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Sociodemographic, lifestyle, and psychosocial determinants of hair cortisol in a South London community sample

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ABSTRACT

Objective: Hypothalamic–pituitary–adrenal (HPA) measures are crucial for research into stress and stress-related disorders. Most HPA measures fluctuate depending on diurnal rhythms and state confounders. Hair cortisol concentrations (HCC) are less susceptible to such fluctuations, but less is known about trait-like confounders. Using a community sample, we tested the relationship between HCC and a range of variables including demographic variables, hair treatment, and medication, as well as psychosocial variables, namely childhood trauma, critical life events, and depressive symptoms.
Methods: Hair samples were collected from 144 individuals from the South East London Community Health (SELCoH) study. Childhood trauma, life events, and depressive symptoms were measured, together with age, sex, ethnicity, relationship status, educational attainment, employment status, occupational social class, hair washing frequency, hair treatments, season reflected in the hair sample, hazardous drinking, smoking, medication intake, and body mass index. Hair samples reflecting the past 3 months were collected and analysed using immunoassays. First, correlations (continuous variables) and simple linear regressions (dichotomous variables) were conducted to identify sociodemographic, hair-related, and lifestyle determinants of HCC. Next, multiple linear regressions were conducted to test the relationship between psychosocial variables and HCC when controlling for the identified confounders.
Results: Age ($r = -0.17$, $p = 0.050$), White British ethnicity ($\beta = -0.19$, $p = 0.023$), heat-based treatments ($\beta = -0.22$, $p = 0.010$), and winter season ($\beta = -0.18$, $p = 0.024$) were associated with lower HCC, whereas summer season ($\beta = 0.24$, $p = 0.024$), painkillers ($\beta = 0.25$, $p = 0.003$), anxiolytics/antidepressants ($\beta = 0.21$, $p = 0.014$), and hormonal contraceptives ($\beta = 0.27$, $p = 0.006$) were associated with higher HCC. Controlling for these confounders, physical neglect during childhood ($\beta = -0.17$, $p = 0.057$), war-related experiences ($\beta = 0.20$, $p = 0.027$), separation ($\beta = 0.18$, $p = 0.054$), and being the victim of a serious crime ($\beta = -0.17$, $p = 0.062$) were linked with altered HCC.
Conclusion: Our findings suggest that variation in HCC occurs according to sociodemographic, hair-related, and lifestyle variables, and that certain associations between stress and altered HCC can only be revealed when accounting for these confounders.

1. Introduction

The hypothalamic–pituitary–adrenal (HPA) axis is the most relevant endocrine system in stress-related research. It follows a distinct basal circadian rhythm, and is highly responsive to stimulation. On the one hand, this allows for an adaptation of the body to mild, short-term stress. On the other hand, it renders the HPA axis vulnerable to the detrimental effects of severe and long-term stress. There is ever-increasing evidence for the long-lasting ram-

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ifications of early life adversity and chronic psychosocial stress via epigenetic modification of genes involved in HPA axis regulation (Lupien et al., 2009). It is therefore not surprising that the presence of psychosocial stressors, such as childhood trauma and critical life events, is frequently associated with dysregulations of the HPA axis, which in turn may predispose an individual to develop stress-related disorders, such as depression or somatoform disorders (Heim and Nemeroff, 2001; Nater et al., 2011). Hypothalami–pituitary–adrenal measures have therefore become crucial parameters for research looking into stress and the pathophysiology of stress-related disorders.

Indexing of HPA activity and reactivity has traditionally relied on peripheral markers, such as total and free cortisol measured in blood, 24 h urine, and saliva (Kirschbaum and Hellhammer, 1989). The determination of hair cortisol concentrations (HCC) was introduced as a novel method to measure HPA activity. It makes use of the fact that endogenous cortisol is incorporated into hair follicles, mainly via passive diffusion from the blood stream (Stalder and Kirschbaum, 2012). As hair is known to grow at an average rate of about 1 cm per month (Wennig, 2000), a scalp-near collected hair segment of 3 cm would therefore provide a window into cortisol secretion over the past three months. The advantages offered by the measurement of HCC are manifold: it is non-invasive, economical in that repeated sampling can be avoided, and for the first time provides an assessment of cumulative cortisol concentrations over an extended period of time akin to the glycosylated haemoglobin as a long term measure of blood glucose concentration. This seems to render the HCC methodology an ideal candidate for stress-related research, where invasive procedures are often not feasible due to limited financial and time resources, and repeated sampling schedules often present with adherence problems. Most importantly, compared to conventional specimens, HCC could prove a more reliable indicator of HPA abnormalities which is less susceptible to the influence of state variables (e.g., day of the week, time of day; Kudielka and Wüst, 2010). However, less is known about potential trait-like confounders of HCC, such as sex, educational attainment, or body mass index (BMI).

In a systematic review on confounders of HCC, the relationship between age and HCC was deemed "complex" and most likely "non-linear", and it was concluded that more studies with a broad age range are needed (Wosu et al., 2013). Similarly, evidence on sex differences was inconsistent, while very few studies were identified that allowed investigation of potential differences across ethnicities, or by relationship and socioeconomic status. The literature on lifestyle variables suggested that alcohol intake and vigorous physical activity are positively correlated with HCC, while smoking status and intake of medication including oral contraceptives showed no association, and findings regarding BMI were inconsistent. Research using the HCC methodology was still at an early stage when this review was conducted, and information on potential confounders mainly relied on small studies using highly selected populations (e.g., mothers of new-borns and patients with endocrine disorders). Some of the more recent studies using larger and more diverse samples suggest that in adults, HCC increases with age (Feller et al., 2014; Stalder et al., 2013; Staufenbiel et al., 2015), is higher in men (Abell et al., 2016; Dettenborn et al., 2012; Feller et al., 2014; Manenschijn et al., 2013; Staufenbiel et al., 2015), in black people (Abell et al., 2016; Wosu et al., 2015), and the unemployed (Feller et al., 2014); is positively associated with alcohol consumption (Feller et al., 2014; Manenschijn et al., 2013); is higher in smokers (Feller et al., 2014; Wosu et al., 2015); higher in women on hormonal contraceptives (Staufenbiel et al., 2015); and positively linked with BMI (Abell et al., 2016; Stalder et al., 2013). However, evidence overall is still scarce and inconclusive. It is therefore uncertain which sociodemographic and lifestyle confounders should be considered in the design and interpretation of future studies investigating HCC in relation to psychosocial stress.

The present study was conducted in order to study a population of community residents regarding a potential relationship between childhood trauma, critical life events, psychological distress (i.e. depressive symptoms) and HCC. This seemed especially important in light of the fact that so far, evidence for a link between psychosocial stress and HCC is sparse and findings regarding an association between HCC and psychological distress are inconsistent, highlighting the need for further research (Herane Vives et al., 2015). In a first step, however, potential sociodemographic and lifestyle confounders of HCC, and potential hair-related confounders (e.g., washing frequency) were investigated. Finally, to eliminate any potential confounding influence, the initial analyses looking at psychosocial stressors, depressive symptoms, and HCC were repeated, this time controlling for the identified confounders. The current study complements the above-mentioned research by, for the first time, reporting on the influence of a wide range of commonly used medications on HCC. Based on the literature, it was expected that older people, men, people of Black African and Black Caribbean ethnicity, and people outside of regular employment would have higher HCC. It was further hypothesised that people reporting a high number of life events would exhibit comparably higher levels of HCC.

2. Methods

2.1. Participants

Hair samples were collected from a total number of 144 individuals who took part in phase 3 of the South East London Community Health (SELCoH) study. SELCoH was a longitudinal study that aimed to identify antecedents and consequences of various health outcomes in a local community sample. Details of the initial recruitment procedures can be found elsewhere (Hatch et al., 2011). Briefly, in phases 1 and 2, households located in the two adjacent South London boroughs Lambeth and Southwark were randomly selected and repeatedly visited by researchers trained in conducting clinical interviews. All residents aged 16 and over were eligible. Phase 3 used a purposive subsample of 500 of these people and included biomedical data collections. Ethnicity was assessed at a previous phase. The study was approved by the King's College London Psychiatry, Nursing and Midwifery Research Ethics Committee, reference PNM/12/13-152. All procedures were in accordance with the Declaration of Helsinki and written informed consent was obtained from all participants.

2.2. Sociodemographic measures

Age and sex were recorded. In addition to being included as a continuous variable, age was divided into bands: 18–29, 30–59, and 60+. For ethnicity, data came from phase 2 and was recorded based on UK Census categories: White British, Black African, Black Caribbean, Asian, and Other. Relationship status was categorised as "not in a relationship" vs. "in a relationship". The former category included single, separated, divorced, and widowed people, whereas the latter included people being in a long-term relationship or marriage. Indicators of socioeconomic status included educational attainment, employment status, and occupational social class. Educational attainment was divided into no school qualifications or up to GCSE levels, A levels or vocational, and higher qualifications (three categories). Employment status was indicated as "not in regular employment" vs. "in regular employment". Importantly, the vast majority of people that were classified as "not in regular employment" were retired rather than currently seeking a job.