Psychoneuroendocrinology 70 (2016) 58–62

Contents lists available at ScienceDirect

Psychoneuroendocrinology

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

Short communication

Validation of an adapted procedure to collect hair for cortisol determination in adolescents

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ARTICLE INFO

Article history:
Received 8 February 2016
Received in revised form 3 May 2016
Accepted 3 May 2016

Keywords:
Hair cortisol
Collection protocol
Chronic stress
HPA axis
Epidemiological studies

ABSTRACT

Introduction: In the last decades, cortisol has been extensively studied in association to early exposure to adversity as well as in the etiology of a number of physical and mental problems. While saliva and blood samples allow the measurement of acute changes in cortisol secretion, hair samples are thought to provide a valid retrospective measure of chronic cortisol secretion over an extended period of time. Nevertheless, the existing protocol for hair collection involves considerable financial and logistical challenges when performed in large epidemiological studies.
Objective: This study aimed to validate an adapted collection protocol asking participants to sample their hair at home and to send it back to our laboratory by regular mail.
Methods: Participants were 34 teenagers between 17 and 18 years of age. They participated in two hair collections: (a) at home, with the help of someone they know, and (b) in our laboratory, with a trained research assistant.
Results: We noted a strong correlation between cortisol ascertained from hair collected at home and at the laboratory. No mean difference in cortisol levels could be detected between the two protocols. Moreover, we showed that a wide range of hair-related, sociodemographic, lifestyle factors that may be associated with hair cortisol levels did not affect the association between cortisol measures derived from each protocol.
Conclusion: Our study provides initial support that reliable measures of chronic cortisol secretion could be obtained by asking adolescents to collect a sample of their hair at home and send them to the laboratory by regular mail. This adapted protocol has considerable financial and logistical advantages in large epidemiological studies.

1. Introduction

Over the past 25 years, many scholars have been engaged in identifying the early roots of physical and mental health problems. Longitudinal studies initiated in early childhood, some spanning over extended periods, have provided evidence that exposure to a wide range of adverse environments – from economic deprivation to maltreatment – may shape later vulnerability to health problems in addition to, or in combination with, inherited differences in individuals' sensitivity to the environment (Shonkoff et al., 2012). While the mechanisms underlying this association remain unclear, many hypothesize that the hypothalamic pituitary adrenal (HPA) axis may be at play (Gunnar and Quevedo, 2007; Lupien et al., 2009).

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http://dx.doi.org/10.1016/j.psyneuen.2016.05.002
0306-4530/

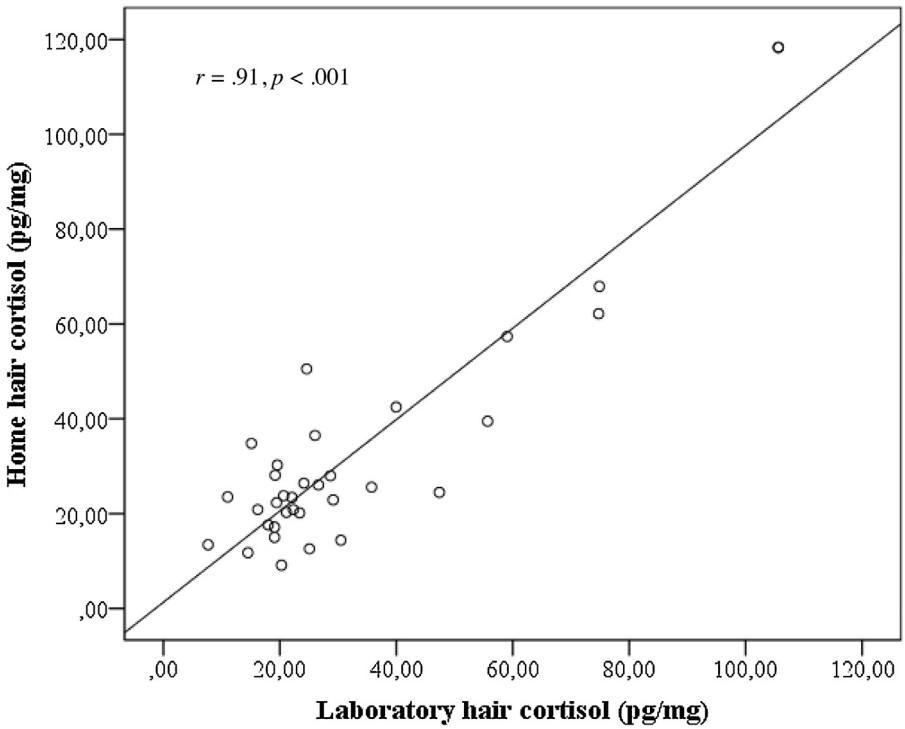

Fig. 1. Association between cortisol measured from hair collected by the participants at home and at the laboratory.

Cortisol has certainly been the most often studied biomarker in that regard (Doom and Gunnar, 2013).

To date, cortisol has mainly been measured from saliva or blood samples. These biospecimens have many advantages, such as reflecting responses to acute stress (experimentally-induced or not) and diurnal patterns of secretion (Russell et al., 2012). However, they also have limitations: they are susceptible to situational factors (e.g., time of day, transient variation in physical health or mood), non-adherence to the sampling protocol and requiring the collection of many samples over multiple days, which can be costly in larger samples and burdensome for participants (Adam and Kumari, 2009; Stalder and Kirschbaum, 2012). Ascertaining long-lasting disruptions of cortisol secretion in saliva or blood can also be inferred from flattened, higher or lower patterns of secretion, but these are merely proxies, essentially reflecting short-term secretion. Blood collection is invasive, may inadvertently increase the measurement of acute cortisol secretion, requires trained research assistants (Wosu et al., 2013) and both blood and saliva require storage equipment (e.g. freezers).

In the last decade, growing empirical support has indicated that hair may be a useful medium to retrospectively measure chronic cortisol secretion over an extended period of time, typically up to three months (D'Anna-Hernandez et al., 2011; Kirschbaum et al., 2009). Hair cortisol has been shown to be stable over time, and is easy to collect by minimally-trained research assistants (Adam and Kumari, 2009; Stalder and Kirschbaum, 2012). It is also less restrictive and more convenient than other procedures used for ascertaining cortisol secretion over a prolonged period (e.g., urine over 24 h). Moreover, hair samples can be stored at room temperature without requiring storage equipment (Dettenborn et al., 2012; Stalder and Kirschbaum, 2012). Considering that the use of hair samples to ascertain chronic cortisol secretion is still at an early stage, much work remains to be done to clearly identify its potential confounders, such as hair-related (e.g., frequency of wash) and sociodemographic and lifestyle factors (e.g., sex, body mass index (BMI); Wosu et al., 2013; Rippe et al., 2016).

Hair cortisol has definite logistical advantages in measuring chronic cortisol secretion. Nevertheless, hair collection requires that a trained research assistant follow a standardized protocol, by going to the participants' home or by asking them to come to the laboratory. This implies financial and logistical burden for large epidemiological studies in which participants are dispersed over a wide territory or in isolated populations (e.g., Northern Aboriginal communities). It is still unclear, however, whether participants can reliably collect hair samples themselves (with the help of a family member or a friend) and whether these samples can be sent to the laboratory by regular mail without affecting the cortisol measurement.

The goal of the present study is to evaluate whether a reliable measurement for chronic cortisol secretion can be obtained by asking the participants to collect the hair samples themselves. First, we examined whether cortisol ascertained from hair collected by the participants was correlated with cortisol measured in hair samples collected by a trained research assistant. We also tested the stability of cortisol concentrations across the two collection protocols to ascertain that shipping the samples by regular mail does not deteriorate cortisol. Finally, we extended earlier investigations and examined whether a range of hair-related, sociodemographic and lifestyle characteristics were associated with hair cortisol levels and whether they affected the strength of the association between cortisol obtained from the original and adapted protocols.

2. Material and methods

2.1. Sample

Participants were recruited through advertisements on the Centre for Studies on Human Stress website and on the Kijiji Montréal, a free local classified website. Adolescents between the ages of 17 and 18 years were targeted because that age corresponded to the target population in the main cohort that we intended to follow. Only those whose hair was at least three centimeter (cm) long were included. A total of 34 adolescents (25 females, 9 males) living in the