The Relationship between Personality and Perceived Mental Fatigability

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Abstract

An increase in number of adults over the age of 65 living in the United States has led to a proportionate increase in the number of individuals reporting symptoms of fatigue - one of the chief complaints among older adults that has been associated with a decline in functionality, and increased risk for negative health outcomes. Perceived mental fatigability is a construct of fatigue that is ideal for the measurement of perceived mental tiredness in an aging population because it accounts for self-pacing bias, provides activities that are standardized in intensity and duration, and can be done with a self-report questionnaire as opposed to a performance-based assessment, which are common among measures of fatigue, but difficult for older adults. Personality traits may be related to perceived mental fatigability through several direct and indirect mechanisms including health behaviors, sensation seeking behaviors, and the cost/benefit theory of motivation. This cross-sectional analysis considers a sample of 1,812 relatively healthy and educated older men from the 4^{th} visit of the Osteoporotic Fractures in Men (MrOS) Study, completed between 2014 and 2016. Linear regression models were used to assess the relationship between optimism, conscientiousness, goal reengagement, goal disengagement, and perceived mental fatigability as measured by the Pittsburgh Fatigability Scale (PFS) when controlling for relevant demographics, psychological and behavioral variables, comorbidities, and physical activity and function.

Approximately a quarter of the sample (25%, n=448) reported higher perceived mental fatigability. Goal disengagement was not associated with perceived mental fatigability, and goal reengagement was only significantly associated before the addition of age and demographic variables. Lower conscientiousness and optimism remained significantly associated with higher perceived mental fatigability, independent of all significant covariates. However, depression, self-rated health status, and global sleep quality appeared to have the largest effect on the strength of the relationship. The public health significance of these findings is that the mechanism in which personality traits influence perceived mental fatigability can be used to help design targeted interventions that can reduce perceived mental fatigability in older adults and decrease the prevalence of related adverse health outcomes.

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1.0 Introduction

1.1 The Aging Population and Implications for Functional Decline and Disability

The population of adults over the age of 65 in the United States is rapidly increasing. In 1900, an individual could expect to live, on average, approximately 11.9 more years after their 65th birthday. However, by 1992, the average 65-year-old could expect to live an additional 17.5 years (Guralnik, Fried, & Salive, 1996). According the U.S. Census Bureau, in 2016, 15.2% of the U.S. population was over the age of 65, and by 2060, this percentage is expected to rise to 23.4% (Vespa, 2018). An increase in chronic disease diagnoses and physical symptoms is common with age, and the larger the population at an increased risk for these health outcomes, the larger the burden of disease and disability. According to the Health and Retirement Study (HRS), there have been significant increases in the prevalence of hypertension, diabetes, cancer, chronic lung disease, and arthritis between 1998 and 2008 (Hung, Ross, Boockvar, & Siu, 2011). Additionally, approximately a quarter (25.4%) of adults in the United States over the age of 50 are living with functional disability related to activities of daily living (ADL) or instrumental activities of daily living (IADL) (Hung et al., 2011). Understanding the pathway from disability to disease is difficult because disability can be tied to several aspects of functioning and is further influenced by various psychosocial factors. Fatigue, however, is a known contributor to functional decline and disability. It is estimated that about 37.2% of community-dwelling adults in the U.S. experience heightened fatigue (Deary et al., 2018). In a longitudinal study of independent adults age 65 and older, among those who reported tiredness (a proxy measure for fatigue), 29% reported that their function was moderately affected, and 26% reported that their function was affected quite a lot. For all three physical function measures in the study, baseline tiredness was associated with worse function (Hardy & Studenski, 2008a) The predictive value of self-reported tiredness for identifying an increased risk for worse function persisted even after controlling for comorbid chronic conditions including sleep and emotional disorders, and chronic pain (Hardy & Studenski, 2008a). Further, in a study of older adults assessing the relationship between fatigability (a more robust measure of fatigue) and functional decline, investigators identified a 13% to 19% greater likelihood of significant decline in physical function measures such as gait speed, physical performance, and walking index among those with higher perceived fatigability (Simonsick et al., 2016). In a longitudinal assessment of the effect of fatigue on survival, Hardy & Studenski (2008b) found that mortality rates at 10 years were 59% for older adults with fatigue, compared to 38% of those without fatigue. In a period where the number of older adults experiencing fatigue and subsequent functional decline and disability is expected to increase, work to understand the underlying mechanisms of these pathways is of particular importance.

1.2 Definition and Measurement of Perceived Fatigability as Compared to Fatigue

Fatigue is a self-reported measure of tiredness, or perceived lack of energy, and is one of the most reported complaints among older adults (Eldadah, 2010; Simonsick et al., 2016). Among adults over age 65, fatigue is associated with decreased ability to function, several comorbid health conditions, and mortality (Hardy & Studenski, 2008b; Moreh, Jacobs, & Stessman, 2010; Simonsick, Schrack, Glynn, & Ferrucci, 2014). Fatigue is not grounded in one's ability to function, meaning that two individuals with distinctive functional abilities could perform tasks that require different levels of energy and report the same level of perceived tiredness. Similarly, people are often predisposed to avoid working to their full capacity, i.e., to the point of fatigue. This desire to minimize exertion in order maintain a comfortable level of activity and avoid fatigue has been conceptualized as self-pacing (Eldadah, 2010; Glynn et al., 2015). Alexander et al. (2010) describes the importance of controlling for self-pacing in studies of older adults who are likely to experience a reduction in physical fitness, an increase in energy needed to maintain equilibrium in the body, and a reduction in biomechanical efficiency that causes daily activities to require significantly more energy than they might in younger individuals. When older adults reach their maximum energy expenditure, their brain sends an alert, warning that energy is scare. At this point, many individuals will reduce their activity to slow the body down and increase the availability of energy (Alexander et al., 2010). Fatigability is the measure of fatigue that accounts for self-pacing by anchoring the perception of tiredness to activities of various intensities that are standardized in duration (Glynn et al., 2015).

In a review of fatigability measures, 35.7% of studies measured self-report fatigue after a defined performance test. The remainder of studies assessed fatigability as either performance fatigability and performance deterioration (7.1%) or just self-reported perceived fatigability with no explicit performance measure (14.3%) (Kim et al., 2018). Among the performance-based measures, the type, intensity, and duration of activity varied. Most of the measures used wide-ranging walking tests, while a few others use physical tasks, cognitive tasks, both, or measured fatigue during “free-living” activities. Apart from the free-living activities, all performance measures require subjects to travel to a study center to participate. These in person measurements may pose a challenge to older adults, individuals with disabilities, or those without access to reliable transportation.

Fatigability, as measured by the Pittsburgh Fatigability Scale (PFS), fills this gap by functioning as a valid self-report measure that can be administered in a variety of settings to people of various functional abilities via a simple questionnaire. Of the self-report measures of fatigability in the review by Kim et al. (2018) only the Pittsburgh Fatigability Scale (PFS) was designed and validated for measurement in older adults, and is one of the only self-report measures that incorporates a range of activities of various intensities while standardizing them by duration (Glynn et al., 2015; Kim et al., 2018).

1.3 Perceived Mental Fatigability

Lin et al. (2016) reports that mental fatigability is one of the most common neurological conditions associated with aging, yet few fatigability scales are equipped for its measurement. The PFS, however, provides fatigability sub scores independently for perceived physical and perceived mental fatigability. Mental fatigability, for the purposes of these analyses is defined as "self-report cognitive tiredness related to activities of fixed intensity and duration" (Glynn et al., 2015; Wasson et al., 2019, p. 140). It is important to note that in the context of this study, perceived mental fatigability is not simply mental tiredness following tasks that are explicitly cognitive in nature. The PFS asks participants to rate their perceived mental fatigue on all tasks, including a wide variety of activities such as "high-intensity activity for 30 minutes", "watching TV for 1 hour", and "participating in a social activity for 1 hour" (Glynn et al., 2015). The psychometric properties of the mental PFS have recently been evaluated with good concurrent and construct validity and strong test-retest reliability (Cronbach's α=0.90) (Renner et al., 2019).

In a review of the impact of mental fatigability on physical performance, Van Cutsem et al. (2017) discussed subjective, behavioral, and physiological manifestations of mental fatigue, emphasizing the range of ways that the concept can be defined and measured. Mental fatigue is discussed elsewhere (Karshikoff, Sundelin, & Lasselin, 2017; Van Cutsem et al., 2017) specifically as fatigue following completion of a cognitive task. Typically, these cognitive tasks are delivered in an experimental setting and include activities such as the Stroop color-word task, concentration grids, switch task paradigms, and the AX-continuous performance test (AX-CPT). Mental fatigue, as distinct from mental fatigability due to lack of standardization to activities of fixed intensity and duration has also been defined in a several other contexts. More broadly – a complex phenomenon that involves changes in mood, information processing and behavior (Boksem & Tops, 2008; Desmond & Hancock, 2001); more specifically- a "state of reduced alertness and decreased overall performance due to prolonged cognitive activity" (Arnau, Mockel, Rinkenauer, & Wascher, 2017, p. 17); and in terms of motivation – a feeling of weariness in addition to an individual's unwillingness to continue performing the task at hand. This phenomena is said to impact mental processes such as goal-directed attention, error process, and executive control processes (Arnau et al., 2017), and also has a demonstrated neural basis. In a small pilot study within the Lifestyle Interventions and Independence for Elders (LIFE) cohort, mental fatigability, independent of physical fatigability, was related to the posterior cingulate, the home of cognitive control and function, and the amygdala where emotion processing, including that of anger, fear, and motivation, takes place (Wasson et al., 2019). Perceived mental fatigability as measured by the PFS was also found to be significantly correlated with other trait level fatigue measures, such as the fatigue severity scale (FFS, $\rho = 0.63$, p-value < 0.001), and the cognitive subsection of the Modified Fatigue Impact Scale (MFIS, $\rho = 0.36$, $p = 0.03$) (Burke et al., 2018).

The relationship between mental fatigability and physical activity may be of particular importance in older adults. In a study of healthy old and young adults who completed physical performance measure after a mental fatiguing task, dual-task gait variability, measured in terms of walking speed, stride length, stance time, double support time, and swing time, increased significantly in the old participants (Behrens et al., 2017). Further, in a large sample of 1,557 adults from the Northern Sweden MONICA study, longer sitting time was associated with higher mean fatigue scores on all fatigue scales (general, physical, mental, reduced activity), indicating that physical activity may, therefore, be protective against all types of high fatigue, including mental (Engberg, Segerstedt, Waller, Wennberg, & Eliasson, 2017). Finally, as measured with the PFS in the Baltimore Longitudinal Study of Aging, individuals with higher mental fatigability were 2.5 times as likely to experience a decline in gait speed compared to those who were low in the measure (Simonsick et al., 2018). The study concluded that there was significant evidence for the mental fatigability assessment, in additional to the well-used physical fatigability assessment, to identify individuals at risk of performance and functional decline, in addition to other "debilitating health conditions" (Simonsick et al., 2016; Simonsick et al., 2018, p. 7). Physical activity and function is also strongly associated with individual level personality traits. In a sample of almost 6000 older men in the United States, the Osteoporotic Fractures in Men (MrOS) Study demonstrated a relationship between conscientiousness and every physical and mental health outcome, and in the same study, optimism was found to be related to several physical (IADL and SF-12 physical) and mental (SF-12 mental) function measures. (Smagula et al., 2016). As both personality and perceived fatigability have been shown on the pathway leading to worse physical and mental function, there is reason to believe that personality and perceived fatigability are additionally related.

1.4 Personality Variables and their Association with Fatigue

Personality attributes, some of which remain stable over time, and others of which fluctuate from the impact of the life course, may be the ideal tool to assess individual-level differences in susceptibility to perceived fatigability. This is particularly true in older adults as one's true personality may be more visible in older individuals (compared to younger individuals) because time provides people with the opportunity to "become increasingly like themselves" (Hooker & McAdams, 2003; Neugarten, 1964, p. 198). Additionally, these attributes could be important for estimating one's success in the aging process as they predict type of coping mechanisms, adherence to medical regimes, social support networks, and other health-behavior related attributes (Hooker & McAdams, 2003).

The definition of personality as a whole is not widely agree upon. However, generally speaking, personality is "the set of psychological traits and mechanisms within the individual that are organized and relatively enduring and that influence his or her interactions with, and adaptations to, the intrapsychic, physical and social environment" (Larsen & Buss, 2013). Optimism, conscientiousness, and goal reengagement and disengagement are traits that may be ideal for studying individual differences in health outcomes, such as perceived fatigability. Optimism has consistently been linked to both physical and mental health outcomes (Rasmussen, Scheier, & Greenhouse, 2009; Smagula et al., 2016). As has conscientiousness, or the tendency to be organized, thorough, rule-abiding, and self-disciplined (De Vries & Van Heck, 2002; Martin, Friedman, & Schwartz, 2007; Smagula et al., 2016). Goal disengagement, or the ability to abandon unattainable goals, is protective against the accumulation of failure that may cause loss of motivation, time, and resources (Wrosch, Scheier, Miller, Schulz, & Carver, 2003). Relative to goal disengagement, goal reengagement functions by complimentary, yet independent means. It is often the case that an individual may disengage from one goal only to reengage in a different goal much later. One may even engage in a new goal before disengaging the previous one. Goal reengagement is of its own importance because disengaging from a goal without having a viable alternative can cause additional distress. Through the pursuit of new, more obtainable objectives, goal reengagement can help one to overcome or avoid feelings of failure (Wrosch et al., 2003).

Few studies have attempted to specifically understand the individual level differences that may influence the presence and severity of perceived mental fatigability, but several studies have related personality to general measures of fatigue. In a meta-analytic review of 35 studies assessing goal adjustment, goal reengagement (r=-0.11) and goal disengagement (r=-0.09) were both significantly negatively correlated with fatigue (Barlow, Wrosch, & McGrath, 2019). Further, in the Netherlands, De Vries and Van Heck (2002) assessed the relationship between the Five-Factor-Model (FFM) of personality and two fatigue questionnaires that covered a wide range of fatigue symptoms with five subscales of the Checklist Individual Strength-20 (CIS-20) and the emotional exhaustion subscale from the Maslach Burnout Inventory (EE-MBI). Among their sample of 765 adults in the working population, as trait-level conscientiousness increased, fatigue significantly decreased with a correlation coefficient magnitude ranging from -0.10 to -0.26, depending on the measure of fatigue (De Vries & Van Heck, 2002).

The relationship between personality and fatigue in the context of driving tasks is well documented (Matthews & Desmond, 1998), and may help to explain the relationship between personality and perceived mental fatigability. Driving tasks are a good measure of mental fatigue, independent of physical fatigue, because they are sedentary activities that require significant cognitive effort that is more likely to induce mental tiredness over physical tiredness. In Lal and Craig (2002) drivers hooked up to electroencephalograms (EEG) showed increased delta and theta waves associated with both fatigue and psychological factors that are related to personality, such as anxiety and mood state. Craig, Tran, Wijesuriya, and Boord (2006) also measured the relationship between extraversion, and a number of other personality traits and driving-related fatigue. In a study of 50 young individuals (mean age=32.6 years), impulsivity, anxiety, and conscientiousness were the psychological factors most strongly related to their five measures of fatigue (Craig et al., 2006). Conscientiousness alone explained 10.2% of the variance in percent change in Chalder Scale fatigue measures before and after the driving task.

1.5 Covariates Impacting the Relationship between Personality and Perceived Mental Fatigability

The mechanism by which personality influences health outcomes may often involve an indirect relationship. For example, optimists may have a friendlier disposition which may encourage the development of a better social support network, decrease interpersonal stress, and consequently decrease the risk of stress-related health outcomes like heart disease (Martin et al., 2007; Smith, 2000). There are several studies that have noted numerous factors, in addition to social support, that may confound levels of mental fatigue and personality.

Depression needs to be controlled for in studies of personality and health outcomes. Otherwise any relationship credited to personality may just be the result of acute mood changes or symptoms of the disorder rather than trait-level personality attributes (Duberstein et al., 2003). In a previous study on The Osteoporotic Fractures in Men (MrOS) cohort, depression was significantly related to optimism, conscientiousness, goal reengagement and goal disengagement (Smagula et al., 2016). Additionally, symptoms of depression may be mistaken for high fatigue because there are numerous overlapping characteristics, such as extreme tiredness and lack of motivation (Eldadah, 2010). In a large sample of older adults from primary care facilities, it was suggested that depression is likely to have an increased effect on health outcomes in old age due to the mental weight of increasing medical burdens and life transitions (Duberstein et al., 2003).

Personality is likely to be related to several other psychosocial predictors of health outcomes. For example, those who are high in conscientiousness may be less likely to smoke, or drink excessively (Martin et al., 2007), more likely to be married, and more likely to have higher educational attainment (Martin et al., 2007; Smagula et al., 2016). Similarly, in the Dutch working adults cohort there was an inverse relationship between marital status and fatigue such that singles reported more fatigue, particularly on the motivation and physical activity subscales, than those who had a partner (De Vries & Van Heck, 2002). Further, one's social environment typically has a reciprocal relationship with health status (Smith & Spiro, 2002). In old age, living arrangement may be a large part of one's social environment as individuals are typically spending more time at home. Living environment can predict an individual's psychological engagement and productivity (Friedman & Kern, 2014), and may be related to fatigue, such that individuals who have an engaging or more positive living space may feel less fatigued.

On average, the number of medical diagnoses significantly increases with age (Weber et al., 2015). Many of these diagnoses are chronic diseases that could be related to both personality and fatigue. In the Women's Health Initiative measurement of cardiovascular disease, optimists had a decreased risk of coronary heart disease and mortality compared to pessimists (Tindle et al., 2009). The same may be true of others who have negative personality attributes such as low conscientiousness, and low goal disengagement and reengagement. Furthermore, some personality traits, such as conscientiousness, are related to behavioral factors for diabetes (Sanatkar et al., 2019), and others factors like goal reengagement and disengagement may affect management of the disease. Barlow et al. (2019) also found that goal reengagement and goal disengagement are associated with fewer physical symptoms (*r* = −0.13 for both traits) and goal reengagement is associated with less chronic illness (*r* = −0.09). In regards to fatigue, the Jerusalem Longitudinal Cohort study identified significant relationships between ischemic heart disease, hypertension and fatigue at 70, 80, and 85 years of age, and between diabetes and fatigue at age 70 (Moreh et al., 2010). The comorbidity between fatigue and diabetes is likely caused by hypo- or hyperglycemia or various psychological and physical factors, such as lack of exercise (Fritschi & Quinn, 2010). In the Nordic Research on Aging (NORA) study of 546 men and women over the age of 75, the odds of tiredness, a similar measure to fatigue, were over 4.5 times higher among those with at least 2 comorbid medical conditions (Avlund, Rantanen, & Schroll, 2007). Beyond the presence of actual medical conditions, Engberg et al. (2017) found that self-rated health status was strongly associated with lower mean fatigue scores on all fatigue scales, including mental fatigue. There was a mean difference in fatigue scores of 3.3 points between the lowest and highest self-rated health status ($p<0.001$), even after adjustment for age, sex, and socioeconomic status.

On similar physical health pathways, body mass index (BMI) is likely related to personality and fatigue as those who are, for example, high on conscientiousness or goal adjustment may be more likely to adhere to advantageous health behaviors and maintain a healthier weight. Individuals with a high BMI may have less energy and consequently be at risk of higher mental fatigability. Moreover, poor sleep quality could increase one's perception of their fatigue level, and global sleep quality scores from the Pittsburgh Sleep Quality Index have previously been shown to have a significant relationship with optimism, conscientiousness, and goal reengagement (Smagula et al., 2016).

These variables capture combinations of genetic, environmental, and sociocultural elements that are important for our understanding of the biopsychosocial processes that are both directly and indirectly responsible for both our mental and physical health (Martin, Friedman, & Schwarz, 2007), and consequently, personality and fatigability.

1.6 Mechanism for the Relationship between Personality and Perceived Mental Fatigability

In addition to the direct and indirect effects that personality has on perceived mental fatigability through health behaviors, and health status, there are several other possible mechanism which may help to explain the relationship. Several papers have used Eysenck's Biological Basis of Personality and Arousal Theory to describe the association. According to Eysenck's theory, certain personality traits, such as extraversion, may predispose an individual to fatigue during tasks they perceive to be monotonous and boring (Craig et al., 2006). Psychological constructs that are related to extraversion, such as arousability and sensation seeking, are likely to explain the association between the trait and susceptibility to fatigue. Thiffault and Bergeron (2003) also found an association between sensation seeking, or more specifically, experience seeking, and fatigue during a driving task. Additionally, they observed an interaction between extraversion and sensation seeking such that sensation seeking explained 26% of the variance in fatigue during the monotonous driving task, but only for participants who were high in extraversion (Thiffault & Bergeron, 2003). This relationship suggests that individuals who prefer high levels of stimulation may have a more negative reaction, such as heightened fatigue, to tasks that they perceive to be boring, compared to individuals who prefer lower levels of stimuli. This mechanism can be applied outside the trait of extraversion to other personality constructs such as high goal disengagement that may also relate to high levels of stimulation.

This arousal and stimulation mechanism of personality and fatigue is similar to Boksem and Tops (2008) cost and benefit theory. This theory discusses two motivational systems – motivation to obtain rewards and motivation to avoid harm and punishment, that constantly interact and come with energetical costs. That is to say, people will only expend energy when energetical costs are low compared to the perceived benefit (ex; reward or avoidance of punishment). When someone preforms a task over a long period of time, significant energy is invested that builds up, and eventually the energy loss will outweigh the perceived reward, resulting in decreased motivation to continue. This concept is fatigue – the drive to end a task, or hesitancy to start another when the energy-related costs exceed the perceived benefits of continued performance (Boksem & Tops, 2008).

In the context of personality, extraverts, for example, have shown to have higher sensitivity to rewards such that those who are lower on extraversion may be predisposed to perceive that costs outweigh potential rewards and succumb to mental fatigue earlier. Similarly, individuals who are higher on optimism may be able to use their positive disposition to focus on the reward, and therefore be able to continue the task longer before experiencing fatigue (Boksem & Tops, 2008). Perfectionism, a trait similar to conscientiousness but considered to be more maladaptive (Stoeber, Otto, & Dalbert, 2009), is also related to the motivational pathway to fatigue and fatigability. Perfectionists may sacrifice immediate pleasure (i.e., stopping their workout early to feel less tired and avoid fatigue) to optimize task performance, and may even continue the activity even after energy costs are high to avoid the punishment they perceive to be associated with stopping (i.e., poor self-esteem) (Boksem & Tops, 2008). Conscientious individuals may experience the same drive to focus on longer term goals and continue past the point of energy deficit (fatigue). This persistence-type mindset is likely also related goal adjustment. The ability to understand the balance between short-term and long-term goals is important in the motivation pathway because as fatigue increases, long-term goals experience competition from short term goals (ex; rest) that are directed at maintaining general well-being (Boksem & Tops, 2008). Individuals who are able to disengage from unattainable goals and reengage in more obtainable goals may experience less fatigue.

The proposed conceptual framework for these analyses recognizes the sensation seeking and cost/benefit mechanism as well as the health behavior mechanisms to explain the association between personality, other potential influential factors, and perceived mental fatigability (Figure 1). Sociodemographic variables such as age and race are likely to act as confounding variables because they are consistent factors that have large influences on our environment and experiences that explain our personalities and our ability to perceive mental fatigability. As previously explained through the health behaviors, sensation seeking and cost/benefit mechanisms, other variables have the potential to act as mediators between personality, which is relatively stable over time, and perceived mental fatigability.

1.7 Gaps in the Literature

Since it's validation in 2015 (Glynn et al.), significant work has been done assessing the factors associated with the perceived physical fatigability subscale of the PFS, but few studies have focused specifically on perceived mental fatigability. Mental fatigue has been studied in a variety of specific contexts, such as during driving tasks or after completion of cognitive tests, but mental fatigability as measured by the Pittsburgh Fatigability Scale provides information on perceived mental tiredness following a number of simple day-to-day tasks, standardized in intensity and duration, that are applicable to the general population and realistic among a cohort of older adults. Additionally, the use of fatigability, as opposed to global fatigue, is of particular importance in studies of older adults since these individuals are more likely to adjust their activity levels to avoid fatigue (Alexander et al., 2010), which is likely to impact the accuracy of the measurement.

Personality has been studied in older adults. However, despite the stability of personality and the prevalence of fatigue, few studies have looked specifically at the association of these trait-level differences and fatigue in this population. In the work that does address the association between personality and fatigue in groups other than older adults, very few covariates were included that may help to explain the mechanism in which the constructs are related and also contribute to the direction and strength of the association (Barlow et al., 2019; De Vries & Van Heck, 2002).

This study fills a gap in the literature by (1) adding to the body of work on perceived mental fatigability; (2) assessing how personality contributes to mechanisms that influence the highly prevalent condition; and (3) providing evidence for the amount of variation in perceived mental fatigability that may be explained by our individual-level differences.

1.8 Public Health Significance

Fatigue is a highly prevalent condition among older adults that may be indicative of more serious disease and is related to functional limitation and mortality. As the proportion of adults over the age of 65 is expected to rise to nearly a quarter of the U.S. population, work that may help to limit adverse health outcomes in this group is of particular importance. If clinicians and public health officials are able to recognize symptoms of fatigue early on, they may be able to intervene before worse aging outcomes develop.

Several personality traits have been found to be protective against fatigue. Others, such as low conscientiousness and low optimism are shown to be related to the same negative health outcomes and comorbidities as fatigue, such as depression and increased mortality. In this study, with thorough modeling and a wide variety of covariates, we were able to not only assess if personality was related to perceived mental fatigability, but also further unpack what factors explain this association and determine how the relationship exists. Further understanding into the mechanisms that lead to perceived mental fatigability will help clinicians design more targeted and effective interventions to lower fatigability, and consequently decrease the risk of several negative health outcomes.

2.0 Objectives

The objectives of this study were to examine (1) which covariates significantly contribute to the relationship between personality and perceived mental fatigability; and (2) determine the amount of variation in perceived mental fatigability that can be explained by personality independent of other significant covariates. We hypothesize that in older adults, individuals with higher scores on all four personality domains will have lower perceived mental fatigability. We also hypothesize, according to the literature, that conscientiousness and optimism will have a stronger association with perceived mental fatigability than either of the goal adjustment variables. Although the relationship between personality and perceived mental fatigability is likely to be explained largely through several mechanisms involving indirect relationships, we expect that at least a portion of the variation in perceived mental fatigability can be explained by personality alone.

3.0 Methods

3.1 MrOS Study Population

This study population is derived from The Osteoporotic Fractures in Men (MrOS) Study. MrOS is a multicenter prospective longitudinal cohort study designed to identify risk factors for osteoporosis as well as other age-related medical conditions in community dwelling, ambulatory men aged 65 years and older (Blank et al., 2005). Recruitment took place beginning in March 2000 from San Diego, CA; Palo Alto, CA; Pittsburgh, PA; Birmingham, AL; and Minneapolis, MN. MrOS aimed to include men who were able to walk without assistance, did not have bilateral hip replacements, were able to provide self-reported data and informed consent, lived near a clinical site throughout the duration of the study, and at the discretion of the investigator, did not have a medical condition that would results in imminent death.

A total of 5,994 men were enrolled at baseline. Minorities were recruited such that enrollment would reflect the demographic distribution of minorities at each site, and approximately 10.6% of the overall sample was made up of minority men. Overall, the sample was highly educated and of good health. At baseline, 86% of the MrOS population reported good or excellent health, only 3% were current smokers, and 53% had college, some graduate school, or had completed graduate school. Additional recruitment information (Blank et al., 2005) and baseline characteristics (Orwoll et al., 2005) are reported elsewhere.

This study is a cross sectional analysis of measures available from individuals who were willing and able to complete visit 4 of MrOS, which took place between May 2014 and May 2016.

3.2 Perceived Mental Fatigability

Perceived mental fatigability was measured with the validated 10-item Pittsburgh Fatigability Scale (PFS) (Renner et al., 2019). The PFS was self-administered and consisted of questions related to social, sedentary, lifestyle or light-intensity, and moderate to high-intensity activities. Participants rated their perceived physical and perceived mental fatigue for each activity on a 0-5 scale ranging from no fatigue to extreme fatigue, and also reported whether or not they had done the activity in the past month. Continuous summary scores were created independently for perceived physical and perceived mental fatigability ranging from 0-50 such that a higher score indicates greater fatigability. A PFS mental score $\geq$ 13 indicates higher perceived fatigability (Simonsick et al., 2018; Wasson et al., 2019). The PFS demonstrated strong internal consistency (Cronbach's alpha=0.88) and test-retest reliability (intraclass correlation=0.86) (Glynn et al., 2015). The PFS mental has a Cronbach's alpha=0.90 (Renner et al., 2019). For individuals with incomplete responses to the PFS, perceived mental fatigability scores were imputed based on the mean value of their valid responses and adjusted for the intensity of activity and differences in the level of fatigue reported by study participants who had completed the item in question and those who had not (Cooper et al., 2019).

3.3 Personality Measures

In MrOS, a five-page personality questionnaire measured optimism, conscientiousness, goal disengagement, and goal reengagement traits. Responses to each question were measured on a one to five scale ranging from strongly disagree to strongly agree. Summary scores were created for each of the four personality variables by summing the responses to trait-specific questions, some of which were in reverse order.

Optimism was measured with the Life Orientation Test-Revised (LOT-R), which maintains a Cronbach's alpha of 0.74 and test-retest reliability of 0.79 at 28 months (Scheier, Carver, & Bridges, 1994).

Conscientiousness was measured with the International Personality Item Pool (IPIP) scale and has a Cronbach's alpha of 0.78. The IPIP was validated against the revised NEO Personality inventory (NEO-PI-R). The conscientiousness subscales, including self-efficacy, orderliness, dutifulness, achievement-striving, self-discipline, and cautiousness, are all highly correlated with the NEO-PI-R conscientiousness subscales with corrected correlation coefficients ranging from 0.89 to 0.99 (Goldberg, 1999).

Goal disengagement and goal reengagement were both measured with the Goal Adjustment Scale. Disengagement is comprised of relinquishment of commitment and reduction of effort. Goal reengagement is made up of the ability to identify new goals, to commit to new goals, and to begin active pursuit of new goals, respectively, when unattainable goals were encountered. Goal disengagement has a Cronbach's alpha of 0.84 and goal reengagement has a Cronbach's alpha of 0.86 (Wrosch et al., 2003).

Summary scores are on a scale of 0-24 for optimism, 5-50 for conscientiousness, 4-20 for goal disengagement and 6-30 for goal reengagement. In these analyses, each personality variable was standardized such that mean=0 and standard deviation=1.0.

3.4 Demographic, Lifestyle and Health-related variables

Demographic variables included in these analyses were age, race (White, African American, Asian, other), education (high school or less, some college/college graduate, or some/all graduate school), and marital status (married, widowed/separated/divorced, or single/never married). We also included several psychological and behavioral variables such as whether or not the participants lived alone, smoking status (never, past, or current smokers), number of alcoholic drinks consumed per week (< 1 drink, 1-5 drinks, or 6-14 or more drinks), and self-rated health status (excellent/good, or poor/very poor/bad). Additionally, mental health was measured with the Teng Modified Mini-Mental State Exam (3MS) to assess cognitive abilities. The 3MS is a continuous measure ranging from 0 to 100 where a higher score indicates better cognitive function (Teng & Chui, 1987). The Geriatric Depression Scale, including 15 yes or no questions regarding mood in the past week, was used to measure clinically significant depression. On a scale of 0 to 15, a score ≥ 6 was used to define depression (Almeida & Almeida, 1999). Finally, global sleep quality was measured with the Pittsburgh Sleep Quality Index, which has been validated in a population of older adults, and a cut point of score >5 is used to indicate significant sleep disturbance (Buysse et al., 1991).

Participants also self-reported whether or not they currently have or have ever had hypertension, congestive heart failure, heart attack, diabetes, or stroke. Body mass index (BMI) was also recorded in kg/m^2. BMI was recorded as a continuous variable, however, a value <18.5 indicated underweight; 25.0 and 29.9 indicated overweight; and a value over 30.0 indicated obesity where obesity class increases as score increases ("Classification of Overweight and Obesity by BMI, Waist Circumference, and Associated Disease Risks,").

Physical health was measured with the instrumental activities of daily life difficulty rating where a score ≥2 on the Euro-Quality of Life-5 instrument (EQ-5D) was indicative of moderate to severe IADL difficulty (Johnson, Coons, Ergo, & Szava-Kovats, 1998). A continuous measure of the Physical Activity Scale for the Elderly (PASE) was used to assess physical activity as a weighted measure of 12 different types of activities of various intensities (Washburn, Smith, Jette, & Janney, 1993).

3.5 Statistical Analyses

Descriptive characteristics including frequency (for categorical variables) or mean ± standard deviation (for continuous variables) were reported overall, and by higher and lower perceived mental fatigability. We compared baseline characteristics between groups using t-test or nonparametric alternatives for continuous outcomes, and chi-squared tests for categorical variables. Pearson's correlations are reported for each pair of the continuous variables, including the continuous versions of IADL difficulty, clinically significant depression, and global sleep quality that are otherwise reported dichotomously by their respective cut points.

Multivariable linear regression models were used to determine the association between each personality variable and perceived mental fatigability, when controlling for significant covariates. Independent variables were divided into five classes: demographics, psychological and behavioral factors, comorbidities, physical activity and function, and personality. Although the number of alcoholic drinks consumed per drink was originally included in psychological and behavior factors, the variable was excluded from further analyses as 39% (n=715) of the data points were missing and was not found to be significantly associated with any of the personality variables.

Each model begun with one personality variable of interest and age. Age remained in all models, irrespective of significance, in order to account for differences in the relationship between personality and perceived mental fatigability across various ages. Covariates were entered into the model one class at a time. Only variables that were significant at alpha=0.05 remained in the model at the addition of the next class, and the final model for each personality variable contained only the independent variables significantly associated with perceived mental fatigability. We tested for the presence of multicollinearity between independent variables using variance inflation factors (VIF) and tested interactions terms between significant variables to determine if the effect of personality on perceived mental fatigability depended on any third variable in our models.

A final model was reported for the relationship between each significant personality variable, appropriate covariates, and perceived mental fatigability with corresponding coefficients (β), 95% confidence intervals, and adjusted r^2 values. All analyses were performed using SAS 9.4 and Stata 15.1 software.

4.0 Results

Of 5,994 men who were enrolled in MrOS at the baseline examination in 2000, 2,424 men were still enrolled by visit 4 of the study in 2014. Complete PFS questionnaires were available for 2,206 of these men. Incomplete questionnaires were available for an additional 12 men and imputations were completed so that fatigability data was available for a total 2,218 individuals. Of these participants, about 82% completed the personality questionnaire and were included in our final analytic sample (n=1812) (Figure 2).

Demographic, lifestyle, health, and personality information for the overall sample and stratified by perceived mental fatigability score can be found in Table 1. Overall, 25% (n=488) of the sample had mental fatigability score $\geq$ 13. The mean age of the analytical sample was approximately 84 years (SD=4.2), and 90.4% of participants were white.

Compared to those with lower perceived mental fatigability, individuals with higher perceived mental fatigability were significantly older; had poorer global sleep quality, higher BMI, higher frequencies of hypertension and stroke, poorer self-rated health status, a lower cognitive function score, more severe difficulty with IADLs, lower physical activity scores, and higher frequency of clinically significant depression (Table 1). Individuals with lower mean optimism, conscientiousness, and goal reengagement scores, and higher mean goal disengagement scores had significantly higher perceived mental fatigability (Table 1).

Correlations between continuous independent variables are found in Table 2. Conscientiousness (r=-0.20) and optimism (r=-0.20) had a modest but significant negative association with perceived mental fatigability, but neither of the goal adjustment variables were significantly associated. Covariates that were positively associated with higher perceived mental fatigability include age (r=0.16) , IADL difficulty (r=0.13), depression (r=0.36) and global sleep quality (r=0.23, p-value <0.0001 for all). Physical activity had a small, negative correlation (r=-0.25, p-value<0.0001) with higher perceived mental fatigability. A majority of these covariates, including lower physical activity, higher depression score, and higher global sleep quality score were also significantly related to lower conscientiousness, optimism, and goal reengagement. Our measure of cognitive function (3MS exam) was not significantly related to perceived mental fatigability, but a higher cognitive function score was significantly associated with higher conscientiousness (r=0.10), optimism (r=0.19), and goal reengagement (r=0.08). The only continuous independent variable associated with higher goal disengagement in this study was lower conscientiousness (r=-0.12, p<0.0001), but the association was weak.

In the linear regression analyses, goal disengagement was not significantly associated with perceived mental fatigability (β=0.20, p-value=0.33), and therefore, no additional classes of covariates were added into the model. Similarly, goal reengagement (GR) was significantly associated with perceived mental fatigability in a univariate model (GR β=-0.53, p-value=0.01), but the relationship was weakened after the addition of age (GR β=-0.41, p-value=0.04), and then fully attenuated when race, marital status, and education covariates were added to the model (GR β=-0.38, p-value=0.06).

Conscientiousness remained significantly associated with perceived mental fatigability even after the addition of all classes of covariates, and the beta coefficients and 95% confidence intervals for each covariate are available in Table 3. For model one, which included only conscientiousness and age, every one standard deviation higher conscientiousness score resulted in a 1.61 standard deviation lowered perceived mental fatigability score. None of the demographic variables in model 2, including race, marital status, and education had a significant effect on the relationship. Conversely, the psychological and behavioral covariates added in model 3 had the largest effect on the relationship between conscientiousness and perceived mental fatigability, such that the effect of conscientiousness on perceived mental fatigability decreased by 0.47 standard deviations after the addition of these traits. Depression had the largest effect on the relationship between conscientiousness and perceived mental fatigability, and on average, participants with clinically significant depression had a perceived mental fatigability score 6.74 points higher than those without clinical depression when controlling for conscientiousness, age, and all psychological and behavioral variables (Model 3, Table 3). In this class of variables, good/excellent self-rated health status had a significant negative relationship, and poor global sleep quality a had a significant positive relationship with perceived mental fatigability and also contributed to the attenuation of conscientiousness and perceived mental fatigability. In model 4, we observed a null effect of comorbidities including hypertension, hearth failure, stroke, heart attack, diabetes and BMI on the association of interest. Of physical activity and function variables, only PASE score significantly contributed to the effect of lower conscientiousness on higher perceived mental fatigability (Model 5, Table 3). In model six, lower optimism and goal reengagement were significantly associated with higher perceived mental fatigability, and further contributed to the attenuation of the relationship between lower conscientiousness and higher perceived mental fatigability. In the final model, conscientiousness remained significantly associated ($p<0.01$) with perceived mental fatigability after controlling for statistically significant covariates (age, self-rated health status, depression, global sleep quality, physical activity score, optimism, and goal reengagement), but the effect size decreased from -1.61 in model one, to -0.93 by the final model (Table 5). Depression, self-rated health status, and global sleep quality had the largest effect on the attenuation.

The relationship between lower optimism and higher perceived mental fatigability was nearly identical to that of lower conscientiousness and higher perceived mental fatigability. In model one, every one standard deviation higher optimism score resulted in a 1.57 standard deviation lower perceived mental fatigability score when controlling for age. In models 2-6, the same covariates significantly attenuated the relationship between optimism and perceived mental fatigability that also attenuated the relationship between conscientiousness and perceived mental fatigability with depression (β=6.58), sleep disturbance (β=2.21), and good/excellent self-rated health status (β=-2.71) having the largest effects on the relationship. By the final model, lower optimism remained significantly associated with higher perceived mental fatigability after controlling for age, self-rated health status, depression, global sleep quality, physical activity score, conscientiousness and goal reengagement ($p<0.001$, Table 5). As the final optimism and conscientiousness models contained the same variables, the fits of the models were identical (adjusted $r^2 = 0.16$). Finally, no interactions were observed between any of the four personality of interest and significant covariates in the mental fatigability models. There were also no issues with collinearity in this sample.

5.0 Discussion

As hypothesized, lower conscientiousness and lower optimism were the personality variables that demonstrated the most robust relationship with higher perceived mental fatigability. Goal disengagement was not significantly correlated with perceived mental fatigability. The results also demonstrated that while lower goal reengagement was significantly associated with higher perceived mental fatigability in the univariate model, and when controlling for age, the addition of the marital status, race, and education fully attenuated the relationship. Outside of age, none of the demographic variables were significant (p-values>0.05). However, it appeared that of these variables, race had the largest effect (β=0.32) on the relationship, although race was relatively homogenous in this sample (90.4% white).

Interestingly, the relationships between lower conscientiousness and higher perceived mental fatigability, and lower optimism and higher perceived mental fatigability were nearly identical. The covariates that significantly contributed to each association were the same, and consequently, the amount of variation in perceived mental fatigability that could be explained by the independent variables in the models was also identical (adjusted r^2=0.16). Despite the similarities in the relationships, it is of note that each trait was independently related to the outcome such that lower conscientiousness was still significantly associated with higher perceived mental fatigability when controlling for optimism, and vice versa. In the correlation analyses, conscientiousness and optimism were correlated to the same degree with perceived mental fatigability (r=-0.20 for both). A similar association between personality and fatigue was seen in the literature where, in a sample of working adults from the Netherlands, the correlation between fatigue and conscientiousness ranged from -0.1 to -0.26 depending on the measure of fatigue (De

Vries & Van Heck, 2002). However, to our knowledge, there have not been any studies on the relationship between conscientiousness, or any other personality trait measured in the study and perceived mental fatigability when controlling for other related factors.

In the final models, clinically significant depression, poor global sleep quality, and poor self-rated health status had the largest effect on higher perceived mental fatigability of all independent variables, including personality. The effect sizes of the dichotomous depression, global sleep quality (sleep disturbance), and self-rated health status variables were 5.72, 2.02, and -2.02, respectively (Table 5). These psychological and behavioral variables also had the largest impact on the relationship between lower conscientiousness and higher perceived mental fatigability and lower optimism and higher perceived mental fatigability as the largest attenuation in the value of the personality beta coefficients was observed after the addition of these variables. However, these three variables appeared to have a slightly larger effect on the relationship between optimism and perceived mental fatigability. The optimism beta coefficient decreased by approximately 48% after the addition of depression, self-rated health status, and global sleep quality, as compared to a 29% decrease in the conscientiousness beta coefficient after the addition of the same variables.

The significance of depression in regression analyses is in line with the correlations between continuous variables observed in Table 2. Of all Pearson correlation coefficients recorded in this analysis, the strongest correlations were for the depression (continuous version of the variable) and optimism (r=-0.43), followed by depression and perceived mental fatigability (r=0.36), and depression and conscientiousness (r=-0.26). As depression score increases, mental fatigability score increases, and conscientiousness and optimism scores decrease. Given the effect of covariates, such as depression on the relationships between personality and perceived mental fatigability in these analyses, any association between personality and fatigue observed without the measurement of covariates may simply be a reflection of these outside influences. The relationship between personality and depression, and fatigue and depression, had previously been observed in the literature (Duberstein et al., 2003; Eldadah, 2010; Smagula et al., 2016), and the relationship fits well into the motivation mechanism. Individuals who are low on conscientiousness and optimism may already have an improperly balanced cost/reward system. When a situation that requires high energy cost but low perceived benefit persists, stress increases, and physiologically, cortisol increases and dopamine decreases (Boksem & Tops, 2008), which may lead to symptoms of depression. When depression persists, the perceived amount of energy necessary to perform tasks is inflated, and therefore, perceived mental fatigue increases as well.

The relationship between personality, perceived mental fatigability and the other influential covariates, global sleep quality and self-rated health status, also had associations previously demonstrated in the literature (Engberg et al., 2017; Smagula et al., 2016). Since both health-status and global sleep quality are measures of an individual's perception, it is logical that they would be related to perceived mental fatigability. An individual who is optimistic is likely to believe their sleep is better, or their health status is better than it may actually be, and individuals who feel well rested and believe to be of good health are likely to have a lower perceived mental fatigability. Similar effects of optimism on other health outcomes were observed in Smagula et al. (2016). After adjustment for relevant health-related characteristics, the odds of being in a lower physical activity (PASE) quartile decreased by 5% for every standard deviation increase in optimism score, and a standard deviation increase in optimism score decreased the odds of being in a lower SF-12 mental health quartile by 53%. Conscientious individuals, who are likely to maintain healthier lifestyles, would be at lower risk for poor sleep quality, and would likely have a higher self-rated health status, therefore decreasing their risk for higher perceived mental fatigability.

Independent of these psychological and behavioral variables, age, physical activity score, and other personality variables that had significant but smaller effects, conscientiousness and optimism each remained significantly associated with higher perceived mental fatigability. Although the effect was small - conscientiousness lowered by 0.93 standard deviations for every 1-point higher perceived mental fatigability score, and optimism lowered by 0.61 standard deviations for every 1-point higher perceived mental fatigability score, the association did hold true even when controlling for a variety of potentially related variables.

Although this analysis was cross sectional, in order to hypothesize that personality traits influence higher perceived mental fatigability scores (as opposed to perceived fatigability scores influencing personality), we made the assumption that personality factors are stable characteristics that remain constant over time. In another analysis of personality in older adults, measurements of conscientiousness across two time points were highly correlated (r=0.67) (Andersen et al., 2012). Additionally, several studies on optimism have produced test-retest correlations ranging from .58 to .79 (Carver, Scheier, & Segerstrom, 2010). It is possible that persistent higher perceived fatigability might influence mood such that, for example, one might appear less optimistic, but the evidence suggests that one's core personality traits remain constant over time. Future studies should use longitudinal analyses to confirm the temporality of the association between personality, potential cofounders, and perceived mental fatigability. Future endeavors should also consider the impact of personality constructs outside the scope of theses analyses on perceived mental fatigability, such as neuroticism, locus of control, or extraversion, which was shown to have a large impact on fatigue through sensation seeking behaviors (Thiffault & Bergeron, 2003).

Apart from the cross-sectional design, an additional limitation to this study is that nearly all dependent and independent variables in this analysis were obtained through self-reported responses to questionnaires, increasing the chances of self-report bias. Additionally, anxiety is an independent variable not measured in these analyses that is likely to be related to personality and perceived mental fatigability because of its comorbid relationship with depression. In Craig et al. (2006) anxiety alone contributed to 7.8% of the variation in the Chalder fatigue outcome. An anxiety measure was not available for our time point of interest in the MrOS study, but future studies of personality and fatigability should include this variable.

Further, there is a clear issue with generalizability in this sample. The MrOS cohort was of particular good health (93.2% self-reported good or excellent health) and highly educated (38.7% attended college, and 43.8% attended graduate school) compared to other cohorts of older adults. The proportion of higher perceived mental fatigability (25%) observed in this sample of 1812 men from MrOS is similar to that observed in other large studies with similarly healthy and educated older adults. In a sample of 579 men and women participating in the Baltimore Longitudinal Study of Aging (BLSA), 23% (n=131) had perceived mental fatigability scores ≥ 13 (Simonsick et al., 2018). Likewise, in a study of 2,342 older adults in the Long Life Family Study (LLFS), the prevalence of higher perceived mental fatigability was approximately 25% overall, and 41.8% in the 80-89 age group that captures the mean age of this MrOS analysis (Meinhardt et al., 2019). However, caution should be taken when comparing the results of these analyses to other older populations that may have different characteristics. The prevalence of higher perceived mental fatigability is likely to be higher in samples that have less education and poorer health.

Additionally, this sample was over 90% white, and all 1,812 individuals were men. Engberg et al. (2017) stated that women are more likely to experience fatigue, including mental fatigue, than men. Minority men and women are also likely to have different personality traits related to cultural differences, different behavioral factors, and a higher prevalence of several of the comorbid disorders assessed in this study, such as diabetes. Future studies should be conducted to replicate this work in samples that include all gender identities and are more representative of minority populations so that differences among groups can be observed, and in these higher fatigue populations, a larger effect size for personality may be detected.

An important strength of this study is the large sample size that provided sufficient power to address numerous gaps in the literature. This study added to the personality and aging literature by conducting analyses of both robust and well-known personality traits, and newer and lesser known traits in a large sample of older adults across the United States. Additionally, there is limited availability of literature on personality and fatigue in any population. This study used a strong, validated measure of perceived mental tiredness with the Pittsburgh Fatigability Scale, which controls for self-pacing and is able to be administered in a variety of settings with a self-report questionnaire as opposed to a performance-based examination. Further, this study demonstrated key factors that influence the relationship of interest, and although the majority of covariates were not significant, these analyses had the opportunity to control for a large number of variables thought to be related to personality and perceived mental fatigability.

In conclusion, the strength of the relationship between personality, particularly lower conscientiousness and optimism, and higher perceived mental fatigability in these analyses warrants further investigation into how personality traits may help clinicians design more targeted and effective interventions to reduce fatigability, and consequently lower the risk of several adverse aging-related health outcomes. Since clinically significant depression, self-rated health status, and global sleep quality all significantly influenced the relationship between personality and higher perceived mental fatigability, future studies may also assess how interventions based on these factors can lower the prevalence of fatigue as well. For example, if individuals low in conscientiousness also have poorer sleep quality and higher perceived mental fatigability, clinicians may focus on improving sleep to improve fatigability outcomes in this population. Future studies of perceived mental fatigability should be longitudinal in nature and include personality assessments to confirm the relationships observed in these analyses.

Appendix Tables and Figures

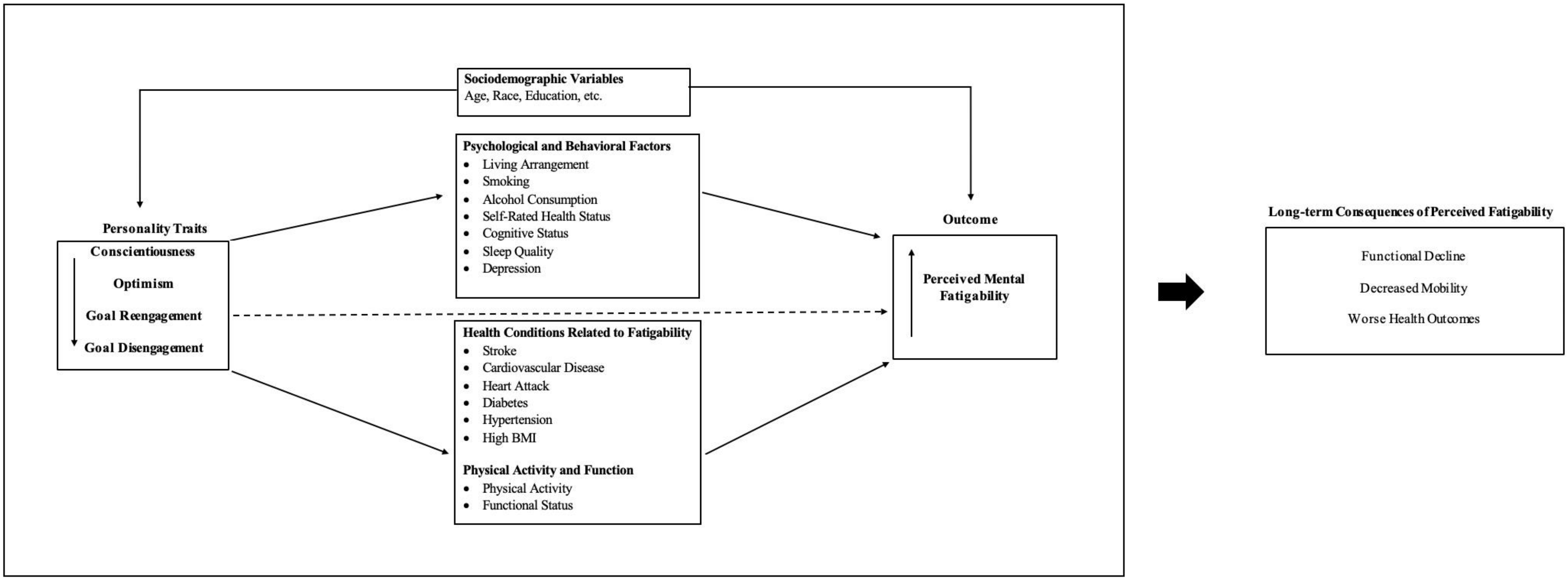

Figure 1. Conceptual model for the relationship between personality and perceived mental fatigability

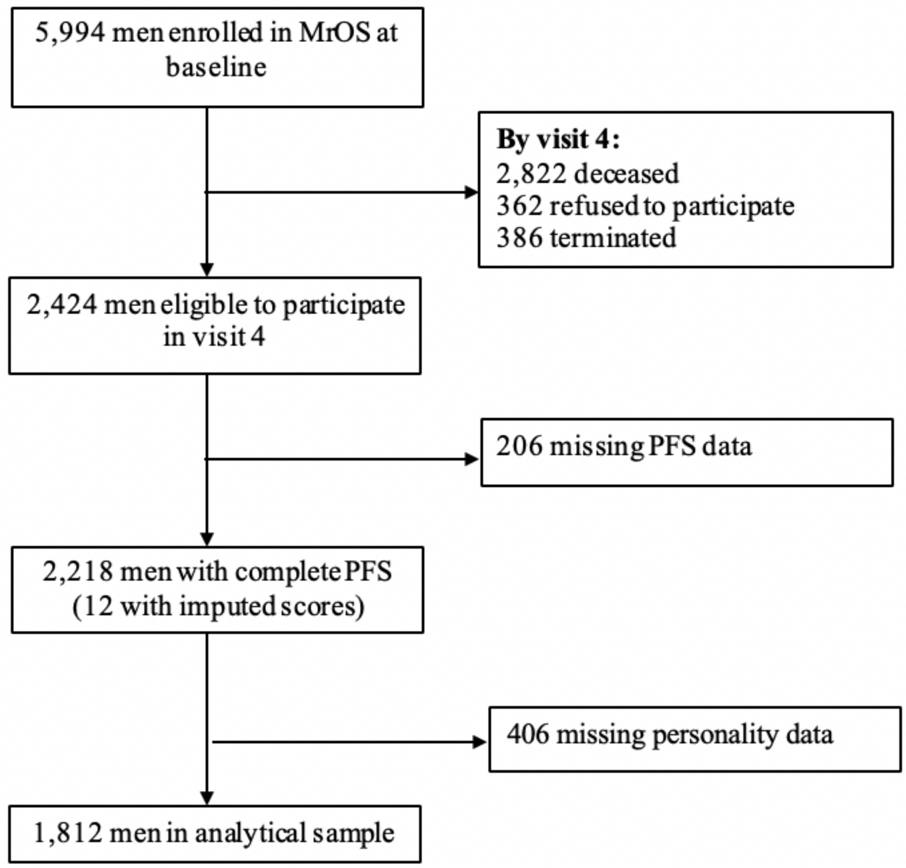

Figure 2. Analytic sample flow chart for MrOS visit 4

Table 1. Baseline characteristics overall and stratified by perceived mental fatigability status: MrOS

Characteristics	Perceived Mental Fatigability Status			
	Overall N=1812	High (≥13) N=448	Low (<13) N=1364	P-value
Demographics				
Age (years)	84.4 ± 4.2*	85.2 ± 4.6	84.2 ± 4.1	**<0.0001**
Race				0.40
White	90.4 [1638]	90.2 [404]	90.5 [1234]	
African American	2.8 [51]	3.4 [15]	2.6 [36]	
Asian	3.6 [66]	2.7 [12]	4.0 [54]	
Other	3.2 [57]	3.8 [17]	2.9 [40]	
Education				0.88
High School or less	17.4 [316]	17.2 [77]	17.5 [239]	
Some/all college	38.7 [702]	39.7 [178]	38.4 [524]	
Some/all Graduate School	43.8 [794]	43.1 [193]	44.1 [601]	
Marital status				0.50
Married	86.3 [1563]	85.3[382]	86.6 [1181]	
Widowed	4.7 [85]	4.2 [19]	4.8 [66]	
Separated/Divorced	6.3 [11]	7.4 [33]	5.9 [81]	
Single, never married	2.8 [50]	3.1 [14]	2.6 [36]	
Psychological and Behavioral Factors				
Currently living alone				0.77
No	75.6 [1370]	76.1 [341]	75.4 [1029]	
Yes	24.4 [442]	23.9 [107]	24.6 [335]	
Smoking status				0.07
Never	42.9 [777]	38.9 [174]	44.2 [603]	
Past	54.5 [987]	57.5 [257]	53.5 [730]	
Current	2.6 [47]	3.6 [16]	2.3 [31]	
Alcohol consumption per week				0.12
< 1 drink	19.1 [209]	23.2 [59]	17.8 [150]	
1-5 drinks	43.8 [480]	43.3 [110]	43.9 [379]	
6-14+ drinks	37.2 [408]	33.5 [85]	38.3 [323]	
Self-rated health status				**<0.0001**
Good/Excellent	93.2 [1688]	88.4 [396]	94.7 [1292]	
Poor/Very Poor/Fair	6.8 [124]	11.6 [52]	5.3 [72]	

Table 1. continued				
Cognitive function (3MS Scale: 0-100)	95.2 ± 4.1	95.0 ± 4.0	95.2 ± 4.1	**<0.0001**
Global sleep quality				**<0.0001**
No sleep disturbance (≤5)	41.6 [753]	44.0 [197]	63.2 [862]	
Sleep disturbance (>5)	58.4 [1059]	56.0 [251]	36.8 [502]	
Depression				**<0.0001**
No depression (<6)	92.9 [1683]	82.3 [368]	96.4 [1315]	
Clinical Depression (≥6)	7.1 [128]	17.7 [79]	3.6 [49]	
Comorbidities				
BMI (kg/m^2)	27.3 ± 3.5	27.5 ± 3.6	27.3 ± 3.5	**<0.0001**
Comorbidities (ever)				
Hypertension	33.9 [614]	40.4 [181]	31.7 [433]	**0.0008**
Congestive Heart Failure	2.4 [43]	2.37[12]	2.3 [31]	0.62
Diabetes	6.8 [124]	8.3 [37]	6.4 [87]	0.17
Heart Attack	8.3 [150]	9.8 [44]	7.8 [106]	0.17
Stroke	2.7 [48]	4.7 [21]	2.0 [27]	**<0.01**
Physical Activity and Function				
IADL difficulty				**0.02**
No difficulty (<2)	96.1 [1741]	94.2 [422]	96.7 [1319]	
Severe difficulty (≥2)	3.9 [71]	5.8 [26]	3.3 [45]	
Physical activity (PASE Scale: 0-431.8)	114.4 ± 66.3	90.1 ± 63.6	122.3 ± 65.3	**<0.0001**
Personality[1]				
Optimism (Scale: 5-30)	22.4 ± 3.2	21.6 ± 3.3	22.7 ± 3.2	**<0.0001**
Conscientiousness (Scale: 5-50)	38.0 ± 5.5	36.6 ± 5.8	38.4 ± 5.4	**<0.0001**
Goal Reengagement (Scale: 6-30)	21.2 ± 3.5	21.0 ± 3.5	21.2 ± 3.5	**<0.0001**
Goal Disengagement (Scale: 4-20)	11.5 ± 2.7	11.5 ± 2.7	11.5 ± 2.6	**<0.0001**

*Mean ± SD or % [N]
[1]Higher score = better

Table 2. Correlations between continuous variables in MrOS sample (n=1812)

	1	2	3	4	5	6	7	8	9	10	11	12
1. Mental Fatigability												
2. Conscientiousness	-0.20**											
3. Optimism	-0.20**	0.32**										
4. Goal Reengagement	-0.06	0.20**	0.31**									
5. Goal Disengagement	0.02	-0.12**	-0.06	-0.00								
6. Age (years)	0.16**	-0.07	-0.11**	-0.10**	0.01							
7. BMI[1]	0.03	-0.09*	-0.03	-0.02	0.03	-0.11**						
8. Cognitive Function	-0.04	0.10**	0.19**	0.08*	-0.01	-0.12**	-0.04					
9. Physical Activity	-0.25**	0.13**	0.11**	0.14**	-0.07	-0.31**	-0.10**	0.03				
10. IADL Difficulty[1]	0.13**	-0.08*	-0.07	-0.02	0.00	0.04	0.15**	-0.11**	-0.14**			
11. Depression	0.36**	-0.26**	-0.43**	-0.23**	0.02	0.18**	0.09**	-0.10**	-0.33**	0.18**		
12. Global Sleep Quality	0.23**	-0.13**	-0.20 **	-0.07*	0.00	0.05	0.09**	-0.01	-0.11**	0.10**	0.33**	

*p<0.001

**p<0.0001

[1]BMI: body mass index, IADL: instrumental activities of daily living

Table 3. Linear regression model examining the association between conscientiousness and perceived mental fatigability: MrOS (n=1812)

	Model One	Model Two	Model Three	Model Four	Model Five	Model Six
Conscientiousness	-1.61 (-1.99 – -1.23)*	-1.60 (-1.98 – -1.21)*	-1.14 (-1.52 – -0.76)*	-1.12 (-1.50 – -0.74)*	-1.01 (-1.39 – -0.64)*	-0.94 (-1.32 – -0.55)*
Age	0.31 (0.23 – 0.40)*	0.31 (0.22 – 0. 41)*	0.29 (0.20 – 0.38)*	0.27 (0.19 – 0.36)*	0.20 (0.11 – 0.29)*	0.19 (0.10 – 0.28)*
Race		0.23 (-0.36 – 0.83)	-	-	-	-
Marital Status		0.18 (-0.23 – 0.58)	-	-	-	-
Education		-0.01 (-0.54 – 0.51)	-	-	-	-
Living Alone			-0.44 (-1.31 – 0.38)	-	-	-
Smoking			0.21 (-0.48 – 0.89)	-	-	-
Cognitive Function			0.01 (-0.08 – 0.10)	-	-	-
Good/Excellent health status			-2.59 (-4.07 – -1.11)*	-2.37 (-3.89 – -0.86)*	-1.98 (-3.46 – -0.51)*	-2.02 (-3.48 – -0.56)*
Clinical Depression			6.74 (5.24 – 8.23)*	6.71 (5.21 – 8.20)*	6.13 (4.66 – 7.61)*	5.72 (4.20 – 7.24)*
Sleep Disturbance			2.26 (1.50 – 3.02)*	2.19 (1.42 – 2.96)*	2.12 (1.37 – 2.87)*	2.02 (1.26 – 2.77)*
Hypertension				0.71 (-0.10 – 1.51)	-	-
Heart Failure				0.11 (-1.25 – 1.47)	-	-
Stroke				1.50 (-0.81 – 3.81)	-	-
Heart Attack				-0.41 (-2.84 – 2.03)	-	-
Diabetes				0.31 (-1.18 – 1.80)	-	-
BMI[1]				0.00 (-0.12 – 0.11)	-	-
IADL Difficulty					1.09 (-0.81 – 2.99)	-
Physical Activity					-0.02 (-0.03 – -0.02)*	-0.02 (-0.03 – -0.02)*
Optimism						-0.62 (-1.03 – -0.20)*
Goal Reengagement						0.40 (0.02 – 0.79)*
Goal Disengagement						-0.08 (-0.45 – 0.29)
Adjusted R^2	0.06	0.06	0.13	0.13	0.16	0.16

β coefficient (95% confidence interval)

*significant at alpha=0.05

[1]BMI= body mass index, IADL= instrumental activities of daily living

Table 4. Linear regression model examining the association between optimism and perceived mental fatigability: MrOS (n=1812)

	Model One	Model Two	Model Three	Model Four	Model Five	Model Six
Optimism	-1.57 (-1.96 - -1.18)*	-1.59 (-1.99 – -1.19)*	-0.82 (-1.22 – 0.42)*	-0.80 (-1.19 – -0.41)*	-0.75 (-1.14 – -0.36)*	-0.62 (-1.03 – -0.20)*
Age	0.30 (0.20 – 0.39)*	0.30 (0.21 – 0.39)*	0.29 (0.20 – 0.38)*	0.27 (0.18 – 0.36)*	0.19 (0.10 – 0.28)*	0.19 (0.10 – 0.28)*
Race		0.14 (-0.46 – 0.74)	-	-	-	-
Marital Status		0.19 (-0.22 – 0.59)	-	-	-	-
Education		0.22 (-0.32 – 0.75)	-	-	-	-
Living Alone			-0.36 (-1.24 – 0.52)	-	-	-
Smoking			0.24 (-0.45 – 0.93)	-	-	-
Cognitive Function			0.02 (-0.07 – 0.11)	-	-	-
Good/Excellent health status			-2.71 (-4.20 – -1.22)*	-2.43 (-3.95 – -0.91)*	-2.05 (-3.54 – -0.57)*	-2.02 (-3.48 – -0.56)*
Clinical Depression			6.58 (5.04 – 8.11)*	6.55 (5.01 – 8.09)*	5.94 (4.42 – 7.46)*	5.72 (4.20 – 7.24)*
Sleep Disturbance			2.21 (1.44 – 2.97)*	2.13 (1.36 – 2.91)*	2.06 (1.30 – 2.81)*	2.02 (1.26 – 2.77)*
Hypertension				0.66 (-0.14 –1.47)	-	-
Heart Failure				-0.51 (-2.95 – 1.94)	-	-
Stroke				1.58 (-0.74 – 3.91)	-	-
Heart Attack				0.17 (-1.20 – 1.54)	-	-
Diabetes				0.47 (-1.03 – 1.97)	-	-
BMI[1]				0.02 (-0.08 – 0.13)	-	-
IADL Difficulty[1]					1.18 (-0.72 – 3.08)	-
Physical Activity					-0.02 (-0.03 – -0.02)*	-0.02 (-0.03 – -0.02)*
Conscientiousness						-0.94 (-1.32 – -0.55)*
Goal Reengagement						0.40 (0.02 – 0.79)*
Goal Disengagement						-0.08 (-0.45 – 0.29)
Adjusted R^2	0.06	0.06	0.12	0.12	0.15	0.16

β coefficient (95% confidence interval)
*significant at alpha=0.05
[1]BMI = body mass index, IADL = instrumental activities of daily living

Table 5. Final linear regression models for personality variables significantly associated with perceived mental fatigabilty in MrOS sample

	Conscientiousness Model	P-value		Optimism Model	P-value
Personality Variable of Interest	-0.93 (-1.31 - -0.54)	<0.01	Personality Variable of Interest	-0.61 (-1.02 – 0.20)	<0.01
Age	0.19 (0.10 – 0.28)	<0.01	Age	0.19 (0.10 – 0.28)	<0.01
Self-rated Health Status	-2.02 (-3.49 - -0.56)	<0.01	Self-rated Health Status	-2.02 (-3.49 - -0.56)	<0.01
Depression	5.72 (4.21 – 7.24)	<0.01	Depression	5.72 (4.21 – 7.24)	<0.01
Global Sleep Quality	2.02 (1.27 – 2.78)	<0.01	Global Sleep Quality	2.02 (1.27 – 2.78)	<0.01
Physical Activity	-0.02 (-0.03 - -0.02)	<0.01	Physical Activity	-0.02 (-0.03 - -0.02)	<0.01
Optimism	-0.61 (-1.02 - -0.20)	<0.01	Conscientiousness	-0.93 (-1.31 – 0.54)	<0.01
Goal Reengagement	0.40 (0.01 – 0.78)	0.04	Goal Reengagement	0.40 (0.01 – 0.79)	0.04
Adjusted r^2	0.16	P<0.001	Adjusted r^2	0.16	P<0.001

β coefficient (95% confidence interval)

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