



Conscientiousness, hair cortisol concentration, and health behaviour in older men and women



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ABSTRACT

Conscientious is associated with greater longevity and other favourable health outcomes, but the processes underlying these links are poorly understood. Health behaviours such as physical activity and avoidance of smoking and excessive alcohol consumption may contribute, but direct associations with neuroendocrine and inflammatory processes may also be relevant. We tested the associations between conscientiousness and hair cortisol concentration in 2318 older men and women (mean age 66.2 years) from the English Longitudinal Study of Ageing. Conscientiousness was positively associated with physical activity and fruit and vegetable consumption, and negatively related to alcohol intake, sedentary behaviour, body mass index and depressive symptoms (all $p < 0.001$). We found an inverse association between conscientiousness and hair cortisol concentration that was independent of age, sex, education and wealth ($\beta = -0.053$, $p = 0.012$), and the relationship remained significant with additional adjustment for health behaviour and depressive symptoms ($\beta = -0.048$, $p = 0.025$). The observation that greater conscientiousness was correlated with lower hair cortisol indicates that this trait might impact central nervous regulation of hypothalamic-pituitary-adrenocortical function, with effects that are possibly advantageous for health.

1. Introduction

Conscientiousness is a trait characterized by self-discipline, dependability, and planfulness coupled with tendencies to follow socially prescribed norms and to be goal-directed (Roberts et al., 2009). Conscientiousness appears to be an important determinant of longevity among older adults (Kern and Friedman, 2008). For example, in an analysis of the Health and Retirement Study (HRS), conscientiousness predicted increased longevity after adjustment for age, gender, education, cognitive functioning, and reported health state (Hill et al., 2011). A large investigation aggregating seven cohort studies from Europe, the USA and Australia showed that low conscientiousness predicted increased mortality after age, sex, other personality traits and health behaviours were taken into account (Jokela et al., 2013). Conscientiousness was also associated with reduced mortality in the Midlife in the United States (MIDUS) study, mediated in part by low alcohol consumption, less smoking, and lower waist circumference (Turiano et al., 2015). Similar findings have been reported from the Whitehall II cohort study (Hagger-Johnson et al., 2012). Deary et al. (2008) reported that participants who were rated as dependable in childhood were more likely to be alive at age 65 years. Conscientiousness is also

related to better health, including reduced incidence of diabetes, more positive self-rated health, and fewer depressive symptoms (Hakulinen et al., 2015a; Jokela et al., 2014; Turiano et al., 2012).

One pathway relating conscientiousness to favourable health outcomes may be lifestyle choice. As noted above, associations between conscientiousness and mortality are mediated in part by health behaviour (Jokela et al., 2013; Turiano et al., 2015). Conscientiousness has been linked with reduced involvement in detrimental health behaviours such as smoking, heavy alcohol consumption, illegal substance use and risk-taking activity, while being positively correlated with physical activity, prudent diet, adherence to medication and other protective behaviours (Allen et al., 2017; Bogg and Roberts, 2004; Hakulinen et al., 2015b,c; Molloy et al., 2014; Strickhouser et al., 2017; Sutin et al., 2016a).

A second possibility is that there are direct psychobiological processes linking conscientiousness with health outcomes. Conscientiousness is associated with reduced exposure to situations that elicit stress and with more effective coping with stressors (Bogg and Roberts, 2013; Connor-Smith and Flachsbart, 2007). There is also evidence that greater conscientiousness is correlated with reduced inflammation, as indexed by C-reactive protein or interleukin (IL) 6 in the

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HRS, MIDUS, the National Longitudinal Study of Adolescent Health in the USA, and a study in Sardinia (Elliot et al., 2017; Luchetti et al., 2014; Sutin et al., 2010; Turiano et al., 2013). Cortisol is a key biomarker relating psychosocial factors with health, since it is sensitive to stress and is implicated in a range of cardiometabolic, inflammatory, neural and endocrine disorders (Girod and Brotman, 2004; McEwen, 2007). However, evidence relating cortisol with conscientiousness is limited (Bibbey et al., 2013; Bogg and Slatcher, 2015; Nater et al., 2010).

Hair cortisol concentration has emerged over recent years as an indicator of tonic cortisol output over several weeks, and is not subject to the acute variations related to momentary events and moods that influence salivary levels (Stalder and Kirschbaum, 2012; Stalder et al., 2017). It may therefore be particularly suitable for investigations of a relatively stable construct such as conscientiousness. Accordingly, we analysed the association between conscientiousness and hair cortisol concentration in 2318 participants in the English Longitudinal Study of Ageing (ELSA), a nationally representative sample of men and women aged 50 and older living in England. We hypothesized that conscientiousness would be inversely related to hair cortisol concentration. Cortisol in hair has also been associated with health behaviours such as smoking and physical activity (Wosu et al., 2013), raising the possibility that relationships with conscientiousness are driven by differences in health behaviour. We therefore also tested with relationship between cortisol and health behaviours, and evaluated whether associations with conscientiousness remained robust after health behaviours had been taken into account. Depressive symptoms are also potential confounders, since they are associated with elevations of hair cortisol concentration (Abell et al., 2016), so were included in the analytic models.

2. Method

2.1. Participants

Data were analysed from the English Longitudinal Study of Ageing (ELSA), a study of men and women aged 50 or more living in England that started in 2002 with an original sample of 12,099. Comparisons of the sociodemographic characteristics of participants against the national census show that the sample was representative of the English population (Stepptoe et al., 2013). The study sample is periodically refreshed to maintain the age profile of the cohort. Conscientiousness was measured in 8755 of the 9090 participants in wave 5 (2010/11), while samples of hair were collected as part of a nurse visit to participants' homes in wave 6 of ELSA (2012/13). Of the 7699 individuals visited at home, hair samples were successfully collected from 5451; the remainder either had insufficient hair, a medical condition that precluded hair sampling, or refused to have their hair cut. There were insufficient funds to assay all hair samples, so it was decided to prioritise individuals who had participated in the maximum number of previous waves of data collection. Cortisol was assayed from 2583 individuals, and 2391 had data on both conscientiousness and hair cortisol, with 265 having missing data on key covariates. The main analyses of hair cortisol were therefore carried out on 2318 people. It has previously been shown that people who attend follow-up assessments over several years are likely to be younger more educated, wealthier and in better health than those who miss appointments (Stepptoe et al., 2013). Consequently, participants in these analyses were significantly younger (means 66.20 vs 68.15 years, $p < 0.001$), better educated and wealthier ($p < 0.001$) than those who were excluded. They also had higher conscientiousness scores on average (means 2.32 vs 2.28, $p = 0.002$). ELSA was approved through the National Research Ethics System, and all participants gave informed consent.

2.2. Hair sample collection and analysis

Hair samples were obtained as part of the visit by a research nurse to participants' homes. A scalp hair strand of 3 cm was collected from the posterior vertex position by cutting the hair as close to the scalp as possible with fine medical scissors. These were placed onto aluminium foil, and stored in a dry, dark place before shipping to the Technische Universität Dresden, Germany. The wash procedure and steroid extraction were undertaken using high performance liquid chromatography–mass spectrometry (LC/MS), as described by Gao et al. (2016), with a minimum of 7.5 mg \pm 0.2 mg of hair, cut from each 3 cm hair segment. Hair cortisol concentration was expressed in pg/mg. Based on an average monthly hair growth of around 1 cm, the scalp-nearest hair segment of 3 cm represents averaged cortisol accumulated over an approximate timespan of three months prior to sampling. Hair-specific factors that could affect hair cortisol concentration (washing frequency, hair colour and curvature, hair treatment) were assessed by self-report.

2.3. Conscientiousness

Conscientiousness was assessed using the Midlife Development Inventory (MIDI) Personality Scales, a set of measures have been used widely in previous cohort studies such as the Midlife in the United States (MIDUS) and Health and Retirement Study (HRS) (Lachman and Weaver, 1997). Participants were asked how much each of 26 adjectives described themselves on a scale ranging from 1 (*not at all*) to 4 (*a lot*). Four items (e.g. organized, responsible) contributed to the conscientiousness scale, and the Cronbach alpha for the scale in this study was 0.67.

2.4. Health behaviours

Smoking status was classified on the basis of current tobacco smoking. Alcohol was assessed by questions concerning the number of pints of beer, lager or cider, the number of glasses of wine, and the number of measures of spirits that the participant had consumed over the previous 7 days. These were summed to derive a measure of units of alcohol in the past week. Respondents were asked about the number of portions of vegetables and fruit that they ate on a typical day, using a validated measure (Cappuccio et al., 2003), with missing data from 44 respondents. Physical activity was assessed by asking participants about mild intensity (e.g. laundry, home repairs), moderate intensity (e.g. cleaning the car, walking at a moderate pace) and vigorous intensity (e.g. digging with a spade, cycling, aerobics) activity. Respondents indicated frequency of participation in four categories (hardly ever or never, one to three times per month, once per week, or more than once per week). The examples at different intensities were selected as being among the most commonly reported in previous UK-based population studies, and were categorized on the basis of metabolic equivalents (MET), with scores between 2–3.5, 3.5–6 and greater than 6 corresponding to mild, moderate and vigorous activity (Ainsworth et al., 2000). In the present analyses, we classified people as physically active if they reported moderate or vigorous activity once a week or more, and as sedentary if they reported no light, moderate or vigorous activity or never.

2.5. Other variables

Educational attainment and wealth were assessed as indicators of socioeconomic position. Education was divided into five categories ranging from no qualifications to University graduate or higher. Wealth was derived from a detailed assessment of the participant's economic resources, and included financial, housing and physical wealth (such as land, business wealth and jewellery), but excluded pension wealth, and was divided into quintiles for the purposes of analysis. Wealth is a strong indicator of socioeconomic resources among older people (Banks

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