Mood

Variables	β	*p*
Depressed Mood		
Gender [a]	-0.04	0.001
Ethnicity [b]	-0.01	0.481
Age, years	-0.05	0.000
Expense Difficulties [c]	0.24	0.000
Vigorous Minutes/week	-0.09	0.000
WRJ MPH	-0.07	0.000

[a] Gender: 1=female, 2=male
[b] Ethnicity: 1=White, 2=Black
[c] Expense Difficulties: 1=Financial difficulties absent, 2=Financial difficulties present

This hypothesis was also measured by a linear multivariate regression model where 2010-11 PA variables, WRJ MPH and Vigorous Activity (after controls: age, gender, ethnicity, and difficulty with expenses) was associated with 2010-11 depressed

mood (see Table 4) using standardized beta weights. Both PA variables had a negative relationship with depressed mood. However, in this time point ethnicity was associated with depressed mood and age was not.

Table 4

Linear Multivariate Regression of Concurrent 2010-11 PA with Depressed Mood

Variables	β	*p*
Depressed Mood		
Gender [a]	-0.04	0.029
Ethnicity [b]	-0.07	0.000
Age, years	0.00	0.875
Expense Difficulties [c]	0.16	0.000
Vigorous Minutes/week	-0.10	0.000
WRJ MPH	-0.07	0.000

[a] Gender: 1=female, 2=male
[b] Ethnicity: 1=White, 2=Black
[c] Expense Difficulties: 1=Financial difficulties absent, 2=Financial difficulties present

The data was also examined using logistic regression with a dichotomous CES-D score as the dependent variable. For depression screening purposes (not diagnosis), scores of 16 or greater indicate clinical levels of depressive symptomology (see Table 5). Vigorous Activity Minutes was divided by 20 due to the diminutive effect of one unit (one minute of PA) of this variable. Both WRJ MPH and Vigorous Activity Minutes had a significant relationship with depression. Vigorous Activity Minutes and WRJ MPH had small protective effects with ORs of 0.931 and 0.778 respectively. Few financial difficulties within the last year had the most protective effect with an OR of 0.426 ($p <$

0.001). In this model, gender and ethnicity were not significant though age was significant.

Table 5

Logistic Regression of 2006-7 Depressed mood with PA

Variables	β	*p*	
Depressed Mood			
Gender [a]	1.58	(0.87-2.87)	0.136
Ethnicity (1) [b]	1.41	(0.84-2.4)	0.195
Age, years	0.97	(0.95-0.99)	0.012
Expense Difficulties (1)[c]	1.68	(1.42-1.98)	0.000
Vigorous Minutes per week/20	0.93	(0.87-0.99)	0.032
WRJ MPH	0.83	(0.68-0.99)	0.043

[a] Gender: 1=female, 2=male
[b] Ethnicity: 1=White, 2=Black
[c] Expense Difficulties: 1=Financial difficulties absent, 2=Financial difficulties present

Hypothesis 1b stated that 2006-7 PA would be inversely associated with 2010-11 depressed mood. A multivariate regression model with 2006-7 PA (covariates: age, gender, ethnicity, and expense difficulties) predicted a change in level of depression between 2006-7 and 2010-11. Both PA variables had inverse relationships with depressed mood (see Table 6). Although the standardized beta weights were small, it is important to note that the standard deviation for vigorous exercise minutes was only 13 minutes per day. Exercising an extra 30 to 45 minutes per day would be a three standard deviation increase in Vigorous Minutes potentially leading to a greater protective effect for depression. Further, the average WRJ MPH standard deviation

was 1.3 MPH. Given that average walking speeds are typically around 3 MPH and running speeds frequently range between 5 and 8 MPH, increasing a walk or run speed by 1.3 MPH or more is not unreasonable. Interestingly, neither age nor gender were significant predictors.

Table 6

Linear Multivariate Regression of PA and Depressed Mood 1-3 Years Later

Variables	β	*p*
2010-11 Depressed mood		
2006-7 Depressed mood	0.57	0.000
Gender [a]	-0.01	0.650
Ethnicity [b]	-0.05	0.000
Age, years	0.02	0.064
2006-7 Expense Difficulties [c]	0.05	0.000
2006-7 Vigorous Minutes	-0.04	0.001
2006-7 WRJ MPH	-0.04	0.010

[a] Gender: 1=female, 2=male
[b] Ethnicity: 1=White, 2=Black
[c] Expense Difficulties: 1=Financial difficulties absent, 2=Financial difficulties present

Hypothesis 2a stated that concurrent levels of PA would be associated with the greatest decreases in depression in quartile 1. Four identical regression models for each age quartile were conducted. Table 7 shows concurrent levels of PA and depression in participants from age quartiles 1, 2, 3, and 4. The covariates (gender, ethnicity, and expense difficulties) and depressed mood scores were collected in 2006-7. All four quartiles showed significant PA effects on concurrent depressed mood though the effects

were small. The standardized beta weights for the PA variables were similar across all four quartiles. The PA items for Quartile 2 had the largest standardized beta weights. Expense difficulties were the most predictive of depression in Quartile 1 with a depreciating impact for Quartiles 2, 3, and 4 in a stepwise fashion.

Table 7

Linear Multivariate Regression of 2006-7 PA and Demographic Variables with Depressed Mood between Quartiles

Variables	β Q1 Ages 35-52	β Q2 Ages 53-61	β Q3 Ages 62-72	β Q4 Ages 73-106
Depressed Mood				
Gender [a]	-0.05	-0.05*	-0.01	-0.06*
Ethnicity [b]	0.02	-0.02	-0.02	-0.02
Expense Difficulties [c]	0.29**	0.23**	0.20**	0.19**
Vigorous Minutes/week	-0.06*	-0.10**	-0.11**	-0.08**
WRJ MPH	-0.05*	-0.09**	-0.05*	-0.06*

[a] Gender: 1=female, 2=male
[b] Ethnicity: 1=White, 2=Black
[c] Expense Difficulties: 1=Financial difficulties absent, 2=Financial difficulties present
*p < .05, **p < .01

A second analysis was conducted, predicting 2010-11 depressed mood with 2010-11 PA levels in each age quartile. All four quartiles showed significant PA effects on depressed mood with an inverse relationship. The standardized beta weights for the PA variables were again similar across all four quartiles, suggesting comparable degrees of efficacy. Expense difficulties were again the strongest predictor of depressed mood in all age quartiles except the oldest. Gender was not a significant predictor in any age group and ethnicity was only significant in age quartiles 2 and 3.

Table 8

Linear Multivariate Regression of 2010-11 PA and Demographic Variables with Depressed Mood between Quartiles

Variables	β Q1 Ages 35-52	β Q2 Ages 53-61	β Q3 Ages 62-72	β Q4 Ages 73-106
Depressed Mood				
Gender [a]	-0.04	-0.05	-0.06	-0.05
Ethnicity [b]	-0.03	-0.08**	-0.11**	-0.03
Expense Difficulties [c]	0.19**	0.14**	0.22**	0.03
Vigorous Minutes/week	-0.09**	-0.12**	-0.05**	-0.14**
WRJ MPH	-0.07**	-0.05**	-0.08**	-0.09**

[a] Gender: 1=female, 2=male
[b] Ethnicity: 1=White, 2=Black
[c] Expense Difficulties: 1=Financial difficulties absent, 2=Financial difficulties present
*p < .05, **p < .01

Hypothesis 2b stated that 2006-7 PA would be predictive of greater decreases in depression upon follow up in 2010-11 for quartile 1 than for quartiles 2-4. To test this, four identical regression models were conducted for each of the age quartiles (see Table 9). PA had no significant relationship with later depression for quartiles 1-3. However, for the most elderly (quartile 4), both 2006-7 PA items had a significant negative relationship with 2010-11 depression. In the first two quartiles, age was not significantly related to depression whereas for the older two quartiles, increasing age was predictive of increases in depressed mood (SD=8 years). Interestingly, ethnicity was found to be significantly related to later depression for quartiles 1 and 2 but not 3 and 4. Gender was not a significant predictor for any group whereas expense difficulties were a significant predictor for quartiles 1 and 3.

Table 9

Linear Multivariate Regression of 2006-7 PA, Demographics, and Depressed Mood with 2010-11 Depressed Mood by Age Quartiles

Variables	β Q1 Ages 35-52	β Q2 Ages 53-61	β Q3 Ages 62-72	β Q4 Ages 73-106
2010-11 Depressed Mood				
2006-7 Dep Mood	0.61**	0.59**	0.52**	0.53**
Gender [a]	0.03	-0.02	-0.02	-0.01
Ethnicity [b]	-0.06*	-0.06*	-0.05	-0.01
Expense Difficulties [c]	0.05*	0.04	-0.06*	0.04
Vigorous Minutes/week	-0.05	-0.02	-0.03	-0.08**
WRJ MPH	-0.01	-0.05	-0.02	-0.06*

[a] Gender: 1=female, 2=male
[b] Ethnicity: 1=White, 2=Black
[c] Expense Difficulties: 1=Financial difficulties absent, 2=Financial difficulties present
*p < .05, **p < .01

An identical analysis to that shown in Table 9 was conducted without a control for 2006-7 depressed mood in Table 10 (as such this analysis is not examining change in depression over time). This was done to examine the effect of independent variables, most notably PA items, on 2010-11 depression without the control of previous depression. Larger standardized coefficients were detected for PA items; Vigorous minutes were significant in all age quartiles and WRJ MPH was significant in all age quartiles except the youngest group indicating less depressed mood with more PA in the older quartiles.

Table 10

Linear Multivariate Regression of 2006-7 PA and Demographics with 2010-11 Depressed Mood by Age Quartiles

Variables	β Q1 Ages 35-52	β Q2 Ages 53-61	β Q3 Ages 62-72	β Q4 Ages 73-106
2010-11 Depressed Mood				
Gender [a]	-0.02	-0.05	-0.02	-0.04
Ethnicity [b]	-0.04	-0.08**	-0.07*	-0.05
Expense Difficulties [c]	0.21**	0.19**	0.14**	0.11**
Vigorous Minutes/week	-0.09**	-0.09**	-0.08**	-0.12**
WRJ MPH	-0.03	-0.10**	-0.10**	-0.11**

[a] Gender: 1=female, 2=male
[b] Ethnicity: 1=White, 2=Black
[c] Expense Difficulties: 1=Financial difficulties absent, 2=Financial difficulties present
*p < .05, **p < .01

CHAPTER FOUR

DISCUSSION

The benefits for PA on depression have been well established in the literature. Although numerous studies support the finding that PA benefits older adults by buffering depressed mood, only this study has evaluated age differences. The benefits of PA for other areas of functioning (metabolism, muscle synthesis, cardiovascular health, self-efficacy, etc.) have been shown to decline with age in late adulthood. The current study examined whether this decline in PA benefits applies to depressed mood as well.

The first hypothesis (parts A and B) was confirmed. The results indicated what has already been demonstrated in previous studies, that PA and depression are inversely related. The individuals who participated in more PA tended to be less depressed though causality cannot be established. While it is possible that engagement in PA diminished the symptoms of depression, it may also be that individuals who were more depressed began to exercise less and became less physically active. Further, there could be additional variables impacting both. For example, an individual's physical health could impact both their sense of mental well-being (depression) as well as their ability to engage in PA. Logistic regression analysis determined that difficulty with finances during the past year played the most significant role in depression. Of note, only 23.3% of those over the age of 60 reported financial difficulty (1.9% reported very great financial difficulty) while 35.8% of those age 60 and below reported financial difficulty (4.8% reported very great financial difficulty). Because of the significant impact of financial difficulty on depressed mood and its heavier burden in younger adults, it is likely that this may serve to mitigate the effects of other variables on depressed mood by age.

PA in 2006-7 was predictive of depression in 2010-11. Although the effect was small, PA did indeed have a protective or ameliorating effect toward depressed mood. The standard deviation for PA was also quite small. By increasing an individual's PA by 30-60 minutes per day, a more significant effect could be facilitated. Further, considering the complexity of a construct such as depression and the plethora of protective and risk factors to be considered, a small beta weight is not unexpected for any one predictor. Finally, it is important to note that the measure of PA was conducted 1-3 years before depressed mood was measured. Had the measures been six months or one year apart, the impact of PA on depression may have been considerably larger.

The age difference hypothesis was not supported. It was expected that those in the youngest age quartile would experience the greatest concurrent benefit from PA on depressed mood compared to those in older quartiles. Instead, the relationship was fairly similar between quartiles with the impact appearing slightly larger for the quartiles 2 and 3. Contrary to the hypothesis, quartile 1, the youngest group, was found to have the weakest predictive relationship between PA and depression. Younger adults do not receive greater improvements in depressed mood than older adults in this sample.

Part B of the second hypothesis proposed that individuals in the youngest age quartile would receive greater benefits to their depressed mood in 2010-11 from being physically active in 2006-7 than those in older quartiles. Conversely, PA did not have a significant benefit on depressed mood in quartile 1 (or quartiles 2 and 3). However, in the oldest age group, there was a significant benefit of PA on depressed mood. It could be that the oldest adults who are physically active are more likely to maintain a lifestyle and physical wellness which allows them independence, social life, self-efficacy, etc. Middle

aged adults may enjoy these benefits regardless of PA. Since many of the stressors of the elderly are more physical health-related than is the case for the middle-aged, it may be that the benefits of PA are indeed more important for the elderly. It is further possible that older adults who exercise more regularly are less likely to incur the onset of many losses which a sedentary lifestyle may facilitate (inability to walk, complete activities of daily living, drive, etc.) due to the onset of chronic illnesses like obesity, diabetes, cardiovascular disease, etc.

A recent study examined the validity and reliability of the PA data of the AHS-2 (Silber, Morton, & Fraser, 2014). Findings suggested that participants, particularly older adults and females, tended to overestimate the amount of PA they engaged in. Specifically, females over-reported by 209.5% whereas male participants over-reported by 130.9%. This may, in part, have resulted in an attenuation of the correlations between PA and depression. While an elderly female participant may have reported 15 hours of moderate activity, she may have only engaged in four hours. It is likely that an objective measurement would have been more strongly related to the benefits for depressed mood. Similar studies which have examined the relationship between PA and depression have typically used more objective measures of PA than the method utilized here which may have contributed to a difference in the findings.

A final aspect to consider relates to PA as a measure of lifestyle choices in general. Although not within the scope of the current study, it is not unreasonable to suggest that individuals who are more physically active may also be more likely to eat healthy diets or attend to other aspects of their health. The Seventh-day Adventist (SDA) church places a heavy emphasis on "the health message." The health message typically

refers to a balance of elements historically considered by the church to be necessary for healthy living. These are typically listed as pure water, fresh air, sunlight, a well-balanced vegetarian diet, exercise, and avoidance of harmful substances such as tobacco, alcohol and mind-altering substances. Although these aspects of living are not prerequisites for church membership, they are intertwined within the Seventh-day Adventist subculture and are highly encouraged. It may be that elderly SDA who regularly exercise also regularly engage in the other elements of the health message that maintains health into late life. Should this be the case, the impact of these components taken together would likely be of even greater significance for the participants' physical and mental well-being. Although these elements may again also be present in the middle-aged adult participants, health choices and resulting disease processes become more prominent with advancing age.

Age had a negative relationship with depression. This is not consistent with other literature; elderly adults are at greater risk for depression than middle aged adults. This finding may therefore be specific to the sample studied here or may represent a selection bias in those that remained in this cohort study.

In conclusion, while PA and depression are certainly inversely related, elderly individuals benefit just as much from PA if not more so compared to younger adults. Based on the results of the current study, it is reasonable that elderly individuals engage in PA, especially if they have been suffering depressed mood. It is reassuring to uncover evidence that the basic principles of healthy living do not become less relevant in an aging population.

Limitations

As is the case in all research, there were limitations to the current study. First, previous research (Silber, et al., submitted 2014) has shown participants in the AHS-2 sample to over-report PA with marked differences between male and female participants (females over-reporting more than males). A regression-based calibration of the PA items has been proposed but not yet completed. Although previously detected exaggerations were more prominent in items which were not utilized in this paper, the PA data by these participants in likely over reported and this may have weakened standardized beta weights.

A second limitation is the time lag in the longitudinal data. The BRHS was designed to measure, among other things, cumulative risk exposure on quality of life, health, and mortality and how manifestations of religious experience relate to biologic indicators of allostatic load. Therefore, the measures were several years apart. The present study however was interested in evaluating the impact of PA on depression and this relationship may not be clear with a three year time lag. It is quite plausible that had the measures been provided months or perhaps a year apart, a greater benefit of PA on depression may have been found.

Future Directions

The current study was limited it its ability to thoroughly evaluate several potential moderating and/or mediating factors which may play a very important and central role in providing a more comprehensive answer to how age impacts the benefits for PA on depression. A future study could provide a similar examination of the data but

incorporate variables measuring physical well-being, social support, and other health variables (e.g. diet, sleep) as likely moderators and mediators.

The primary focus of the current study was to examine whether an elderly population equally benefitted from PA with regard to depression. Instead it was found that it was the middle-age adults who benefitted less. Other similar studies have found the benefits of PA on depression to be clearly substantiated for this age range (Strawbridge, et al., 2002; Deslandes, et al., 2010). Exploring what factors may have impacted the PA and depressed mood relationship with age should be examined in future studies.

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APPENDIX A

PHYSICAL ACTIVITY ITEMS

INSTRUCTIONS

Please answer the questions below concerning you usual physical activity during the LAST TWELVE MONTHS.

1. Do you usually have a regular exercise program?
   ____No (Skip to Questions 3a)
   ____Yes

2. During your regular exercise, how **hard** does it feel more of the time?
   ____ Very light
   ____ Fairly light
   ____Somewhat hard
   ____ Hard
   ____ Very Hard
   ____ Very very hard

3a. How many times per week do you usually engage in regular vigorous activities such as brisk walking, jogging, bicycling, etc., long enough or with enough intensity to work up a **sweat**, get your **heart thumping** or get **out of breath**?
   ____Never engage in activities this vigorous
   ____Less than once per week
   ____1 time per week
   ____2 times per week
   ____3 times per week
   ____4 times per week
   ____5 times per week
   ____6 or more times per week

3b. On average, how many **minutes** do you exercise **each session**? Choose the best answer.
   ____Never
   ____10 minutes or less
   ____11-20 minutes
   ____21-30 minutes
   ____31-40 minutes
   ____41-50 minutes
   ____51-60 minutes
   ____more than 1 hour

4a. Do you **walk, run, or jog** as part of a physical activity program? (include these same activities when they are performed on exercise machines)
____No (Skip to Question 5 on the next page)
____Yes (continue)

4b. How many of these "walk" or "run" or "jog" workouts do you usually do per week?
____Less than once/week
____1 time per week
____2 times per week
____3 times per week
____4 times per week
____5 times per week
____6 or more times per week

4c. How many miles do you average per "walk" or "run" or "jog" workout? Please mark the nearest category below.
____1/4 mile or less
____1/2 mile
____1 mile
____1 ½ miles
____2 miles
____3 miles
____4 or more miles

4d. What is your average time spent in each "walk" or "run" or "jog" exercise session (excluding rest stages)?
____10 minutes or less
____11-20 minutes
____21-30 minutes
____31-40 minutes
____41-50 minutes
____51-60 minutes
____more than 1 hour

5. The following questions will help us understand how active you are during your **usual** week. Please fill in the circle that best fits the total time you spend in each type of activity during a **normal day**. Include activities at work, at home, and elsewhere.

AVERAGE TIME SPENT								
	Never Do	Less than 20 min.	29-39 min.	40-59 min.	At least 1 but less than 2 hrs.	At least 2 but less than 3 hrs	At least 3 but less than 6 hrs.	More than 6 hours
a) NAPPING (do not include regular night's sleep):								
On a usual week day								
On a usual Saturday								
On a usual Sunday								
b) LYING DOWN- (watching TV or reading while lying down, etc.)								
On a usual week day								
On a usual Saturday								
On a usual Sunday								
c) LIGHT ACTIVITIES- are intentionally not included as they are hard to measure accurately. These would have been activities such as: **Leisure**: Watching TV while sitting, hobbies working at a desk or standing still, slow walking **At work**: Desk work, driving **House/Yard work**: Cooking, washing dishes, hand-watering								
d) MODERATE ACTIVITY- such as **Leisure**: Fast walking, golfing, sailing, calisthenics (moderate), causal cycling **At work**: Fast walking, repeated lifting of objects up to 15 lbs., carpentry, patient care. **House/Yard work**: Vacuuming/mopping, active child care, house painting, cleaning windows, mowing lawn (power mower), gardening, repeated lifting of objects up to 15 lbs., carpentry								
On a usual week day								
On a usual Saturday								
On a usual Sunday								
e) VIGOROUS ACTIVITY- such as **Leisure**: Moderate running/jogging, faster/harder cycling, team sports, tennis, aerobics, skiing, calisthenics (vigorous). **At work**: Patient lifting, repeated lifting of heavy objects 20-35 lbs. **House/Yard work**: Hoeing, scrubbing floors, repeated lifting of objects 20-35 lbs.								
On a usual week day								
On a usual Saturday								
On a usual Sunday								
f) EXTREMELY VIGOROUS ACTIVITY- such as **Leisure**: Fast running, heavy weight lifting, marathon, racquet ball. **At work**: Digging, working with heavy tools, repeatedly lifting or carrying 40 lbs. or more. **House/Yard work**: Continuous digging, chopping with heavy tools, carrying 40 lbs, or more.								
On a usual week day								
On a usual Saturday								
On a usual Sunday								

APPENDIX B

CES-D ITEMS

Below is a list of some of the ways you may have felt or behaved. Please indicate how often you have felt this way **during the past week** by marking the appropriate bubble.		Rarely or none of the time (Less than 1 day)	Some or a Little of the Time (1-2 days)	Occasionally or a Moderate Amount of the Time (3-4 days)	Most or All of the Time (5-7 days)
78.	I did not feel like eating; my appetite was poor.	○	○	○	○
79.	I felt depressed.	○	○	○	○
80.	I felt that everything I did was an effort.	○	○	○	○
81.	My sleep was restless.	○	○	○	○
82.	I was happy.	○	○	○	○
83.	I felt lonely.	○	○	○	○
84.	People were unfriendly.	○	○	○	○
85.	I enjoyed life.	○	○	○	○
86.	I felt sad.	○	○	○	○
87.	I felt that people disliked me.	○	○	○	○
88.	I could not get "going."	○	○	○	○