THE IMPACT OF HEALTH STATUS ON THE EVERYDAY PROBLEM SOLVING OF OLDER ADULTS

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In the Department of Psychology

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ABSTRACT

Cognitive decline in older adults has implications for the ability to function in daily life. Thus, there has been increasing interest in measures of everyday problem solving (EPS), which require traditional cognitive abilities as well as the appropriate application of these abilities to solving problems relevant to naturalistic, everyday situations. We examined the differential contribution of general illness burden and two subsets (non-vascular, and vascular illness burden) as well as two aspects of self-rated health (SRH; mental and physical) to individual differences in EPS performance in a sample of 102 community-dwelling older adults. Illness burden was conceptualized as the total number of each type of illness, and SRH was assessed with two scales from the Short Form 36 (SF-36). The vascular, but not non-vascular, subset of general illness burden was associated with poorer EPS performance; however, this relationship was largely accounted for by demographic variables (i.e., age, education, and gender). Lower self-rated physical functioning (SRPF), but not self-rated mental health (SRMH) predicted poorer EPS performance after demographic variables were taken into consideration. Self-rated physical functioning may be of particular importance as a predictor of EPS performance in the expanding older adult population in North America.

Keywords: aging; health; everyday problem solving; chronic illness; self-rated health
To my parents, whose love and support have given me the confidence to pursue my goals

To Matthew for his patience and unwavering faith in my abilities

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INTRODUCTION

Cognitive aging is becoming an increasingly important area of research as the average lifespan increases. Findings indicate reliable declines in cognitive functioning associated with increasing age (Salthouse, Pink, & Tucker-Drob, 2008), which has implications for the ability to function in daily life (Njegovan, Man-Son-Hing, Mitchell, & Molnar, 2001). Thus, there has been increased interest in measures of everyday problem solving (EPS), which require traditional cognitive abilities as well as the appropriate application of these abilities to solving problems relevant to naturalistic, everyday situations (Allaire & Marsiske, 1999; McCue, Rogers, & Goldstein, 1990). Measures of EPS have a demonstrated association with real world outcomes relevant to older adults, such as functional independence, quality of life, and mortality (Allaire & Marsiske, 2002; Gelb, Shapiro, & Thornton, in press; Gilhooly, et al., 2007; Weatherbee & Allaire, 2008). Additionally, measures of EPS predict real world functioning beyond traditional measures of cognition (Allaire & Marsiske, 2002; Thornton, Kristinsson, DeFreitas, & Thornton, 2010).

Tests of EPS are valuable cognitive outcome measures in adult populations, leading researchers to examine factors underlying individual differences in EPS ability in adults. Poor health status has emerged as one factor that negatively impacts EPS ability. There are two general ways of describing health status. Diagnoses (e.g., hypertension and arthritis) are common objective
indicators, and individuals' own evaluation of their health is a subjective indicator. Objective measures of health have been shown to predict declines in EPS. The total number of medical diagnoses (i.e., illness burden; Whitfield, Wiggins, & Allaire, 2004), as well as specific illnesses, (Thornton, Deria, Gelb, Shapiro, & Hill, 2007) have been seen to predict declines in EPS performance. However, what is unknown is whether certain types of illness burden have a differential impact on EPS. Additionally, subjective, or self-rated health (SRH) predicts variance in EPS (Whitfield, et al., 2004). However, global ratings of health, such as the ones used in the study by Whitfield and colleagues, have not allowed specific aspects of SRH (e.g., self-rated physical and mental health) to be studied separately in relation to EPS. Thus, questions remain regarding the relationship between objective health status, subjective health status, and EPS ability. For example, it may be that EPS performance is particularly vulnerable to a specific type of illness burden, or that physical and mental aspects of SRH are differentially related to EPS performance. It is within this context that we investigate the contributions of two different subsets of general illness burden, non-vascular and vascular, as well as specific aspects of SRH, physical and mental, in predicting individual differences in EPS.

**EPS and Age**

There are two lines of evidence regarding the effect of age on EPS. Some researchers have suggested that in order to solve everyday problems, older adults rely on experience and accumulated knowledge (crystallized intelligence) that is more robust to aging effects (Baltes, 1993). Supporting evidence has
shown that EPS is preserved or even improves in older age (Cornelius & Caspi, 1987). However, others have found a reduction in EPS ability in older adults (see Allaire & Marsiske, 1999 for review), and propose that tests of EPS rely on cognitive abilities that have been shown to decline with age, such as memory, fluency, processing speed, and executive functioning (Salthouse et al., 2008).

Results of a meta-analysis provide partial support for both theories (Thornton & Dumke, 2005). The authors reported that there was no reliable difference in the EPS performance of young and middle aged participants. Thus, for middle-aged participants completing EPS tasks, accumulated experience and knowledge may offset declines in cognitive abilities that are susceptible to aging. However, the EPS performance of older adults was seen to be significantly lower than that of both younger and middle aged adults, suggesting that for older adults, the benefits of experience and knowledge may no longer be sufficient to compensate for further declines of these cognitive abilities (Thornton & Dumke, 2005). The two lines of evidence appear not to be mutually exclusive in that both crystallized intelligence and cognitive abilities such as memory, fluency, processing speed, and executive functioning may be advantageous for successfully completing tests of EPS.

**Illness Burden**

Many older adults do not present with just one illness, but rather with multiple illnesses. In a review of the literature on multiple chronic (i.e., long lasting or recurrent) illnesses, Vogeli and colleagues (2007) found that approximately one in five Americans have multiple chronic conditions, and the
chances of having multiple chronic illnesses increase with age so that 62% of Americans over the age of 65 present with comorbid chronic illnesses (Vogeli, et al. 2007). According to the Center for Disease Control and Prevention (CDCP; 2003), at least 80% of adults aged 60 and over have been diagnosed with one chronic illness, and 50% have two chronic illnesses. Further, the presence of one chronic illness has been shown to increase the risk of developing other related illnesses (Vogeli, et al., 2007).

Research has revealed a steeper decline in cognition in individuals presenting with more than one illness (Elias et al., 1997; Hassing, et al., 2004). Specifically, one study examined 258 non-demented individuals with a diagnosis of a) hypertension, b) diabetes, c) both, or d) neither, and measured their cognitive functioning four times at two-year intervals (Hassing, et al.). They found that all groups showed cognitive decline, but individuals with both comorbid hypertension and diabetes showed the greatest decline in scores on the Mini Mental Status Examination (MMSE), suggesting that the conditions interact to cause greater impairment than that caused by either illness on its own. Elias and colleagues (1997) looked at a sub-sample of the Framingham Study (Wolf, Dawberm, Thomas, & Kannel, 1978) to examine the interaction of non-insulin-dependent diabetes mellitus (NIDDM) and hypertension in relation to cognitive functioning. Using a comprehensive neuropsychological battery, they found that although both diseases were independent predictors of cognitive decline, participants with hypertension as well as NIDDM had an even greater risk of decline, particularly on tasks of memory and visual organization.
Prior research has also demonstrated an association between higher illness burden and poorer EPS performance. A study by Whitfield and colleagues (2004) revealed that illness burden explained unique variance in EPS performance in a sample of 209 community-dwelling African American adults ranging in age from 47 to 91 years. In the study, illness burden was conceptualized as the total number of self-reported doctor’s diagnoses of the following five systemic chronic illnesses: cardiovascular disease, hypertension, diabetes, arthritis, and stroke. Results indicated that higher illness burden is a unique and significant predictor of EPS performance, even after age, education, and gender are considered.

Questions remain regarding the mechanisms underlying the relationship between illness burden and EPS performance. In previous research, illness burden was conceptualized as a unitary construct (Whitfield, et al., 2004). The inclusion of various types of illnesses (i.e., arthritis and hypertension) in a single variable has not allowed for determination as to whether EPS performance is particularly vulnerable to a specific type of illness comorbidity, or whether the demonstrated relationship is due to general factors (e.g., the overall negative impact of multiple illnesses on individuals’ wellbeing; Miller, et al., 1992).

With regard to specific types of chronic illness, a distinction can be drawn between illnesses whose primary disease mechanism directly involves the vascular system (vascular illnesses, e.g. hypertension and diabetes; Cohen et al., 2009; Creager, Lüscher, Cosentino, & Beckman, 2003; Lüscher, Creager, Beckman, & Cosentino, 2003; Rosendorff, 2002; Triantafyllidi, et al., 2009), and
those whose primary disease mechanism does not directly involve the vascular system (non-vascular illnesses, e.g. arthritis and osteoporosis; Delles, 2007; Dey, Michalkiewicz, Huffman, & Hedge, 1993; Findlay, 2007; Gupta, & Aronow, 2006; Müller, Tsakiris, Roth, Guglielmetti, Staub, & Marbet, 2001). Research has shown that the presence of vascular illness increases the risk for cerebrovascular disease in the frontal lobes (O’Brien, et al., 2003; Raz & Rodrigue, 2006). Cerebrovascular disease arises as result of reduced cerebral blood flow producing changes in cerebral microvasculature, and is associated with increased white matter hyperintensities (WMH; Novak, et al., 2006; O’Brien, et al., 2003).

Evidence from MRI studies links WMH, particularly in the frontal lobes, with declines in cognitive functioning (Gunning-Dixon & Raz, 2000; van Harten, et al., 2007). Cognitive abilities such as memory, fluency, executive functioning, abstract reasoning, and processing speed are mediated by the frontal lobes, and have been seen to be negatively impacted by vascular illness (Brady, Spiro, & McGlinchey-Berroth, 2001; Elias, et al., 2004; Elias, et al., 1997; Hassing, et al., 2004; Patrick, Gaskovski, & Rexroth, 2002; Pugh, Kiely, Milberg, & Lipsitz, 2003). The relationship between vascular illnesses and cognitive decline has been demonstrated longitudinally (Elias, et al., 2004; Hassing, et al., 2004; Seshadri, Wolf, Beiser, Elias, et al., 2004), and persists even when the illness is controlled by medication (Elias, et al., 1997; Hassing, et al., 2004; Raz, Rodrigue, & Acker, 2003; Saxby, Harrington, Wesnes, McKeith, & Ford, 2008).
The above findings are particularly important with regard to older populations, as many of these cognitive abilities are already vulnerable to the aging process (Cattell, 1987; Salthouse et al., 2008), and the presence of vascular illness may exacerbate this effect. Studies have shown that white matter pathology is most evident in the last third of the lifespan (see Raz & Rodrigue, 2006 for a review). White matter hyperintensities accumulate during the healthy aging process, with an even more marked increase in individuals with illnesses directly involving the vascular system (Novak, et al., 2006; Raz, et al., 2007). In fact, results from a longitudinal study revealed that WMH more than doubled in adults with vascular health risks (e.g. hypertension), while there were significantly smaller increases in healthy older adults (Raz, et al., 2007).

The demonstrated negative effect of both increasing age and vascular illness on cognitive functioning has implications for EPS in older populations. As previously discussed, poorer EPS performance of older adults may partially be due to declines in cognitive abilities for which accumulated, crystallized knowledge can no longer compensate (Thornton & Dumke, 2005). Thus, it is reasonable to predict that the relationship between vascular burden and associated declines in cognitive functioning may underlie age-related declines in EPS performance, as vascular illnesses are substantially more prevalent in older adults (Rockwood, Tan, Phillips, & McDowell, 1998; Wolf-Maier, et al., 2003). Partial support for this line of reasoning comes from a previous study demonstrating that a factor score composed of executive functioning and verbal memory mediated the relationship between age and EPS performance.
(Thornton, et al., 2007). In other words, the relationship between increasing age and declines in EPS performance was partially explained by decreased cognitive functioning in these domains.

If the negative effect of age on cognitive abilities is exacerbated by the presence of vascular illnesses, and EPS performance relies in part on these cognitive abilities, we would expect a differential impact of vascular illness burden versus non-vascular illness burden on EPS performance. Specifically, vascular illness burden would be expected to have a more negative impact on EPS performance than non-vascular illness burden. To our knowledge however, this has not yet been empirically examined. One of the aims of the current study was to separately examine non-vascular and vascular subsets of general illness burden in relation to EPS performance.

**Self-rated Health (SRH)**

In addition to objective measures of health, subjective health has also been shown to predict EPS performance. In the study done by Whitfield, Wiggins, and Allaire (2004), SRH was assessed using four items for which participants used a Likert-type scale to rate their overall health a) currently, b) compared to the past month, c) compared to five years prior, and d) compared to their age-peers. Although demographic variables (i.e. age, gender, and education) accounted for the majority of variance in EPS performance, higher participant ratings of their current health compared to their health five years prior (item c) predicted better EPS performance.
The association between SRH and EPS is interesting in that both constructs have been linked to future outcomes. Self-rated health has been shown to predict mortality, as well as functional and cognitive impairment (Bond, Dickinson, Matthews, Jagger, & Brayne, 2006). Longitudinal data indicates that individuals rate their health based not only on the current experience of health, but also on their intentions to modify poor health and on predictions regarding their future functioning (Bailis, Segall, & Chipperfield, 2003). Some studies have found that SRH is a better predictor of future functional outcomes than objective measures of health (Winter, Lawton, Langston, Ruckdeschel, & Sando, 2007). Thus, determining whether subjective health predicts EPS is fundamental to our understanding of the relationship between health status and EPS performance in older adults.

One question that has not been addressed in previous research is whether there are specific components of SRH that predict EPS performance better than others in older populations. Prior research has examined SRH as a unitary construct, which does not take into account the fact that health is multidimensional, and involves various mental and physical components such as pain, psychological distress, fatigue, and limitations in activities (Ware & Sherbourne, 1992). Thus, the second aim of the current study was to examine different aspects of subjective health in relation to EPS performance.

We considered the contributions of physical and mental aspects of SRH separately in predicting individual differences in EPS performance. The physical component examined in the current study was self-rated physical functioning.
Physical functioning has emerged as one of the most prominent components of SRH (Hart & Wright, 2002; Raczek, et al., 1998; Johnson, & Wolinsky, 1993). Research suggests that information regarding a medical diagnosis remains somewhat abstract to an individual until the knowledge is activated and made salient through subjective experiences such as physical limitations (Benyamini, Leventhal, & Leventhal, 1999). Functional limitations are current reminders of the illness, as well as potential indications of future health and wellbeing. Additionally, the experience of physical limitations can potentially impede interactions with the world, which results in reduced physical activity and mental stimulation (Kramer, Erickson, & McAuley, 2008). Thus, physical limitations may negatively impact daily functioning and cognitive ability, which may lead to lowered ability to solve real-world problems.

The potential impact of self-rated mental health (SRMH) on EPS performance was taken into consideration as well. Psychological distress often occurs with chronic medical illness, (Baune, Suslow, Arolt, & Berger, 2007; Ronchi, Bellini, Beranrdi, Serretti, & Ferrari, 2005), and can negatively impact cognitive functioning and real-world outcomes (Beaudreau & O'Hara, 2008; Brown, Glass, & Park, 2002; Gelb, et al., accepted). Given the previously demonstrated links between psychological wellbeing, cognitive ability, and real-world functioning, it is essential to consider the mental component of SRH in relation to EPS performance. Difficulty performing daily physical activities and feelings of psychological distress negatively impact daily and cognitive functioning in different ways, but both have the potential to lower EPS
performance. Thus, we separately examined the contributions of SRPF and SRMH to individual differences in EPS performance.

**Current Study**

The overall objective of the current study was to investigate potential health-related predictors of EPS performance in later life. Within this context, we examined the relationships among illness burden, SRH, and EPS performance. First, we investigated the predictive utility of general illness burden (total number of chronic illnesses), as well as the relative effectiveness of two subsets of general illness burden, vascular illness burden (total number of vascular illnesses) and non-vascular illness burden (total number of non-vascular illnesses) in predicting EPS performance. This approach is in contrast with previous research, in which illness burden has been conceptualized as the total number of all types of illnesses. Viewing illness burden as a unitary construct in this way may have posed a significant limitation in our understanding of the role of chronic illness in EPS performance in later life. Separately examining subsets of illness burden better allows for the examination of the mechanisms underlying the relationship between illness burden and EPS performance.

The vascular illnesses included in the analyses (diabetes mellitus, cardiovascular disease, hypertension, and high cholesterol) were chosen because they are common in the older adult population (see Table 12) and have primary disease mechanisms that directly involve the vascular system (Cohen et al., 2009; Creager, Lüscher, Cosentino, & Beckman, 2003; Lüscher, Creager, Beckman, & Cosentino, 2003; Rosendorff, 2002; Triantafyllidi, et al., 2009),
which may lead to brain pathology associated with poorer cognitive functioning (Brady, et al., 2001; Elias, et al., 2004; Elias, et al., 1997; Hassing, et al., 2004; Raz, et al., 2003). Non-vascular chronic illnesses included in the analyses (thyroid dysfunction, rheumatoid arthritis, osteoarthritis, and osteoporosis) were chosen because they are common in the older adult population (see Table 13), and generally do not have primary disease mechanisms that directly involve the vascular system \(^1\) (Delles, 2007; Dey, Michalkiewicz, Huffman, & Hedge, 1993; Findlay, 2007; Gupta, & Aronow, 2006; Müller, Tsakiris, Roth, Guglielmetti, Staub, & Marbet, 2001).

For general illness burden as well as the non-vascular and vascular subsets, we expected that higher illness burden would predict poorer EPS performance. Further, we predicted that the vascular subset of illness burden would predict more variance in EPS performance than the non-vascular subset. Given that vascular illnesses have been shown to have a negative impact on cognitive functioning, a statistical corollary to the above hypothesis is that cognitive abilities will mediate the relationship between vascular illness burden and EPS performance (Baron & Kenny, 1986). Of the cognitive abilities that have

\(^1\) It should be noted that non-vascular illnesses are associated with pain and fatigue (Scudds, & Ostbye, 2001; van der Windt, et al., 2008), both of which have been shown to negatively impact the cognitive and everyday functioning of older adults (Bennett, Stewart, Kayser-Jones, & Glaser, 2002). However, research reliably supports a more direct link between vascular illnesses and cognitive decline (Brady, et al., 2001; Elias, et al., 2004; Elias, et al., 1997; Hassing, et al., 2004; Raz, et al., 2003).
been seen to be negatively affected by vascular illness and risk factors, research most consistently supports the negative impact of vascular illnesses and risk factors on executive functioning in particular (O'Brien, et al., 2003; Pugh et al., 2003; Raz & Rodrigue, 2006). Although research exists demonstrating the impact of vascular illnesses on other cognitive abilities such as memory and abstract reasoning, findings are discrepant and vary widely (Akisaki, et al., 2006; Pugh et al., 2003). Thus, we specifically aimed to determine whether higher vascular burden predicts lower executive functioning, which in turn predicts poorer EPS performance.

The second objective of the current study was to further examine the relationship between SRH and EPS. Global evaluations of SRH, which use a single item asking participants to rate their health in general, have been shown to predict EPS performance (Whitfield, et al., 2004). However, different dimensions of SRH, such as physical and mental, have not been separately studied in relation to EPS performance. To this end, we explored both SRPF and SRMH as independent predictors of EPS performance while controlling for covariates such as demographic variables. We predicted that both SRPH and SRMH would account for a significant and unique amount of variance in EPS performance.
METHOD

Participants

As part of a larger, ongoing study, 102 participants aged 50 years and older were recruited from the greater Vancouver area by way of advertisements placed at local community centres, public libraries, golf courses, grocery stores, churches, and published in online community bulletin boards (e.g., Craigslist). In addition, participants were sought via seminars hosted by senior activity programs throughout the greater Vancouver area. Participants were considered eligible for inclusion if they met the following criteria: a) fluency in the English language as indexed by five self-report questions pertaining to primary language used across multiple domains, b) a minimum of grade six education, c) adequate hearing (corrected or uncorrected) as indexed by self-report, and d) free of any other major sensory impairments that could interfere with testing.

Individuals were considered ineligible to participate in the current study if they reported: a) a history of previously determined cognitive impairments (e.g. dementia), (b) a major psychiatric illness (e.g. schizophrenia), c) a concurrent terminal illness known to affect the CNS or any major neurological illness (e.g., Parkinson’s disease, Huntington’s disease, Multiple Sclerosis), d) history of major stroke, major head injury (defined by a loss of consciousness > 5 minutes), major organ failure, or e) alcohol consumption of more than three units/day (one unit = one ounce). Adequate vision was necessary for the completion of three cognitive
tasks used to assess executive functioning and processing speed; thus, all participants were screened for visual acuity using a Snellen chart. Only data from participants with adequate visual acuity (i.e., lower limit of 20/50 in both eyes either corrected or uncorrected) were included in the specific set of analyses that included the three cognitive tasks used to assess these cognitive abilities. For these analyses, data from three participants were excluded because of low visual acuity. Two of the remaining participants had missing data for at least one of the cognitive tasks, leaving the $n$ for these analyses at 97, and the $n$ for all other analyses at 102\(^2\).

**Procedures**

Participants underwent a battery of physiological and neuropsychological tests to assess blood pressure, traditional cognitive functioning and EPS functioning. Prior to each participant’s assessment date, a package including a consent form, health questionnaires and scales was mailed out to each participant be completed at home and brought to their appointment. In order to confirm self-reported medical diagnoses, participants were asked to bring in a list of current medications or, when possible, the pill bottles of the medications they were presently taking. All testing was conducted individually and lasted

\(^2\) To ensure the appropriateness of using the full sample for analyses not using scores based on tasks requiring a specific level of visual acuity, all analyses were conducted with and without individuals not meeting the vision criteria. Results were not affected by the inclusion of these individuals; thus, in order to preserve power, the full sample was used whenever possible.
approximately two hours. Participants were compensated $15 for time and travel expenses.

Testing occurred at various senior community centres throughout the lower mainland as well as the Simon Fraser University (SFU) Cognitive Aging lab. Participants were first screened for inclusion and exclusion criteria over the phone. If these criteria were met, participants were then mailed the questionnaire package and given an appointment for individual testing. Questionnaires and cognitive measures were administered and scored by trained research assistants following manualized procedures. Study protocol were approved by the SFU research ethics board. Data from the following measures were included in the current study.

**Measures**

*Global Mental Status.* The *Mini-Mental Status Examination* (MMSE; Folstein, Folstein, & McHugh, 1975) was used as a descriptive measure of participants’ global mental status. The MMSE assesses five cognitive domains including orientation, registration, attention and calculation, recall, and language. Scores range between 0 and 30, with scores below 24 reflecting impaired cognitive functioning consistent with dementia (Brady, Spiro, & Gaziano, 2005; Oosterman, de Vries, & Scherder, 2007). The reliability and validity of the MMSE has been demonstrated in geriatric populations and populations with medical conditions (Kurlowicz & Wallace, 1999). This measure also possesses adequate internal consistency in community based populations (Holzer, Tischler, Leaf, & Myers, 1984).
Demographics and Health. All participants completed a health questionnaire developed by our lab to evaluate demographic information as well as general medical history (Thornton, et al., 2007). Demographic characteristics examined in the current study were age, education, gender, ethnicity, and smoking status. To obtain health information, participants provided information regarding about past and present health status (e.g., prior stroke, vision, current medical diagnoses, psychiatric history, exercise habits, alcohol and tobacco use, etc.). Health information was used in various aspects of the study (i.e., to confirm inclusion and exclusion criteria, as descriptive information, etc.). In terms of the main analyses, health information was used to determine the presence/absence of the chronic illnesses of interest.

To be considered to have high cholesterol, hypertension, diabetes, or cardiovascular disease, participants were required to have a self-reported physician’s diagnosis of the illness and a current prescription of a medication to control the illness (e.g. insulin or oral medication to control diabetes, Breteler, 2000; anti-hypertensive medication to control hypertension, Campbell, Joffres, & McKay, 2005). With the exception of thyroid dysfunction, self-report of physician’s diagnoses was sufficient to establish the presence of non-vascular illnesses (Bombard, Powell, Martin, Helmick, & Wilson, 2005; Hootman, Bolen, Helmick, & Langmaid, 2006; Sacks, et al., 2005). The presence of thyroid dysfunction was determined by self-report of a physician’s diagnosis and concurrent treatment of the illness with a prescription medication (e.g. Synthroid; Flynn, MacDonald, Morris, Jung, & Leese, 2004). Participants were asked to
bring in current medications for objective confirmation of self-reported diagnoses of vascular illnesses and thyroid dysfunction.

*Self-rated Health.* The *Short Form-36* was used to assess self-rated health (SF-36; Ware & Sherbourne, 1992). This health form surveys self-reported health status, and includes 36 items capturing eight different health concepts. The Physical Functioning scale was used in the current study as a summary of self-rated medical illness burden. This scale is comprised of ten items directly related to physical health, asking participants to rate the extent to which specific activities are limited, such as lifting groceries, walking certain distances, and bathing and dressing. Scores are derived from a three-level response continuum, and range from 5-100, with lower scores indicating more limitations in physical functioning. The General Mental Health scale was used as a measure of self-reported psychological distress and psychological wellbeing. This scale consists of nine items, each addressing one of four aspects of mental health (anxiety, depression, loss of behavioural control, and psychological wellbeing). Scores are derived from a five-level response continuum, and range from 35-100, with lower scores indicating greater psychological distress.

The SF-36 has been standardized across multiple patient populations (McHorney, Ware, Lu, & Sherbourne, 1994). Across patient groups, all scales met standards set forth by McHorney and colleagues for item-internal consistency and discriminant validity, suggesting adequate content validity. Each scale exceeded recommendations for minimum reliability standards for group comparisons (0.50 to 0.70). Their recommended standard (0.90) for individual
comparisons was met for both the Physical Functioning and Mental Health scales, with Physical Functioning displaying the highest reliability at 0.93. In our lab, internal consistency is high for this measure (see Table 4 in the Data Analysis section for alpha coefficient).

Everyday Problem Solving (EPS). The EPS task consists of 16 paper and pencil vignettes for which participants are asked to generate as many solutions as possible. In contrast to other tasks of EPS, this measure includes open ended questions that allow for multiple solutions to problems frequently encountered in the real world (Allaire & Marsiske, 2002). Vignettes consist of problem situations, such as, “let’s say that one evening you go to the refrigerator and you notice that it is not cold inside, but rather it’s warm. What would you do?” In order to receive a point for a proposed solution, the solution must: (1) actively deal directly with the problem at hand, (2) be safe for all individuals involved, and (3) be likely to be effective in resolving the problem (Thornton & Dumke, 2005). The total number of items that fit all three criteria is then combined into a total EPS score for each, to account for the quantity as well as quality of an individual’s generated solutions. This measure has been adapted from previous relevant literature (Artistico, Cervone, & Pezzuti, 2003; Denney & Palmer, 1981; Denney & Pearce, 1998; Mariske & Willis, 1995), and similar tasks have been used in previous EPS studies with older adults (Allaire & Marsiske, 2002; Allaire & Willis, 2006; Thornton, et al., 2007). In our lab, inter-rater reliability and internal consistency are high for this measure (see Table 4 in the Data Analysis section for alpha coefficient).
Executive Functioning. The Delis – Kaplan Executive Function System (D–KEFS; Delis, Kaplan, & Kramer, 2001) is used to assess various aspects of executive functioning. The Trail Making subtest from this battery of tests specifically has been shown to be sensitive to executive dysfunction (Yochim, Baldo, Nelson, & Delis, 2007). In this study, we used scores (completion time in seconds) on the 4th condition of the Trail Making subtest (Letter-Number Sequencing) as a measure of set-shifting ability. For this condition, participants are instructed to connect letters and numbers in consecutive order, alternating from letter to number (i.e., A-1-B-2-C-3). The Trail Making Test has demonstrated ecological ($r = .66$; Mitchell & Miller, 2008) and construct validity in community-dwelling older adults (Sanchez-Cubillo et al., 2009). Reliability (internal consistency) of scores is in the range of .57 to .81 (Dugbartey, 2004).

The D-KEFS Color-Word Interference subtest was used in the current study as a measure of cognitive response inhibition. We examined participants’ scores (completion time in seconds) from the 3rd condition of this subtest, which introduces inhibition. On this condition, participants are presented with words printed in an ink colour incongruous with the colour expressed by the semantic value of the word. They are instructed to name the colour that the words are printed in, while suppressing their automatic verbal response of reading the word (this specific type of inhibition is sometimes referred to as the Stroop Effect). Scores on the Color-Word Interference subtest have been seen to be sensitive and reliable measures of inhibition ability (Jefferson, Paul, Ozonoff, & Cohen, 2006). The Colour-Word Interference subtest has adequate internal consistency.
(r = 0.75; Delis et al., 2001) and validity in detecting executive dysfunction in both experimental and clinical populations (Homack, Lee, & Riccio, 2005). Reliability (internal consistency) of scores is in the range of.62 to .86 (Dugbartey, 2004).

The Wechsler Adult Intelligence Scale III (WAIS III; Wechsler, 1997) Digit Symbol Coding task was used in the current study to measure processing speed. For this task, participants are instructed to match a set of nine symbols with the numbers one through nine in random order as quickly as they can, with the score being the total number of items correctly matched in 120 seconds. The task is frequently used to examine processing speed in cognitive aging research looking specifically at the effects of chronic illness (Elias et al., 2004; Hassing et al., 2004). Average test-retest reliability of scores on this subtest is 0.84 (Wechsler, 1997), indicating relatively high reliability. This task has demonstrated validity as a measure of processing speed across the lifespan (Joy, Kaplan, & Fein, 2004).
DATA ANALYSIS

Variable Construction

In order to determine the extent to which illness burden predicts EPS performance, we considered each index of illness burden separately (i.e., general, non-vascular, and vascular illness burden) with the understanding that general illness burden encompasses non-vascular and vascular illness burden. For each index of illness burden, we grouped participants based upon the number of that type of illness they presented with. For each index of illness burden, groups were as follows: zero illnesses (group 1), one illness (group 2), and two or more illnesses (group 3). For example, consider a participant who has osteoporosis, hypertension, and diabetes (i.e., three general illnesses; one non-vascular illness and two vascular illnesses). This participant would be placed in group 3 for general illness burden, group 2 for non-vascular burden, and group 3 for vascular illness burden (please refer to Table 1 for cell counts).

Table 1. Cell counts for each index of illness burden.

<table>
<thead>
<tr>
<th>Number of illnesses (group)</th>
<th>General Illness Burden</th>
<th>Non-Vascular Burden</th>
<th>Vascular Burden</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero (1)</td>
<td>32</td>
<td>46</td>
<td>63</td>
</tr>
<tr>
<td>One (2)</td>
<td>21</td>
<td>28</td>
<td>24</td>
</tr>
<tr>
<td>Two or more (3)</td>
<td>49</td>
<td>28</td>
<td>15</td>
</tr>
<tr>
<td>Total</td>
<td>102</td>
<td>102</td>
<td>102</td>
</tr>
</tbody>
</table>

*Note: All participants (n = 102) are counted for each index of illness burden, thus columns are not mutually exclusive nor additive.*
The aim was to determine the extent to which additional diagnoses of each type of illness affected EPS performance, so a coding system that would allow us to examine the shape of the function was necessary. Default coding systems such as dummy and effects coding were not considered, as they did not allow us to address the specific research questions in the current study. Specifically, as dummy coding is used to compare the mean of each group to a reference group, and effects coding is used to compare the mean of each group to the grand mean of all groups (Cohen, Cohen, West, & Aiken, 2003), these coding systems were not appropriate for our specific type of research question. The most suitable coding system was Reverse Helmert, as the contrast terms created allowed us to compare the mean EPS score of each group to the mean of mean EPS scores of all preceding groups (with the exception of the first group, for which there are no preceding groups; Wendorf, 2004).

There were three groups for each of the three indices of illness burden (i.e. zero, one, and two or more illnesses, for general, non-vascular, and vascular illness burden), allowing two degrees of freedom for making comparisons within each index of illness burden. The contrast terms were identical across sets of illness burden. The first contrast term (C1) compared the mean EPS score of participants with one illness (group two) to the mean EPS score of participants with zero illnesses (group one). The second contrast term (C2) compared the mean EPS score for participants with two or more illnesses (group three) to the mean of mean EPS scores of participants with zero illnesses and participants with one illness (groups one and two).
It should be mentioned that sample sizes were unbalanced across groups. However, because each mean was compared with the mean of means of the preceding groups (rather than a grand mean), the Reverse Helmert coding scheme ensured that the unstandardized regression coefficients could be interpreted as the desired mean differences regardless of group n. Specifically, the k'th unstandardized regression coefficient is the difference between the mean of group k and the mean of the means of groups 1, ..., k-1. (Koopman, R. F., personal communication, October 1, 2009; see Table 2 for coding scheme).

**Table 2. Reverse-Helmert coding scheme.**

<table>
<thead>
<tr>
<th>Group</th>
<th>X1</th>
<th>*X2(C1)</th>
<th>*X3(C2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>1/2</td>
<td>1</td>
</tr>
</tbody>
</table>

*Note: Group is based on the number of illnesses participants presented with (zero, one, or two or more) for each set of illness burden (general, non-vascular, and vascular). *Contrasts X2 and X3 were entered into the regression analysis as C1 and C2 respectively. X1 is automatically supplied by SPSS 17.*

To determine whether executive functioning mediate the relationship between vascular illness burden and EPS performance, we constructed a composite variable representing these cognitive abilities, as assessed by D-KEFS Trailmaking and Color-Word subtests, and WAIS-III Digit-Symbol Coding subtest. To create this variable, raw scores on each of these measures were converted to z-scores. As raw scores for the Trailmaking and Color Word subtests were based on seconds to completion, z-scores computed from these subtest scores were reversed (multiplied by -1) in order to ensure compatible
directionality with the z-scores computed from the Digit Symbol Coding subtest raw scores, which are based on total number of items completed. Subtest z-scores were then summed to create a composite score (Eddington, 1995), representing different components of executive functioning (EF), which was then used in subsequent analyses.

**Statistical Power**

To adequately control for type I and II errors, analyses were conducted at an alpha level of 0.05. Given a sample size of \( N = 102 \), using multiple regression with three predictor variables on step one (potential demographic covariates, age, gender and education), and one or two predictor variables on step two (which, depending on the analysis, would be SRPF, SRMH, or EF, or both illness burden contrast variables) our analyses are able to detect a medium effect size \( (f^2 = .15) \) in both \( R^2 \) and \( \Delta R^2 \) respectively. Table 3 shows the results of the power analyses conducted using G3 power calculator (http://wwwpsycho.uni-duesseldorf.de/aap/projects/gpower/; Erdfelder, Faul, & Buchner, 1996).

**Table 3. Power analysis for hierarchical regression analyses.**

<table>
<thead>
<tr>
<th>( f^2 )</th>
<th>( \alpha )</th>
<th>n</th>
<th># Predictors</th>
<th>1-β err prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>.15</td>
<td>.05</td>
<td>102</td>
<td>3</td>
<td>.911</td>
</tr>
<tr>
<td>( \Delta R^2 )</td>
<td>( f^2 )</td>
<td>( \alpha )</td>
<td>n</td>
<td># Predictors</td>
</tr>
<tr>
<td>.15</td>
<td>.05</td>
<td>102</td>
<td>1</td>
<td>.972</td>
</tr>
<tr>
<td>.15</td>
<td>.05</td>
<td>102</td>
<td>2</td>
<td>.941</td>
</tr>
</tbody>
</table>
Missing Data and Outliers

To account for missing data while retaining power, we used pair-wise deletion to exclude cases only if they were missing data required for a specific analysis (Tabachnick & Fidell, 2007). Two participants were missing data on the executive functioning (D-KEFS Trail Making and Color-Word subtests) and processing speed (WAIS-III Digit-Symbol Coding) measures, thus those individuals were not included in analyses requiring those data. There were no variables determined to have extreme outliers (i.e., values more than three times the interquartile range below or above the mean, as determined by scatter plots; Cohen, et al., 2003).

Internal Consistency

Reliability (internal consistency) analyses for scores on the EPS measure, the SF-36 Physical Functioning scale (SRPF), and the SF-36 Mental Health scale (SRMH) indicated good reliability in our sample (see Table 4 for Cronbach’s Alpha coefficients). Inter-rater reliability in our lab has been determined to be high ($r = .85$) for the EPS measure.

Table 4. Internal consistencies of scores on scales/measures.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Cronbach’s $\alpha$</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPS</td>
<td>.914</td>
</tr>
<tr>
<td>SRPF</td>
<td>.899</td>
</tr>
<tr>
<td>SRMH</td>
<td>.869</td>
</tr>
<tr>
<td>EF</td>
<td>.810</td>
</tr>
</tbody>
</table>

*Note: EPS = Everyday Problem Solving; SRPF = SF-36 Physical Functioning; SRMH = SF-36 Mental Health; EF = Executive Functioning*
**Descriptive Statistics**

Descriptive statistics including mean, standard deviation, and skew and kurtosis were analysed. Descriptive analyses indicated that the distributions of SRPF and SRMH were negatively skewed to a greater extent than is considered acceptable for use in regression analyses (> 2 x the $SE$ skewness; +/- .478), and that the kurtosis of SRPF distribution was also more negative than considered acceptable for the analyses to be carried out (> 2 x the $SE$ kurtosis; +/- .948). As these distributions are considered asymmetrical (Tabachnick & Fidell, 2007), and such non-normality can violate the assumptions of regression, transformations were performed on the variables in order to achieve a more normal distribution (see Tables 14 and 15 in Appendix C for details regarding these transformations). However, results from analyses were not affected by these transformations, and thus, non-transformed variables were used in subsequent analyses (please refer to Tables 16 and 17 in Appendix A for the results from analyses using the transformed variables).

**Participant Characteristics**

Descriptive statistics including means, $SD$’s, and percentages are reported for demographic, health, cognitive variables, in Table 5. Group differences on a number of demographic, cognitive, and health characteristics were analyzed (at an alpha level of 0.05) for general, non-vascular, and vascular illness burden. Categorical variables examined included gender (female/male), ethnicity (Caucasian/Asian), and current tobacco use (yes/no). Continuous variables examined included EPS performance, EF, age, years of education, global
cognition (MMSE; Folstein et al., 1975), SRPF, and SRMH (SF-36; Ware & Sherbourne, 1992). For categorical variables, Pearson chi-squared tests were used to determine whether group differences existed among the three sets of illness burden. When results indicated a significant difference, standardized residuals of the difference between the actual and observed frequencies were examined and compared to a critical value of 1.96 (z-score corresponding to alpha level 0.05) to determine between which groups the difference existed. For continuous variables, one-way analysis of variance was used to determine whether significant group differences existed, and Tukey's HSD post hoc analyses were conducted to determine between which groups the differences existed. Effect sizes of group differences are presented in Tables 6, 7, and 8.

Table 5. Demographic and cognitive variables for the full sample.

<table>
<thead>
<tr>
<th>Participant Characteristics</th>
<th>(n = 102)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean ± SD)</td>
<td>66.47± 8.51</td>
</tr>
<tr>
<td>Female n(%)</td>
<td>77(75.5%)</td>
</tr>
<tr>
<td>Education (mean ± SD)</td>
<td>14.61± 2.69</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
</tr>
<tr>
<td>Caucasian n(%)</td>
<td>90(88.2)</td>
</tr>
<tr>
<td>Asian n(%)</td>
<td>6(5.9)</td>
</tr>
<tr>
<td>East Indian n(%)</td>
<td>6(5.9)</td>
</tr>
<tr>
<td>EPS (mean ± SD)</td>
<td>61.41± 20.12</td>
</tr>
<tr>
<td>‡EF (mean ± SD)</td>
<td>.08±2.49</td>
</tr>
<tr>
<td>SRPF (mean ± SD)</td>
<td>79.71± 20.98</td>
</tr>
<tr>
<td>SRMH (mean ± SD)</td>
<td>78.74± 15.42</td>
</tr>
</tbody>
</table>

*Note. Age and education are presented in years. EPS = Everyday Problem Solving; SRPF = SF-36 Physical Functioning scale; SRMH = SF-36 Mental Health scale; EF/Speed = executive functioning/speed z-score composite ‡EF/Speed computed with an n of 97
Table 6. Demographic, health, and cognitive characteristics by general illness group.

<table>
<thead>
<tr>
<th>Participant Characteristics</th>
<th>Zero Illnesses (a)</th>
<th>One Illness (b)</th>
<th>Two or More Illnesses (c)</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n = 32</td>
<td>n = 21</td>
<td>n = 49</td>
<td>Eta squared</td>
</tr>
<tr>
<td>Age (mean ± SD)</td>
<td>61.84 ±6.81</td>
<td>67.81 ±8.56</td>
<td>68.92 ±8.41</td>
<td>.14 (a)</td>
</tr>
<tr>
<td>Education (mean ± SD)</td>
<td>14.84 ±2.33</td>
<td>15.24 ±2.49</td>
<td>14.18 ±2.95</td>
<td>.03</td>
</tr>
<tr>
<td>EPS (mean ± SD)</td>
<td>63.91 ±18.77</td>
<td>63.43 ±21.36</td>
<td>58.92 ±20.55</td>
<td>.01</td>
</tr>
<tr>
<td>±EF (mean ± SD)</td>
<td>1.04(1.99)</td>
<td>-1.07(3.59)</td>
<td>-.05(1.92)</td>
<td>*.10(ab)</td>
</tr>
<tr>
<td>SRPF (mean ± SD)</td>
<td>89.84±7.46</td>
<td>80.28 ±18.46</td>
<td>72.86 ±25.12</td>
<td>*.13 (ac)</td>
</tr>
<tr>
<td>SRMH (mean ± SD)</td>
<td>83.13 ±13.90</td>
<td>76.67 ±13.17</td>
<td>76.76 ±16.88</td>
<td>.04</td>
</tr>
<tr>
<td>MMSE (mean ± SD)</td>
<td>28.69 ±1.15</td>
<td>28.10 ±2.19</td>
<td>28.51±1.41</td>
<td>.02</td>
</tr>
<tr>
<td>Female n(%)</td>
<td>22(68.8)</td>
<td>14(66.7)</td>
<td>41(83.7)</td>
<td>.184</td>
</tr>
<tr>
<td>Caucasian n(%)</td>
<td>27(84.4)</td>
<td>21(100)</td>
<td>42(46.7)</td>
<td>.140</td>
</tr>
<tr>
<td>Non-smoking n(%)</td>
<td>28(90.3)</td>
<td>19(100)</td>
<td>44(93.6)</td>
<td>.059</td>
</tr>
</tbody>
</table>

Note. Age and education are presented in years. EPS = Everyday Problem Solving; EF = executive functioning composite; SRPF = SF-36 Physical Functioning scale; SRMH = SF-36 Mental Health scale; MMSE = Mini Mental Status Examination
Eta squared (Small = .01, Medium = .06, Large = .14; Cohen, 1988). Cramer’s V (Small = .07, Medium = .30, Large = .50).
* p <.05 obtained from Pearson chi-square or one-way analysis of variance (ANOVA)
ANOVA with EF was computed with an n of 97
abc = identifies groups for which significant differences were observed based upon post-hoc tests (e.g., b = one illness group is significantly different from either zero illness or two illness group, which do not reliably differ).
Table 7. Demographic, health, and cognitive characteristics by non-vascular burden group.

<table>
<thead>
<tr>
<th>Participant Characteristics</th>
<th>Zero Illnesses (a)</th>
<th>One Illness (b)</th>
<th>Two or More Illnesses (c)</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>n = 46</td>
<td>n = 28</td>
<td>n = 28</td>
<td>Eta squared</td>
<td></td>
</tr>
<tr>
<td><strong>Age</strong> (mean ± SD)</td>
<td>64.04 ±8.09</td>
<td>66.25 ±6.95</td>
<td>70.68 ±9.22</td>
<td>.11 (ac)</td>
</tr>
<tr>
<td>Education (mean ± SD)</td>
<td>14.78 ±2.56</td>
<td>14.46 ±2.59</td>
<td>14.46 ±3.05</td>
<td>.004</td>
</tr>
<tr>
<td>EPS (mean ± SD)</td>
<td>60.76 ±19.20</td>
<td>62.29 ±18.39</td>
<td>61.61 ±23.69</td>
<td>.001</td>
</tr>
<tr>
<td>EF (mean ± SD)</td>
<td>-.08(3.13)</td>
<td>.33(1.77)</td>
<td>-.03(1.83)</td>
<td>.004</td>
</tr>
<tr>
<td>SRPF (mean ± SD)</td>
<td>85.02 ±15.04</td>
<td>75.00 ±27.11</td>
<td>75.71 ±21.11</td>
<td>.05</td>
</tr>
<tr>
<td>SRMH (mean ± SD)</td>
<td>81.85 ±14.39</td>
<td>78.79 ±12.80</td>
<td>73.57 ±18.35</td>
<td>.05</td>
</tr>
<tr>
<td>MMSE (mean ± SD)</td>
<td>28.59 ±1.60</td>
<td>28.39 ±1.57</td>
<td>28.50±1.42</td>
<td>.003</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Cramer’s V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female n(%)</td>
<td>27(58.7)</td>
</tr>
<tr>
<td>Caucasian n(%)</td>
<td>38(82.6)</td>
</tr>
<tr>
<td>Non-smoking n(%)</td>
<td>40(88.9)</td>
</tr>
</tbody>
</table>

*Note. Age and education are presented in years. EPS = Everyday Problem Solving; EF = executive functioning composite; SRPF = SF-36 Physical Functioning scale; SRMH = SF-36 Mental Health scale; MMSE = Mini Mental Status Examination. Eta squared (Small = .01, Medium = .06, Large = .14; Cohen, 1988). Cramer’s V (Small = .07, Medium = .30, Large = .50). * p < .05 obtained from Pearson chi-square or one-way analysis of variance (ANOVA). ANOVA with EF was computed with an n of 97.**
Table 8. Demographic, health, and cognitive characteristics by vascular burden group.

<table>
<thead>
<tr>
<th>Participant Characteristics</th>
<th>Zero Illnesses (a)</th>
<th>One Illness (b)</th>
<th>Two or More Illnesses (c)</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$n = 63$</td>
<td>$n = 24$</td>
<td>$n = 15$</td>
<td>Eta squared</td>
</tr>
<tr>
<td>Age (mean ± SD)</td>
<td>64.19 ±7.66</td>
<td>69.17 ±8.12</td>
<td>71.73 ±9.45</td>
<td>*.13(a)</td>
</tr>
<tr>
<td>Education (mean ± SD)</td>
<td>14.98 ±2.47</td>
<td>14.54 ±3.09</td>
<td>13.13 ±2.53</td>
<td>.06(ac)</td>
</tr>
<tr>
<td>EPS (mean ± SD)</td>
<td>66.17 ±20.99</td>
<td>57.08 ±16.63</td>
<td>48.33 ±14.07</td>
<td>*.11 (ac)</td>
</tr>
<tr>
<td>EF (mean ± SD)</td>
<td>.70(1.88)</td>
<td>-.75(3.43)</td>
<td>-1.327(2.32)</td>
<td>*.11(a)</td>
</tr>
<tr>
<td>SRPF (mean ± SD)</td>
<td>86.75 ±11.51</td>
<td>74.00 ±24.37</td>
<td>59.33 ±29.81</td>
<td>*.23 (c)</td>
</tr>
<tr>
<td>SRMH (mean ± SD)</td>
<td>78.17 ±15.59</td>
<td>81.25 ±13.21</td>
<td>77.09 ±18.39</td>
<td>.01</td>
</tr>
<tr>
<td>MMSE (mean ± SD)</td>
<td>28.70 ±1.19</td>
<td>28.00 ±2.17</td>
<td>28.53±1.55</td>
<td>.04</td>
</tr>
<tr>
<td>Female n(%)</td>
<td>49(77.8)</td>
<td>20(83.3)</td>
<td>8(53.3)</td>
<td>.220</td>
</tr>
<tr>
<td>Caucasian n(%)</td>
<td>57(90.5)</td>
<td>22(91.7)</td>
<td>11(73.3)</td>
<td>.136</td>
</tr>
<tr>
<td>Non-smoking n(%)</td>
<td>56(90.3)</td>
<td>21(95.5)</td>
<td>15(93.3)</td>
<td>.079</td>
</tr>
</tbody>
</table>

Note. Age and education are presented in years. EPS = Everyday Problem Solving; EF = executive functioning composite; SRPF = SF-36 Physical Functioning scale; SRMH = SF-36 Mental Health scale; MMSE = Mini Mental Status Examination Eta squared (Small = .01, Medium = .06, Large = .14; Cohen, 1988). Cramer’s V (Small = .07, Medium = .30, Large = .50). * $p < .05$ obtained from Pearson chi-square or one-way analysis of variance (ANOVA) + ANOVA with EF/Speed was computed with an $n$ of 97 abc = identifies groups for which significant differences were observed based upon post-hoc tests (e.g., b = one illness group is significantly different from either zero illness or two illness group, which do not reliably differ).
Correlations

Bivariate Spearman correlations were conducted to examine intercorrelations among all variables of interest. Variables included EPS performance, EF, SRPF, SRMH, the six contrast variables representing the three indices of illness burden (general, vascular, non-vascular), and demographic variables (age, education, and gender). Intercorrelations are presented in Table 9. In order to preserve statistical power, variables of interest that were not the main focus of the study (i.e. demographic variables) were only included as covariates in the regression analyses if they were significantly correlated with the outcome variable at $p < .05$. 
Table 9. Intercorrelations among EPS, demographic variables, indices of illness burden, EF, SRPH, and SRMH for the full sample.

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 EPS</td>
<td>___</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Age</td>
<td>-.44**</td>
<td>___</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>3 Gender</td>
<td>-.30**</td>
<td>-.01</td>
<td>___</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Education</td>
<td>.38**</td>
<td>-.23*</td>
<td>-.04</td>
<td>___</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 General C1</td>
<td>-.06</td>
<td>.30**</td>
<td>-.02</td>
<td>.03</td>
<td>___</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 General C2</td>
<td>-.16</td>
<td>.28**</td>
<td>-.18</td>
<td>-.15</td>
<td>.20*</td>
<td>___</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 Non-Vasc C1</td>
<td>.01</td>
<td>.18</td>
<td>-.30**</td>
<td>-.04</td>
<td>.63**</td>
<td>.41**</td>
<td>___</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 Non-Vasc C2</td>
<td>-.06</td>
<td>.27**</td>
<td>-.25*</td>
<td>-.02</td>
<td>.13</td>
<td>.64**</td>
<td>.20*</td>
<td>___</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 Vasc C1</td>
<td>-.26**</td>
<td>.32**</td>
<td>.02</td>
<td>-.13</td>
<td>.36**</td>
<td>.48**</td>
<td>.18</td>
<td>.03</td>
<td>___</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 Vasc C2</td>
<td>-.28**</td>
<td>.25*</td>
<td>-.21*</td>
<td>-.26**</td>
<td>.08</td>
<td>.43**</td>
<td>.02</td>
<td>-.07</td>
<td>.32**</td>
<td>___</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 SRPF</td>
<td>.36**</td>
<td>-.35**</td>
<td>-.01</td>
<td>.18</td>
<td>-.23*</td>
<td>-.24*</td>
<td>-.14</td>
<td>-.17</td>
<td>-.28**</td>
<td>-.26**</td>
<td>___</td>
<td></td>
</tr>
<tr>
<td>12 SRMH</td>
<td>.16</td>
<td>.04</td>
<td>-.07</td>
<td>.07</td>
<td>-.22*</td>
<td>-.10</td>
<td>-.15</td>
<td>-.17</td>
<td>.08</td>
<td>-.01</td>
<td>.18</td>
<td>___</td>
</tr>
<tr>
<td>13 EF</td>
<td>.31**</td>
<td>-.55**</td>
<td>.20</td>
<td>.15</td>
<td>-.27**</td>
<td>-.16</td>
<td>-.06</td>
<td>-.10</td>
<td>-.24*</td>
<td>-.28**</td>
<td>.31**</td>
<td>.04</td>
</tr>
</tbody>
</table>

*Note. EPS = everyday problem solving; C1 = comparison of the mean EPS score of participants with one illness to the mean EPS score of participants with zero illnesses; C2 = comparison of the mean EPS score for participants with two or more illnesses to the mean of mean EPS scores of participants with zero illnesses and participants with one illness; SRPF = SF-36 Physical Functioning scale; SRMH = SF-36 Mental Health scale; EF = executive functioning composite

*Correlations among EF and all other variables were computed with an n of 97

*p < .05

**p < .01
Assumptions of Multiple Regression

The following checks were conducted to ensure interpretability of results, given the assumptions made by multiple regression analyses (Cohen, et al., 2003; Tabachnick & Fidell, 2007). In order to assess normality of residuals, we examined normal probability plots of residuals for each regression equation. We also examined normal q-q plots of each variable to be entered in the regression analyses to determine whether variables were normally distributed. Normal q-q plots and normal probability plots of residuals indicated that none of the variables or residuals had distinctly non-normal distributions. Next, we verified a linear relationship among variables by plotting the standardized residuals against the standardized predicted value for each regression equation. It was determined that linearity was likely, as the scatterplots were approximately rectangular in shape. Inspection of these graphs also permitted confirmation of the assumption of homoscedasticity, or the constancy of error variance. The Durbin-Watson statistic was used to examine the independence of errors for each variable in this study. These analyses indicated no violations of this assumption. Finally, for regression analyses with more than one predictor variable, the level of multicollinearity among predictor variables was examined. Using the Variance Inflation Factor (VIF), it was determined that the level of multicollinearity among predictor variables in each regression equation was acceptably low (VIF < 10).
Hierarchical Regression Analyses

To determine the utility of illness burden (general, non-vascular, and vascular) in predicting EPS performance, a series of hierarchical regression analyses were conducted with EPS as the outcome variable, while statistically controlling for demographic variables that were significantly correlated with EPS at $p < .05$. Step one of the regression model included demographic variables; step two of the model included the set of contrast codes representing the specific index of illness burden being examined. For the mediational model with vascular illness burden, EF, and EPS, in order to meet Baron and Kenny’s (1986) conditions of mediation we would need to establish that 1) the independent variable (vascular burden) is significantly associated with the dependent variable (EPS performance), 2) the independent variable (vascular burden) is significantly associated with the mediator (EF), and 3) the mediator (EF) predicts the dependent variable (EPS performance) when the independent variable (vascular burden) is statistically controlled for.

Our second aim was to determine to what extent SRPF and SRMH predict EPS performance. A hierarchical regression analysis was conducted that included demographic variables significantly correlated with EPS at $p < .05$ on step one and SRPF and SRMH on step two.
RESULTS

Participant Characteristics

Information regarding participant demographic characteristics for the full sample is presented in Table 5. For each index of illness burden, group differences on demographic, cognitive, and health characteristics are presented in Tables 6, 7, and 8. For general illness burden, individuals with no illnesses were younger than those with one illness and those with two or more illnesses. Individuals with no illnesses had higher EF than those with one illness and those with two or more illnesses, and higher SRPF than those with two or more illnesses. With regard to non-vascular burden, individuals with no illnesses were younger than those with two or more illnesses. Additionally, the proportion of females was lower than expected in the group of individuals with no illnesses compared to the groups with one illness and with two or more illnesses. In terms of vascular burden, individuals with no illnesses were younger than those with one illness and those with two or more illnesses and had higher EF than both of the latter groups. Individuals with no illnesses had higher education and better EPS performance than those with two or more illnesses, and individuals with two or more illnesses had lower SRPF than those with either no illnesses or one illness. No other group differences were observed.
Correlations

As seen in Table 9, better EPS performance was associated with younger age, female gender, and higher education, thus these variables were entered on step one of the regression analyses. In contrast with previous research (Whitfield, et al., 2004), EPS performance was not associated with general illness burden in the current study. When vascular and non-vascular illness burden were examined separately, only vascular illness burden was negatively associated with EPS performance, while the relationship between non-vascular illness burden and EPS performance was not statistically significant. Higher EPS performance was associated with higher SRPF, but not SRMH. Self-rated physical functioning was associated with younger age, general illness burden (C1 and C2) and vascular illness burden (C1 and C2), but was not associated with non-vascular illness burden. Higher SRMH was associated with lower general illness burden (C1). Higher EF was associated with younger age, higher EPS performance, lower general illness burden (C1), lower vascular illness burden (C1 and C2), and higher SRPF. Because SRMH was unrelated to EPS performance, it was thus not included in any of the analyses.

Regression Analyses

The first aim of the current study was to confirm and expand upon the findings of Whitfield, Wiggins, and Allaire (2004) by investigating the separate contributions of general, vascular and non-vascular illness burden to variance in EPS performance. According to the Spearman correlations, only the vascular illness burden contrasts were correlated with EPS performance. Thus, we
conducted one hierarchical regression analysis to examine the utility of vascular illness burden only in predicting EPS performance. Our results indicated that higher age, male gender, and lower education were significant predictors of lower EPS scores, $F (3, 98) = 16.36, p < .001$. After accounting for these demographic variables, vascular illness burden contrast variables did not account for a significant amount of variance in EPS performance, $R^2\Delta = .013, \Delta F (2, 99) = .937, ns$ (see Table 10). Given that the expected relationship between vascular illness burden and EPS performance was not found, the first condition of mediation (Baron & Kenny, 1986) was not met for the mediational model including EF, thus further mediational analyses were not conducted.
Table 10. Hierarchical multiple regression examining vascular illness burden contrast terms as predictors of EPS performance (n = 102).

<table>
<thead>
<tr>
<th>Predictor</th>
<th>B</th>
<th>S.E.</th>
<th>p</th>
<th>∆R²</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
<td></td>
<td></td>
<td>.334**</td>
</tr>
<tr>
<td>Age</td>
<td>-.890</td>
<td>.199</td>
<td>&lt;.001</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>-13.48</td>
<td>3.84</td>
<td>.001</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>2.06</td>
<td>.629</td>
<td>.001</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td></td>
<td></td>
<td></td>
<td>.013</td>
</tr>
<tr>
<td>Age</td>
<td>-.797</td>
<td>.211</td>
<td>&lt;.001</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>-13.03</td>
<td>3.95</td>
<td>.001</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>1.947</td>
<td>.642</td>
<td>.003</td>
<td></td>
</tr>
<tr>
<td>Contrast 1</td>
<td>-4.99</td>
<td>4.14</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Contrast 2</td>
<td>-2.55</td>
<td>5.09</td>
<td>ns</td>
<td></td>
</tr>
</tbody>
</table>

*Note. EPS = everyday problem solving; C1 = comparison of the mean EPS score of participants with one illness to the mean EPS score of participants with zero illnesses; C2 = comparison of the mean EPS score for participants with two or more illnesses to the mean of mean EPS scores of participants with zero illnesses and participants with one illness. p-values are indicated for the change in R² after the entry of each block of variables in the equation. * p <.05 ** p <.01

Ob Unstandardized regression coefficients for Reverse-Helmert contrast terms represent the functions of the group means on the adjusted y after demographic variables were accounted for. Only unstandardized coefficients are presented, as standardized coefficients cannot be meaningfully interpreted in this case.

As the prevalence of vascular illness increases reliably with age (American Heart Association, 2010), follow up analyses were conducted to ensure that the inclusion of age in the model was not overly conservative. Thus, four analyses were conducted. Two were conducted to determine whether the inclusion of age in the model accounts for the relationship between either of the vascular burden contrasts and EPS performance. If this were the case, it might be said that age was a necessary covariate in the model. However, we would also need to establish that neither of the vascular burden contrasts account for the relationship between age and EPS. Thus, the other two analyses were
conducted to determine this. If age can be said to partially account for the relationship between either of the vascular burden contrasts and EPS performance, and the vascular contrasts do not account for the relationship between age and EPS performance, we could have more confidence that the inclusion of age as a covariate in the model was indeed necessary.

Statistically speaking, if the path from vascular burden contrasts to age is significant, and the path from age to EPS performance is significant with vascular burden contrasts in the model, the effect of vascular burden contrasts on EPS is necessarily reduced with the inclusion of age in the model. Sobel’s test was used to determine the significance of these paths simultaneously. Results indicate that there is indeed a direct effect of each vascular burden contrast (C1 and C2) on age: (C1) $R^2 = .055$, $F (1, 100) = 5$, $p < .05$; (C2) $R^2 = .074$, $F (1, 100) = 7.938$, $p < .01$. Additionally, each vascular burden contrast (C1 and C2) accounted for variance in age: (C1) $R^2 = .082$, $F (1, 100) = 8.970$, $p < .01$; (C2) $R^2 = .067$, $F (1, 100) = 7.133$, $p < .01$, and age accounted for variance in EPS performance when each vascular burden contrast (C1 and C2) was statistically controlled for: (C1) $R^2 = .189$, $F (2, 99) = 11.56$, $p < .001$; (C2) $R^2 = .203$, $F (2, 99) = 12.64$, $p < .001$. Sobel’s test confirms that the effect of vascular illness burden on EPS performance is significantly reduced by the inclusion of age in the model: (C1) $\Delta \beta = .109$; Sobel’s $Z = -2.51$, $p < .05$; (C2) $\Delta \beta = .096$; Sobel’s $Z = -2.317$, $p < .05$.

To determine whether the effect of age on EPS is necessarily reduced with the inclusion of vascular burden contrasts in the model, we would need to demonstrate that the path from age to vascular burden contrasts is significant,
and the path from vascular burden contrasts to EPS performance is significant with age in the model. Results indicate that there is indeed a direct effect of age on EPS performance: $R^2 = .175$, $F (1, 100) = 21.189$, $p < .001$. Additionally, age accounted for variance in each vascular burden contrast (C1 and C2): (C1) $R^2 = .082$, $F (1, 100) = 8.970$, $p < .01$; (C2) $R^2 = .067$, $F (1, 100) = 7.133$, $p < .01$.

However, the vascular burden contrasts, C1 and C2 did not account for a significant amount of variance in EPS performance when age was statistically controlled for (C1; $\beta = -.126$, ns) (C2; $\beta = -.175$, ns). Thus, the vascular burden contrasts cannot be said to significantly reduce the effect of age on EPS performance.

The second objective of the current study was to assess the utility of SRPF (SF-36 Physical Functioning scale) and SRMH (SF-36 Mental Health scale) in predicting EPS performance while controlling for the influence of demographic variables (age, education, and gender). However, as SRMH was found to not correlate with EPS performance in the current study, only one regression analysis was performed, with SRPF as a predictor of EPS performance. In this analysis, higher age, male gender, and lower education were significant predictors of lower EPS scores, explaining 33.4% of the variance in EPS performance. Self-rated physical functioning ($\beta = .214$, $p < .05$) explained an additional 3.8% of the variance in EPS performance over and above age, gender, and education, $R^2 \Delta = .038$, $\Delta F (4, 97) = 5.90$, $p < .05$. The total variance explained by the final model as a whole was 37.2%, $F (4, 97) 14.36$, $p < .001$ (see Table 11 for results).
Table 11. Hierarchical multiple regression analysis examining SRPH variable as a predictor of EPS performance \((n = 102)\).

<table>
<thead>
<tr>
<th>Predictor</th>
<th>(B)</th>
<th>S.E.</th>
<th>(\beta)</th>
<th>(p)</th>
<th>(\Delta R^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>-.890</td>
<td>.199</td>
<td>-.376</td>
<td>&lt;.001</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>-13.475</td>
<td>3.841</td>
<td>-.289</td>
<td>.001</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>2.055</td>
<td>.629</td>
<td>.274</td>
<td>.001</td>
<td></td>
</tr>
<tr>
<td>SRPF</td>
<td>.205</td>
<td>.084</td>
<td>.214</td>
<td>.017</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>-.706</td>
<td>.208</td>
<td>-.298</td>
<td>.001</td>
<td>.038*</td>
</tr>
<tr>
<td>Gender</td>
<td>-13.08</td>
<td>3.752</td>
<td>-.281</td>
<td>.001</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>1.868</td>
<td>.619</td>
<td>.249</td>
<td>.003</td>
<td></td>
</tr>
<tr>
<td>SRPF</td>
<td>.205</td>
<td>.084</td>
<td>.214</td>
<td>.017</td>
<td></td>
</tr>
</tbody>
</table>

Note. EPS = everyday problem solving; SRPF = self-rated physical functioning (SF-36). Significant \(p\)-values are indicated for the change in \(R^2\) after the entry of each block of variables in the equation.

* \(p < .01\)

** \(p < .001\)
DISCUSSION

The first aim of the current study was to examine the differential impact of three types of medical illness burden on EPS performance among community-dwelling older adults. When general burden, non-vascular illness burden, and vascular illness burden were examined separately, higher vascular illness burden was correlated with poorer EPS performance, while general illness burden and non-vascular illness burden were unrelated to EPS performance. Contrary to our expectations, when age, gender, and education were considered in the model, vascular illness burden did not account for a significant amount of variance in EPS performance. As the prevalence of vascular illness increases reliably with age (American Heart Association, 2010), we ran a series of analyses to ensure that including age as a covariate in the analysis was not overly conservative. Analyses indicated that age partially accounts for the relationship between vascular illness burden, meaning that the strength of the relationship was significantly reduced when age was included in the model. However, vascular illness burden did not account for the relationship between age and EPS performance, meaning that the strength of the relationship was not significantly reduced by the inclusion of vascular illness burden in the model. Thus, the inclusion of age as a covariate was important, as association between higher vascular burden and poorer EPS performance can be partially explained by increasing age.
Contrary to the study conducted by Whitfield, Wiggins, and Allaire (2004), the current study did not demonstrate a predictive relationship between illness burden and EPS performance. This may in part be due to the non-generalizability of our sample to the sample in the study by Whitfield and colleagues. Although the average age and gender composition was similar across the two studies, other demographic characteristics varied greatly. Whitfield and colleagues’ sample consisted solely of African American older adults, while the current sample was composed primarily of Caucasian (88.2%) adults, with a small proportion of Asian (5.9%) and East Indian (5.9%) individuals. This discrepancy is important given the prevalence of chronic illnesses across ethnicities. In our sample, with the exception of thyroid disorders and osteoporosis, the prevalence of the specific illnesses examined is well below that of older adults in the general North American population (Tables 12 and 13 compare our sample with North American populations). In contrast, previous research has demonstrated that the African American population has a significantly higher prevalence of chronic illness and vascular risk factors relative to other ethnicities, and in particular to Caucasian and Asian individuals (Taylor, et al., 2005).

In addition to differences in ethnic composition, there was also a large discrepancy between levels of education across the two samples. Participants in the current study had, on average, 4.73 more years of education than those in the study conducted by Whitfield and colleagues. Given that in both studies, education was found to be a significant predictor of EPS performance, this demographic difference may also have been an important contributing factor in
the discrepant findings. The current findings suggest that Whitfield and colleagues’ results do not generalize to the current study’s sample, potentially due to key differences in ethnic makeup and educational attainment across the two samples.

Table 12. Comparison of population and sample prevalence rates of vascular illnesses of interest.

<table>
<thead>
<tr>
<th>Illness</th>
<th>General Prevalence</th>
<th>Community Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiovascular Disease</td>
<td>32% of adults over the age of 65 (US Department of Health and Human Services; Trends in Health and Aging)</td>
<td>10.0 %</td>
</tr>
<tr>
<td>Diabetes Mellitus</td>
<td>12% of community-dwelling Canadians over the age of 65 (Rockwood, et al., 1998)</td>
<td>4.9%</td>
</tr>
<tr>
<td>Hypertension</td>
<td>64.23% of North American adults over the age of 55 (American Heart Association, 2010)</td>
<td>33.0%</td>
</tr>
<tr>
<td>High Cholesterol</td>
<td>50.72% of North American adults over the age of 55 (American Heart Association, 2010)</td>
<td>13.0%</td>
</tr>
</tbody>
</table>
Table 13. Comparison of population and sample prevalence rates of non-vascular illnesses of interest.

<table>
<thead>
<tr>
<th>Illness</th>
<th>General Prevalence</th>
<th>Community Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thyroid Dysfunction</td>
<td>Hypothyroidism: up to 15% by age 75; Hyperthyroidism: 5-10 times fewer</td>
<td>19.8%</td>
</tr>
<tr>
<td></td>
<td>(Hollowell, et al., 2002)</td>
<td></td>
</tr>
<tr>
<td>Rheumatoid Arthritis</td>
<td>21% of individuals in the US (Helmick, et al., 2008)</td>
<td>5.9%</td>
</tr>
<tr>
<td>Osteoarthritis</td>
<td>Over 50% of people over the age of 65</td>
<td>35.0%</td>
</tr>
<tr>
<td></td>
<td>(Helmick, et al., 2008)</td>
<td></td>
</tr>
<tr>
<td>Osteoporosis</td>
<td>12.6% of women, and 3.8% of men</td>
<td>26.5%</td>
</tr>
<tr>
<td></td>
<td>(Chiang, Jones, Humphreys, &amp; Martin, 2006)</td>
<td></td>
</tr>
</tbody>
</table>

The unequal distribution of participants across vascular illness burden groups may also potentially help to explain the fact that vascular illness burden was not a significant predictor of EPS in the current study. Although unequal group size did not affect the accuracy of statistical results, differentially small cell sizes likely had a negative impact on the amount of statistical power available to detect any effect for analyses using the illness burden variables. This is particularly true of the vascular burden group with two or more illnesses, which included only fifteen participants (as opposed to the group with zero illnesses, which included sixty-three participants). A larger sample size in further examinations of these relationships will help to minimize the impact of the uneven distribution across illness burden groups.
The second aim of the current study was to address the utility of specific aspects of SRH in predicting of EPS performance. Results demonstrated that SRPF was positively correlated with EPS, while SRMH was not. Thus, lower self-assessed physical functioning was related to poorer EPS performance, while individuals’ subjective ratings of psychological wellbeing were unrelated to EPS. As SRMH was not associated with EPS performance, further analyses were not conducted with this variable.

Consistent with previous research (Whitfield, et al., 2004), results of the hierarchical regression analysis indicated that demographic variables (age, gender, and education) accounted for a high proportion of the variance in EPS performance in our sample. Additionally, SRPF remained a unique and significant predictor in the model after statistically controlling for the relevant demographic variables. Results confirm the perspective that SRH may provide unique information regarding older adults’ ability to solve everyday problems (Whitfield, et al., 2004). Results also extend previous research by narrowing the focus to the importance of SRPF. The fact that SRPF but not SRMH significantly predicted EPS performance may be related to previous research demonstrating that physical functioning is one of the most prominent components of SRH (Hart & Wright, 2002; Raczek, et al., 1998; Johnson, & Wolinsky, 1993), with physical limitations being the most salient subjective measure of health (Benyamini, et al., 1999).

The current results suggest that for a subset of community-dwelling older adults that is generally well educated, relatively healthy, and predominantly
Caucasian, SRPF is a better predictor of EPS performance than illness burden. One way to interpret this might be to consider the possibility that vascular illness burden may not have been an adequate indicator of vascular health. This may be due in part to the fact that chronic illness counts cannot account for the severity of illnesses, and thus do not provide as precise a measure of health as may be required to predict variance in EPS performance in the current sample.

Given the previously demonstrated saliency of SRPF as an indicator of health (Benyamini, et al., 1999), it may have been that SRPF was a more accurate measure of health, and vascular health in particular. It is reasonable to expect that individuals with poor vascular health would experience more physical limitations in their daily lives than those without vascular illness. Indeed, research demonstrates that poor vascular health impedes physical functioning, while subsequent medical interventions result in higher reported physical functioning (O'Sullivan & McCarthy, 2007; Pepke-Zaba, et al., 2008). Physical limitations likely lead to less of an opportunity for physical activity and associated mental stimulation, both of which facilitate cognitive and daily functioning (Arcoverde, et al., 2008; see Kramer, Erickson, & McAuley, 2008 for a review). It may be that in the current study, SRPF was an indicator of vascular health. This interpretation is partially supported by the current results demonstrating that higher vascular burden was associated with lower SRPF, and lower SRPF predicted lower EPS performance. It will be important to further examine this particular relationship in future research.
The current study expands our understanding of the health variables contributing to variance EPS performance of older adults. These findings have important implications given the expanding older adult population in North America. Measures of EPS performance predict mortality, quality of life, and real world functioning (Allaire & Marsiske, 2002; Gilhooly, et al., 2007; Weatherbee & Allaire, 2008), and may be particularly useful in assessing older individuals’ ability to function in their daily lives. Thus, any understanding of the mechanisms underlying the EPS declines of older adults may provide information regarding these real-world outcomes. A large number of older individuals require assistance with daily activities, and this number will increase as the proportion of older adults in our population rapidly expands (Kassner & Bectel, 1998). However, there are also a vast number of older adults who maintain independence into very late life. Determining factors related to these individual differences may be aided by exploring EPS ability. Further understanding will enable us to better predict future functional independence and effectively target potential risk factors for negative future outcomes.

Interventions aimed at improving SRPF in older adults may not only have a positive affect on EPS performance, but may also improve objective health outcomes. Self-rated health has been shown to reflect individuals’ intentions to modify health status, and to predict objective changes in health (Bailis, et al., 2003; Ferraro, Farmer, & Wybraniec, 1997). Thus, even in cases of persistent chronic illness, a positive outlook on one’s health may be a protective factor in
terms of future functioning. Determining factors that have a positive effect on SRPF could in turn lead to improved objective health outcomes.

**Future Research and Directions**

Given that objective and subjective health status may predict age-related declines in cognition, examining these aspects of health in aging populations is imperative. The null findings regarding illness burden and EPS performance should not preclude further exploration of the relationship between cumulative chronic illness and real world problem solving ability. Chronic illnesses are common in older populations. Research indicates that 30% of older adults report a newly diagnosed chronic illness within one year of the initial interview, 49% report new chronic conditions within two years, and 61% report new diagnoses within three years (Wolff, Boult, Boyd & Anderson, 2005). Epidemiologic research has demonstrated that a substantial proportion of older adults have multiple medical diagnoses (Vogeli, et al., 2007). As the prevalence of chronic illness in the current sample was generally low, it would be beneficial for future research to examine the impact of illness burden on EPS performance in a sample that is more representative of the general population.

Although one of the unique and informative aspects of the current study’s methodology is that it enables researchers to determine whether the additive effect of cumulative illness burden predicts EPS performance regardless of the specific diagnoses, future research could also examine the effect of specific illnesses and interactions among illnesses on EPS performance. Future research could also clarify the relationships among illness burden, SRH and EPS
performance. The potential for moderating and mediating relationships among chronic illness burden, SRH and EPS performance have not yet been examined. It would be informative to establish whether illness burden influences SRPF, which in turn affects everyday problem solving ability (i.e., whether SRPF mediates the relationship between illness burden and EPS performance). This would be a valuable method of determining the previously mentioned proposition that SRPF may indicate vascular illness burden in particular. Alternatively, due to its self-fulfilling quality (Bailis, et al., 2003; Ferraro, et al., 1997) it might also be that SRPF predicts illness burden, which then negatively impacts the ability to solve everyday problems (i.e., illness burden mediates the relationship between SRPF and EPS performance). Another possibility is moderation, where SRPF and illness burden interact to affect EPS. It could be that high illness burden predicts poor EPS performance particularly for individuals with low SFPF.

For future research examining chronic illness burden and EPS performance, it will be necessary to carefully consider the most accurate objective indicators of health. Although the use of an illness count is common in health research (Duff, Mold, & Gidron, 2009; Wolff, et al., 2005; Verropoulou, 2009), alternatively, measures such as the Cumulative Illness Rating Scale (Linn & Gurel, 1968) are available, which capture both objective (diagnoses) and subjective (severity and SRH) elements of health simultaneously. Future research may be able to use such a measure to examine chronic illness burden in relation to EPS performance. It would be ideal to find a measure that can be
used to capture the complexity of the combined subjective and objective impact of cumulative illness burden on EPS performance.

The current study contributes to our understanding of how different components of health status relate to older adults’ ability to solve everyday problems. Findings demonstrate the utility of SRPF in accounting for individual differences in EPS performance, highlighting the role of physical functioning in the real world problem solving ability of older adults. Continued exploration of the underlying health-related mechanisms of everyday cognition in older populations will be of great importance for future research, and may lead to positive real-world outcomes for the expanding aging population.
APPENDICES

Appendix A

For SRMH the square root transformation reduced skewness to an acceptable level within the range of 2 x the SE skewness. For SRPF the kurtosis value was reduced to a level within the range of 2 x the SE kurtosis; however, the level of skewness remained outside of the optimal range of 2 x the SE skewness; thus, a reflected $\log_{10}$ transformation was performed. However, there was no further improvement in skewness for SRPF subsequent to the reflected $\log_{10}$ transformation; thus, the reflected square root transformation was retained for both SFPF and SRMH (see Tables 14 and 15 for transformations). Because skewness does not make a substantive difference in the analysis when the sample size is 100 or more (Tabachnick & Fidell, 2007), we were not overly concerned about underestimation of variance. There were no other severe departures from normality for other independent variables or for the outcome variable. See Tables 16 and 17 for main analyses conducted using transformed variables.
Table 14. Amount of skewness in transformed variables of interest.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Untransformed Skew</th>
<th>Skew After Reflected Square Root Transformation</th>
<th>Skew After Reflected log(_{10}) Transformation</th>
<th>2 x SE Skewness*</th>
</tr>
</thead>
<tbody>
<tr>
<td>SRPF</td>
<td>-1.52</td>
<td>.647</td>
<td>-.691</td>
<td>+/- .478</td>
</tr>
<tr>
<td>SRMH</td>
<td>1.445</td>
<td>.478</td>
<td>N/A</td>
<td>+/- .478</td>
</tr>
</tbody>
</table>

Note: SRPF = SF-36 Short Form, Physical Functioning scale; SRMH = SF-36 Short Form, Mental Health scale

* Range of skewness thought to be acceptable for variables used in regression analyses (+/- 2 x SE skewness)

^ Only SRPF was not brought within range by transformation.

Table 15. Amount of kurtosis in transformed variables of interest.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Untransformed Kurtosis</th>
<th>Kurtosis After Reflected Square Root Transformation</th>
<th>Kurtosis After Reflected log(_{10}) Transformation</th>
<th>2 x SE Kurtosis*</th>
</tr>
</thead>
<tbody>
<tr>
<td>SRPF</td>
<td>1.717</td>
<td>-.133</td>
<td>-.127</td>
<td>.948</td>
</tr>
</tbody>
</table>

Note: SRPF = SF-36 Short Form, Physical Functioning scale; SRMH = SF-36 Short Form, Mental Health scale

* Range of Kurtosis thought to be acceptable for variables used in regression analyses (+/- 2 x SE Kurtosis)
Table 16. Intercorrelations among EPS, demographic variables, indices of illness burden, SRPF-trans, and SRMH-trans for the full sample (n = 102).

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
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</thead>
<tbody>
<tr>
<td>1 EPS</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>2 Age</td>
<td>-.44**</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>3 Gender</td>
<td>-.30**</td>
<td>-.01</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>4 Education</td>
<td>.38**</td>
<td>-.23*</td>
<td>-.04</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>5 General C1</td>
<td>-.06</td>
<td>.30**</td>
<td>-.02</td>
<td>.03</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>6 General C2</td>
<td>-.16</td>
<td>.28**</td>
<td>-.18</td>
<td>-.15</td>
<td>.20*</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>7 Non-Vasc C1</td>
<td>.01</td>
<td>.18</td>
<td>-.30**</td>
<td>-.04</td>
<td>.63**</td>
<td>.41**</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
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<tr>
<td>8 Non-Vasc C2</td>
<td>-.06</td>
<td>.27**</td>
<td>-.25*</td>
<td>-.02</td>
<td>.13</td>
<td>.64**</td>
<td>.20*</td>
<td>___</td>
<td>___</td>
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<td>___</td>
</tr>
<tr>
<td>9 Vasc C1</td>
<td>-.26**</td>
<td>.32**</td>
<td>.02</td>
<td>-.13</td>
<td>.36**</td>
<td>.48**</td>
<td>.18</td>
<td>.03</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>10 Vasc C2</td>
<td>-.28**</td>
<td>.25*</td>
<td>-.21*</td>
<td>-.26**</td>
<td>.08</td>
<td>.43**</td>
<td>.02</td>
<td>-.07</td>
<td>.32**</td>
<td>___</td>
<td>___</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>11 SRPF-trans</td>
<td>-.36**</td>
<td>.35**</td>
<td>.01</td>
<td>-.18</td>
<td>.23*</td>
<td>.24*</td>
<td>.14</td>
<td>.17</td>
<td>.28**</td>
<td>.26**</td>
<td>___</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>12 SRMH-trans</td>
<td>-.16</td>
<td>-.04</td>
<td>.07</td>
<td>-.07</td>
<td>.22*</td>
<td>.10</td>
<td>.15</td>
<td>.17</td>
<td>-.08</td>
<td>.01</td>
<td>.18</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>13 EF</td>
<td>.31**</td>
<td>-.55**</td>
<td>-.20</td>
<td>.15</td>
<td>-.27**</td>
<td>-.16</td>
<td>-.10</td>
<td>-.24*</td>
<td>-.28**</td>
<td>.31**</td>
<td>.04</td>
<td>___</td>
<td>___</td>
</tr>
</tbody>
</table>

Note. EPS = Everyday Problem Solving; General C1 = general illness burden contrast 1; General C2 = general illness burden contrast 2; Non-Vasc C1 = non-vascular burden contrast 1; Non-Vasc C2 = non-vascular burden contrast 2; Vasc C1 = vascular burden contrast 1; Vasc C2 = vascular burden contrast 2; SRPF = reflected square root of SF-36 Physical Functioning scale; SRMH = reflected square root of SF-36 Mental Health scale; EF = executive functioning

* Correlations among EF/Speed and all other variables were computed with an n of 97
* p < .05
** p < .01
Table 17. Hierarchical multiple regression examining transformed SRPH variable as a predictor of EPS performance.

<table>
<thead>
<tr>
<th>Predictor</th>
<th>B</th>
<th>S.E.</th>
<th>p</th>
<th>∆R²</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td></td>
<td></td>
<td></td>
<td>.334**</td>
</tr>
<tr>
<td>Age</td>
<td>-.890</td>
<td>.199</td>
<td>.001</td>
<td></td>
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<tr>
<td>Gender</td>
<td>-13.475</td>
<td>3.841</td>
<td>.001</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>2.055</td>
<td>.629</td>
<td>&lt;.001</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td></td>
<td></td>
<td></td>
<td>.030*</td>
</tr>
<tr>
<td>Age</td>
<td>-.717</td>
<td>.211</td>
<td>.001</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>-13.140</td>
<td>3.777</td>
<td>.001</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>1.925</td>
<td>.621</td>
<td>.003</td>
<td></td>
</tr>
<tr>
<td>SRPF-trans</td>
<td>-1.793</td>
<td>.843</td>
<td>.036</td>
<td></td>
</tr>
</tbody>
</table>

*Note. EPS = Everyday Problem Solving; SRPF = reflected square root of SF-36 Physical Functioning scale.
Significant p-values are indicated for the change in R² after the entry of each block of variables in the equation.

* p < .01
** p < .00
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