Personality and Individual Differences 111 (2017) 205–210

Contents lists available at ScienceDirect

Personality and Individual Differences

journal homepage: www.elsevier.com/locate/paid

Five factor personality traits and inflammatory biomarkers in the English longitudinal study of aging

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ARTICLE INFO

Article history:
Received 13 November 2016
Received in revised form 7 February 2017
Accepted 10 February 2017
Available online xxxx

Keywords:
C–reactive protein
Fibrinogen
Gerontology
Immune function
Neuroticism
White blood cell

ABSTRACT

Inflammatory processes are putative mechanisms underlying chronic disease. In this study we explore linear and non-linear associations between personality and change in inflammatory markers (C–reactive protein [CRP], fibrinogen, and white blood cell count [WBC]). In total, 5294 older adults (M_{age} = 64.51 ± 8.34 years) provided blood samples in 2008 with 3751 providing follow-up samples four year later. Midway between the two assessments, participants completed a measure of personality. After controlling for participant demographics (e.g., age, gender) and health-related lifestyle factors (e.g., exercise, cigarette smoking), we found that higher levels of agreeableness and lower levels of conscientiousness were associated with higher CRP levels, and (for conscientiousness) an increase in CRP over time. Age moderation effects indicated that agreeableness and conscientiousness were related to WBC among older participants in the sample (over ~ 70 years of age). These findings provide evidence that agreeableness and conscientiousness traits are important for inflammatory biomarkers in older adulthood.

1. Introduction

Inflammation is one of the first responses of the immune system to harmful stimuli. Inflammatory abnormalities underlie biological processes that contribute to cardiovascular disease and other age-related diseases (Emerging Risk Factors Collaboration, 2010, 2012; Grivennikov, Greten, & Karin, 2010; Libby, 2002). Inflammatory markers, including C–reactive protein (CRP) and fibrinogen, reflect demographic, anthropometric, behavioural, and psychosocial factors (McDade, Hawkley, & Cacioppo, 2006) including trait personality (Luchetti, Barkley, Stephan, Terracciano, & Sutin, 2014). The five factor model (McCrae & John, 1992) considers that personality is best captured through the assessment of five broad trait dimensions: neuroticism, extraversion, openness, agreeableness and conscientiousness. Of these, there is emerging evidence that high conscientiousness might have a protective role in inflammatory processes independent of behavioural and anthropometric factors such as cigarette smoking and body mass (Luchetti et al., 2014). However, the potential involvement of other trait dimensions is less clear. The current study sought to explore associations between the big five trait dimensions and three markers of chronic inflammation (CRP, fibrinogen, and white blood cell count [WBC]) in a large sample of older adults from England.

Personality is thought to relate to inflammatory biomarkers through behavioural and psychophysiological mechanisms (Segerstrom, 2000). For example, personality is a strong predictor of stress appraisal and coping (Carver & Connor-Smith, 2010), and psychological stress can activate acute phase reactants associated with inflammation (Black, 2002, 2003). Inflammation (and activation of the immune system) can be detected by an increase in several biomarkers including WBC, fibrinogen, CRP, and interleukin-6 (IL-6). The most consistent finding across studies is that lower levels of conscientiousness relate to higher levels of IL-6 and CRP (Chapman et al., 2011; Mõttus, Luciano, Starr, Pollard, & Deary, 2013; Stephan, Sutin, Luchetti, & Terracciano, 2016; Sutin et al., 2010; Turiano, Mroczek, Moynihan, & Chapman, 2013), as well as increases in these markers over time (Chapman et al., 2011; Turiano et al., 2013), and this was supported in a recent meta-analysis of seven (CRP) and six (IL-6) independent samples (Luchetti et al., 2014). In addition to conscientiousness, the meta-analysis also found that lower levels of openness related to higher CRP levels, and that effects remained significant after controlling for some behavioural and anthropometric factors (cigarette smoking and body mass). There were no significant effects for neuroticism, extraversion or agreeableness (but notable heterogeneity across study samples), and sample age was not found to moderate associations between personality and CRP. The authors pointed towards the small number of samples limiting statistical

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http://dx.doi.org/10.1016/j.paid.2017.02.028
0191-8869/

power to detect age moderation effects, and recommended researchers continue to search for important moderators that might explain heterogeneity across studies (Luchetti et al., 2014).

Less research has explored fibrinogen and WBC as correlates of trait personality. In a sample of Israeli adults, after controlling for body fat and health behaviour, lower levels of openness and higher levels of neuroticism were found to be associated with higher fibrinogen levels, and (for neuroticism) an increase in fibrinogen over four years (Armon, Melamed, Shirom, Berliner, & Shapira, 2013). However, a further study of Scottish older adults, that included two measures of personality, found that agreeableness had a negative association with fibrinogen for one personality measure, but overall, fibrinogen (and change in fibrinogen over time) was unrelated to personality (Mõttus et al., 2013). Similar findings were observed in a study exploring two of the big five traits, in which neuroticism and extraversion were unrelated to fibrinogen after controlling for body mass and health behaviour (Millar et al., 2013). For WBC, a large sample study of Sardinian adults found that broad trait dimensions were not consistently associated with WBC and were unrelated to change in WBC over three years (Sutin et al., 2012). However, the study did find that higher levels of openness and lower levels of conscientiousness were related to a WBC range associated with increased risk of mortality ($\geq 7.6 \times 10^9$ cells/L).

Taken together, there is good (but not robust) evidence that conscientiousness is important for CRP and IL-6 (but associations for other dimensions remain unclear), mixed findings for an association between personality and fibrinogen, and a shortage of research into personality and WBC meaning generalizable conclusions about important associations cannot be made at this stage. One explanation for some of the inconsistent findings might be that personality becomes more or less important for inflammatory processes among particular subgroups. Indeed, psychological stress is often the mechanism considered most responsible for connecting personality to inflammation (Armon et al., 2013) and psychological stress becomes more important for inflammatory responses as people become older (Segerstrom & Miller, 2004). This would suggest that personality might have an important role in chronic inflammation but only among older adults. The current study is interested in the association between personality and inflammatory markers independent of health behaviour, and therefore we control for health-related factors such as exercise, cigarette smoking and body mass. We hypothesised that lower levels of conscientiousness would be associated with higher inflammation, and increases in inflammation over time, as measured via CRP, fibrinogen and WBC. We also explore age as a potential moderator of associations between personality and inflammatory markers, and hypothesised stronger associations between personality and inflammatory markers among older adults.

2. Method

2.1. Sample

The English Longitudinal Study of Aging (ELSA) is a biannual survey that collects information on health, social, and economic circumstances of the English population aged 50 and older. Postcode sectors are selected from the national Postcode Address File, and addresses are selected randomly from each sector. At wave 1 there was a 77.5% response rate. At waves 3, 4, and 6 the sample was replenished with new participants to maintain the size and representativeness of the panel. The data is broadly considered to be representative of older adults in England. Detailed information on sampling and attrition across waves is available elsewhere (Steptoe, Breeze, Banks, & Nazroo, 2013). Ethical approval was granted by the National Research and Ethics Committee UK.

We refer to data collected at wave 4 as Time 1 (2008) and data collected at wave 6 as Time 2 (2012). In total, 10,749 adults aged 50 and over were sampled at Time 1 with 6384 (59.4%) providing blood samples. Compared to those that provided blood samples, non-sampled participants were older, $t(10{,}747) = 4.65$, $p < 0.001$, $d = 0.09$, less physically active, $t(10{,}737) = 15.43$, $p < 0.001$, $d = 0.30$, and had lower levels of extraversion, $t(7884) = 3.42$, $p = 0.001$, $d = 0.08$, and conscientiousness, $t(7866) = 3.75$, $p < 0.001$, $d = 0.08$. Personality data were available for 5294 of the participants that provided blood samples (82.9%). Compared to participants with personality data, those without personality data were older, $t(6382) = 17.39$, $p < 0.001$, $d = 0.44$, less physically active, $t(6381) = 12.81$, $p < 0.001$, $d = 0.32$, had a lower body mass, $t(6382) = 5.84$, $p < 0.001$, $d = 0.15$, higher blood CRP levels, $t(6382) = 5.88$, $p < 0.001$, $d = 0.15$, and a higher WBC count, $t(6233) = 6.65$, $p < 0.001$, $d = 0.17$.

At Time 2, 10,372 participants were included, with 6039 (58.2%) providing blood samples. Compared to those that provided blood samples, non-sampled participants were older, $t(10{,}370) = 4.90$, $p < 0.001$, $d = 0.10$, had a higher body mass, $t(7742) = 6.43$, $p < 0.001$, $d = 0.15$, were less physically active, $t(10{,}365) = 13.46$, $p < 0.001$, $d = 0.26$, and had lower levels of extraversion, $t(7662) = 4.36$, $p < 0.001$, $d = 0.10$, and conscientiousness, $t(7652) = 4.19$, $p < 0.001$, $d = 0.10$. There were personality data available for 4911 participants that provided blood samples (81.3%). Compared to participants with personality data, those without personality data were younger, $t(6037) = 21.27$, $p < 0.001$, $d = 0.55$, less physically active, $t(6036) = 4.94$, $p < 0.001$, $d = 0.13$, and had a higher WBC count, $t(6037) = 3.52$, $p < 0.001$, $d = 0.09$. In total, there were 5294 participants available at Time 1 (2908 women, 2386 men; $M_{age} = 64.51 \pm 8.34$ years), 4911 participants at Time 2 (2702 women, 2209 men; $M_{age} = 67.90 \pm 8.20$ years), and 3751 participants sampled at both Time 1 and Time 2 (2065 women, 1686 men; $M_{age\ (Time\ 1)} = 64.14 \pm 7.94$ years).

2.2. Measures

2.2.1. Personality

Data on personality were collected midway between Time 1 and Time 2 (at wave 5) using a modified version of the Midlife Development Inventory (MDI; Lachman & Weaver, 1997). ELSA included an additional item ("thorough") to the original 25 item measure to increase internal consistency of the conscientiousness subscale. The questionnaire uses 26 adjectives to assess five personality traits: neuroticism (e.g., "nervous"), extraversion (e.g., "outgoing"), openness (e.g., "creative"), agreeableness (e.g., "helpful"), and conscientiousness (e.g., "organised"). Participants indicate how well each adjective described them on a four-point scale: 1 (*a lot*), 2 (*some*), 3 (*a little*) or 4 (*not at all*). Scales were reversed so that higher scores represent higher levels of neuroticism ($\alpha = 0.68$), extraversion ($\alpha = 0.76$), openness ($\alpha = 0.79$), agreeableness ($\alpha = 0.80$), and conscientiousness ($\alpha = 0.68$). The MDI has demonstrated evidence of criterion validity in adult samples (e.g., Joshanloo, 2017).

2.2.2. Clinical assessment

A trained nurse collected anthropometric data (body mass and height) and blood samples. Body mass was measured using Seca 877 scales and height was measured using a portable Stadiometer. Participants did not wear shoes for anthropometric measures but wore light clothing. Body mass index (BMI) was calculated as mass (kg)/height squared (m^2). Blood samples were taken from the left or right arm using a Vacutainer or Butterfly needle, and a maximum of two attempts were made to extract blood. Measurement of CRP was carried out using the N Latex CRP mono Immunoassay on the Behring Nephelometer II Analyzer. Fibrinogen analysis was carried out using the Organon Teknika MDA 180 analyser, using a modification of the Clauss thrombin clotting method. WBC was measured using the Sysmex XE2100 analyser that uses electrical impedance technology (Coulter principle) to count the white cells combined with hydrodynamic focusing and flow cytometry to differentiate the blood cells. All analyses were carried out according to Standard Operating Procedures by state registered medical laboratory scientific officers.