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Gender, Race/Ethnicity, Personality, and Interleukin-6 in Urban Primary Care Patients

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Abstract

Gender, race/ethnicity, and personality are markers of significant psychosocial and biological variability. Each may have implications for allostatic load and resulting inflammatory processes, yet findings have been largely mixed. We investigated whether women, minorities, and those higher in Neuroticism and lower in Extraversion were at risk for elevated circulating levels of the pro-inflammatory cytokine interleukin (IL)-6 in a sample of 103 middle aged and older urban primary care patients. Regression analyses controlling for age, education, current depression levels, and chronic medical conditions revealed that women, minorities, and individuals lower in Extraversion had higher circulating levels of IL-6. Analyses of more specific personality traits revealed that the sociability and positive emotions components of Extraversion were unassociated with IL-6, but the activity facet--reflecting dispositional vigor and energy--was robustly associated with IL-6. The difference between high (+1 Standard Deviation (SD)) and low (−1 SD) trait activity was sufficient to shift IL-6 levels beyond a previously established high risk cut-point in both white and minority women. These findings suggest that while broad group differences between genders and races/ethnicities exist, personality represents an important source of individual differences in inflammation within groups. Future work should examine to what extent IL-6 levels are linked to temperament or genetic activity levels vs. physical activity itself, and whether IL-6 levels may be reduced by boosting regular activity levels in demographic segments such as women and minorities who appear susceptible to greater inflammation.

Keywords

Interleukin-6; Gender differences; Race/Ethnicity; Extraversion; Activity; Primary Care

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1. Introduction

Gender, race/ethnicity, and individual differences in personality are powerful sources of variation in both psychosocial and biological attributes. Yet the extent to which each is associated with underlying inflammation remains unclear. In this paper, we focus specifically on gender, racial ethnic, and personality variation in the inflammatory cytokine interleukin (IL)-6, because it is an important indicator of allostatic load (De Martinis, Franceschi, Monti, et al., 2005; Franceschi, Bonafe, Valensin, et al., 2000), included in allostatic load composites (Glei, Goldman, Chuang, & Weinstein, 2007), and hence theoretically linked to stress-related factors which may differ by gender, race/ethnicity, and personality. We note, however, that IL-6 was not originally included in allostatic load composites. It has, however, been shown to be highly predictive of mortality (Grunewald, Seeman, Ryff, Karlamangla, & Singer, 2006; Harris, T, Ferrucci, Tracy, Corti, Wacholder, Ettinger, et al., 1999), with mortality risk reportedly doubling at levels of 3.19 picograms per milliliter (pg/ml) (Harris et al., 1999). We also focus on a middle aged and older sample, given the cumulative nature of chronic stress adaptation and systemic inflammation (De Martinis, Franceschi, Monti, et al., 2005), and on the urban primary care population, given the large minority representation often served by these clinics (Fiscella & Williams, 2004).

Prior reports on gender differences in IL-6 have been mixed. O'Connor et al. (2007) reported higher levels of IL-6 in lipopolysaccharide (LPS)-stimulated monocytes from women compared to men (mean age of 36.2 yrs). In contrast, others have observed a small but significant increase in LPS-stimulated production of IL-6 in young adult males compared to females (Von Aulock et al., 2006), and another study conducted in young adults found no significant gender differences in levels of serum IL-6 (Yang et al., 2007). Other report higher levels of IL-6 among women in older samples (Grunewald et al., 2006). Suarez (2008) also recently found that sleep may account to some degree for gender differences in inflammation.

Differences in serum IL-6 have also been observed in racially-diverse women over the age of 65, with higher levels of IL-6 observed in African American women compared to Caucasians (Allison et al., 2006; Walston et al., 2005). In contrast, no significant differences in serum IL-6 were observed in African Americans versus Caucasians in a mixed gender sample aged 70–79 (Yaffe et al, 2003). If such differences in inflammation do exist however, they may constitute one conceivable explanation for *general susceptibility*, or the notion that individuals of disadvantaged socioeconomic status (SES) or disenfranchised groups show increased susceptibility to illness (Berkman & Kawachi, 2000). Furthermore, immune function is strongly influenced by psychosocial factors related to stress and coping (Coe & Laudenslager, 2007), and increased stressors such as perceived discrimination frequently encountered by historically disenfranchised groups (Williams, Yu, Jackson, J.S., Anderson, 1997) have been hypothesized to increase allostatic load and resulting inflammation (Carlson & Chamberlain, 2005).

Race/ethnicity and gender represent general demographic group markers. However, considerable individual variation in inflammation may exist within genders and racial/ethnic groups related in part to social disadvantage and allostatic load. Five Factor Model (FFM) personality dimensions (McCrae & Costa, 2003), representing the primary axes of individual differences in psychological and behavioral dispositions, index variation in stress, coping, and genetic parameters potentially relevant to immune function and inflammation (Coe & Laudenslager, 2007; Segerstrom, 2000; Segerstrom, 2003). Neuroticism has been linked to exaggerated HPA axis responses to stressors (Eysenck, & Eysenck, 1985), and appears associated with higher resting cortisol (Miller, Cohen, Rabin, Skoner, & Doyle, 1999), lower antibody response to vaccination for hepatitis B (Marsland, Cohen, Rabin, & Manuck, 2001) and influenza (Phillips, Carroll, Burns, & Drayson, 2005), and lower resistance to a common

cold virus after infection (Cohen, Doyle, Turner, Alper, & Skoner, 2003b). Extraversion is thought to be associated with a lower threshold for sympathetic arousal, (Eysenck & Eysenck, 1985; Geen, 1997) and greater natural-killer cell cytotoxicity (Miller et al., 1999). Specific Extraversion components of sociability (Cohen, Doyle, Turner, Alper, & Skoner, 2003a) and positive emotions (Cohen, Doyle, Turner et al., 2003b) are also associated with resistance to common cold, while the latter is also associated with higher antibody titers in response to hepatitis B vaccination (Marsland et al., 2001). One study in an older, partly depressed sample found positive associations between Neuroticism, but not Extraversion and IL-6 (Bouhuys, Flentge, Oldehinkel, & van den Berg, 2004). Other studies have variously reported associations between IL-6 and positive affect (Prather, Marsland, Muldoon, & Manuck, 2007), specific aspects of negative affect such as depression and cynicism that may be a function of poor health behaviors (Sjögren, Leanderson, Kristenson, & Ernerudh, 2006), and no associations between trait negative affect and IL-6 (Marsland, Sathanoori, Muldoon, & Manuck, 2007).

We examined whether IL-6 varied between gender and/or racial/ethnic groups in diverse urban primary care patient population. Although prior results have been mixed, we hypothesized that women and minority patients would show higher circulating levels of IL-6, as such differences have appeared at least as often as not in prior studies. We also hypothesized that higher Neuroticism and lower Extraversion would be associated with higher IL-6. In other words, we suspected that while gender and/or race/ethnicity would mark general group differences in inflammation, personality would index individual variability in inflammation within groups, corresponding to independent effects for each factor. We also explored all 2 and 3 way interactions between these factors.

2. Methods

2.1 Participants and Procedure

Patients aged 40 and older, recruited in person at the time of clinical visits and through flyers at the Family Medicine Center (FMC) of the University of Rochester Medical Center (URMC), attended a research appointment at the FMC or the URMC General Clinical Research Center (GCRC). At the appointment, participants completed an interview assessing demographics and psychosocial characteristics, the NEO-Five Factor Inventory (NEO-FFI) measure of personality, the Center for Epidemiologic Studies Depression Scale-Revised (CES-D R), and a checklist of chronic health-conditions (see instruments, below). Patients then underwent venipuncture by a trained phlebotomist in either the FMC laboratory, or by a clinical research nurse in the GCRC. Approximately 2/3 of the measurements were taken in the afternoon, the remainder being a random group of subjects taken in the morning according to availability of research staff and facilities. Subjects received \$50 compensation, and the study was approved by the local IRB.

Of 107 patients recruited and interviewed, 103 patients provided usable data on all variables of interest. As can be seen in Table 1, the sample was on average 52 (SD=9) years old, 58% were of minority race/ethnicity (almost all African American), and 77% were female. With respect to SES, 61% reported an income less than \$20,000 a year, and 81% less than \$30,000; 25% were employed full or part time, 10% were retired, and 65% unemployed; 52% had high school or less education, while 48% had one year or more of college. On average, patients had two chronic conditions, with the three most common being hypertension (35%), gastro-esophageal reflux (GERD; 25%), and Type II diabetes (18%).

2.2 Instruments

IL-6 Assay—Subsequent to venipuncture, blood was kept on ice, centrifuged, and serum stored at -80°C . Serum IL-6 concentrations were determined via assay using non-duplicate

standard ELISA protocols and anti-cytokine antibody pairs (BD Biosciences, San Diego, CA). *NEO-FFI*. The NEO-FFI is a well-validated and heavily used 60-item measure assessing the FFM personality domains of Neuroticism, Extraversion, Openness, Agreeableness, and Conscientiousness (Costa & McCrae, 1992). Responses involve a 5-point Likert scale ranging from 0 (“Strongly Disagree”) to 4 (“Strongly Agree”). In the current sample, Cronbach’s alpha internal consistency estimates were .85 (Neuroticism), .76 (Extraversion), .71 (Openness), .60 (Agreeableness), and .81 (Conscientiousness). Personality scales were converted to T-scores (Mean 50, Standard Deviation [SD] 10) according to national norms (Costa & McCrae, 1992). T-scores of 50 thus represent the 50th percentile of national norms. Each domain scale can also be broken down into subcomponents, which can be used to isolate which component (s) of a given broad-band FFM dimension are responsible for observed associations (Chapman, 2007; Saucier, 1998). The present analyses focused on the Neuroticism subcomponents of depression, anxiety, and self-reproach, and the Extraversion subcomponents of sociability, activity, and positive affect.

CES-D R—The CES-D R is a 20-item measure of depressive symptoms experienced in the previous week (Gallo, & Rabins, 1999). Responses involve a 4-point Likert scale ranging from 0 (“not at all”) to 3 (“nearly every day”). Cronbach’s alpha internal consistency in the current sample was .93. CES-D R scores served as a control variable in analyses, to ensure that any observed associations between IL-6 and gender, race/ethnicity, or personality were not artifacts of group or individual differences in current depressive symptoms.

Chronic Conditions Checklist—Patients completed a checklist of chronic conditions adapted from that used in the Midlife Development in the US survey (Brim, Ryff, & Kessler, 2004). The checklist asked if a physician had diagnosed them with any of 25 common chronic medical conditions spanning respiratory, gastro-intestinal, neurological, endocrine, and cardiovascular problems, ranging from hypertension, to diabetes, to cardiovascular disease (CVD). These were summed to form a morbidity index (Fortin, Bravo, Hudon, Vanasse, & Lapointe, 2005), which served as a control variable to ensure that any observed associations between IL-6 and gender, race/ethnicity, or personality Neuroticism and/or Extraversion and IL-6 were not simply due to the differences between groups or individuals in disease burden.

2.3 Statistical Analysis

For all analyses, IL-6 was log₁₀ transformed to improve normality and reduce outlier influence, and personality scores were scaled by the national standard deviation (i.e., 10 T-score points) to facilitate interpretation. Thus, a 1 unit increase in personality represented the difference between a person relative average in a trait (population mean, or 50th percentile) and one high (+1 population SD, or 84th %ile); or, equivalently, between a person low in a trait (−1 SD, or 16th percentile) and average (mean, or 50th percentile). Subsequent to descriptive analyses characterizing the sample, we examined the associations between IL-6 gender, race/ethnicity, and personality in a series of linear regression analyses with robust standard errors. We began by fitting separate bivariate models for gender, minority status, Neuroticism, and Extraversion, then multivariate models including all factors and additionally adjusting for 1) age (scaled in decades) and education (some college or greater against a reference category of high school or less), then 2) additionally adjusting for current depressive symptoms and chronic conditions. As we tested 4 hypotheses, we applied the False Discovery Rate (FDR; Benjamini & Hotchberg, 1995) to p-values from the fully adjusted model. In the event of significant Neuroticism or Extraversion associations, we then conducted follow-up analyses replacing the broad domain scale with its subcomponents to clarify which specific aspects of the FFM dimension were responsible for observed associations, applying the FDR to the p-values for multiple components of each domain.

We gauged the magnitude of IL-6 associations for gender, race/ethnicity, and personality in two ways. First, we examined increments in IL-6 variance explained by each factor of interest. Second, we computed covariate adjusted means from the final model for different combinations of gender, race/ethnicity, and high (+1 SD) vs. low (−1 SD) levels of personality traits, holding other covariates at sample means. We then reverse-log transformed these covariate-adjusted means back to their original scale and compared them to the “high-risk” IL-6 threshold of 3.19 pg/ml, at which Harris et al. (1999) reported a doubling of mortality risk in a large epidemiologic study. This study used the same assay kit as ours. We also examined interactions between gender, minority status, and personality.

3. Results

3.1 Unadjusted Results

Unadjusted associations between IL-6 and gender, race/ethnicity, and personality traits (Models 1–4, respectively) are shown in the first four columns of Table 2. Higher Extraversion was related to lower, while female gender was related to higher levels of IL-6. A trend suggested that minority race/ethnicity was also associated with higher levels of IL-6.

3.2 Adjusted Results

Model 5, mutually adjusting gender, race/ethnicity, and personality for one another and for education and age (Table 2) revealed that Extraversion and female gender continued to be associated with IL-6, while the minority association reached conventional significance. All associations persisted after further adjustment for chronic diseases and depression in Model 6.

Subcomponent analyses isolated the Extraversion association strictly to dispositional activity, which was strongly negatively associated with IL-6 levels ($B [SE] = -.11 [.03]$, $t(92) = -.361$, $p = .001$). Extraversion's sociability component was non-significantly negatively associated with IL-6 ($B [SE] = -.03 [.04]$, $t(92) = -.81$, $p = .419$), and its positive affect component was non-significantly positively ($B [SE] = .07 [.05]$, $t(92) = 1.50$, $p = .138$) associated with IL-6. Figure 1 depicts the regression slopes of the three Extraversion components, fully adjusted for demographics, Neuroticism, and illness burden and current depressive symptoms. Follow-up analyses also covarying a short form of the UCLA Loneliness revealed that the Extraversion effect was also not due to loneliness.

3.3 Magnitude of Associations

With respect to total variation explained in Table 2 models, Cohen (1988) opined that R^2 values of 2–12% represent small, 13–25% medium, and $\geq 26\%$ large effect sizes. Figure 2 depicts the variance explained by age, education, depression, and chronic disease alone, and the additional significant increments in variance explained sequentially by race/ethnicity ($\Delta R^2 = .0443$, $\Delta \text{adj } R^2 = .0365$, $F(1, 97) = 4.91$, $p = .0291$), gender ($\Delta R^2 = .09$, $\Delta \text{adj } R^2 = .0838$, $F(1, 96) = 10.77$, $p = .001$), and trait activity ($\Delta R^2 = .0667$, $\Delta \text{adj } R^2 = .0628$, $F(1, 95) = 8.85$, $p = .004$).

Figure 3 depicts covariate adjusted means in pg/ml for different combinations of gender, race/ethnicity, and high vs. low activity, as well as the high-risk demarcation of 3.19 pg/ml. After covariates had been accounted for, the difference in IL-6 levels between low and high dispositional activity was sufficient to move both white and minority women across the high risk threshold. No interactions were observed between gender, race/ethnicity, and personality.

4. Discussion

Our findings indicate that in a racially diverse urban primary care sample, women, minorities, and patients lower in Extraversion--specifically, dispositional activity, but not positive affect

or sociability—possessed higher circulating levels of IL-6. Gender and race/ethnicity thus appear to be important dimensions of group differences in IL-6 levels, but after these group differences are accounted for, dispositional activity poses an important source of individual variability in IL-6. We discuss gender, race/ethnicity, and personality correlates of IL-6 each in turn.

Our finding that women appear to have higher levels of IL-6 is consistent with some (Grunewald et al., 2006; O'Connor et al., 2007), but not all (Von Aulock et al., 2006; Yang et al., 2007) prior reports. In our sample of urban primary care patients, gender differences were robust in both unadjusted and adjusted analyses, and substantial. They also could not be attributed to gender differences in Neuroticism or depression (Goodwin & Gotlib, 2004), factors which might plausibly enhance stress-vulnerability, allostatic load, and inflammatory consequences. Similarly, gender differences in IL-6 cannot be accounted for by gender differences in disease load. Psychophysiological responses to stress vary between men and women in ways that are not entirely understood, but fundamental differences in hormones may render women more susceptible to higher levels of IL-6 (Taylor et al., 2000). Our findings thus underscore the need for greater understanding of what leads to these gender differences in inflammation.

Patients of minority race/ethnicity—nearly all of them African American, in our sample—also appeared to have higher IL-6 levels than Caucasian patients. However, these differences were not as substantial as the difference between men and women in IL-6, and were only marginally significant in unadjusted analyses. When other demographics, as well as Neuroticism, Extraversion, depression, and chronic illness burden were controlled, differences were slightly accentuated. This suggests that racial/ethnic differences may be masked in studies which do not adjust appropriately for confounding factors. Prior work has suggested that minorities experience substantial elevations in stress from perceived discrimination, which in turn have health consequences (Williams, Yu, Jackson, & Anderson, 1997). Cumulative daily hassles, stresses, and life challenges as a member of a disenfranchised group likely lead to higher allostatic load (Carlson & Chamberlain, 2005), of which inflammation is one consequence. Inflammation may also provide one mechanism for the hypothesis of increased general susceptibility to ill-health (Berkman, & Kawachi, 2000) among socially disadvantaged groups. It is also possible that higher levels of IL-6 reflect unmeasured confounding by subclinical infection. (McQuillan, Kruszon-Moran, Kottiri, Curtin, Lucas, & Kington, 2004) though such infection could conceivably result from increased susceptibility to infection from greater chronic stress. Our results speak to the need for increased attention to the specific social, psychological, and behavioral channels leading to compromised immune function in racial/ethnic minority populations.

Finally, results implicate Extraversion, and specifically its activity component, in IL-6 levels. Whereas gender and race/ethnicity represent demographic group factors across which average IL-6 levels may vary, personality represents an additional individual-level, within-group source of variation. Prior work has linked general Extraversion to better functioning in other immune parameters such as natural killer cell lysis (Miller et al., 1999), but we are the first study, to our knowledge, to report an association with IL-6. Most noteworthy, however, is the specific component of Extraversion responsible for this association. Although considerable focus has been devoted to the health benefits of positive emotions (Pressman & Cohen, 2005) and social support or social-integration (Berkman, L.F., & Glass, T., 2000), our findings indicate that the activity is robustly associated with IL-6.

The items from this subcomponent (“I like to be where the action is; I often feel as if I’m bursting with energy; My life is fast-paced; I am a very active person.”) suggest a sense of innate vigor, verve, or active engagement with life. In one sense, they recall the metaphorical

élan vitale, or “vital force” animating life, described at least as far back as French philosopher Henri Bergson (1911). Adjectives and other scales measuring vitality or activity routinely load on the Extraversion factor in studies of personality structure (Costa & McCrae, 1992; Goldberg, 1992; 1993). An important consideration, however, is that activity is only one facet of the broad, multicomponent Extraversion dimension. Thus, individuals may score low in activity but relatively high in sociability and positive affect, thus achieving higher Extraversion scores.

Indeed, activity may reflect individual variation in fundamental, biologically-based reserves of energy, as it is a basic dimension of temperament manifest as early infancy (Caspi, 2000). This facet of Extraversion also wanes normatively with age, a pattern hypothesized to reflect biological age-related declines in energy and vitality (Terracciano, McCrae, Brant, & Costa, 2005). One theory is that reward dependence is the central feature of the Extraversion dimension linking covariation in specific components (Lucas, Dienr, Grob, Suh, and Shao, 2000). If so, another factor to consider is that dispositional activity may be associated with neural structures mediating reward sensitivity.

In light of its probable biological bases, high levels of dispositional activity may mark a basic constitutional resistance to inflammation. Alternatively, it may represent a marker of improved health not fully captured by the morbidity index.

Higher levels of activity may also signal greater participation in physical activity. Extraversion in general and its activity component in particular are associated with exercise (Courneya & Hellsten, 1998; Courneya, Bobick, & Schinke, 1999; Rhodes & Courneya, 2003; Rhodes, Courneya, & Jones, 2003; Rhodes, Courneya, & Jones, 2005), and higher daily physical activity is inversely associated with IL-6 in large community samples of older adults (Reuben, Judd Hamilton, Harris, & Seeman, 2003). Experimental increases of physical activity via exercise programs also reportedly reduce IL-6 levels in older participants (Kohut et al., 2006). Further investigation of the neural, endocrine, and immunological substrates, as well as behavioral tendencies underlying this personality attribute appear warranted.

Finally, we note that Neuroticism did not appear linked to higher IL-6 levels, as would be predicted by the notion that it enhances vulnerability to the biological effects of chronic stress. Although at least one prior study reported a link between Neuroticism and IL-6, other studies of its role in adaptive immune function have been mixed. Miller, based on a review of the literature and a large study of his own, concluded that Neuroticism may be more involved in symptom complaint than biological vulnerability to illness (Miller et al., 1999). Our findings would tend to support this view with respect to IL-6, or at least suggest that Neuroticism-immune associations may be population dependent.

Current findings have both public health and clinical intervention research implications. The concept of chronic stress/allostasis may provide additional insight on psychophysiologic pathways between marginalization or social disadvantage and health (Dowd & Goldman, 2006; Gimeno et al., 2007; Ramsey et al., 2008;). From a public health perspective, the relative impact of gender and race/ethnicity on inflammation may be substantial, but cannot be considered irrespective of individual differences in dispositional characteristics such as trait activity. Although basic elements of temperament are not easily altered, if activity works even in part via physical exercise, efforts to enhance physical activity and exercise levels among women and minorities are worthwhile directions for clinical interventions research aimed at reducing inflammation and promoting other health benefits. At the level of basic science, the biological mechanisms linking the activity dimension of temperament with lower chronic inflammation also deserve careful consideration.

We encourage appropriate restraint in interpretation of our findings, based on a balanced assessment of study strengths and limitations. We carefully avoid causal inference given our

cross-sectional data. In the present context, dispositional activity may reduce IL-6, or IL-6 may reduce dispositional activity. Some credence for the former possibility comes from exercise induced reductions in IL-6 (Kohut et al., 2006). On the other hand, the biology of aging may drive naturalistically observed declines in dispositional activity (Terracciano et al., 2005). We were unable to disentangle physical activity levels from possible genetic or temperament factors underlying dispositional activity. Exercise interventions may or may not reduce IL-6, underscoring the need for empirical examination of this question. We did not have information on BMI. As BMI may be related to multiple factors of interest in this study including IL-6 (Visser, Bouter, McQuillan, Wener, & Harris, 1999), an interesting avenue of future research would be to examine whether observed associations among our cohort can be explained by BMI. Our measure of disease load was based on self-report. Also, we could not differentiate stimulated from circulating IL-6 levels; multiple factors contribute to IL-6. Blood levels of IL-6 are only partially a function of the immune system. Some allostatic load composites do and some do not include IL-6, reflecting different emphases on this cytokine in allostatic load. A subset of morning blood draws occurred. However, this likely introduced random variation into IL-6 levels, as time of blood draw was not a function of gender, race/ethnicity, or personality making it more, rather than less difficult to detect systematic associations. Nevertheless, we note this as a caveat. Thus, our estimates of associations may be conservative.

Strengths of the study included the use of an ethnically diverse population well-equipped to examine race/ethnicity differences in IL-6. It should be emphasized that because the sample was predominantly low SES, SES was held fairly homogenous by design, allowing us to examine race/ethnicity differences more clearly. This is often difficult to do due to the confounding of these factors. This is both a strength and limitation of the study, as the findings may or may not generalize to other regions of the SES spectrum. We also conducted careful assessment and isolation of the specific components of general Extraversion associated with IL-6, and distinguished sources of IL-6 variation at both the demographic group level, as well as the individual level. In the final analysis, our findings underscore the potential importance of gender, race/ethnicity, and personality in inflammatory processes, suggesting that individual dispositional differences may be a useful ingredient to consider in health disparities research, and invite further studies on the extent to which activity-IL-6 levels are temperamental/genetic, due to physical activity levels, and the extent to which physical activity interventions reduce inflammation in at-risk populations.

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Figure 1. Associations of Difference Extraversion Subcomponents With IL-6

Note. Adjusted for age, gender, education, illness burden, current depressive symptoms, and Neuroticism

Figure 2. Incremental Variance Explained in IL-6 by Race/Ethnicity, Gender, and Trait Activity
 Note: Increments to R^2 and Adjusted R^2 from adding denoted variables in hierarchical regression.

Figure 3. Model 6 Predicted IL-6 Means for Combinations of Gender, Race/Ethnicity, and Trait Activity

Note. Model 6 predicted values for different configurations of gender, race/ethnicity, and activity level, holding other covariates at mean values. Horizontal line marks IL-6 level of 3.19 pg/ml identified in prior epidemiologic work (Harris et al., 1999) as threshold doubling mortality risk.

Table 1

Sample Descriptives

	Overall	White	Minority	Male	Female
	Mean / N (SD / %)	Mean / N (SD / %)	Mean / N (SD / %)	Mean / N (SD / %)	Mean / N (SD / %)
Age (years)	52 (9)	51.7 (7.1)	52.1 (10.2)	50.5 (6.2)	52.4 (9.7)
Female	79 (76.7%)	32 (73%)	47 (80%)	--	--
Male	24 (23.3%)	12 (27%)	12 (20%)	--	--
Minority	59 (57.3%)	--	--	12 (50%)	47 (60%)
White	44 (42.7%)	--	--	12 (50%)	32 (40%)
Some College or Greater Education	50 (48.5%)	28 (64%)	22 (37%)	11 (46%)	39 (49%)
High School or Less Education	53 (51.5%)	16 (36%)	37 (63%)	13 (54%)	40 (51%)
CES-D R Scores	16.9 (13.2)	16.5 (13.7)	17.1 (12.9)	18.1 (13.8)	16.5 (13)
Chronic Conditions	2 (2)	2 (2)	1.9 (1.8)	1.4 (1.4)	2.1 (2)
Neuroticism Domain (T-scores)	55.4 (11.2)	56.5 (12.2)	54.6 (10.5)	54.5 (10)	55.7 (11.6)
Neuroticism Subcomponents (raw scores)					
Anxiety	6.7 (2.6)	7.2 (2.9)	6.4 (2.3)	6.4 (2.4)	6.8 (2.6)
Depression	6.4 (2.8)	6.5 (3.1)	6.4 (2.6)	6 (2.2)	6.6 (3)
Self-Reproach	12.8 (5.7)	13.8 (6.2)	12 (5.3)	12.6 (5.4)	12.8 (5.9)
Extraversion (T-scores)	47.6 (11.4)	47.8 (10.9)	47.4 (11.8)	50.3 (10.5)	46.8 (11.6)
Extraversion Subcomponents (raw scores)					
Sociability	8.3 (3)	8 (3.1)	8.5 (2.9)	9.3 (2.8)	8 (3)
Positive Affect	10 (3.1)	10.2 (2.9)	9.9 (3.3)	10.6 (2.3)	9.8 (3.3)
Activity	7.7 (3)	8 (2.7)	7.6 (3)	7.9 (3)	7.6 (3)
UCLA Loneliness Scale	19.5 (4.7)	19.2 (4.3)	19.7 (5.1)	20.2 (5)	19.2 (4.7)
Interleukin-6 (pg/ml)	3.8 (3)	3.4 (2.6)	4.2 (3.2)	2.4 (2.1)	4.3 (3.1)

Note. NEO-FFI T-scores according to national norms (Costa & McCrae, 1992). Subcomponents do not have T-scores but see Saucier, 1998 and Chapman, 2007 for raw scores in community samples.

Table 2
Unadjusted and Adjusted Associations Between Neuroticism, Extraversion, and IL-6

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	B (SE)	p	B (SE)	p	B (SE)	p	B (SE)	p	B (SE)	p	B (SE)	p
Neuroticism					.05 (.03)	.125			.03 (.03)	.357	.00 (.04)	.903
Extraversion							-.08 (.03)	.004	-.05 (.03)	.046	-.05 (.03)	.050
Female	.30 .08	<.001							.25 (.08)	.002	.24 (.08)	.004
Minority			.12 .07	.088					.13 (.06)	.051	.13 (.06)	.042
Age									.05 (.04)	.237	.04 (.04)	.343
Some College or Greater Education									.08 (.06)	.208	.10 (.06)	.090
Morbidity Index											.03 (.02)	.136
CES-D R Scores											.02 (.04)	.553
R ²	.1277		.0293		.0210		.0638		.216		.243	
Adjusted R ²	.1191		.0197		.0113	.	.0545		.1671		.1791	

Notes: Linear regression with robust standard errors. Model 1 = Gender unadjusted; Model 2 = Minority status unadjusted; Model 3 = Neuroticism unadjusted; Model 4 = Extraversion unadjusted; Model 5 = gender, minority status, and personality, adjusted for other demographics; Model 6 = Model 5 additionally + adjusted for chronic conditions and depressive symptoms. Personality traits scaled in national T-score standard deviation units; Female vs. reference of male; Minority vs. reference of White; Age scaled in decades; Morbidity Index scaled in 1 condition increments; CES – D R scores scaled by standard deviation units. Bolded entries significant. Log10 IL-6 values.