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DETERMINANTS OF SELF-REPORTED FATIGUE WITH AGING

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REBECCA BERTHOLF
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DETERMINANTS OF SELF-REPORTED FATIGUE WITH AGING

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BY THE COMMITTEE CONSISTING OF

Dr. Hugo Pereira, Chair

Dr. Julie Ober Allen

Dr. Christopher Black

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ABSTRACT

Purpose: To determine factors affecting the presence of self-reported fatigue in middle-aged and older individuals. Some of the factors investigated include age, sex, cortisol levels, health status, education level, stress, cortisol levels, minutes of sleep, psychological stress, and joint pain. **Methods:** Data from the Midlife Development of the United States 2 (MIDUS 2) as well as the Stress Study was used for this thesis. The sample consisted of adults living in the coterminous of the United States ages 30-85. Data was previously collected through phone interviews as well as a questionnaire. **Results:** The prevalence of fatigue in the sample is approximately 58%, and higher in women than men independent on the age group. The predictors of the presence of fatigue were different between healthy men and women and individuals with disease. Predictors of fatigue included presence of joint pain, highest education level completed, self-reported stress, age, and the negative affect of stress which measured psychological stress. **Conclusion:** The determinants of fatigue are different between men and women as well as individuals that have the presence of disease.

CHAPTER 1

INTRODUCTION

1.1 Background:

Fatigue is defined as a disabling symptom in which physical and cognitive function is limited by interactions between performance fatigability and perceived fatigability (Enoka & Duchateau, 2016). In this thesis self-reported fatigue is being used as a metric of perceived fatigue. Pre-existing factors such as disease, depression, anxiety, overexertion in physical activity, and lack of sleep potentially have an effect on the symptom of fatigue (Junghaenel et al., 2011). Fatigue is experienced by approximately 31% of older adults (de Rekeneire et al., 2014) and approximately 38% of United States workers in various industries (Junghaenel et al., 2011). In general, the symptoms of fatigue can decrease quality of life and reduce ability to complete tasks of daily living (Moreh et al., 2010). Considering the increase in life expectancy (Werner, 2011), identifying determinants of fatigue in the aging population could lead to improved quality of life. This thesis will explore the influence of minutes of sleep, cortisol levels, presence of joint pain, stress, psychological stress, and demographic variables such as age, education, and sex on self-reported fatigue.

1.2 Participants, Delimitations, and Limitations:

This project used data available from the Midlife in the United States 2 (MIDUS 2) study via the Inter-university Consortium for Political and Social Research (ICPSR). Data from 2,022 individuals between the ages of 30 and 85 was available for analysis. Data from the MIDUS including age, sex, highest education level, minutes of sleep, presence of joint pain, cortisol levels, more/less stress over the past seven days, and the sum of the negative affect of stress which measures psychological stress will be analyzed to determine the variables that are determinants of the prevalence of fatigue. Limitations could occur from the data being pre-published and our research team not being involved the data collection procedures.

1.3 Variables

The dependent variable for the study is presence of fatigue reported in the MIDUS 2, while the independent variables include age, sex, minutes of sleep, highest education level completed, cortisol levels, more/less stress over the past 7 days, presence of joint pain, and the negative affect of stress sum.

1.4 Operational Definitions:

- Fatigue is defined as a disabling symptom in which physical and cognitive function is limited by interactions between performance fatigability and perceived fatigability (Enoka & Duchateau, 2016).
- Aging is defined as an age-dependent or age-progressive physiological function, leading to an increase in age-specific mortality rate and a decrease in age-specific reproductive rate (Williams, 1957).
- Negative effect of Stress is a variable that was used to determine the sum of the negative effects of stress experienced by each individual in the study. This is a measure of psychological stress. This value was derived from a series of 14 questions regarding emotions. The sum of each individual's negative affect score was calculated (Ryff et al., 2016).

1.5 Hypothesis:

1. Presence of fatigue will be associated with lower education levels.
2. In accordance with previous studies, women will have greater prevalence of fatigue compared with men.
3. Biomarkers of stress, such as cortisol levels, will be associated with presence of fatigue.
4. Presence of fatigue will be associated with poor quality of sleep.
5. Joint pain will be a predictor of the presence of fatigue.
6. A positive correlation exists between aging and fatigue.
7. Presence of fatigue will be predicted by joint pain, highest education level completed, the negative effect of stress, more/less stress, minutes of sleep, and the presence of joint pain.

1.6 Statistical Hypothesis

H_0 : There is no association between the presence of fatigue and education levels

H_1: There is an association between presence of fatigue and education levels

H_0 : There will be no difference in the prevalence of fatigue between men and women

H_1: There will be a difference between the prevalence of fatigue between men and women

H_0 : Cortisol levels will not be associated with the presence of fatigue

H_1: Cortisol levels will be associated with the presence of fatigue

H_0 : Presence of fatigue will not be associated with poor quality of sleep

H_1: Presence of fatigue will be associated with poor quality of sleep

H_0 : Joint pain will not be a predictor of the presence of fatigue

H_1: Joint pain will be a predictor of the presence of fatigue

H_0 : There is no correlation between aging and fatigue

H_1: There is a correlation between aging and fatigue

H_0 : Presence of fatigue will not be predicted by the independent variables

H_1: Presence of fatigue will be predicted by the independent variables

1.7 Purpose:

The purpose of the study is to determine factors affecting the presence of self-reported fatigue in middle-aged and older individuals. Some of the factors investigated include age, sex, cortisol levels, education level, stress, psychological stress, and joint pain.

1.8 Research Questions:

1. Determine sex difference in self-reported fatigue.
2. Determine age difference in self-reported fatigue.
3. Determine the predictors of self-reported fatigue.

1.9 Significance:

Symptoms of fatigue can lead to a decrease in quality of life and reduce ability to complete tasks of daily living for individuals of all ages (Moreh et al., 2010). There has been a steady increase in life expectancy with individuals living to older ages. Considering this increase, identifying determinants of self-reported fatigue for men and women could lead to improved quality of life for individuals of all ages as well as improve the clinical understanding of self-reported fatigue and its impact on individuals and their psychological and physical wellbeing.

CHAPTER 2

LITERATURE REVIEW

This section examines the construct of fatigue, its physiological mechanisms and any potential factors that are thought to influence the self-reported fatigue in young and older individuals.

2.1 Fatigue

As mentioned in chapter 1, fatigue is defined as a disabling symptom in which physical and cognitive function is limited by interactions between performance fatigability and perceived fatigability (Enoka & Duchateau, 2016). There is a large scope in the usage of fatigue, so establishing a concrete definition is of importance when trying to determine causes and mechanisms of fatigue. The authors Enoka and Duchateau suggest that in order to determine how fatigue influences human performance, it is best to identify factors responsible for the levels of fatigability that contribute to the observed trait and state fatigue. Trait fatigue is defined as the average amount of fatigue that is experienced by the individual over the past several days. This variable is dependent upon the factors that contribute to the perceived fatigability. State fatigue is the change in the rate of the factors that contribute to performance and perceived fatigability during ongoing activity (Enoka & Duchateau, 2016).

2.1.1 Determinants of performance fatigability

Fatigue can result in a decline in force capacity (Kent-Braun et al., 2012). Production of force involves cortical, spinal, and peripheral processes to complete a task. A reduction is muscle force, as a response to fatigue, can be the result of a deficiency in the cortico-spinal pathway.

This phenomenon has been measured in vivo, but specific causes of this phenomena are yet to be fully understood (Gandevia, 2001). A decline in force output as a result of fatigue can also be a result of motor neuron and motor unit recruitment. Motor units are recruited smallest to largest, and the rate at which the action potentials are discharged is dependent upon the recruitment (Kent-Braun et al., 2012). An increase in the rate at which action potentials are discharged effects the amount of force that is produced. Alterations in motor unit recruitment can directly affect force production which leads to the development of muscle fatigue (Kent-Braun et al., 2012). The lack of motor unit recruitment is a source of fatigue which effects activities of daily living and quality of life in individuals of various ages, but specifically effecting older adults (Kent-Braun et al., 2012).

Aging is associated with declines in motor performance. Example of factors responsible for the age-related decrease in motor performance include age-related changes within the muscles, such as slower mechanical properties that potentially lead to increased fatigability during faster dynamic tasks. However, there is large variability within and between subjects for age related declines in force, velocity, and fatigability. This intra and inter individual variability in age related loss of motor performance could also be also be explained by the neural factors described above (Hunter et al., 2016).

2.2 Assessing the state and traits of fatigue

Fatigue is often quantified through various questionnaires. The assessments of fatigue can be identified into unidimensional and multidimensional instruments. Unidimensional scales focus on a specific aspect of fatigue and can include the Brief Fatigue Inventory (*Brief Fatigue Inventory*, 1997) while the multidimensional scales are typically longer and include more detailed information about the fatigue experienced (Zengarini et al., 2015). An example of a questionnaire that is multidimensional is the Multidimensional Fatigue Inventory (Rupp et al., 2004). Other questionnaires that are typically used for research include the Edmonton Functional Assessment Tool, and the Patient-Reported Outcome Measurement Information System. At the conclusion of the questionnaires, the number value from each question is totaled and a value is given which determines the level of fatigue (Neuberger, 2003). State fatigue is measured using the Fatigue Severity Index, and Brief Fatigue Inventory Questionnaire, while trait fatigue is measured using a Multidimensional approach such as the Multidimensional Fatigue Inventory. The various fatigue questionnaires often measure the presence of fatigue or fatigue severity.

Evaluation of the presence and severity of fatigue in the clinical and laboratory settings is dependent upon patient and subject communication. Measuring fatigue is typically dependent on the subjective nature of the symptom (Zengarini et al., 2015).

2.3 Association between self-reported fatigue and stress response

Stress can be a feeling or emotion that is the result of an event or situation. One hormone that is a marker of stress levels is cortisol. Typically men have increased cortisol levels in response to a stressor compared to women (Kudielka & Kirschbaum, 2005), and older men have increased cortisol levels in response to a stressor compared to other age groups (Kudielka & Kirschbaum, 2005).

Stress is potentially associated with fatigue (Kop & Kupper, 2016). However, this evidence is from small sample of men and women. Another limitation is the stressor that was experienced by the participants was a laboratory stressor compared to a stressor that occurs in everyday life. Further research is necessary on this topic.

2.4 Association between self-reported fatigue and physical activity levels

Physical activity is defined as any bodily movement produced by skeletal muscles that results in energy expenditure (Caspersen et al., 1985). The full range of human movement is included in this definition: activities of daily living, participating in organized sports, and exercise. In clinical populations, lower levels of physical activity and lower sleep quality have both been observed to be related to self-reported feelings of fatigue (Valentine et al., 2009).

A study conducted on older adults in community living found a negative correlation between physical activity and fatigue (Egerton et al., 2016). The 7-item Fatigue Severity Scale was used to measure trait levels of fatigue in the population. The older adults with greater self-reported fatigue also had less steps per day (measured with a pedometer) and showed significantly less proportions of moderate to vigorous activity and daily activities compared to the adults that had lower prevalence of self-reported fatigue (Egerton et al., 2016). These results indicate that physical activity levels are inversely related to levels of self-reported fatigue in older adult communities leading to the assumption that physical activity is a determinant of the self-report fatigue in aging individuals.

A study conducted by Christie et al. (2016) evaluated the relationship of physical activity with sleep quality and fatigue across the adult lifespan (Christie et al., 2016). The participants were grouped by age including young (21-29 years), middle-aged (36-64 years), and older individuals (65-81 years) who were all in good health and reported less than 30 minutes of physical activity per week. Physical activity and sleep quality were measured through logs that were kept by each of the participants, and activity monitors were used to measures physical activity. Fatigue was measured using the Patient-Reported Outcomes Measurement Information

System (PROMIS). The results indicated a greater score on the PROMIS fatigue scores in the middle-aged group compared to the other groups, mean scores on sleep quality were not different between the groups, and there was no difference in amount of physical activity between the groups. There was a relationship between sleep quality, self-reported fatigue, and habitual physical activity across the lifespan of adults. There was no relation between physical activity and fatigue. Further research is needed on the relation between physical activity and fatigue to determine if a relationship is present.

Physical activity is an important component in treatment of multiple diseases such as cardiovascular disease, type 2 diabetes, cancer risk, bone health, psychological wellbeing, and mental health (Miles, 2007). Since physical activity plays a large role in treatment of various diseases, there has the potential to be a large relationship between physical activity and fatigue. There is a need for more research regarding the correlation of fatigue and physical activity in a variety of populations including younger and older adults.

2.5 Influence of sleep quality on fatigue

The relationship between sleep quality and fatigue is an important relationship to determine in order to reduce fatigue symptoms and potentially improve quality of life. Sleep is an essential biological process that the human body requires in order to function at an optimal level (Grandner, 2017). Sleep and quality of sleep can be impacted by the conditions of the individual (e.g. health and disease); personal choices as well as the demands of society. Personal and societal demands can include, knowledge and beliefs about sleep, sleep environment, family, neighborhood, occupation, and socioeconomic status (Grandner, 2017). Some of these factors can prevent individuals from obtaining adequate and good quality sleep (Grandner, 2017).

Although it is typically recommended between seven and nine hours of sleep for adults (Hirshkowitz et al., 2015), it was found that 36.7% of employed adults in a variety of fields slept for less than seven hours a night (Shockey & Wheaton, 2017). Inadequate sleep can lead to on the job sleepiness, and it can negatively impact mood, performance, health, as well as various other factors of everyday life (Caldwell et al., 2019). In clinical populations, it has been estimated that fifty percent of the population over the age of 65 years of age had reported poor quality of sleep and chronic fatigue (Foley et al., 1995). The decreased quality of sleep and the presence of chronic fatigue, which is defined as a disorder characterized by extreme fatigue that lasts for at least six months, are both associated with a decreased quality of life and mortality of the older adult population (*Symptoms and Causes - Mayo Clinic, 2020,* n.d.). It was also reported in this population that about 42% of subjects had difficulty falling asleep and maintaining sleep (Foley et al., 1995), and the amount of time spent fully asleep each night had decreased compared to adults below the age of 65 (Buysse et al., 1991). Amount of sleep and sleep quality is a large variable effecting a large amount of individuals.

Amount of sleep and sleep quality is often measured using a questionnaire or a sleep diary that subjects usually fill out once a day (typically in the morning) on how many hours they slept, and various questions regarding how they feel when they woke up. This is a very inexpensive and rapid way to assess the individual amount of sleep and sleep quality. Using one of these questionnaires, a sample of doctoral students that were preparing for their dissertation defense reported that an increase in the state level of fatigue (fatigue also measured with a questionnaire) was associated with the decrease in sleep quality (Van Laethem et al., 2017). Another study aimed to investigate the correlation between sleep quality (Pittsburg Sleep Quality Index), self-reported fatigue (using the Patient-Reported Outcomes Measurement Information

System), and physical activity (using an accelerometer). The results indicated an inverse relationship between sleep-quality and fatigue in older adults, but no correlation was found between sleep-quality and fatigue in the young or middle-aged groups. These results suggest that improved sleep-quality may mitigate self-reported fatigue in older adults independently of physical activity levels (Christie et al., 2016). Further studies are needed to address if the population tested is responsible for the discrepancy between the findings in young adults. The difference in the results obtained in this study could be due to the sleep index used, or the experimental design.

2.6 Influence of aging on self-reported fatigue

There has been an increasing number of older adults, and the numbers are predicted to continue to increase over the coming years according to predictions made by the U.S. Census (Vespa, 2018). It has been estimated that approximately 13% of the population consists of adults over the age of 65 (Werner, 2011), and that number will continue to increase where the number of older adults is greater than the number of kids in the United States population. With the increase in this population, most likely due to the increase in life expectancy, it is essential to also increase in quality of life for this population. A large factor effecting quality of life in these individuals is fatigue (Moreh et al., 2010). Fatigue is a symptom that is most often reported in the older population and often the cause is unknown (Moreh et al., 2010). There is some indication of a positive correlation between an increase in age and fatigue (Hajjar et al., 2018). For example, at the ages of 70, 78, and 85, fatigue prevalence increased from 29%, 53% and 68% (Moreh et al., 2010). Increased prevalence of self-reported fatigue in older individuals potentially can increases the risk of exposing the individual to negative health related outcomes (Schultz-Larsen & Avlund, 2007). Fatigue is often a result of various diseases but in healthy older individuals, it is difficult to pinpoint its determinants (Schultz-Larsen & Avlund, 2007). The frailty syndrome is a condition of extreme vulnerability characterized by the older individual with limited physiological reserves (Alexander et al., 2010). Some suggest that fatigue is generated when there are insufficient required resources due to disproportionate demand for the altered homeostatic mechanism (Alexander et al., 2010). The consequences of fatigue in older populations has greater significance because it can further enhance the loss of strength and power as well as effect performance of activities of daily living leading to a decreased quality of life and greater impact for disease (Schultz-Larsen & Avlund, 2007).

2.7 Influence of demographics on fatigue

Socioeconomic status is defined as a measure of one's combines economic and social status and tends to be positively associated with better health (Cockerham et al., 2014). It is suggested that socioeconomic status can influence the magnitude of self-reported fatigue. One example of this relationship was observed by Hajjar et al., in a group of individuals with common variable immunodeficiency (Hajjar et al., 2018). In this study involving 1608 individuals, approximately 77% indicated that they experienced fatigue. Fatigue was self-reported using a questionnaire. There was a higher prevalence of fatigue in unemployed subjects, subjects with less than a 4-year college degree, and subjects with an income less than $25,000 a year. It was concluded that there is an association between quality of life, patient-reported health status, rate of employment, education, and household income with fatigue response (Hajjar et al., 2018).

Junghaenel et al. studied the correlation between levels of fatigue and sex and marital status on 666 individuals. The sample consisted of the general population in the United States. The subjects were also administered additional questions regarding health, age, body mass index, prescribed medications, education, employment, sex, race and ethnicity, and income. The results indicated that women experience higher levels of fatigue than men, and that older age and higher academic degrees are associated with less fatigue (Junghaenel et al., 2011).

Another example indicating the influence of socioeconomic status on fatigue was observed in individuals with multiple sclerosis. In a survey with approximately 7,000 participants it was found that individuals with a lower economic status experienced worse symptoms of fatigue (Wang et al., 2020). This observation was independent of race (i.e. occurred both in the Caucasian American and African American populations) (Wang et al., 2020). Further identification of factors leading to the association between fatigue and socioeconomical status could be beneficial to potentially improve quality of life in young and older adults.

2.8 Midlife Development in the United States (MIDUS) study

The Midlife Development in the United States 2 (MIDUS 2) is a longitudinal study that followed up on the original MIDUS sample (Brim et al., 2018). The purpose of the original MIDUS national survey was to investigate the role of behavioral, psychological, and social factors to understand age-related differences in health and well-being. The MIDUS 1 was funded by the MacArthur foundation Research Network on Successful Midlife Development, and the MIDUS 2 and 3 were funded by the National Institute on Aging. The original MIDUS data collection took place from 1995-1996 and had a sample that ranged from ages 25-74 (Brim et al., 2018). The study was constructed by a team of scholars in the fields of psychology, sociology, epidemiology, demography, anthropology, medicine, and health care policy.

A list was generated for each household that was contacted for all people between 25 and 74 years of age, and a respondent was chosen at random. The MIDUS 1 collected survey data from a total of 7,108 individuals. From the baseline measures, there were 4 subsamples; a national random digit dialing (RDD) sample (N=3,487), oversamples from 5 metropolitan cities in the United States (N=757), individuals with siblings from the RDD (N=950), and twin pairs from RDD (N=1,914) (Brim et al., 2018). The over-samples took place in 5 cities that were chosen to provide greater depth in key areas of research including stress, cognition, and other topics. If the individual that was selected did not complete the interview, then no one else from the household was selected. From the RDD sample of individuals who reported having at least one sibling, 529 individuals were selected at random. Only siblings that had the same biological mother and father were selected. From the eligibility requirements, 1,480 siblings were eligible and 950 of those individuals completed the phone interview. Some of the individuals that were siblings came from the same family. A two-part sampling design was used to recruit the twin-pairs that were used in the study. The first part of the sample design screened a sample of approximately 50,000 households for the presence of twins. There were 14.8% respondents who reported having twins, and of those who reported twins in the family were asked if the research team could contact the twins for their participation in the study. There were 60% of respondents who gave permission to contact the individuals.

All the studies in the MIDUS consisted of the same group of individuals. To be eligible, the participants had to be non-institutionalized English-speaking individuals in the coterminous of the United States. The MIDUS provided ground-breaking assessment on many psychological traits, well-being, positive and negative effects, sense of control, and goal commitments in a national sample of Americans. The MIDUS also studied various psychological factors that linked to demographic variables such as marital status, family structure, socioeconomic standing, social participation, social surroundings, social support, employment status, and health care utilization (Brim et al., 2018).

The MIDUS was conducted through a phone interview as well as a lengthy self-administered survey. The phone interview was approximately 30 minutes in length, and the participants were given two lengthy self-administered questionnaires each about 45 pages in length. The basic demographic questions were conducted through a phone interview, and short answer questions were conducted through a self-administered survey. All participants that completed the data collection received $20 for the MIDUS 1 and received $60 for completing data collection from the MIDUS 2. A follow-up on the original MIDUS was conducted as well as five additional studies from 2004-2006. Of the 7,108 participants from the MIDUS 1, 4,963 responded for a follow up interview of about 30 minutes in total length and a self-administered questionnaire of about 55 pages in length. The questionnaires were mailed to the participants and returned to the researchers by mail. The number of completed participants that completed all aspects of the study was 4,186 with a main RDD of 1,846, city oversamples of 417, siblings of 661, and twins of 1,262. The average follow-up was approximately 9 years with a range from 7.8-10.4 years.

A study that was conducted as part of the MIDUS 2 was the Daily Stress Study. This study used the same sample as the MIDUS with the addition of the Milwaukee oversample. In this study, participants were responsible for 8 consecutive phone interviews over the period of 8-days. The purpose of this study was to examine how sociodemographic factors, health status, and personality characteristics can change patterns of exposure to stressors that occur in day to day life (C. D. Ryff & Almeida, 2009).

One of the specific aims of the second MIDUS 2 was to recruit a new city-specific oversample of African Americans to participate in an interview and questionnaire that mirrored the main sample interview and questionnaire. The city of Milwaukee was chosen to potentially recruit the participants to the biological and neuroscience assessments (projects 4 and 5 of the MIDUS II) in Madison, Wisconsin. The final number of completed interviews was 592 individuals between the ages of 35 and 85 years of age who identified as black during the in-person interview. Data collection for the Milwaukee sample was the same protocol as used in the larger MIDUS. An incentive of $50 for the survey and $20 for the short answer questionnaire were used to increase participation in the study. Due to the quality and use of the MIDUS data, the study was extended for a 3rd round (C. Ryff et al., 2016).

2.8.1 MIDUS and Fatigue

The MIDUS survey asked a list of questions regarding each subjects physical and mental state including muscle soreness, participation in physical activity, hours slept, quality of sleep, joint pain, severity of menstrual symptoms, and if anxiety/depression medication is prescribed. The questionnaire also asked if fatigue was experienced, and the severity of fatigue is then ranked on a scale from one to five by each participant. Because the experience and severity of fatigue are potentially related to some of the questions regarding sleep disturbances, depression and weakness (Persson & Persson, 2016), the MIDUS dataset can provide further insight on the relationship between these constructs in an aging cohort. Fatigue can be a determinant of various diseases (Klimas et al., 2012), thus it is essential to further address gaps in knowledge on factors influencing self-reported fatigue.

CHAPTER 3

METHODS

3.1 Study Design

We will use data available from the MIDUS 2, which is a longitudinal study that consists of two main studies. The MIDUS 2 followed up on the same sample with the addition of a city oversample approximately 10 years after the MIDUS 1 was conducted. This data has been published for public access through the Inter-University Consortium for Political and Science Research (C. Ryff et al., 2016).

3.2 MIDUS dataset

Data from the 2004-2006 MIDUS 2 will be used for this study. Participants from the MIDUS were selected using a random-digit-dialing system (RDD) of adults living in the United States. A list was generated of known adults living in each household consisting of people between the ages of 25 and 74, and a respondent from each household was then chosen at random. Participants were recruited in this way for the 1995-1996 MIDUS I, and a follow-up on the participants approximately 10 years after the original MIDUS was conducted used the sample for the MIDUS 2 (C. D. Ryff & Almeida, 2009). There were 4 subsamples of individuals including a total sample of 4,032 individuals which included a metropolitan city oversample of 386 individuals, a Milwaukee oversample of 592 individuals, 637 siblings, and 1,204 twins (C. D. Ryff & Almeida, 2009). About 2,022 individuals participated in the Daily Stress Study which was an additional study of the MIDUS 2 (C. D. Ryff & Almeida, 2009). This additional short answer questionnaire included questions regarding factors that affect reactivity to daily stressors such as education, physical or emotional stressors and health status. The data from the Daily Stress Study as well as various demographic variables from the MIDUS 2 is what will be analyzed in this study.

A phone interview was conducted with each participant lasting about 30 minutes in length. The phone interview was conducted in sections including health, education, occupation, marital status, caregiving, living arrangements, race and ethnicity, and life satisfaction. The responses to the questions from each individual were recorded. A short answer questionnaire was then mailed to each respondent at the conclusion of the phone interview. The short answer questionnaire included various sections including short answer, and yes or no questions. There were also various topic sections including work, community involvement, the neighborhood of the individual, social networks, children, marriage and close relationships, sexuality, religion and spirituality, discrimination, and life overall. Within each section were a series of questions regarding details of each topic. A $60 incentive was given to each participant who completed all aspects of the MIDUS 2 data collection (C. D. Ryff & Almeida, 2009). There was an additional aspect of the MIDUS II called the stress study that consisted of an additional questionnaire given to participants. The Daily Stress Project of the MIDUS II contains data from 2,022 respondents between the ages of 35 and 85. The University of Wisconsin had an Institutional Review Board (IRB) approval for data collection procedures. For the current thesis an IRB approval was not needed for the data analysis given that the MIDUS dataset is public and available.

3.3 Variables selected for this thesis:

Demographics- Participants reported date of birth which was used to determine age by finding the difference between date of birth and date of interview. Participants also reported sex (men vs women), race, and highest education level completed in brackets. Average household income was also reported in brackets increasing by $2,000 starting from $0. When reaching $50,000 the brackets increase by $5,000, when reaching $100,000 the brackets increase by $10,000, and when reaching $150,000 the brackets increase by $15,000 ending with “greater than 200,000.”

Health status (presence of disease)- Participants indicated the presence of stroke, Parkinson’s disease, neurological disorders, history of serious head injury, and cardiovascular disease. The questions regarding the presence of the health variables were asked separately and indicated by a yes or no. Presence of disease is considered in this thesis if any of the mentioned conditions was reported.

Minutes of sleep- Each participant was asked in the short answer questionnaire how many hours and minutes of sleep they get on the weekdays or workdays, and how many hours and minutes of sleep they get on the weekends. This measurement was converted to minutes of sleep and averaged across the 8-day period (i.e. summing the total minutes of sleep over the 8 days, and dividing the total by 8).

Presence of fatigue- The presence of fatigue was indicated in the Stress Study by each participant checking yes or no in the Stress Study Questionnaire for an 8-day period. The sum of the presence of joint pain was taken by adding up all of the days that the individual experienced joint pain out of the 8 days of the study. The variable presence of fatigue indicates the prevalence of fatigue during 8-day period.

Presence of Joint Pain- The presence of joint pain was indicated in the Stress Study by each participant checking yes or no in the Stress Study Questionnaire. The sum of the presence of joint pain was taken by adding up all the days that the individual experienced joint pain out of the 8 days of the study. Presence of joint pain was assumed if individuals reported joint pain on one or more days.

Cortisol levels – Measured in micrograms per deciliter (mcg/dL). Samples were taken at four timepoints including wake, 30 minutes after wake, lunch, and before bedtime for 4 out of the 8 days of the Stress Study. The average of the cortisol slopes for each participant was calculated by finding the slope of 30 minutes after wake cortisol and before bed cortisol levels and averaging the slopes over the eight-day period.

More/less stress: Individuals reported their stress levels on the eight days by indicating if they are experiencing more stress than usual.

Negative Affect Scale- It was used to estimate psychological distress using a 14-item self-reported questionnaire (C. D. Ryff & Almeida, 2009) . The scale assessed how often participants felt a range of moods in the past 30 days. The questions were indicative of how much of the time each day that the subject felt restless or fidgety, nervous, worthless, so sad nothing will cheer you up, everything was an effort, hopeless, lonely, afraid, jittery, irritable, ashamed, upset, angry, and frustrated. Each question was ranked on a scale from 0-10; 0 none of the time, 1 a little of the time, 2 some of the time, 3 most of the time, 4 all of the time, 8 refused/missing. Higher scores from the negative affect sum indicated higher negative affect.

3.4 Data analysis

Self-reported fatigue was extracted from the MIDUS stress study and calculated as the sum of the number of days that each participant experienced fatigue during the eight days of the study (i.e. sum of eight total days). Thus, self-reported fatigue is a scale variable (from 0 to 8 to indicate the prevalence of fatigue during 8-day period).

Presence of join pain was calculated as the sum of the number of days that each participant experienced joint pain during the eight days of the study (i.e. sum of eight total days). Presence of joint pain was calculated in this way to broaden the sample size and analyze a trait level of joint pain.

Presence of disease was reported in the original MIDUS study and was exported to the Daily Stress Study SPSS spreadsheet for analysis. The prevalence of disease was calculated in this thesis if any condition such as cardiovascular disease, neurological disease, Parkinson’s disease, a head injury, or a stroke were reported.

Self-reported stress (i.e. more or less stress during the 8 day period) was reported by each participant on each day of the study. To analyze a trait level of stress over the eight-day period, the individuals that reported more stress on any of the eight days were reported experiencing more stress, whereas participants that reported no stress or less stress on all of the 8 days were reported as experiencing no or less stress. This measure was taken on consecutive 8 days of the study, and the trait level of more or less stress was analyzed by looking at the individuals who reported more stress on any of the days, and less or no stress on all of the days. The variable more/less stress over the past 7 days was calculated in this way to analyze a trait level of stress similar to the variables joint pain and fatigue.

Highest education level was reported by each participant. This value was ranked on a scale from 1-12 by each participant. This variable was then combined into brackets that included 1 no school, 2 junior high school, 3 GED/graduated high school, 4 Associates degree, 5 Bachelor’s degree, 6 Master’s degree, 7 PH.D for data analysis. Education brackets were recorded in this thesis from the original MIDUS dataset to exclude unneeded education brackets.

This variable was reported in the original MIDUS study and exported into the Daily Stress Study SPSS spreadsheet for analysis.

Salivary free cortisol was measured on 4 out of the 8 days of the Stress Study. To measure the cortisol slopes, cortisol levels from two time points: 30 minutes after wake and before bed for each participant. The slope was then calculated by finding the difference between the before bed cortisol cortisol level and the 30-minutes after wake cortisol level, and then dividing that value by the difference between the before bed time point and the 30 minutes after wake time point [(level of cortisol at bed time- level of cortisol 30 wake) / (time of bed – time of wake). The average of the slopes for each participant was then taken by finding the sum of the four cortisol slopes, and then dividing the sum by four.

Missing data was coded as missing in SPSS, and not included in the analysis. For example, if individuals did not report cortisol levels on all 4 of the days, they were disregarded from the data analysis.

3.5 Statistical Analysis

The independent variables used in this study are presence of disease (calculated as the total number of associated diseases for each individual), age (years), highest education level obtained (reported as years of education), minutes of sleep, presence of joint pain, results from the negative affect scale (psychological stress), and sex (men vs women). The dependent variable for the study is self-reported fatigue. Chi-square tests was used to calculate frequency distributions of the responses for self-reported fatigue, presence of disease, prevalence of joint pain, highest education level completed, and proportions of stress between age brackets, sex, and presence of disease. The spearman’s rho was also used to determine the association between self-reported fatigue, negative affect of stress sum (psychological stress), average of more/less stress, prevalence of joint pain, average minutes of sleep, and highest education level completed for each sex.

Ordinal logistic regression was used to determine the influence of each independent variable on the self-reported fatigue (the criterion variable). More specifically, age, prevalence of joint pain, more/less stress over the past 7 days, and the variable negative affect of stress sum (psychological stress) that was collected from the questionnaire, and sex were the predictors. Minutes of sleep was not included in the model as it was strongly correlated with negative effect of stress scale (psychological stress).

Statistical significance was set as 5% and all data Analysis were conducted using IBM SPSS statistics version 27.

CHAPTER 4

RESULTS

A total 2,022 participants were in the daily stress study: a sub study of the MIDUS 2. The percentage of individuals reporting presence of fatigue within the sample is 57.7%, or 1,161 individuals out of a total of 2,013 individuals (Fig. 1). From the individuals that reported the presence of fatigue, women reported a greater prevalence of fatigue compared to men (main effect of sex: $p < 0.001$), across all age groups (age effect: $p = 0.092$) (Fig. 2). Approximitely 745 women reported fatigue compared to 416 men.

Figure1: Presence of fatigue. Values are percent of total (total n=2,013)

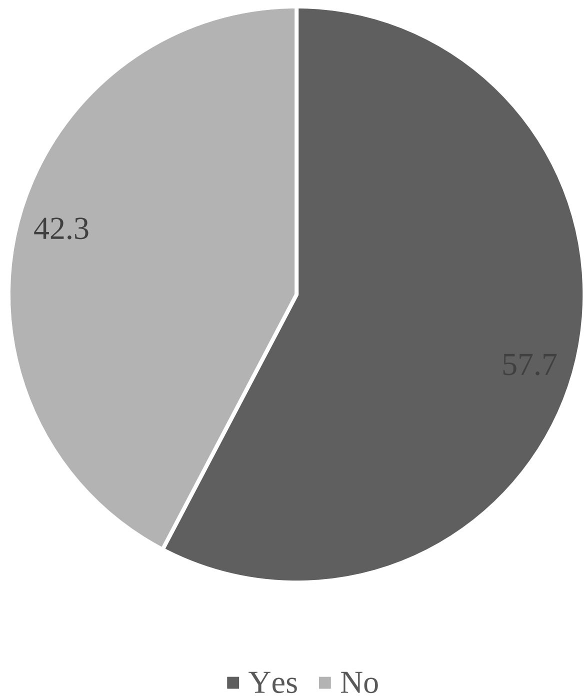


Figure 2: Prevelence of fatigue between men and women. Values are percent of total (total n=1,161)

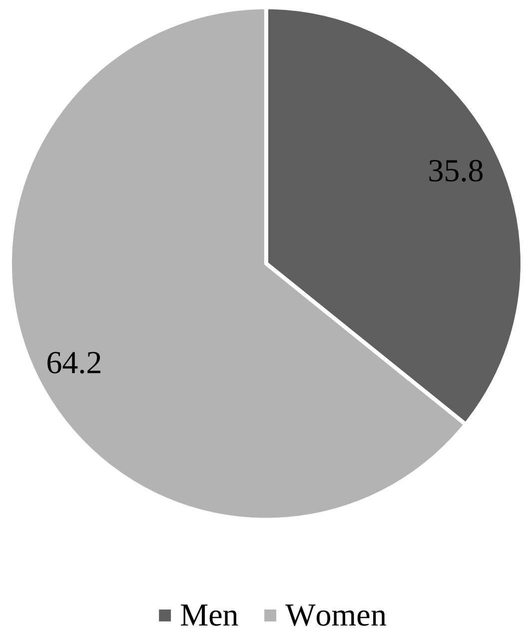


Table 1: Number of individuals reporting fatigue, stress and joint pain in each age bracket.

		30-45 (n=467)	46-55 (n=523)	56-65 (n=548)	66-75 (n=330)	76-85 (n=154)	Total (n=2,022)
Fatigue*	Absolute number	290	287	315	186	83	1161
No fatigue	Absolute number	177	232	228	144	71	852
More Stress	Absolute number	83	85	61	34	15	278
Presence of Joint pain	Absolute number	183	257	314	195	93	1042

*This represents the number of individuals answering yes for presence of fatigue in at least one of the 8-day period

64.2% or 285 individuals that reported having at least one associated disease also reported presence of fatigue. The percentage of individuals that reported having a disease and do not experience fatigue was 35.8% or 159 individuals (Fig, 3).

Figure 4 shows the proportion of women that reported having a disease is higher than men [232 (52.25%) vs 212 (47.75%) respectively, $p<0.001$]. There is also a greater proportion of individuals in the age bracket 56-65 who report a disease compared to the other age brackets with a main effect of age ($p<0.001$).

Figure 3: % of indivdiuals with a disease that do and do not experiece fatigue. Values are percent of total (total n=441)

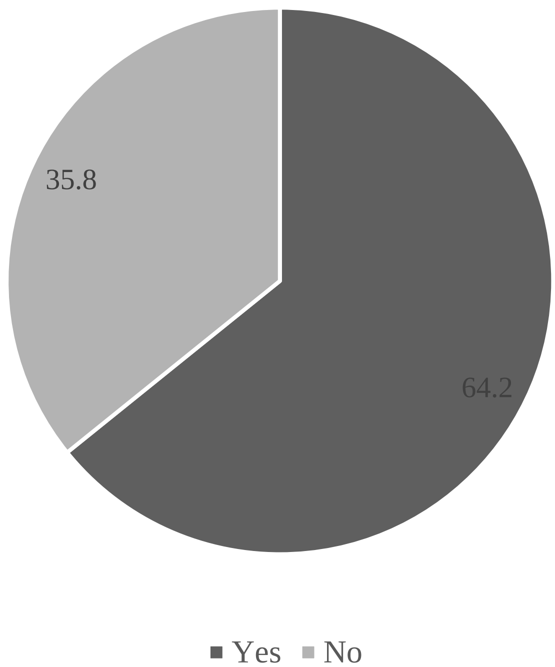


Figure 4: % of men vs. women that have disease. Values are percent of total (total n=441)

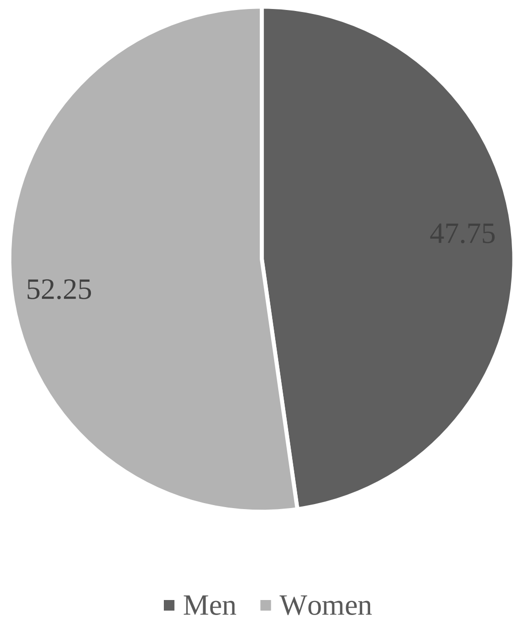


Figure 5 shows the proportions of individuals who indicated having more stress over the past 7 days with a sample size of 2,021 individuals. This measurement was taken each day of the eight-day study. More stress was assumed if a participant indicated more stress on one of more days over the course of the 8-day study. There is no main effect of sex ($p=0.078$) (Fig. 5). Figure 6 shows the proportions across age groups with the highest amount of stress being reported in the ages group of 30-45 (age effect: $p=.014$).

The variable negative affect of stress sum that was collected in the questionnaire showed a significant difference between age and sex. The age bracket with the highest negative effect of stress sum was the 30-45 age bracket ($p=0.003$). Women reported a higher negative affect of stress compared to men ($p<0.001$).

Figure 5: Proportions of stress between men and women. Values are percent of total (total n=2,021)

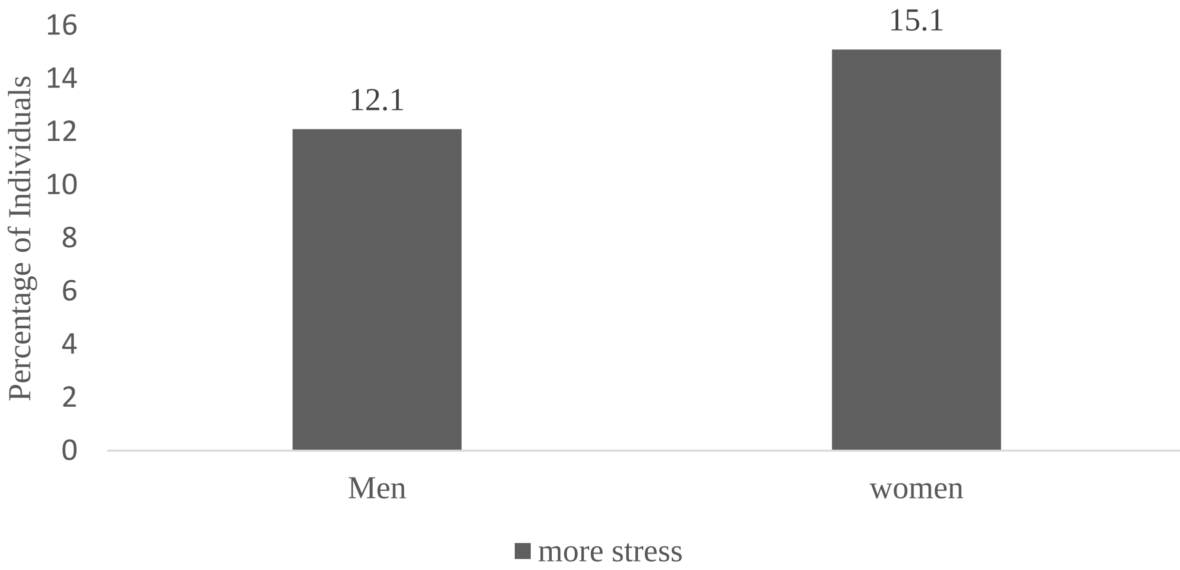


Figure 6: Proportions of stress across age brackets. Values are percent of total (total n=2,021)

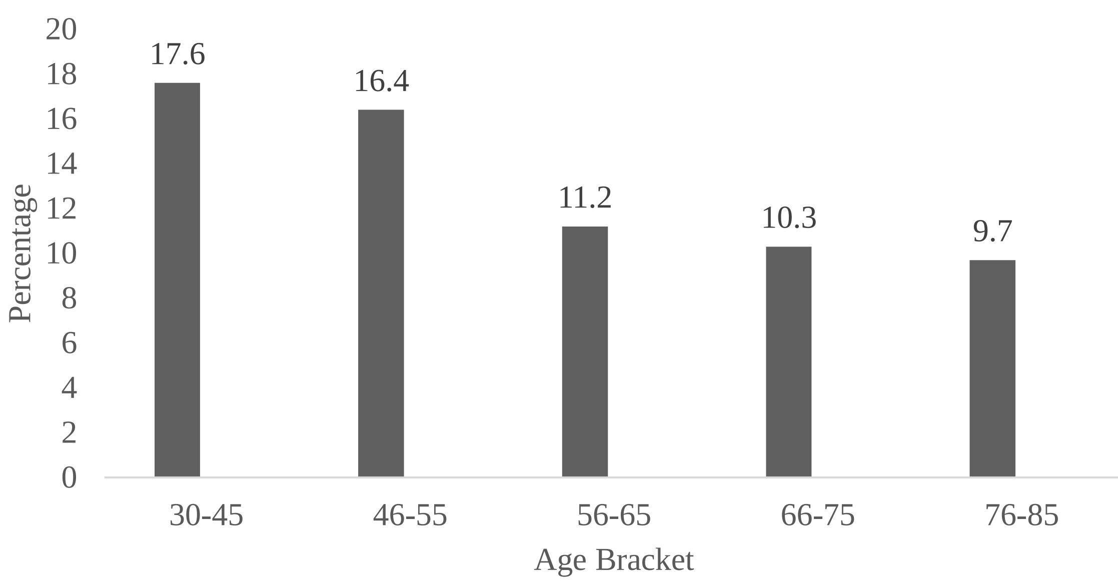


Figure 7 shows the percentage of women that experience joint pain compared to men with a sample size of 1,042 individuals. There is no statistically significant sex difference (p=0.264).

Figure 8 shows the proportions of joint pain across age groups with a sample size of 1,042 individuals. The age group 76-85 reports higher levels of joint pain compared to the other age brackets (age effect: p<0.001).

Figure 7: Percentage of men and women who experience joint pain. Values are percent of total (total n=1,042)

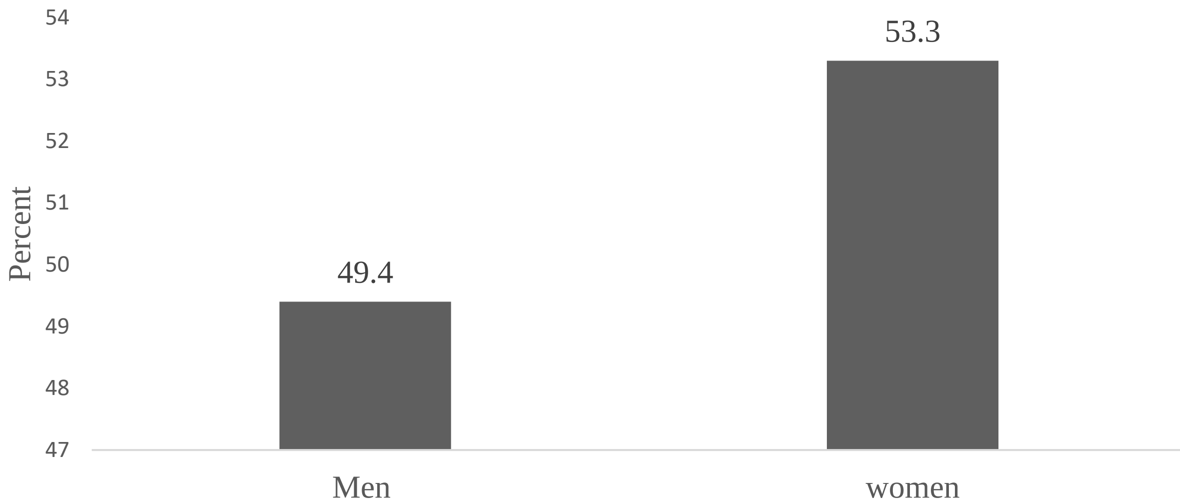
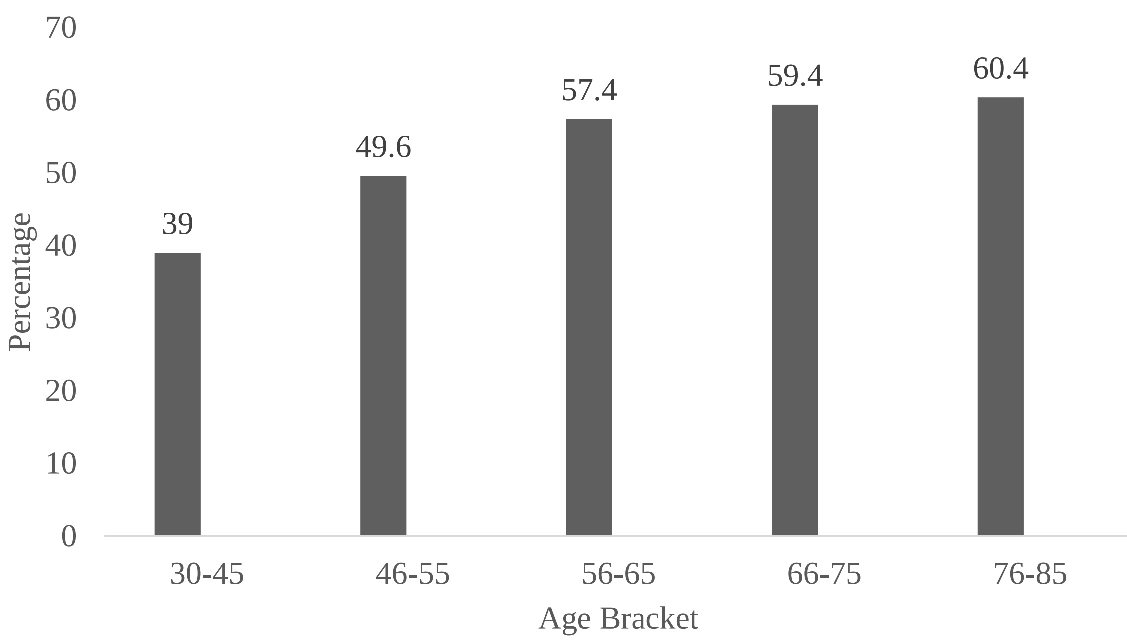


Figure 8: Proprotions of joint pain across age brackets (total n=1,042)



Approximately 50% of the individuals in this study got on average between 400-500 minutes of sleep per night (Figure 9) with a sample size of 1,959. There was not a main effect of sex (p=0.540) but there was a main effect of age (p=0.001). The age group that reported higher average minutes of sleep was the 76-85 age bracket.

The variable education was statistically different between men and women (p<0.001) as well as age brackets (p<0.001) with a sample size of 1,835 individuals (Fig. 10). More specifically, from the sample of individuals that graduated from high school the proportion was higher in women, whereas from the sample who graduated from college the proportion was larger in men. The age bracket of individuals that reported the highest education level was the 30-45 age bracket.

Figure 9: Proportions of minutes of sleep. Values are percent of total (total n=1,959)

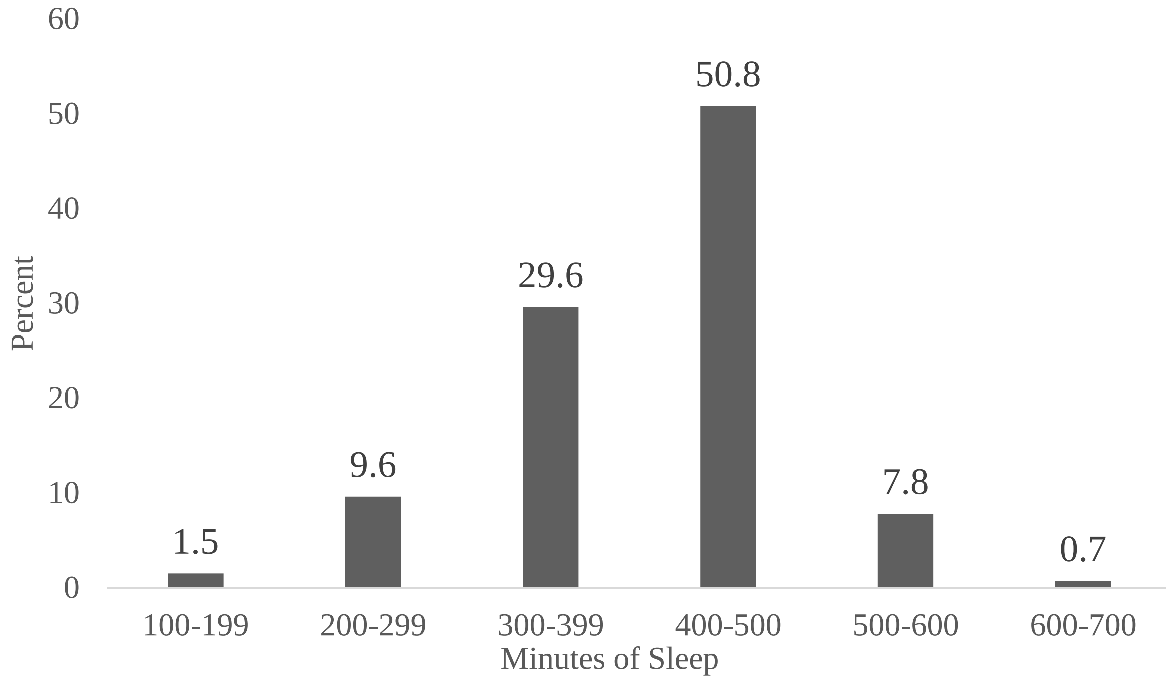
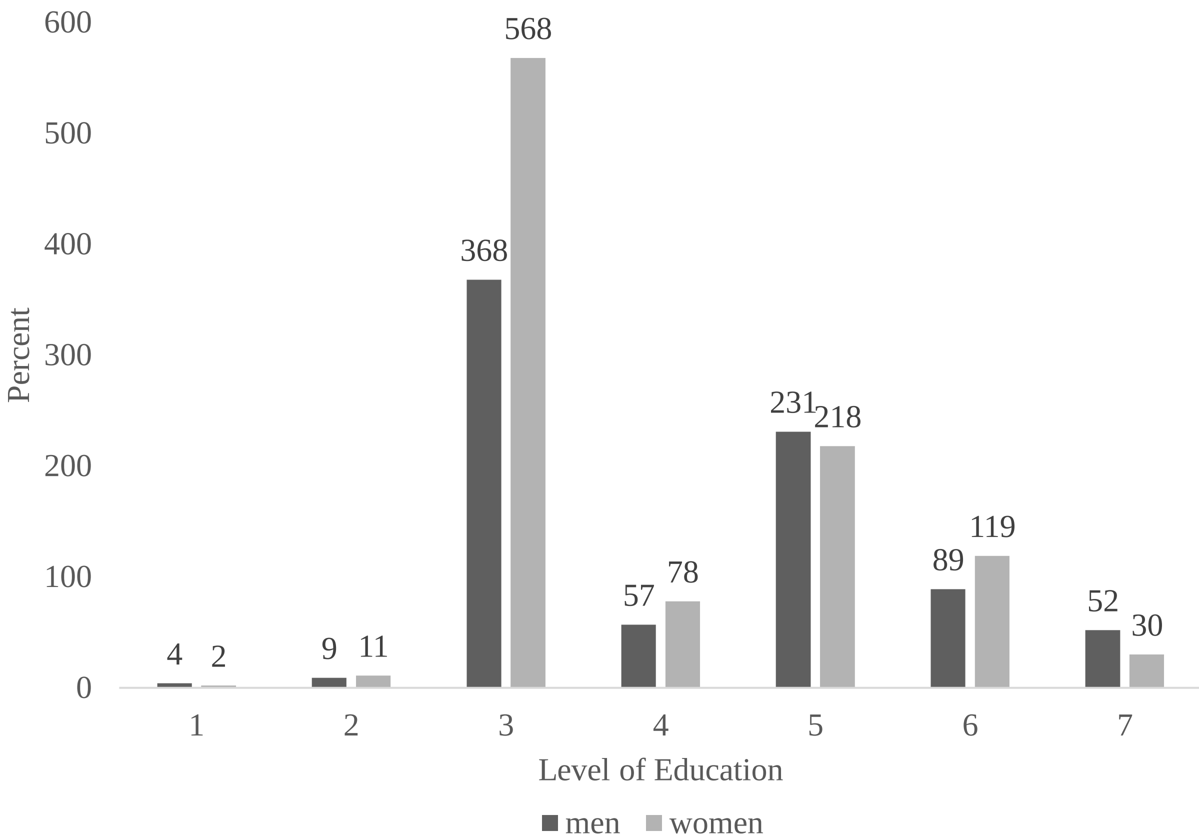


Figure 10: Proportion of eduction level (total n=1,835)



Legend	
1: No school	2: Junior High School (8th grade)
3: GED/graduated high school	4: Associates degree
5: Bachelor’s degree	6: Master’s degree
7: Ph.D.	

Cortisol levels (mcg/dL) vary throughout the day and are different across age groups as well as between men and women. There was a statistically significant difference in average cortisol levels between men and women (*p*$<$0.001) as well as a difference between the age groups (*p*$<$0.001) with a sample size of 1,581. Overall, older adults in the age group 76-85 reported higher average cortisol levels compared to younger adults, and men had a greater mean cortisol compared to women.

Diurnal cortisol slopes were calculated from the 30-mintues after wake data point to the before bed data point for each participant. The average cortisol slope was then calculated. The cortisol slope was not found to be statistically significant in predicting the presence of fatigue in the regression model.

Figure 11: Cortisol levels (mcg/dL) for women across four time points (total n=702)

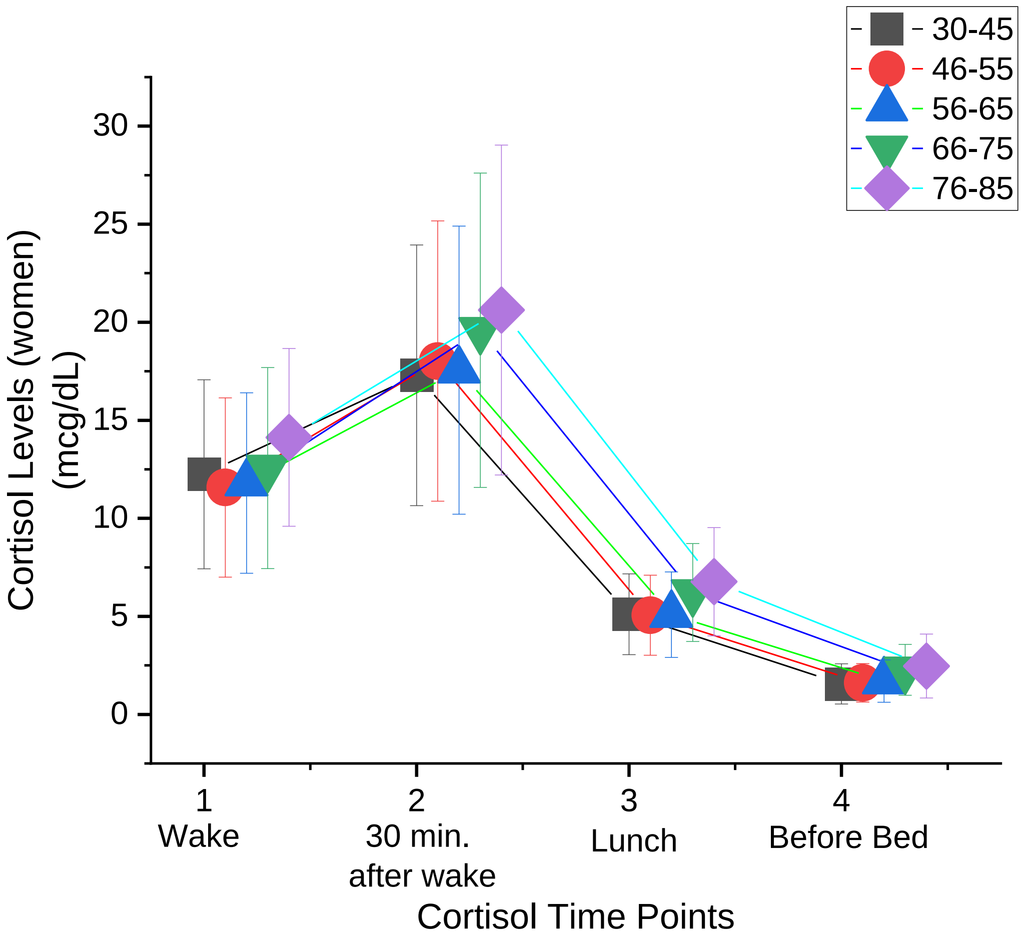


Figure 12: Cortisol levels (mcg/dL) for men across four time points (total n=879)

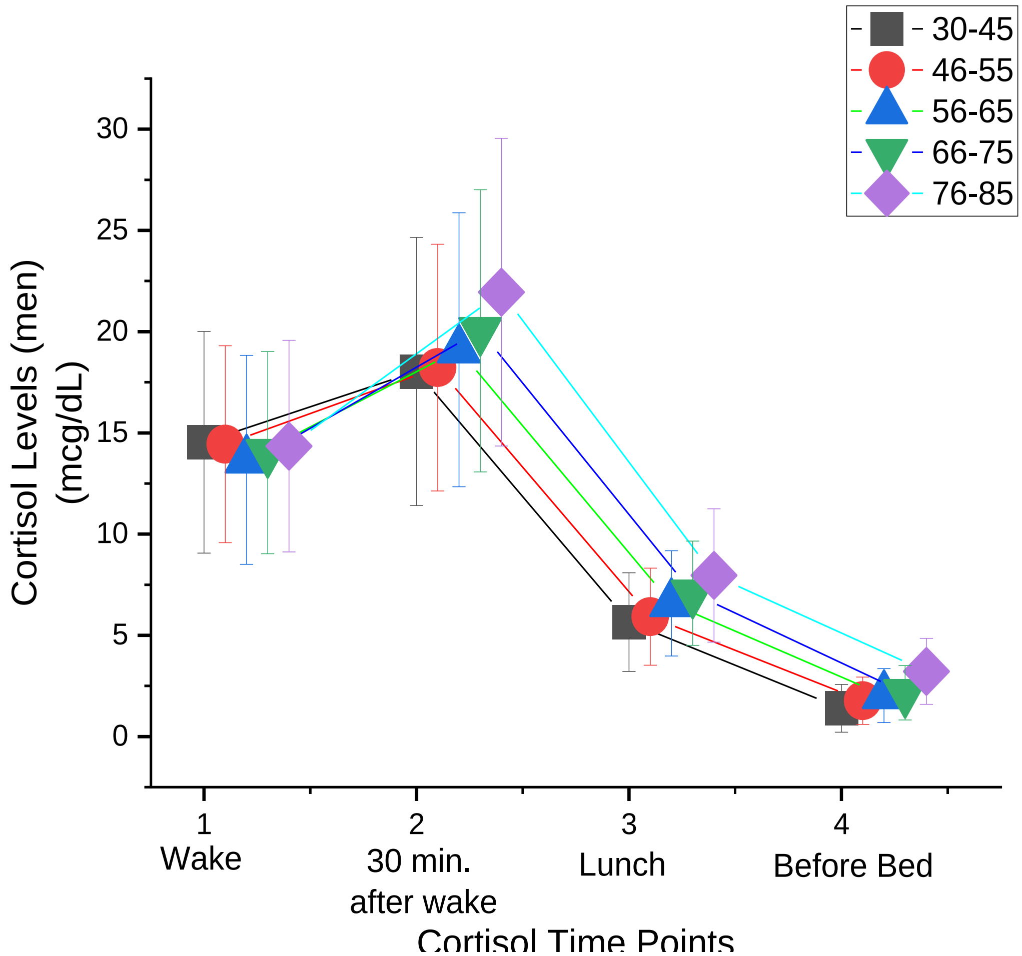


Table 2: Mean and standard deviation of diurnal cortisol slopes for men across age brackets

Age Bracket	Mean	Std. Deviation	Sample Size (n)
30-45	-.126	.093	152
46-55	-.137	.087	207
56-65	-.140	.073	208
66-75	-.142	.077	121
76-85	-.120	.060	64

Table 3: Mean and standard deviation of diurnal cortisol slopes for women across age brackets

Age Bracket	Mean	Std. Deviation	Sample Size (n)
30-45	-.147	.077	235
46-55	-.147	.085	240
56-65	-.145	.088	260
66-75	-.137	.075	173
76-85	-.158	.106	64

A correlation matrix was performed separately for men and women because the large sex differences in the variable presence of fatigue. For women, presence of fatigue was positively associated with the average of more/less stress, and the presence of joint pain. Other significant associations were between the negative effects of stress and the variables: 1) average of more or less stress in the past 7 days, 2) average presence of joint pain, 3) presence of fatigue, and 4) highest level of education completed. Lastly, highest education level completed was correlated with the presence of joint pain (Table 4).

Correlations for men are shown in Table 3. Presence of fatigue was associated with 1) average of more/less stress ($p<0.000$), and 2) presence of joint pain ($p<0.000$). Negative affect of stress was associated with 1) average of more or less stress in the past 7 days, 2) average presence of joint pain, 3) presence of fatigue, 4) highest level of education completed. Lastly, highest education level completed was correlated with the presence of joint pain (Table 5).

Table 4: Correlation matrix – women

		Negative affect average	Average more/less Stress 7 days	Average Presence of Joint Pain	Average Experienced Fatigue	Highest Education Level Completed
Negative affect sum	Correlation Coefficient	1.000	.154**	.123**	.214**	.018
	Sig. (2-tailed)	.	.000	.005	.000	.335
	N	3299	518	517	622	2987
More/less stress 7 days	Correlation Coefficient	.154**	1.000	.043	.245**	.000
	Sig. (2-tailed)	.000	.	.142	.000	.996
	N	518	1160	1155	697	1030
Presence of Joint Pain	Correlation Coefficient	.123**	.043	1.000	.325**	-.088**
	Sig. (2-tailed)	.005	.142	.	.000	.005
	N	517	1155	1157	699	1028
Presence of Fatigue	Correlation Coefficient	.214**	.245**	.325**	1.000	.033
	Sig. (2-tailed)	.000	.000	.000	.	.288
	N	622	697	699	1160	1030
Highest education level completed	Correlation Coefficient	.018**	.000	-.088**	.033	1.000
	Sig. (2-tailed)	.335	.996	.005	.288	.
	N	2987	1030	1028	1030	8202

Table 5: Correlation matrix-men

		Negative affect average	Average more/less Stress 7 days	Average Presence of Joint Pain	Average Experienced Fatigue	Highest Education Level Completed
Negative affect sum	Correlation Coefficient	1.000	.137**	.084	.064	-.048**
	Sig. (2-tailed)	.	.008	.108	.184	.031
	N	2075	369	370	434	1976
More/less stress 7 days	Correlation Coefficient	.137**	1.000	.062	.197**	.049
	Sig. (2-tailed)	.008	.	.067	.000	.166
	N	369	861	860	563	806
Presence of Joint Pain	Correlation Coefficient	.084	.062	1.000	.295**	-.146**
	Sig. (2-tailed)	.108	.067	.	.000	.000
	N	370	860	861	564	806
Presence of Fatigue	Correlation Coefficient	.064	.197**	.295**	1.000	-.053
	Sig. (2-tailed)	.184	.000	.000	.	.132
	N	434	563	564	862	807
Highest education level completed	Correlation Coefficient	-.048**	.049	-.146**	-.053	1.000
	Sig. (2-tailed)	.031	.166	.000	.132	.
	N	1976	806	806	807	6479

As the correlation matrix indicated different predictors for the variable presence of fatigue in men and women, ordinal logistic regression is shown separately for each sex. Variables that were used in the regression model were highest education level completed, presence of joint pain on a trait level, more/less stress over the past 7 days on a trait level, age, and the negative affect of stress sum which measures psychological stress. The regression was conducted controlling for presence of disease. For women that have a disease, the predictors of the prevalence of fatigue are presence of joint pain (p=0.027), and more or less stress over 7 days (p=0.007). The variables negative affect of stress which measures psychological stress (p=0.443), and age brackets (p=0.809) are not predictors of presence of fatigue (Table 6).

For women who indicated not having a disease, the predictors for prevalence of fatigue are presence of joint pain (p<0.001), more/less stress over the past 7 days (p<0.001), and the negative affect of stress which measures psychological stress (p<0.001). Age bracket is not a determinant of the prevalence of fatigue (p=0.873) (Table 7).

The results of the logistic regression for men with the presence of a disease indicate that the prevalence of fatigue is determined by the prevalence of joint pain (p<0.001) and age bracket (p=0.019). More or less stress over the past 7 days (p = 0.469), and the negative affect of stress sum which measures psychological stress (p=0.140) are not predictors of the prevalence of fatigue in this group (Table 9).

The results of the regression for men who indicate having no disease show that prevalence of fatigue can be determined by the average presence of joint pain (p=0.005) and more/less stress over the past 7 days (p=0.001) (Table 8). The negative affect of stress sum which measures psychological stress (p<0.839) and age brackets (p=0.724) are not determinants of the prevalence of fatigue.

The average cortisol slope was not a predictor of presence of fatigue but was correlated with the variable negative affect of stress sum which measures psychological stress (p=0.17).

Table 6: Logistic regression to predict presence of fatigue in the group presence of disease-women

	Exp (B)	Std. Error	95%Wald CI-lower	95%Walk CI- upper	Wald Chi-Square	Df	Sig.
Presence of Joint Pain	1.206	.0846	1.021	1.423	4.881	1	.027
More/less Stress 7 days	4.766	.5738	1.548	14.675	7.406	1	.007
Negative affect sum	1.027	.0345	.960	1.099	.588	1	.443
Age Bracket	1.041	.1670	.751	1.444	.058	1	.809

Table 7: Logistic Regression to predict presence of fatigue in the group no presence of disease- women

	Exp (B)	Std. Error	95%Wald CI-lower	95%Wald CI- upper	Wald Chi-Square	Df	Sig.
Presence of Joint Pain	.984	.0461	1.230	1.473	41.586	1	.000
More/less Stress	1.346	.2686	1.622	4.648	14.146	1	.000
Negative affect sum	2.746	.0253	1.040	1.149	12.457	1	.000
Age Bracket	1.093	.1008	.808	1.199	.026	1	0.873

Table 8: Logistic regression to predict presence of fatigue in the group no presence of disease-men

	Exp (B)	Std. Error	95%Wald CI-lower	95%Wald CI-upper	Wald Chi-Square	Df	Sig.
Presence of Joint Pain	1.170	.056	1.049	1.305	7.941	1	.005
More/less Stress 7 days	3.044	.348	1.539	6.022	10.232	1	.001
Negative affect sum	1.006	.0281	.952	1.063	.041	1	.839
Age Bracket	0.958	.121	.756	1.215	.124	1	.724

Table 9: Logistic regression to predict presence of fatigue in the group presence of disease- men

	Exp (B)	Std. Error	95%Wald CI-lower	95%Wald CI- upper	Wald Chi-Square	Df	Sig.
Presence of Joint Pain	1.389	.0831	1.180	1.634	15.639	1	.000
More/less Stress 7 days	1.477	.5391	.514	4.249	0.524	1	.469
Negative affect sum	1.075	.0493	.976	1.184	2.176	1	.140
Age Bracket	.657	.1788	.463	.933	5.521	1	.019

CHAPTER 5

DISCUSSION

The aim of this thesis was to explore the determinants of the prevalence of self-reported fatigue (indicated by the prevalence of fatigue during 8 days in the MIDUS dataset). Age, sex, and disease were controlled for in the analysis. In this sample of individuals from the Midlife in the United States (MIDUS 2), fatigue affects approximately 57.7% of the population. This is slightly higher than previous reports indicating the prevalence of fatigue was 31% in older adults and 38% in United States workers (Junghaenel et al., 2011). Consistent with previous research (Engberg et al., 2017), we found that women have a higher prevalence of fatigue compared to men (54.2% vs 35.8% respectively). Factors determining the prevalence of fatigue were different across groups.

More specifically: For the women who had the presence of disease, the determinants of fatigue were the prevalence of joint pain, and more/less stress over the past 7 days. For women who did not indicate having a disease, the determinants of the prevalence of fatigue were the prevalence of joint pain, the average of more/less stress of the past 7 days, and the negative affect of stress which measures psychological stress. For men who indicated having the presence of a disease, the determinants of the prevalence of fatigue were the prevalence of joint pain and age. For men who indicated not having a disease, the determinants of the prevalence of fatigue included the average prevalence of joint pain, the average of more/less stress of the past 7 days.

Because fatigue can be a common result of various medical conditions (Junghaenel et al., 2011), it was suggested the prevalence of fatigue is increased in presence of disease compared to healthy individuals (Finsterer & Mahjoub, 2014). This thesis investigated the role of sex (men vs women) and presence of disease as potential factors associated with prevalence of fatigue. In this study about 64.2%, or 285 individuals reported having a disease and the presence of fatigue. Common disease reported were Parkinson's disease, cardiovascular disease, neurological disease, history of serious head injury, or history of a stroke. The prevalence of disease in this sample was greater in women (52.25%) compared to men (47.75%), and individuals in the age bracket 56-65 reported a higher prevalence of disease compared to the other age brackets. The severity of fatigue was not investigated to determine if the self-reported fatigue in presence of disease is greater than in healthy individuals.

A slightly greater proportion of women in our sample reported having more stress than men (15% vs 12%, respectively). This aligns with previous shown sex differences in perceived stress (Chaplin et al., 2008). There was a main effect of age with the highest percentage of reported stress being in the age bracket of 56-65 years of age. The American Psychological association reported a similar trend of stress among generations. The highest amount of stress reported in younger to middle aged adults, with lower amount of stress being reported in older individuals ("Stress by Generation," 2012).

Highest education level was a variable that was not a predictor of the prevalence of fatigue. In previous studies, demographic variables were correlated with fatigue (Junghaenel et al., 2011), however we did not find that highest education level was a predictor of the presence of fatigue in the groups.

Joint pain is often researched along with arthritis. In the MIDUS 2 data set, the presence and severity of joint pain was indicated by each participant. The proportion of joint pain is similar between men and women, and older individuals report more joint pain compared to younger individuals with a main effect of age. When joint pain is studied among arthritic individuals, the prevalence of joint pain is higher in older adults compared to younger adults ("Joint Pain and Arthritis," 2020). Our findings coincide with previous research on joint pain and arthritis.

The average of the cortisol slopes for each individual was not found to be a predictor of the prevalence of fatigue. The diurnal cortisol slopes were however, correlated with the negative affect of stress variable (psychological stress), which was also correlated with more/less stress over the past 7 days. The diurnal cortisol slopes is not a determinant of fatigue, and the negative effects of stress (psychological stress) and more/less stress is a determinant of the prevalence of fatigue in some of the groups. Interestingly, women had greater prevalence of stress compared to men, and also report a higher prevalence of fatigue. When the relationship between fatigue and psychological distress was studied among breast cancer individuals, there was a strong positive correlation between the two variables (Bennett et al., 2004). Others also previously observed that women who reported fatigue were more likely to also report psychological distress (Bennett et al., 2004).

Potential variables that are frequently associated with self-perceived fatigue are perceived stress, and health status which aligns with what was found in all of the age groups. Another study found that fatigue was associated with disease, lower education levels, and lower age (Junghaenel et al., 2011). The results in our study align with previous research, and dive into more detail about the differences in factors that play a role in the presence of fatigue such as sex and presence of disease.

The negative affect of stress evaluated the negative moods and feelings of emotions of an individual, and from past research, physical activity is correlated with positive moods (Pelletier et al., 2017). Physical activity was not associated with the prevalence of fatigue (data not shown). Reported stress (i.e. more stress in the last day) and the variable negative effect of stress which measured psychological stress, were both associated with the presence of fatigue. An important biomarker of stress is cortisol, and cortisol levels increase in response to stress. Diurnal cortisol slopes measure the change in cortisol levels across a specific time point. The normal diurnal pattern is characterized by a spike in cortisol shortly after wake and a steady decline over the course of the day. Past research suggests that the presence of disease as well as fatigue are associated with flatter diurnal cortisol slopes (Adam et al., 2017). In this thesis, the mean cortisol levels as well as diurnal cortisol slopes were not associated with the prevalence of fatigue but were associated with average more/less stress over the past 7 days, and the negative affect of stress which measures psychological stress. This occurrence could be due to the indirect effect of cortisol levels on fatigue: cortisol adjusts in response to a stressor and stress effects the prevalence of fatigue.

There were sex differences in this thesis that indicated women report a higher prevalence of fatigue compared to men. When performance fatigability is tested, it is typically found that men are more fatigable compared to women when performing isometric tasks (Hunter, 2016). The differences that are found when testing performance fatiguability compared to perceived fatiguability could be due to the perceptions of fatigue in women compared to men as well as the social stigma placed on gender and fatigue.

Limitations for this study include the data being pre-collected, and our research team not being involved in the data collection procedures. Another limitation of the study is that variables are self-reported including fatigue, joint pain, stress, and psychological stress. This could lead to error in understanding the definitions of the constructs.

CHAPTER 6

CONCLUSION

The prevalence of fatigue in the MIDUS 2 data sample was 57.5% with a higher prevalence in women compared to men. The determinants of fatigue are different between men and women and different among healthy individuals and in presence of disease. For the women who had the presence of disease, the determinants of fatigue were the prevalence of joint pain, and more/less stress over the past 7 days. For women who did not indicate having a disease, the determinants of the prevalence of fatigue were presence of joint pain, more/less stress of the past 7 days, and the negative affect of stress which measured psychological stress. For men who indicated having the presence of a disease, the determinants of the prevalence of fatigue were the prevalence of joint pain and age. For men who indicated not having a disease, the determinants of the prevalence of fatigue included the prevalence of joint pain, and more/less stress of the past 7 days.

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