Do Disease Clusters Predict Depressive Symptoms in Older Adults?

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Abstract

Multimorbidity is a common occurrence among older adults and has significant ramifications on mental health. As depression is expected to become the top contributor to chronic disease burden, it is important to understand the effect of multimorbidity on depressive symptoms, and whether particular disease clusters are associated with increased depressive symptoms. The present study investigated whether chronic diseases clustered among an older adult population, and whether these clusters predicted depressive symptom severity. Secondary analyses were performed using interview data from the National Social Life, Health, and Aging Project (NSHAP). Participants were Black, White, and Hispanic adults ≥ 65 years of age (M=73.7, SD=5.7) who reported at least two chronic illness diagnoses (mean diagnoses = 3.1, *SD* = 1.2). Patterns of comorbidity were assessed using tetrachoric factor analysis and a multivariable linear regression model. Factor analysis demonstrated five disease patterns: cancers, arthritis, pulmonary, metabolic, and stress factors. Analyses demonstrated that the five factors were not predictive of increased depressive symptom severity. However, the total number of conditions was significantly associated with increased depressive symptomatology. This is likely due to the stress associated with chronic disease symptom management, and reflective of poor or unsuccessful disease management and symptom burden. These findings add to the limited body of knowledge investigating disease patterns in older adults, and help to better understand the reciprocal impact of chronic conditions on mental health.

Keywords: multimorbidity, depression, chronic illnesses, older adults

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Do Disease Clusters Predict Depressive Symptoms in Older Adults?

As a result of improvements in medical procedures and pharmacological treatments, conditions that were once considered fatal (e.g., congestive heart failure, chronic obstructive pulmonary disorder, diabetes) have become chronic, life-long conditions (Anderson & Horvath, 2004; Fortin, Lapointe, Hudon, Vanasse, Ntetu & Maltais, 2004; Garcia-Olmos et al., 2012). Termed "noncommunicable diseases (NCD)," these diseases are thought to be partially attributed to the general deterioration of the body with age, and thus adversely afflict older adults far more than younger adults (Benjamain, 2010; Bisschop, Kriegsman, Beekman & Deeg, 2004; CDC, 2016; Salive, 2013). Commonly referred to as chronic illnesses or chronic diseases, the umbrella term "noncommunicable disease" encompasses conditions that are unable to be passed from person to person (CDC, 2016; World Health Organization [WHO], 2015) with both an extended duration (usually greater than six months) and slow progression (Bisschop et al., 2004; Islam, Yen, Valderas & McRae, 2014). Inherent to these disorders is a complex, multifactorial etiology, and the development is often attributed to multiple risk factors, including environment, genetics, socioeconomic status, and human behavior (Bisschop et al., 2014). Furthermore, chronic illnesses vary in symptomatology, with a presentation heterogeneous to both the disorder and the individual (Wolff, Starfield & Anderson, 2002). Noncommunicable illnesses often have a long latency period (that is, an extended duration of time between exposure to illness and outward display of symptoms), with little demonstrable change over time (Bisschop et al., 2004; Williams, 1997).

Currently, the highest prevalence of chronic conditions is among older adults, with over 90% diagnosed with at least one disease (AARP, 2016; CDC, 2016). However, due to the etiology of chronic conditions, the diseases have a tendency to cluster, where the presence of one condition increases the likelihood of concurrently meeting criteria for another (Anderson & Horvath, 2004; Wolff et al., 2002). While the terms comorbidity and multimorbidity are often used interchangeably to describe the presence of two or more diseases, the operational definitions are quite distinct:

Comorbidity refers to a combination of disorders in addition to an index disease, where an index condition is defined as condition that is thought to be the primary or main disorder of focus (Feinstein, 1970; Formiga et al., 2013; Mercer, Salisbury & Fortin, 2014; Valderas, Starfield, Sibbald, Salisbury & Roland, 2009; van den Akker, Buntix & Knottnerus, 1996) (see Appendix A, Figure 1).

Multimorbidity refers to the co-occurrence of two or more chronic or acute conditions without an identifiable index disease (Formiga et al., 2013; Richardson & Doster, 2014; van den Akker et al., 1996) (see Appendix A, Figure 2). However, for the purpose of this paper and the following analyses (and as is consistent with the literature), the terms comorbidity and multimorbidity will be used interchangeably to describe situations in which individuals have more than one condition, as it is impossible to determine the presence of an identified index disease from the literature.

Morbidity, mortality, and chronic illnesses

Chronic illnesses are swiftly becoming a global health concern due to their significant association with elevated morbidity of additional diseases and mortality risk, as well as rising healthcare costs (Fisher & Ma, 2014). Global findings postulate that

greater than 60% of individuals suffer from comorbid chronic conditions, increasing to 80% for individuals over the age of 85 (Salive, 2013; Wolff et al., 2002), and are the leading cause of premature death and disability worldwide (CDC, 2016; Hunter & Reddy, 2013). Current estimates indicate that chronic illnesses account for roughly 1.7 million deaths each year in the United States alone (CDC, 2016; WHO, 2015).

The prevalence of multimorbidities (both nationally and globally) is expected to rise – current estimates project that 81 million Americans alone will be diagnosed with comorbid conditions by 2020 (Anderson & Horvath, 2004; Anderson & Knickman, 2001; Bayliss, Steiner, Fernald, Crane & Main, 2003). While exact numbers vary, studies consistently find that 29% - 75% of older adults in the United States have been diagnosed with at least two chronic conditions (Anderson & Horvath, 2004; Bayliss et al., 2003; CDC, 2016; Fillenbaum, Pieper, Cohen, Cornoni-Huntley & Guralnik, 2000; Fisher & Ma, 2014; Fortin, Bravo, Hudon, Vanasse & Lapointe, 2005; Fortin et al., 2004; Fortin, Soubhi, Hudon, Bayliss & van den Akker, 2007; Ploeg et al., 2017; Schoenberg, Kim, Edwards & Fleming, 2007; Ward, Schiller & Goodman, 2014; Wolff et al., 2002), with up to 25% diagnosed with four or more (Wolff et al., 2002).

Currently, most research focuses on single chronic conditions, which is quite limiting, and does not reflect complex realities, given the high prevalence rates of comorbid chronic conditions in older adults (Barnett et al., 2012; Vanfleteren et al., 2013). Furthermore, the little existing data varies across studies regarding common co-occurring conditions (Sinnige et al., 2013; van den Bussche et al., 2011). For example, a literature review conducted by Sinnige and colleagues (2013) found hypertension and diabetes to be frequently clustered individual conditions. However, a second study

conducted in 2011 found hypertension, lipid metabolism disorders, chronic low back pain, diabetes, osteoarthritis, and chronic ischemic heart disease to be the most frequently occurring individual diseases within the study population (van den Bussche et al., 2011). A third study illustrated a pattern of hypertension and diabetes, as well as hypertension and stroke, to be commonly disease combinations in older adults (Kirchberger et al., 2012).

Additionally, little information is available regarding common disease clusters, particularly in older adults (Marengoni et al., 2013; Marengoni, Rizzuto, Wang, Winblad & Fratiglioni, 2009). It is also unclear whether diseases cluster in a particular, predictable pattern (such as by body system, or according to health systems as defined by the WHO). The available literature broadly suggests a clustering among cardiovascular and metabolic disorders (Schafer et al., 2010; Sinnige et al., 2013; van den Bussche et al., 2011), cardio-respiratory diseases (Garin et al., 2016), and musculoskeletal disorders (Prados-Torres et al., 2014); however, these clusters tend to differ by study population. The observed differences in the literature may be due to inherent differences in the sample populations, geographical location (Kirchberger et al., 2012; Schafer et al., 2010), focused on racial/ethnic groups (Garin et al., 2014) or differences in inclusion criteria or study design (Schafer et al., 2010). As such, more research is needed to better investigate common disease clusters among those with multimorbidities, particularly in the older adult population.

Mood disorders and chronic illnesses

Not only are chronic illnesses associated with prolonged physical health symptoms and disease burden, but also with long-term psychological effects (Benjamin,

2010; Cella, 1994; Cella & Stone, 2015; Cella & Tulsky, 1993; Gandek, Sinclair, Kosinski & Ware, 2004). Current estimates suggest that the rates of mental health conditions (largely mood and anxiety disorders) are increased by roughly 41% among those with chronic illnesses (Turvey & Klein, 2008); comorbidity rates of depression alone fall between 20-30% among this population (Turvey & Klein, 2008). Depression is thought to be an independent outcome of chronic conditions and may develop as a result of increased symptom burden and functional impairment associated with these complex medical conditions (Blazer, 2004; Ludman et al., 2004; Richardson, Russo, Lozano, McCauley & Katon, 2008).

Depression has been cited as producing the greatest decrement in health status, and is expected to become one of the top contributors to chronic disease burden by 2020 (Moussavi et al., 2007). When compared with healthy cohorts, individuals in psychiatric distress more frequently report medical symptoms and functional impairments, and rate their symptoms and impairments as more severe (Hays, Wells, Sherbourne, Rogers & Spritzer, 1995; Johnson, Weissman & Klerman, 1992; Kroenke et al., 1997; Ludman et al., 2004; Ornel, Vonkorff, Ustun, Pini, Korten & Oldehinkel, 1994; Spitzer et al., 1995; Sullivan, LaCroix, Spertus & Hecht, 2000). Additionally, psychiatric conditions may further complicate the medical presentation, as they are associated with physical disability and greater symptom burden (Earnshaw & Quinn, 2012; Ludman et al., 2004; Richardson et al., 2008, Rutledge et al., 2006). This relationship appears be bidirectional (Turvey & Klein, 2008).

While an association exists between depression and increasing number of physical diseases (presented as a total sum) (Barnett et al., 2012; Gunn et al., 2012; Moussavi et

al., 2007), little information is available regarding the cumulative effect of multimorbidities on depressive symptoms. The literature is devoid of information investigating the effect of specific disease clusters on psychiatric well being, largely due to an inconclusive understanding of cluster patterns in older adults. With a better understanding of the impact of multimorbidities on depressive symptom severity, interventions and treatment plans can be better designed to improve overall health outcomes. Given the percentage of older adults who suffer from multimorbidities, in addition to the impact of depression on disease burden, it is crucial to understand the relationship among these variables. Therefore, the aims of the present study are:

1. To determine which chronic conditions cluster together most frequently
2. To investigate the relationship among disease clusters and depressive symptom severity
3. To better understand the psychosocial factors (gender, race/ethnicity, educational status, socioeconomic status, marital status) that impact the potential relationship among multimorbidities and depressive symptom severity

Methods

Participants

Parent project. Data for this study were obtained from the first wave of national longitudinal data collected by the National Social Life, Health, and Aging Project (NSHAP) from 2005 to 2006. The project is a population-based research study investigating health and social factors among community-dwelling older adults in the United States (Suzman, 2009). The parent study was designed to be a nationally representative probability sample of community-dwelling older adults born between 1920 and 1957, aged 57-85, with an oversampling of African-Americans and Hispanics (O'Muircheartaigh, Eckman & Smith, 2009; Suzman, 2009). To identify individuals within this specific demographic, NSHAP partnered with the 2004 household-screening wave of the Health and Retirement Study (HRS), which was recruiting for a new cohort (Suzman, 2009), and purchased the sample of adults aged 57-85 years (Suzman, 2009). Using a classic multistage area probability sample design, households were identified for interviewing if they fell into one of three predetermined age groups (57 to 65; 66 to 74; 75 to 84) of either gender (O'Muircheartaigh et al., 2009). Sample eligibility was defined based inclusively on year of birth (1920 – 1947) (O'Muircheartaigh et al., 2009). The final sample for this investigation included 3,005 individuals.

Participants completed face-to-face interviews and a self-administered post-interview (or a "leave-behind questionnaire"); the interview was completed in the individual's home in either English or Spanish using a Computer-Assisted Personal Interview (CAPI) questionnaire (Smith et al., 2009). Interviews were conducted by field interviewers who completed an extensive and standardized training prior to commencement.

Current project. For the purpose of this project, Wave 1 was selected for analysis, as it was determined to be the most complete dataset with variables related to chronic illnesses and mental health. The sample population was restricted by age (65 – 85 years), ethnicity (inclusive for those identifying as Caucasian, African-American or Hispanic Non-Black), and by disease diagnosis (including individuals with two or more diagnoses, as the current research is focused on multimorbidities), ending with a sample size of 1,371. This sample was inclusive for those identifying as Caucasian, African-American or Hispanic Non-Black, as 98% of the sample identified as such. It was deemed that the remaining two percent would not lend itself to a meaningful comparison with the three larger groups, and was thus excluded from analyses.

Measures

Chronic condition diagnosis. Prevalence of chronic conditions was assessed via self-report. Each participant was asked, "Has a medical doctor ever told you that you have any of the following conditions?" Participants were then read a list of conditions, with the interviewer checking off each item endorsed. Conditions included arthritis, diabetes or high blood sugar, skin cancer, cancer other than skin cancer, high blood pressure or hypertension, and emphysema, chronic bronchitis, or chronic obstructive lung disease. Participants responded with a "yes" or "no." See Appendix A, Figure 3 for the full measure.

Mental health variables. Depression symptomatology was measured using the 11-item Iowa Short Form of the Center for Epidemiological Studies Scale (CES-D) (Cagney, Browning, Iveniuk & English, 2014; Payne, Hedberg, Kozloski, Dale & McClintock, 2014). The Iowa Short Form of the CES-D was developed in 1993 in efforts

to reduce response burden for participants (Carpenter et al., 1998). The scale includes 11 of the original 20 items and collapses the two highest response categories (Carpenter et al., 1998). Factor analyses demonstrated this form maintained the same four-factor solution as the original form (Carpenter et al., 1998; Radloff, 1997). Reliability analyses showed good internal consistency ($\alpha = 0.81$), and scores were highly correlated with those from the original version ($rs > 0.83$) (Carpenter et al., 1998).

Respondents were asked how often in the past week they experienced thoughts and feelings consistent with depressive symptoms (see Appendix A, Figure 4 for full measure). Responses were presented in a 4 point scale ranging from "Rarely or none of the time," "Some of the time," "Occasionally," and "Most of the time." The two highest response options were collapsed ("Occasionally" and "Most of the time") into "Much or most of the time," to correspond most closely with the 11-item Iowa short form scale. Individuals who answered "Don't Know" or "Refused" were excluded from analyses.

Further calculations were conducted to determine the overall CES-D score, which indicates depressive symptom severity. The three response categories ("Rarely or none of the time", "Some of the time", and "Much or most of the time") were coded as 0, 1 or 2, respectively. The scores were then summed across the 11 elements to produce a total score ranging from 0-22, with higher scores indicating greater depressive symptomatology.

Sociodemographic variables. Sociodemographic factors used in analysis include age, sex, race/ethnicity, marital status, education, and household income. Age is presented as a continuous variable, calculated from the participant's reported date of birth and ranging from 65 to 85. Gender, ethnicity, marital status, education and household

income were self-reported. For analysis, race/ethnicity was categorized into three groups: Non-Hispanic White, Non-Hispanic Black, and Hispanic Non-Black. Education was categorized as: less than high school, high school degree or equivalent, vocational certificate/some college/associate's degree, and Bachelor's degree or higher. Marital status was assessed by asking participants to indicate whether they were married, living with a partner, divorced, separated, widowed, or never married. Participants who endorsed being separated, divorced, widowed or never married were asked, "Do you currently have a romantic, intimate, or sexual partner?" with possible responses "yes" or "no." Combined responses from these two questions will be dichotomized into a partnership variable, where individuals who endorsed married or living with a partner are dichotomized to *"*yes.*"* Household income was a continuous variable, where individuals reported their approximate household income for the last year.

Statistical Analyses

Descriptive analyses were calculated using means and frequencies. Differences in sociodemographic variables, prevalence rates of conditions, and number of multimorbidities were calculated across race using a Chi-square test and analysis of variance test. Analyses were conducted in R 3.3.3 (R Core Team, 2017) using the Psych package (Revelle, 2017).

An exploratory factor analysis was applied to determine the disease clusters. This method identifies groups of correlated diseases (i.e., factors) with an underlying common causal trait. Additionally, this method allows for diseases to be included in multiple simultaneous factors. As is consistent with previous studies (Garin et al., 2014; Kirchberger et al., 2012; Schafer et al., 2010), a tetrachoric matrix was utilized to account

for the presentation of diseases as binary variables (1 = disease present, 0 = disease not present). This assumes that the diseases have an underlying, continuous characteristic (i.e., the diseases are progressive) (Prados-Torres et al., 2012). The factors were extracted using the ordinary least squares method, and the number of factors was determined using parallel analysis. Parallel analysis compares the factor scree of the observed data with that of a similar sized simulated random matrix to determine the number of factors appropriate for extraction (Revelle, 2017). An oblique (Oblimin) rotation was applied for easier interpretation of the results. To determine the adequacy of the sample, a Kaiser-Meyer-Olkin (KMO) test was conducted. This measurement provides values between zero and one, where values closer to one indicate a greater goodness of fit. Additionally, the proportion of cumulative variance was obtained to provide the variance as explained by each factor (Garin et al., 2014; Poblador-Plou et al., 2014; Prados-Torres et al., 2012). Factors with loadings $\geq$0.25 were selected, as is consistent with previous studies (Garin et al., 2014; Kirchberger et al., 2012; Schafer et al., 2010). As multimorbidity is defined as the presence of two or more conditions, individuals were determined to have a specific disease pattern if they presented with at least two disorders that comprised the cluster.

As CES-D scores were positively skewed, a base ten logarithmic transformation was utilized, resulting in a normal distribution of scores. Given the body of literature implicating depression as an outcome of chronic illnesses, depressive symptom severity was determined to be the variable of interest in this study (Blazer, 2004; Ludman et al., 2004; Richardson, Russo, Lozano, McCauley & Katon, 2008; Simon, 2001). As such, multivariate linear regression models were calculated to investigate the relationship among disease clusters and depressive symptom severity, while adjusting for

sociodemographic variables (age, sex, ethnic group, education level, marital status, and income).

Results

Participant Characteristics

Of the 1,371 participants analyzed, the majority identified as non-Hispanic White/Caucasian and female, with a mean age of 73.9 (*SD* = 5.7) years. More than half of the sample was married or living with a partner. Statistically significant differences were observed when comparing race/ethnicity with regard to marital status, education, and income. Black participants were less likely to be married, and reported significantly lower income, while Hispanic participants reported the lowest educational attainment. Additional sociodemographic characteristics are provided in Table 1 (Appendix B).

Significant differences were also observed across race/ethnicity regarding depressive symptom severity ($p = <0.001$), with Hispanic participants reporting the most severe depressive symptoms (Appendix B, Table 2).

Prevalence Rates of Chronic Conditions and Multimorbidities

Participants reported being diagnosed with an average of three (*M* = 3.1, *SD* = 1.2) medical conditions (Appendix B, Table 3). While the sample only included participants endorsing two or more health conditions, nearly a third were diagnosed with four or more. Racial groups did not differ with respect to the total number of diagnosed conditions.

Arthritis, hypertension, and cancers were found to be the most frequently occurring diseases in the overall study population (Appendix B, Table 4). Data showed that arthritis was the most frequently endorsed chronic illness. Cancers, emphysema/chronic bronchitis/COPD, and thyroid problems were significantly more common among White participants; Black and Hispanic participants reported

significantly higher rates of both diabetes and hypertension. Additionally, stroke and poor kidney function were significantly more prevalent among Black participants.

Patterns of Multimorbidities in Older Adults

Four factors were selected based on both the parallel analysis and scree plot. Per established guidelines, the KMO measure (KMO = 0.52) indicated a "miserable" sampling adequacy for factor analysis; this is likely due to low correlations among the diseases in the dataset. The final model demonstrated a Tucker Lewis Index of factoring reliability (TLI = 0.997) and the RMSEA index (0.009, CI = 0, 0.037), suggesting the final model was a very good fit for the dataset, accounting for a cumulative variance of 40%. Arthritis was found to have negative loadings on each factor, and was subsequently placed into the regression model as an independent predictor variable. Leukemia, lymphoma, skin cancer, and other cancers were compiled into a single cancer diagnosis, which comprised the fourth factor (cancer factor).The third factor included emphysema or COPD and asthma (pulmonary factor). The fourth factor included hypertension and diabetes (metabolic factor). Ulcers and stroke comprised the fifth factor (stress factor). Alzheimer's disease, cirrhosis, and poor kidney function were excluded from the factor analysis, given their low prevalence rates in the sample (one, one, and seven percent, respectively). Thyroid problems were also excluded from the factor analysis due to the corresponding low TLI factoring reliability estimate. Table 5 illustrates the factor loadings for each condition.

Among the total sample, approximately half (49.5%) was assigned to one disease pattern, 34.9% to two, and 7.1% to three or more. Only nine percent of participants could not be assigned to any of these disease patterns.

Multimorbidity Patterns as Predictors of Depression in Older Adults

A series of hierarchical regression models were conducted to investigate the degree to which patterns of multimorbidities predict severity of depressive symptomatology (as measured by the CES-D), above and beyond that of sociodemographics. Variables were entered into the model in two steps: the first step included the sociodemographic variables as independent predictors (age, gender, race/ethnicity, marital status, income, and education). The second step included both sociodemographic variables and the multimorbidity disease patterns as determined by the factor analysis.

Table 6 (Appendix B) shows the results from the hierarchical regression models, investigating the predictive power of sociodemographic variables and multimorbidity patterns with respect to depressive symptom severity. The first model demonstrated race/ethnicity to be significantly predictive of greater depressive symptom severity. Marital status, higher education, and greater income were significantly predictive of lower symptom severity.

The second regression analysis (Model 2) included only factors determined by the factor analysis (arthritis, cancer, pulmonary, metabolic, and stress factors), adjusting for sociodemographic variables. This model finds the presence of arthritis ($p = 0.003$), the pulmonary factor (asthma and emphysema or COPD, $p = 0.003$), and the stress factor (ulcers and stroke, $p = 0.008$) to be significantly predictive of increased depressive symptom severity. A significant change in variance was observed after the inclusion of disease factors as predictors when compared with baseline sociodemographics ($\Delta R^2 =$

0.015, $p < 0.001$), suggesting that disease diagnoses accounted for 2% more of the variance observed in CES-D total scores above the sociodemographic predictors.

A third regression analysis (Model 3) was conducted including predictors from Model 2, as well as the diseases of which the factors were comprised to account for baseline disease effect. This was done to determine whether the associated factors contributed to the increase in depressive symptom severity, above and beyond the impact of each individual disorder. The inclusion of additional diseases reduced the estimates for the individual factors found to be significant predictors in the previous model. After adjusting for all predictors in a simultaneous model, arthritis, cancers, stroke, emphysema or COPD, and asthma were all found to be significantly associated with increased CES-D scores. A significant change in variance was observed when comparing Model 2 and Model 3 ($\Delta R^2 = 0.017$, $p < 0.001$). Furthermore, a significant change in variance was observed with the increase inclusion of additional diseases as predictors when compared with Model 1 ($\Delta R^2 = 0.032$, $p < 0.001$).

A fourth regression analysis (Model 4) was conducted utilizing the predictors in the previous model (Model 3), as well as the remaining conditions (poor kidney function, thyroid problems, cirrhosis, and Alzheimer's/dementia, i.e., those not included in the factor analysis). This inclusion led to a significant increase in variance when comparing Model 4 with Model 3 ($\Delta R^2 = 0.006$, $p < 0.001$. This suggests that the inclusion of all diseases as predictor variables accounts for a 4% increase in the variance of depressive symptom severity when compared to the effect of sociodemographic variables alone.

Discussion

The current project contributes to the limited information available regarding disease clusters in older adults, particularly regarding the effect of multimorbidities on depressive symptom severity. Given the high rate of comorbidity and multimorbidity in this population, our findings help to better identify diseases that often occur simultaneously, which may in turn affect mental health outcomes.

Results showed that significant differences existed across race/ethnic groups regarding depressive symptom severity as measured by the CES-D, with Hispanic individuals endorsing the most severe depressive symptoms. This is consistent with the available literature (Gonzalez, Tarraf, Whitfield & Vega, 2010), indicating a higher prevalence of mood disorders among Hispanic and Black older adults.

Significant differences were also observed across race/ethnic groups with respect to specific medical conditions. Diabetes and hypertension were found to be significantly higher among Blacks and Hispanics. These conditions are more prevalent among minority individuals and are inversely associated with socioeconomic standing (Joshy et al., 2009), compounded by risk factors such as obesity, physical inactivity, tobacco use, and diet. These findings are further supported by the discrepancy observed when comparing income across race/ethnicity, as Blacks and Hispanics reported significantly lower incomes.

Blacks were also noted to have a higher prevalence of poor kidney function, which is consistent with current literature indicating a threefold increased risk among Black individuals (National Kidney Foundation, 2016). Kidney failure is often a direct consequence of diabetes and hypertension; hypertension leads to increased pressure in the

blood vessels, which can lead to blockage resulting in kidney failure (Joslin Diabetes Center, 2017). Additionally, high levels of cholesterol and blood sugar can impair vessels, both of which are seen in individuals with diabetes (Joslin Diabetes Center, 2017). Both diabetes and hypertension demonstrated significant elevations in this population; as such, the significant occurrence of poor kidney function is likely related to these two diseases. Additionally, similar to other conditions, kidney disease is impacted by sociodemographic factors such as obesity, physical inactivity, diet, access to resources, and adequate care.

White participants endorsed a higher prevalence of cancers, which was largely driven by skin cancer and other unknown types of cancers. Whites are more likely to suffer from skin cancer due to the pigment of the skin – darker skin produces more melanin, which helps protect the skin from ultraviolet radiation (Buster, You, Fouad & Elmets, 2012; Linos et al., 2009; Skin Cancer Foundation, 2016). Interestingly, skin cancer is more prevalent among those from higher socioeconomic statuses. Individuals from more affluent backgrounds may participate in more outdoor leisure activities such as gardening, exercise, or playing sports, thus increasing their contact with harmful ultraviolet rays (Hausauer, Swetter, Cockburn & Clarke, 2011). Furthermore, White individuals are more likely to seek out medical attention and receive specialty care; as a result, cancer tends to be discovered sooner and at earlier staging. These findings may be reflective of those who have both access to resources (medical and financial) and have sought medical care (Cook et al., 2013; Welch et al., 2005).

Disease Patterns in Older Adults

The factor analysis portion of this study revealed four patterns of multimorbidities in a representative sample of individuals 65 years and older. The first pattern of multimorbidities, "pulmonary," was comprised of emphysema, chronic bronchitis, or COPD, as well as asthma. Despite their differing pathophysiology, asthma and COPD often occur simultaneously, forming a condition known as overlap syndrome (Bell & Busse, 2015; Soriano et al., 2003). As more than 40% of individuals diagnosed with COPD have a history of asthma, asthma has been cited as a potential risk factor for the development of COPD (de Marco et al., 2013; Diaz-Guzman, Khosravi & Mannino, 2011). Asthma, emphysema, and COPD are the most common obstructive lung diseases (Diaz-Guzman et al., 2011; Soriano et al., 2003), and their prevalence increases with age (Diaz-Guzman et al., 2011). Given the overlap among these conditions, as well as the body systems implicated, it is possible that impairment in one part of the pulmonary system leads to increased risk for impairment in another, thus contributing to the findings of overlap syndrome.

The second pattern, termed "metabolic," included hypertension and diabetes. Hypertension is found twice as often in those diagnosed with diabetes (Barnett, 1994; Sowers, Epstein & Frohlich, 2001). While estimates vary, studies suggest that 20-70% of individuals with diabetes concurrently have hypertension, a combination likely due to underlying obesity or endothelial dysfunction (defined as an imbalance of the factors involved in the constriction and relaxation of the endothelium, which contributes to hypertension and diabetes, among other conditions) (Deanfield et al., 2005; Deedwania, 2000; Kaplan, 2002). Furthermore, the presence of one disease exacerbates the other (Sowers et al., 2001), and hypertensive diabetic patients often suffer from increased

diabetic-related complications, such as retinopathy or nephropathy (American Diabetes Association, 2017).

The third multimorbidity pattern, "stress," was comprised of stroke and ulcers. Research has found a correlation between stroke and pressure ulcers, possibly related to undernourishment secondary to eating difficulties following a stroke (Ek, 1987; Suttipong & Sindhu, 2012; Westergren et al., 2001). Other factors contributing to pressure ulcers post-stroke include decreased mobility, impaired functional status, and difficulty conducting activities of daily living (Lindgren, Unosson, Fredrikson & Ek, 2004; Suttipong & Sindu, 2012; Westergren et al., 2001). However, as it is unclear the type of ulcers experienced by individuals within this study population, it is impossible to state whether these findings are consistent with previous research. It could also be, perhaps, that both are associated with stress and chronic activation of the hypothalamic-pituitary-adrenal axis (HPA axis). Older adults experience a number of significant life changes that accompany the aging process that can lead to increased stress (e.g., retirement, death of a spouse or loved one, inability to participate in activities that were previously enjoyed). Chronic stress has been demonstrated to have gastrointestinal effects, and can lead to the onset or exacerbation of chronic digestive disorders (Mayer, 2000). Furthermore, increased and sustained activation of the HPA axis (created by elevated levels of cortisol due to stress) has been implicated in acute stroke (Fassbender et al., 1994). This disease factor may be indicative of poor coping mechanisms among these individuals, and may warrant further investigation as a possible area of intervention in the future.

Lastly, the fourth pattern, "cancers," included skin cancer, leukemia, lymphoma, and other types of cancers not defined by the initial researchers. These conditions were combined into a single group prior to analyses, and were not found to load simultaneously with other factors. This is likely due to the varying types of cancers in this group, as they are quite unique and impact the body in differing ways. Cancer is characterized by uncontrollable division dispersion of cells into the surrounding tissue (National Cancer Institute, 2015), and affects the body in a detrimental manner unique to this disease category. As such, the biological uniqueness of this disorder may explain the singular loading on the fourth factor.

Disease patterns and depressive symptoms

While the observed factors were initially predictive of increased depressive severity, the significance was eliminated with the inclusion of additional conditions and diseases. However, the total number of conditions was predictive of increased depressive symptom severity (Table 7). This is consistent with current literature, suggesting that incidence of depression increases with number of chronic illnesses (Barnett et al., 2012; Gunn et al., 2012; Moussavi et al., 2007). These findings may be reflective of participants who struggle to successfully manage their chronic conditions. It may be that symptom severity is driven not by particular disease clusters, nor is it a reflection of the interaction between specific diseases and mental health, but rather the effort that is required to successfully manage multiple chronic diseases. Individuals with an increasing number of physical health conditions may experience depressive symptoms if they are burdened by the effort necessary to manage these diseases and have not established effective coping strategies to mitigate this stress. It is possible that, for certain individuals, once a disease

threshold is met, the depressive symptoms that occur are irrespective of the types of diseases, but are reflective of the combination of ailments with which the individual is struggling.

Part of the stress that accompanies chronic diseases is learning to effectively manage the symptoms and slow the disease progression. Treatment for chronic conditions is heavily based on self-management, which requires time, effort, and motivation (Harrison et al., 2012); for example, insulin-dependent diabetes involves the administration of insulin, as well as proper management of blood sugar levels. For older adults with multimorbidities, resources (physical, emotional, and cognitive) to engage in treatment may be limited or insufficient. Furthermore, self-management is reliant upon a high level of cognitive capacity – for those with cognitive deficits, this may be difficult or impossible. Given the degree of self-management, as well as the burden associated with chronic conditions (Barnett et al., 2012; Benjamin, 2010; Chan & Corvin, 2016; Gunn et al., 2012; Harrison et al., 2012), it is postulated that the reported depressive symptom severity as seen in this study is driven by the stress associated with coping with multimorbidities.

Depression and disease management

Research has illustrated a strong correlation, as well as potential causal relationship, between chronic illnesses and depression, particularly with multimorbidities. Depression is thought to be an independent outcome of chronic illnesses and may develop as a result of increased symptom burden, disease management, and functional impairment associated with these complex medical conditions (Blazer, 2004; Ludman et al., 2004; Richardson et al., 2008). Individuals with chronic diseases consistently report a

decreased quality of life (Benjamin, 2010; DuGoff, Canudas-Romo, Buttorff, Leff, & Anderson, 2014; Fortin et al., 2004; Kroenke, Jackson & Chamberlin, 1997; Ludman et al. 2004; Salive, 2013), driven largely by disability, loss of independence, and rapid declines in health (Earnshaw & Quinn, 2012; Fortin et al., 2004; Salive, 2013; Violan et al., 2014; Verbunt et al., 2005; Wolff et al., 2002). Additionally, medication usage may play a role in the onset of depressive symptomatology. A study conducted in 2005 found 87% of Americans 65 years or older reported taking prescription medications daily (AARP, 2005). Of this population, individuals reported taking an average of four medications a day (AARP, 2005). Unfortunately, medications used to treat chronic illnesses (e.g., cancer medications, beta blockers, corticosteroids, gastrointestinal and respiratory medications) often have negative mood side effects (Alexopoulos, 2005; Djernes, 2006; Fiske et al., 2009), and may contribute heavily to depressive symptomatology.

Further challenges associated with multimorbidities involve the treatment of these disorders - older adults with multiple chronic conditions are often under the care of multiple different providers. Medical management is complicated and requires substantial coordination. Proper care coordination among specialties is, unfortunately, often unsuccessful, as physicians may fail to communicate with (or be aware of) other specialists, may be uninformed of the medication and care regimens provided by other specialists, and/or may recommend conflicting or contraindicated treatments (Peikes, Chen, Schore & Brown, 2009; Pham et al., 2007). Participants who report higher depressive symptom severity may also have greater difficulties coordinating and receiving adequate care.

Furthermore, depression management may be overlooked in individuals with multiple chronic conditions, as attention may be focused on the physical health conditions given their chronicity and complexity (Nutting, Rost, Smith, Werner & Elliot, 2000; Rost et al., 2000; Vyas & Sambamoorthi, 2011). Older adults are more likely to seek mental health treatment from their primary care providers (Fiske, Wetherell & Gatz, 2009), where time and resources are limited. In this setting, depression symptoms compete with other ongoing medical concerns, and may be considered less urgent given physician time constraints (Nutting et al., 2000). Additionally, few clinicians are trained to detect depression in older adults, and many incorrectly attribute worsening mood symptoms to the aging process. Therefore, it is possible that the symptoms seen in this population are heavily impacted by the competing demands of their other physical health conditions, and little attention is granted to the alleviation of these symptoms.

A number of other factors impact the care and disease management for older adults. Older adults have smaller social networks than younger adults (Fiori, Antonucci & Cortina, 2008), which may have detrimental effects on mental health. Introverted older adults have even smaller social networks, reducing the amount of social support at their disposal. Spouses or caregivers can be crucial in assisting in disease management, particularly with respect to coordinating care among specialists; those without this support may struggle to manage these activities on their own. It is therefore possible that participants endorsing increased mood symptoms have limited social supports and endure more social isolation.

For those without easy access to transportation, attending a variety of appointments or obtaining medications may be a challenge. Older adults may lose the

ability to drive safely; for many, this leads to a greater reliance on family members, friends, or public transportation to attend medical appointments. Coordinating care is further impacted by transportation challenges, and older adults may question the necessity of attending an appointment if they are unable to secure safe transportation. Driving cessation has been demonstrated to heavily impact quality of life, as activities that were once conducted seamlessly now require increased coordination and reliance on others (Fonda, Wallace & Herzog, 2001).

Older adults experience a series of personal losses that impact overall mental health. They experience the loss of loved ones, difficulty or inability to conduct activities independently, increased reliance on others, and worsening health. For those with multimorbidities, these are further compounded by disease progression that heavily impacts senescence. It is therefore postulated that the findings of this study reflect a difficulty coping and conducting disease management that is related to the total number of diagnosed conditions and irrespective of the type of chronic illness with which an individual is diagnosed.

Limitations

This study has several limitations. The study utilized a cross-sectional design, and as such, no causal relationships may be inferred among disease factors. Furthermore, disease conditions were assessed based on occurrence – no information is available regarding age at onset, length of occurrence, or severity. This information was gathered via self-report, and no further medical tests or documentation were required to confirm this diagnosis. The data also does not address whether these conditions are co-morbid or

multimorbid, nor does it indicate whether depressive symptomatology began prior to or after the onset of chronic illnesses.

Statistical analyses revealed little correlation among the diseases within this sample. This is driving the low sampling adequacy seen with the KMO test. This is likely due, in part, to the types of conditions available for endorsement, as well as the population selected for the sample. Given this finding, factor analysis is not the best method for analyzing patterns of disease relationships with a nationally representative heterogeneous sample of older adults. It is suggested that future studies should consider the possible limitations of this type of analysis when conducting research among this subset of the population.

As the study was a secondary data analysis, there was little control over the format of the variables, particularly with respect to the health conditions. For example, COPD, chronic bronchitis, and emphysema are grouped into one variable, making it impossible to determine the portion of individuals diagnosed with any or all of these conditions. Specific cancer prompts included lymphoma, leukemia, and skin cancer; all other forms of cancer were condensed into an "other" category, thus diminishing the biological differences inherent to these diseases. If the "other cancers" category had been further broken down, it may have been possible to determine whether cancers also factored by body system, as was seen with the cardiorespiratory and metabolic factors, or whether specific types of cancers factored with other health conditions. Furthermore, incidence rates of cancer types differ by racial/ethnic group and sex, a distinction that is impossible to observe with the grouping of these variables. Mental health conditions, such as depression and anxiety, were also notably absent from the available list of

diseases, despite current findings suggesting that greater than 20% of older adults suffers from mental illness (CDC, 2008).

As has been indicated in previous research (Garin et al., 2014; Kirchberger et al., 2012), the external validity of these findings is limited, as studies have consistently used different numbers and types of conditions, which ultimately affects the observed factoring pattern. The overarching study of multimorbidities would benefit from an established standard for assessment across study populations (Kirchberger et al., 2012), which would strongly increase the generalizability of the findings.

Future Directions

The results of this study contribute to the existing body of knowledge striving to understand disease patterns in older adults. This study additionally incorporates the usage of depression symptomatology, and attempts to better understand the factors (both sociodemographic and physiological) that are contributing to increased depression severity in the geriatric population. Further research is needed to establish an international standard for assessing multimorbidity across disciplines, including a set group of conditions to be included in analysis. By doing so, studies can be compared more seamlessly across populations, ethnicities, and demographics, increasing the overall understanding regarding disease patterns, especially among older adults. Creating a mechanism for better understanding disease patterns and clusters will likely lead to a more thorough and comprehensive understanding of the factors perpetuating the actual diseases, as well as subsequent health outcomes across domains.

Future research is also needed pertaining to the effect of medications on both multiple chronic conditions and depressive symptomatology. As this study did not

investigate the role of medications or medication side effects, it is unclear the extent to which they may be impacting depressive outcomes. Medications utilized to treat chronic conditions (e.g., beta blockers, gastrointestinal or respiratory medications, some cancer medications) often have negative mood effects and may cause depression (Alexopoulos, 2005; Djernes, 2006; Fiske et al., 2009). Therefore, future research is warranted to explore this relationship and better understand the etiology of depressive symptoms in the chronically ill population.

The clinical implications of this research are primarily related to the impact on treatment intervention both regarding the physical/medical and mental health aspects of care of older patients. A better understanding of the complex dynamic both among and between chronic conditions can help guide treatment for those with overlapping conditions. This information can be utilized to better coordinate care, particularly among differing specialties. Furthermore, it is crucial to comprehend the relationship between depression and the cluster of multiple chronic conditions, as depression can negatively impact disease outcomes (Earnshaw & Quinn, 2012; Ludman et al., 2004; Moussavi et al., 2007; Richardson et al., 2008, Rutledge et al., 2006). Understanding disease patterns with respect to mental health will help healthcare providers to better assess and care for the depressive symptomatology that is so common among the chronically ill population.

Additionally, increased psychoeducation regarding disease courses and patterns can foster patient autonomy, thus allowing older adults to feel more involved in their care and care decisions and better able to handle their own disease management. It is possible that a better understanding of these conditions, and subsequently improved treatment

regimens, will lead to improvements in life quality for older adults, with positive impacts on mental health.

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Appendix A

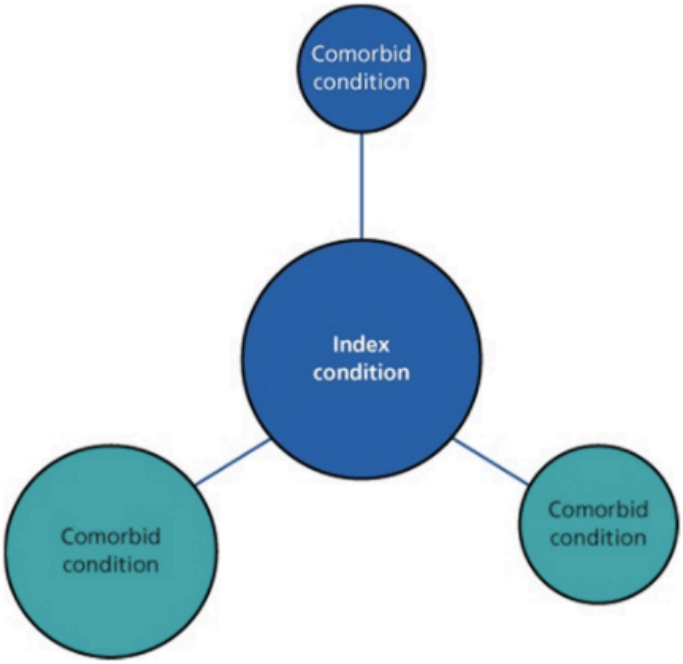

Figure 1. Conceptual diagram of comorbidity (Mercer, Salisbury & Fortin, 2014). This facilitates the understanding of comorbid conditions.

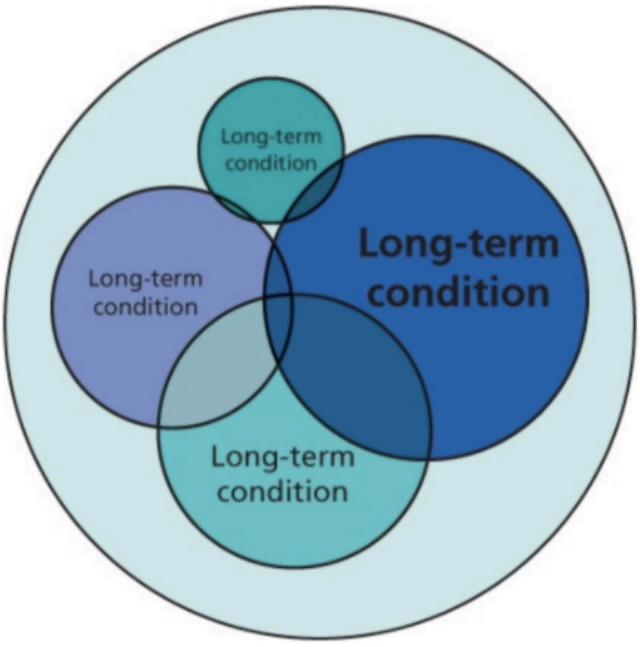

Figure 2. Conceptual diagram of multimorbidity (Mercer, Salisbury & Fortin, 2014). This facilitates the understanding of multimorbid conditions.

6. Has a medical doctor ever told you that you have any of the following conditions? (PROMPT: Medical doctors include specialists such as dermatologists, psychiatrists, ophthalmologists, as well as general practitioners and osteopaths. Do not include chiropractors, dentists, nurses, or nurse practitioners.) (CHOOSE ALL THAT APPLY.)
   - ❑ Arthritis
   - ❑ Stomach ulcers, or peptic ulcer disease
   - ❑ Emphysema, chronic bronchitis, or chronic obstructive lung disease
   - ❑ Asthma
   - ❑ Stroke, cerebrovascular accident, blood clot or bleeding in the brain, or transient ischemic attack (TIA)
   - ❑ High blood pressure or hypertension
   - ❑ Diabetes or high blood sugar
   - ❑ Alzheimer's disease or another form of dementia
   - ❑ Cirrhosis, or serious liver damage
   - ❑ HIV/AIDS
   - ❑ Leukemia or polycythemia vera
   - ❑ Lymphoma
   - ❑ Skin cancer (including melanoma, basal cell carcenoma, squamous cell carcinoma)
   - ❑ Cancer, other than skin cancer, leukemia or lymphoma
   - ❑ Poor kidney function (blood tests show high creatinine), used hemodialysis, peritoneal dialysis, or received a kidney transplantation
   - ❑ Thyroid problems
   - ❑ **MEN ONLY:** Enlarged prostate gland
   - ❑ NONE
   - ❑ DON'T KNOW
   - ❑ REFUSED

Figure 3. Medical condition self report. This self-report questionnaire was used to determine chronic illness diagnoses.

Now let's talk about thoughts and feelings you may have had during the past week. I will read a series of statements. Tell me how often during the past week you felt like this; rarely or none of the time, some of the time, occasionally, or most of the time? Don't take too long over your replies; your immediate reaction to each item will probably be more accurate than a long thought out response. During the past week …

	Rarely or none of the time	***Some of the time***	***Occasion-ally***	***Most of the time***	***DK***	***REF***
I did not feel like eating; my appetite was poor	☐	☐	☐	☐	☐	☐
I felt depressed	☐	☐	☐	☐	☐	☐
I felt that everything I did was an effort	☐	☐	☐	☐	☐	☐
My sleep was restless	☐	☐	☐	☐	☐	☐
I was happy	☐	☐	☐	☐	☐	☐
I felt lonely	☐	☐	☐	☐	☐	☐
People were unfriendly	☐	☐	☐	☐	☐	☐
I enjoyed life	☐	☐	☐	☐	☐	☐
I felt sad	☐	☐	☐	☐	☐	☐
I felt that people disliked me	☐	☐	☐	☐	☐	☐
I could not "get going"	☐	☐	☐	☐	☐	☐

Figure 4. Center for Epidemiological Studies Depression Scale, Iowa 11-item Short Form. This assessment was utilized to provide a measure of depressive symptoms

Appendix B

Table 1

Sample Characteristics

		Total sample (n=1,371) Mean (SD) / n (%)	White (n=1,008) Mean (SD) / n (%)	Black (n=249) Mean (SD) / n (%)	Hispanic (n=109) Mean (SD) / n (%)	*p-value*
Age		73.92 (5.72)	74.29 (5.78)	72.90 (5.42)	72.99 (5.48)	
Gender						0.47
	Female	776 (56.60)	560 (55.55)	149 (59.84)	63 (57.80)	
Marital status						<0.001***
	Married / living with a partner	734 (53.53)	590 (58.53)	80 (32.13)	63 (57.80)	
Education						<0.001***
	< High school	375 (27.35)	181 (17.96)	120 (48.19)	72 (66.06)	
	> High school	996 (72.64)	827 (82.04)	129 (51.81)	37 (33.94)	
Income‡						<0.001***
		26,479.72 (46,613.09)	30,323.28 (51,092.14)	13,671.03 (16,855.45)	20,303.20 (44,308.29)	

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

‡Income was reported as household income for the last year

Table 2

Incidence of Depressive Symptoms

Race/Ethnicity	CES-D Mean (SD)	*p-value*
White/Caucasian	16.78 (4.99)	<0.001***
Black	17.88 (5.45)	
Hispanic	19.21 (6.61)	

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Table 3

Prevalence Rates of Multimorbidities

	Total sample (n=1,371) (*M, SD*)	White (n=1,008) (*M, SD*)	Black (n=249) (*M, SD*)	Hispanic (n=109) (*M, SD*)	*p-value*
Number of reported diseases	3.12 (1.20)	3.16 (1.22)	2.99 (1.13)	2.97 (1.08)	0.06

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Table 4

Disease Prevalence Rates

Diseases	Total sample (n=1,371) (%)	White (n=1,008) (%)	Black (n=249) (%)	Hispanic (n=109) (%)	*p-value*
Alzheimer's or dementia	1.31	1.19	1.20	1.83	0.85
Arthritis	71.19	70.14	76.31	67.89	0.12
Asthma	13.06	13.19	11.24	14.68	0.61
Cancers	36.54	44.74	13.25	14.68	<0.001***
Leukemia	0.73	0.89	0.40	0.00	0.46
Lymphoma	1.31	1.49	0.40	1.83	0.36
Skin cancer	22.32	29.66	0.00	6.42	<0.001***
Other cancers	17.72	20.14	12.45	7.34	<0.001***
Cirrhosis	1.17	1.29	1.20	0.00	0.49
Diabetes	29.76	24.50	42.57	49.54	<0.001***
Emphysema, COPD, or chronic bronchitis	16.48	18.55	8.43	14.68	<0.001***
Hypertension	75.35	71.23	88.35	82.57	<0.001***
Poor kidney function	6.78	5.95	10.44	5.50	0.04*
Stroke	13.86	14.09	16.87	3.67	0.003**
Thyroid problems	21.59	24.31	12.45	15.60	<0.001***
Ulcers	19.77	19.84	16.87	25.69	0.16

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Table 5

Disease factor loadings

Diseases	Factor 1	Factor 2	Factor 3	Factor 4
Arthritis	-0.08	-0.07	-0.58	-0.05
Asthma	-0.07	0.79	-0.01	-0.1
Cancers	1	-0.02	0.01	-0.01
Diabetes	-0.18	-0.08	0.32	-0.19
Emphysema or COPD	0.06	0.65	0.05	0.18
Hypertension	-0.26	-0.23	0.26	-0.18
Stroke	-0.11	-0.05	0.18	0.36
Ulcers	-0.18	-0.01	-0.11	0.34
Factor name	Cancers	Pulmonary	Metabolic	Stress

Note: factor scores $\geq$0.25 are highlighted

Table 6

Hierarchical regression analysis of depressive symptoms

	Individual Model			Hierarchical Regression	
	Beta	SE	*p*-value	ΔR^2	*p*-value
Model 1				0.04	<0.001***
Age	0.001	0.050	0.30		
Gender	0.009	0.001	0.21		
Race/ethnicity	0.014	0.007	0.01*		
Marital status	-0.014	0.006	0.04*		
Education	-0.019	0.003	<0.001***		
Income	0.000	0.000	0.003**		
Model 2				0.015	<0.001***
Age	0.000	0.001	0.422		
Gender	0.009	0.007	0.210		
Race/ethnicity	0.016	0.006	0.005**		
Marital status	-0.015	0.007	0.030*		
Education	-0.018	0.003	<0.001***		
Income	0.000	0.000	0.003**		
Arthritis	0.022	0.007	0.003**		
Cancers	0.014	0.007	0.052		
Pulmonary factor	0.042	0.014	0.003**		
Metabolic factor	0.012	0.008	0.124		
Stress factor	0.048	0.018	0.008**		
Model 3				0.017	<0.001***
Age	0.000	0.001	0.640		
Gender	0.009	0.007	0.221		
Race/ethnicity	0.017	0.006	0.002**		
Marital status	-0.015	0.007	0.037*		
Education	-0.017	0.003	<0.001***		
Income	0.000	0.000	0.002**		
Arthritis	0.025	0.007	<0.001***		
Cancers	0.017	0.007	0.019*		
Pulmonary factor	-0.016	0.021	0.451		
Metabolic factor	0.029	0.018	0.099		
Stress factor	0.000	0.022	0.989		
Hypertension	0.004	0.009	0.657		
Diabetes	-0.016	0.016	0.309		
Ulcers	0.015	0.009	0.086		
Stroke	0.033	0.011	0.002**		
Emphysema	0.031	0.011	0.003**		
Asthma	0.035	0.012	0.005**		

Model 4				0.006	<0.001***
Age	0.000	0.001	0.73		
Gender	0.011	0.007	0.14		
Race/ethnicity	0.017	0.006	0.002**		
Marital status	-0.014	0.007	0.047*		
Education	-0.017	0.003	0.000***		
Income	0.000	0.000	0.002**		
Arthritis factor	0.026	0.007	0.000***		
Cancers factor	0.018	0.007	0.014*		
Pulmonary factor	-0.020	0.021	0.33		
Metabolic factor	0.030	0.018	0.09		
Stress factor	-0.005	0.022	0.84		
Hypertension	0.004	0.009	0.66		
Diabetes	-0.018	0.016	0.28		
Ulcers	0.015	0.009	0.08		
Stroke	0.032	0.011	0.003**		
Emphysema	0.031	0.010	0.003**		
Asthma	0.037	0.012	0.003**		
Cirrhosis	0.037	0.030	0.22		
Alzheimer's disease	0.039	0.029	0.19		
Poor kidney function	0.045	0.013	0.000***		
Thyroid problems	0.001	0.008	0.94		
Change in variance of Model 4 when compared with Model 1 (Model 4 ΔR^2 – Model 1 ΔR^2)				0.038	<0.001***

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$
Additional diseases in each model are bolded.

Table 7

Total number of diseases, as predictive of depressive symptom severity

Variables	Beta	SE	*p-value*
Number of chronic conditions	0.019	0.003	<0.001***
Age	0.000	0.001	0.49453
Gender	0.008	0.007	0.22469
Ethnicity	0.017	0.006	0.002 **
Marital status	-0.014	0.007	0.048 *
Education	-0.018	0.003	<0.001***
Income	0.000	0.000	0.002**

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$