International Journal of Psychophysiology 102 (2016) 12–17

Contents lists available at ScienceDirect

International Journal of Psychophysiology

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

Hair cortisol concentrations in relation to ill-being and well-being in healthy young and old females

Nina Smyth [a], Matilde Bianchin [a], Lisa Thorn [a], Frank Hucklebridge [a], Clemens Kirschbaum [b], Tobias Stalder [b], Angela Clow [a,*]

[a] Psychophysiology and Stress Research Group, Department of Psychology, University of Westminster, 115 New Cavendish Street, London W1W 6UW, UK
[b] Department of Psychology, TU Dresden, Dresden, Germany

ARTICLE INFO

Article history:
Received 15 July 2015
Received in revised form 25 February 2016
Accepted 2 March 2016
Available online 3 March 2016

Keywords:
Hair cortisol concentration
HCC
Age
Females
Well-being
Ill-being

ABSTRACT

Hair cortisol concentration (HCC) provides a retrospective measure of long-term (i.e. over a period of months) cortisol secretion and has been shown to be elevated in relation to chronic stress conditions. However associations in healthy participants with subjective ill-being are less clear and associations with well-being have not been explored. The current study examined HCC in relation to independent comprehensive measures of ill-being (stress, depression, anxiety) and well-being (subjective happiness, life satisfaction, psychological well-being) in healthy young and old females (mean ± SD: 19.5 ± 2.2 years and 78.6 ± 6.7 years respectively, total N = 115). The data supported evidence of increased total cortisol secretion with increased age. No association between ill-being and HCC was found in either the young or older group of participants. A positive association between HCC and well-being was found in the older participant group which was independent of ill-being and potential confounds. These findings do not support associations between HCC and ill-being in healthy young or old females. However the results suggest that HCC is able to distinguish levels of well-being in healthy older females.

1. Introduction

Hair cortisol concentrations (HCC) provide a relatively new way of examining hypothalamic-pituitary-adrenal (HPA) axis secretory activity (Kirschbaum et al., 2009). Cortisol is assumed to be continuously incorporated into growing hair and HCC should thus represent a retrospective measure of integrated cortisol secretion over the period of hair growth, typically the past 2–6 months (Gow et al., 2010; Stalder and Kirschbaum, 2012). The measure has grown in popularity as it is complementary to more commonly used salivary cortisol analysis, providing data on long-term overall cortisol secretion, rather than short-term dynamic changes.

It is clear that high levels of HCC have been associated with demographic and health status, e.g. patients with Cushing's syndrome, markers of metabolic syndrome, smoking and alcoholism (Feller et al., 2014; Kuehl et al., 2015; Stalder et al., 2010; Thomson et al., 2010). In relation to psychosocial factors higher HCC levels have been found in the long-term unemployed (Dettenborn et al., 2012b), chronically stressed dementia caregivers (Stalder et al., 2014) and a range of stress-related psychiatric symptoms and disorders (reviewed in Wosu et al., 2013). These are all relatively severe conditions but the evidence linking HCC with subjective ill-being, (e.g. perceived stress) is mixed, with a majority showing no association (see Staufenbiel et al., 2013). Consequently a question remains about the sensitivity of HCC to sub-clinical levels of ill-being.

In addition to the study of ill-being and health, there is evidence that well-being confers benefit to concurrent and future health prospects (Pressman and Cohen, 2005). This has been demonstrated even after accounting for ill-being in the respective analyses (Chida and Steptoe, 2008; Kubzansky and Thurston, 2007). The comprehensive measurement of well-being involves assessment of different domains including subjective happiness (Lyubomirsky and Lepper, 1999), life satisfaction (Diener et al., 1985) and aspects of psychological well-being such as self-acceptance, environmental mastery, purpose in life and personal growth (Ryff, 1989). The evidence points to well-being as more than the mere absence of negative psychological symptoms and that well-being and ill-being function relatively independently and should be measured separately (Diener and Emmons, 1984; Huppert and Whittington, 2003; Russell and Carroll, 1999; Ryff et al., 2006). The HPA axis has been proposed to be a mediator of the relationship between well-being and health (Dockray and Steptoe, 2010). In line with this, the diurnal pattern of cortisol secretion has been linked with measures of well-being (Evans et al., 2007; Ryff et al., 2004; Simpson et al., 2008; Smyth et al., 2015; Steptoe and Wardle, 2005; Steptoe et al., 2005). However, to the best of our knowledge an investigation of HCC in relation to well-being is still outstanding.

* Corresponding author.
E-mail address: clowa@wmin.ac.uk (A. Clow).

http://dx.doi.org/10.1016/j.ijpsycho.2016.03.001
0167-8760/

Activity of the HPA axis is known to vary across the lifespan (Lupien et al., 2009). Increasing age has consistently been shown to be related to differences in both the diurnal pattern and levels of cortisol secretion (Deuschle et al., 1997; Knoops et al., 2010; VanCauter et al., 1996) and there is evidence suggesting increasing HCC with age (Dettenborn et al., 2012b; Feller et al., 2014; Stalder et al., 2013). However further investigation is justified to explore how well-being and ill-being are related to HCC across age groups. In addition the relationship between stress and measures of salivary cortisol concentration have been shown to vary with sex (Roe et al., 2013). For HCC, although the majority of studies find no difference between the sexes (reviewed in Wosu et al., 2013), there is one notable exception in which levels of HCC were higher in 18–49 year old males compared to females, but not between 50 and 91 year old participants (Dettenborn et al., 2012b).

It is clear that the study of HCC is relatively new and further investigation is warranted. The aim of the current study was to use hair analysis to examine cortisol levels over the 3-month period before sampling (3 cm scalp-near hair segments) in healthy female participants in relation to comprehensive measures of ill-being and well-being assessed at the time of sample collection, whilst accounting for known confounds. We chose to study two distinct age groups to examine potently different relationships within and between the different age groups. We chose to study females only as the relationship between stress and cortisol secretion has been reported to differ between the sexes (Dettenborn et al., 2012a; Roe et al., 2013). We hypothesised that HCC levels would be higher in the old age group but made no predictions about associations with ill-being and well-being.

2. Materials and method

2.1. Participants

Two distinct age groups of healthy females were studied. In the younger group, 88 females were recruited from within the academic community at the University of Westminster. Participant age ranged between 18 and 27 (mean ± SD: 19.5 ± 2.2) years. Volunteers were awarded course credits for participating in the study. In the older group, 27 females were recruited from the University of the Third Age or the Women's Institute. Participant age ranged between 67 and 91 (mean ± SD: 78.6 ± 6.7) years. Volunteers were offered a small monetary award of a £10 high street voucher (only 7 participants accepted the voucher). All participants were selected on the basis that they were not pregnant, they had not taken any corticosteroid medication or suffered from adrenocortical dysfunction in the last year and they had not taken any illicit drugs in the last 6 months (ascertained by self-report). The University of Westminster ethics committee approved the protocol and all participants provided informed written consent.

Information about demographic variables (age, smoking status and ethnicity), health variables (medication, oral contraceptives use) and hair-specific characteristics (washes per week, hair treatments: bleach/colour/perm) were obtained via self-report from a self-developed questionnaire. As an index of subjective socioeconomic status (SES), participants rated where they stood in society in terms of education, occupation and wealth using a 1–10 ladder (Adler et al., 2000). The top of the ladder represented a higher social standing. A dichotomous smoking status variable was used contrasting smokers (current, occasional) vs. non/ex-smoker smokers. Participants rated their health on a 1–5 scale ranging from poor health to excellent health.

2.2. Procedure

Ethics approval was obtained from the University of Westminster Ethics Committee. Following informed consent, participants attended a one-to-one research session with the lead researchers (NS or MB). During this one-to-one session the researchers collected the hair samples and details regarding participants' demographic, health and hair characteristics. Participants completed the self-report well-being and ill-being questionnaires online either one week prior or following the research session. The older group completed the questionnaires during the research session.

2.3. Self-report measures of well-being and ill-being

2.3.1. Subjective happiness

Participants completed the 4-item Subjective Happiness Scale (SHS; Lyubomirsky and Lepper, 1999), a measure of global subjective happiness. Each item is measured on a seven-point scale and following reverse scoring, scores are averaged. Scores range between 1 and 7 with higher scores reflecting higher happiness.

2.3.2. Life satisfaction

The 5-item Satisfaction with Life Scale (SWLS; Diener et al., 1985) measures individual's global cognitive judgments of aspects of general life satisfaction. Items are rated on a seven-point scale ranging from 'strongly disagree' to 'strongly agree'. Items are summed to give a total score, which ranges from 5 to 35, with higher scores indicating greater life satisfaction.

2.3.3. Psychological well-being scales

The present study used dimensions of the Ryffs Psychological Well-being Scales (Ryff, 1989). The dimensions used were Environmental Mastery (EM), Purpose in Life (PIL), Personal Growth (PG) and Self Acceptance (SA). The mid-length version of the scale was used which consists of 54 items (9 per dimension). Items are rated on a six-point scale ranging from 'strongly disagree' to 'strongly agree'. After reverse scoring, items for each dimension are summed, with possible scores ranging between 6 and 64 and higher scores indicating better psychological well-being.

2.3.4. Perceived stress

Participants completed the Perceived Stress Scale (PSS; Cohen et al., 1983). It assesses the subjective appraisal of stress and reflects the degree to which individuals appraise their lives as unpredictable, uncontrollable and overloaded in the last month. The 4-item version was used and items were measured on a five-point (0–4) Likert scale (never, almost never, sometimes, fairly often, very often). After reverse scoring items are summed and total scores can range from 0 and 20, with higher scores indicating greater perceived stress.

2.3.5. Depression, anxiety and stress

Participants completed the Depression, Anxiety and Stress Scale (DASS; Lovibond and Lovibond, 1995) which measures three related negative emotional states of depression, anxiety and stress in the last month. The original scale consists of 42 items; each of the three dimensions consists of 14 items. On a 4-point Likert scale (0–4) respondents rate the severity or frequency to which they have experienced (did not apply to me, applied to me to some degree, or some of the time, applied to me to a considerable degree, or a good part of time, applied to me very much, or most of the time) each statement. Individual scores are obtained for each dimension by summing the scores for the relevant items. A higher score for each dimension indicates higher negative emotional states. The shorter 21-item version (7 items make up each dimension) was used in this study.

All self-report measures had good internal consistency ($\alpha > 0.75$).

2.4. Hair sample and collection preparation

Hair samples were cut as close as possible to the scalp from a posterior vertex position using fine scissors. Cortisol concentrations were determined from the 3-cm hair segment most proximal to the scalp. This was assumed to represent hair grown over the 3-month period prior to hair sampling, based on an average hair growth rate of 1-cm per