Measuring suffering: assessing chronic stress through hair cortisol measurement in humanitarian settings

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Ever increasing humanitarian crises involve prolonged population displacement, a known trigger for chronic stress, which in turn highlights the need for chronic stress to be addressed more explicitly within humanitarian aid work. This calls for better tools to both assess chronic stress in these situations of extended displacement, as well as methods to evaluate the impact of psychosocial interventions in such settings. Noting these challenges, this paper proposes the use of hair cortisol concentration sampling to measure long-term suffering and stress. By including cortisol hair testing as a quantitative measure to complement existing measures of psychosocial programme surveillance, researchers may better understand the nature of chronic stress. Sampling any sort of biomarker, such as cortisol concentration in hair, raises ethical and logistical concerns, therefore this paper address these issues as well, maintaining that a 'do no harm' position should take priority over the decision to measure hair cortisol concentration. Furthermore, as there is also a paucity of evidence regarding the validity of hair cortisol testing on humans, further research will be required.

Keywords: biomarker, chronic stress, hair cortisol concentration, humanitarian, measurement, prolonged displacement, psychosocial

Introduction

The early 1990s marked a shift in humanitarian aid with an increasing emphasis on psychosocial programming (Pupavac, 2004). Programmes that recognise, measure, attempt to understand, address and ameliorate stressors caused by war, disease and (forced) displacement are well established within an ever-growing humanitarian field. In parallel to these developments, interdisciplinary health sciences (medicine, nursing, public health, social sciences) have also come to recognise the detrimental effects of psychological and physical stress on the human body, with innovative qualitative and quantitative studies (Epel, Daubenmier, Moskowitz, Folkman, & Blackburn, 2009; Kosslyn et al., 2002). Such studies, in turn, provide the humanitarian aid community with a particular opportunity to enhance its understanding of the psychological and physical consequences of long-term exposure to stress. This is of increasing relevance given the nature of contemporary humanitarian crises and resulting prolonged displacement. Communities now live in refugee camps for an average of 17 years (Refugee Council, 2011). There is, therefore, a critical need to develop a body of knowledge that assesses the effects of drawn out displacements on quality of life.

Hair cortisol concentration as a marker for chronic stress

The measurement of hair cortisol concentration (HCC) is an innovative process that has been shown to represent the biological effects of chronic stress on the human body. HCC reflects the long-term release of cortisol, a stress hormone found in growing hair, in the human body (Stalder & Kirschbaum, 2012). Cortisol release is the product of a complex process called the

hypothalamic–pituitary–adrenal axis (HPA axis). The HPA axis occurs as a part of the human body's normal response to emotional and physical stress. The fields of neuroscience and genetics have been bridging these connections between stress, and the human body's reaction to it (Surtees et al., 2011; Ladwig et al., 2013).

HCC measurement offers the humanitarian profession a unique method, when combined with other culturally appropriate measures, to assess the general wellbeing of a community over time. The ability to cautiously monitor changes in a population's HCC could allow mental health and psychosocial support (MHPSS) practitioners the ability to address changes in stress levels with evidence based support interventions. This article will argue for the development of HCC measures in the humanitarian field of practice. Based on the successes of HCC monitoring in other sciences, while addressing the current state of prolonged displacement in humanitarian settings, ethical measures of HCC in certain displaced populations can offer a bold step forward in the measurement and evaluation of MHPSS programming.

Protracted displacement and chronic stress

Long-term exposure to stressors, as a result of prolonged displacement, demands that the field of psychosocial response addresses the consequent long-term suffering (Ager et al., 2012; Joshi, Dalton, & O'Donnell, 2008). Stress, as manifested biologically through elevated glucocorticoids,[1] has been associated with the increased risk of mental and physical health disorders. When the body undergoes emotional or somatic (physical) stress, it increases the secretion of glucocorticoids along the HPA axis (cortisol being one of the glucocorticoids); these inflammatory mediators, when accumulated over time can increase the severity of conditions such as anxiety and depression. High levels of glucocorticoids, because of the hyperstimulated HPA axis, are believed to contribute to the development of physical disorders such as cardiovascular disease, diabetes type 2, metabolic syndrome and other autoimmune disorders, all of which are classified as chronic diseases (Chrousos & Kino, 2007).

'*Allostatic load*' is the term used to quantify the effects of heightened neuroendocrine response, which includes the stress response of secreted cortisol (McEwen & Stellar, 1993). Prolonged periods of displacement, many of which have few signs of ending, will logically extend the potential for stressors and the exposure to stress within refugee settings. Furthermore, studies suggest that the compilation of daily stresses within displaced settings are more likely to cause depression as compared to the traumatic, yet acute, stresses of direct war experiences (for example, Miller et al., 2006). Chronic stress, therefore, is considered to potentially elevate risk for mental and physical diseases.

As the field of MHPSS aspires to address and improve quality of life within humanitarian settings, this must also include reducing stress in many instances. However, although this field has made significant progress in measurement and evaluation of stress in the past two decades, there remains ample room to develop better measurement tools. Measuring HCC may, therefore, be a suitable method to increase understanding of the effects of chronic stress.

MHPSS: challenges of building an evidence base for interventions that accurately assesses stress

Typically, psychosocial interventions have used qualitative methods to assess the effectiveness of interventions, although some mixed methods approaches have also been used. The *Inter-Agency Standing Committee (IASC) guidelines* and *Sphere* standards have shaped the field as they have begun to help standardise the objectives, practices and

evaluations of (psychosocial) interventions aimed at improving quality of life.

Many instruments have been tested and validated to meet specific cultural contexts (Betancourt et al., 2009; Bolton, Wilk, & Ndogoni, 2004). Yet, despite great progress in developing new interventions influenced by (if not entirely based on) evidence, there still remains a lack of '*gold standards*' in many instances that researchers can use to robustly validate a tool. The scientific field calls for generalisability of experiments and interventions as a form of validation. While MHPSS programming, however, must remain culturally specific and population appropriate in order to remain ethically sound (Tol, Barbui, & van Ommeren, 2013). Therein lies the conundrum: can a psychosocial intervention be measured both specifically and generally? Further, can its cultural aptness be assessed for a specific culture, while at the same time its overall effectiveness be generalised into measures of stress reduction that may work for other populations? If possible, MHPSS programmes should therefore produce evidence that is both specific to a local context and translatable to other regions and cultures in order to build a robust evidence base.

There is no question that living in a refugee camp, for example, is stressful. Psychosocial interventions seek to identify and relieve those stressors as much as possible, thereby improving an individual or population's quality of life. The original problem remains, however, in the complications of assessing whether the relief of stress is a product of those psychosocial interventions. Some qualitative studies have suggested that specific psychosocial interventions have relieved stress, but it is also arguable that the process of qualitatively assessing stress relief is too biased to provide reliable data (Pérouse de Montclos, 2012).

Although cultures and practices vary, anthropomorphic (measurements of body weight, height or mass) and biological markers are common to all humans. We may follow blood pressure trends to understand cardiovascular health, or body mass indices to understand nutritional status. Likewise, serum tests can indicate the presence of disease and inflammation (Panter-Brick et al., 2008). There is also a growing and sizeable body of evidence concerning stress biomarkers that can be found in blood, saliva and hair. Increased cortisol levels have been positively correlated with increased levels of stress a person is experiencing, or has experienced in the past (Wirtz, Ehlert, Kottwitz, La Marca, & Semmer, 2013; van Uum et al., 2008; Bremner et al., 2003). Blood and salivary cortisol measurements are believed to indicate the physiological response to more acute stressors on one's life. Hair, on the other hand, is thought to provide a retrospective marker of chronic stress on the body. Researchers estimate that a sample of at least one centimetre of hair can reveal stored cortisol that was derived from the bloodstream (Xie et al., 2011). Whereas serum and saliva provide a current measure of stress biomarkers in the body, the hair provides a history of exposure to stress or stressful events.

Application of cortisol measurement

Cortisol can be assessed through serum, saliva, and blood samples. Serum cortisol samples indicate a more acute stress reaction and may offer a more timely measure to immediate events or interventions. However, the process of collecting and storing blood samples in the field is costly, resource intensive and painful for subjects. Salivary sampling is less invasive and has been shown to have similar reliability to serum sampling. Hair cortisol sampling shows longer-term stress on the body as hair, overtime, will collect free cortisol in the blood (Wosu, Valdimarsdóttir, Shields, Williams, & Williams, 2013; van Holland, Frings-Dresen, & Sluiter, 2012). Free cortisol represents cortisol excreted by the body during stressful encounters that is not reabsorbed.

Cortisol production as a result of stress occurs in all people, of all nationalities, therefore cortisol measurements may provide a common denominator between populations that may otherwise express great cultural variations. This is not to suggest that hair cortisol measurement should be used to compare displaced communities, there are far too many confounders, or exceptions, in regard to biological causes of increased or decreased HCC (disease processes, medications, gender and age, to name a few). However, measuring HCC in displaced communities the MHPSS field could have the potential to assess general quality of life within a displaced setting, over long periods of time.

Reliability, validity and feasibility of measuring hair cortisol

As the field of cortisol hair testing expands, improved methods of assessing HCC levels are surfacing. Researchers can use assays, tests that are designed to determine the chemical make up of an element or object, similar to those used to test for the presence of drugs in hair (Gao et al., 2013; Karlén, Ludvigsson, Frostell, Theodorsson, & Faresjö, 2011). Various assays require different sample weights (5–50 mg). The best assays for measurement are yet to be determined and many suitable candidates exist (Staufenbiel, Penninx, Spijker, Elzinga, & van Rossum, 2012). Four labs, all of which measure hair cortisol concentration, but use different methods to extract cortisol from a sample, were assessed by Albar, Russell, Koren, Rieder, & van Umm, (2013) in order to understand variance between the enzyme-linked immunosorbent assay (ELISA)[2] tests used in processing hair samples. This study purported that each lab provided strong reliability for its tests, but that each lab reported slightly different levels of cortisol from the same samples (Albar et al., 2013). As more labs are utilising this developing form of measurement, early adopters of this type of research should remain mindful of discrepancies between tests, and therefore choose one lab and one specific ELISA assay to perform their tests. By doing so, results will remain consistent within a test group, and reliability will remain consistent regarding the ELISA and the individual study. To date, there are no measures available that regulate quality assurance between testing mechanisms, therefore only one lab should be used per study.

There is also a paucity of evidence regarding the validity of hair cortisol testing on humans. One recent study was able to test the validity of human hair samples reflecting changes in allostatic load, as compared to well validated tests that measure serum and salivary cortisol levels (D'Anna-Hernandez, Ross, Natvig & Laudenslager, 2011). Other human and animal studies have observed changes in HCC in accordance with diseases that are known to affect cortisol levels (alcoholism, Cushing Syndrome, Addison's disease). There have also been significant findings in which HCC changes mirror cortisol level changes as measured in blood, saliva, urine and faeces (Davenport, Tiefenbacher, Lutz, Novak, & Meyer, 2006; Accorsi et al., 2008; Sauve, Koren, Walsh, Tokmakejian, & van Uum, 2007) In effect, the current limited literature does support the validity and reliability of this kind of testing (Stadler & Kirschbaum, 2012).

Although the process of extracting cortisol from a hair sample requires specific assays run in a laboratory setting, sample collection and storage is relatively simple. Hair samples can be stored for long periods of time (one study stored samples for 17 months) in containers at room temperature, which allows for flexibility in shipping and storing of these lightweight samples (Macbeth, Cattet, Stenhouse, Gibeau, & Janz, 2010). As a result, HCC sampling is also potentially an effective and useful tool in supporting quantitative studies on stress in remote or lesser developed areas of the world (Russell, Koren, Rieder, & van Uum, 2012).

Hair samples should not be pulled from the scalp, therefore reducing the risk of potential pain, although they should be cut as close to the scalp as possible. Length of sample determines what segment of hair the investigator wants to study. For example, the centimetre of hair closest to the scalp represents the last month in the person's life. Once collected, hair samples should be labelled, stored in a non-airtight container at room temperature and kept dry.

Financial implications of hair cortisol sampling

The actual cost for the process of collecting hair samples, aside from staffing a research team, are low. Materials needed for sampling are easy to come by and inexpensive: scissors, string (to tie samples together), labelling materials and aluminium foil or other non-airtight containers to store samples. Hair samples could easily be collected at a medical setting or clinic where patients receive routine medical care. There are considerable costs, however, in processing samples to ascertain HCC. Prices range from between $32.00 United States Dollars (USD) to $47.50 USD (C. Panter-Brick; M. Laudenslager; A. Ernst, personal communication, 17 July, 2014). The number of samples requiring processing and the type of processing (double extraction or single extraction[3]) will also affect pricing per individual test. Labs require different volumes of hair for sampling as well, therefore it is essential to understand an individual lab's specific requirements in terms of preparation of samples.

Ethical considerations

Evidence suggests that hair colour (natural or dyed), texture, length and amount of washes are all characteristics that have minimal effect in changing cortisol concentration levels. Similarly, smoking status and oral contraceptive use have been shown less likely to affect cortisol levels. Gender and age, however, do correlate with different cortisol levels in hair (Dettenborn, Tietze, Kirschbaum, & Stalder, 2012). According to Dettenborn et al., cortisol levels are thought to present higher in males, young children and older adults. With this in mind, it is necessary to recognise biological confounders that would make it challenging to compare HCC between individuals. Consequently, by achieving a baseline measure of one person's hair cortisol concentration, a research team would be able to follow changes within that individual. With a significant sample size, researchers could monitor collective changes in cortisol levels, over time, within a community. Studies of HCC should not try to determine a '*baseline*' or normal HCC because of the many biological confounders. Rather, studies could establish a given baseline for a population, without determining whether it is bad or good, or whether a population is sick or not sick. The studies could provide information on how HCC changes over time, which then could indicate worsening or improving quality of life within a specific setting.

In addition to accounting for biological confounders, it is essential to recognise the cultural acceptability of collecting hair samples from individuals. Touching hair, much less cutting it, can be taboo within some cultural contexts. In order to maintain dignity and trust with a given population, the research team must first understand whether it is appropriate to take a sample of hair from a participant, whether adult or child, male or female. The *Sphere Project's Humanitarian Charter* and the *Code of Conduct for the International Red Cross and Red Crescent Movement* should help researchers prioritise decisions and determine appropriateness. If collecting hair samples from a culture, age group, or gender in a displaced setting is deemed undignified or inappropriate for the cultural context, then the HCC biomarker should not be studied. Furthermore, while supporting the assessment of HCC when culturally appropriate, the author also recognises there are other methods to

ascertain information on allostatic load, such as a individual's risk for heart disease or hypertension.

Measuring HCC should, first and foremost, be exercised with extreme caution and cultural acumen. While it is a tool that has great potential to measure changes in quality of life and stress on the body, HCC measurements also risk stigmatising a community as 'sick' if the levels of stress (or cortisol measurements) seem to be high or increase over time. It is the ethical responsibility of the research team to clarify its intentions with regards to collecting HCC samples.

Contributions to the field of MHPSS

Monumental progress has been made in the last decade with regards to MHPSS programming. With more rigorous interventions grounded in evidence, stricter guidelines (such as the IASC) and higher levels of accountability imposed by national governmental bodies and multi-national, non-governmental organisations, the practice of psychosocial response continues to thrive. Honing measurement tools is essential to continue to develop best practices. The MHPSS field would benefit greatly by improving quantitative measurements that answer the current reality of long-term humanitarian displacement. Measuring hair cortisol concentrations in displaced populations could provide data suggesting overall quality of life within a particular setting. Quantitative measures, such as biomarkers, could strengthen and complement existing quantitative and qualitative data.

Measuring hair cortisol concentration also provides many interdisciplinary opportunities. The social sciences and medical sciences have begun to follow changes in HCC to understand stress linked mental health conditions in the USA (Wells et al., 2014). Athletic programmes follow HCC in its distance athletes (Skoluda, Dettenborn, Stalder, & Kirschbaum, 2012). Hair cortisol is also closely being studied amongst people with a diagnosed with posttraumatic stress disorder (Steudte et al., 2013). However, one of the fields yet to contribute to the measurement of HCC within a unique setting is that of humanitarian assistance. There is now ample opportunity for interdisciplinary work with HCC to better understand how it can be used to determine changing quality of life.

Limitations

Hair cortisol concentration measurement has limits. The most significant is that chronic stress causing elevated levels of hair cortisol has many sources. Therefore, monitoring changes in HCC may not be able to pinpoint a particular stressor, intervention or event that caused the changes in long-term HCC. It would be unethical to assume a change in hair cortisol levels can be traced back to a specific event, and therefore the measurement of HCC is not appropriate in assessing a particular MHPSS (or other) intervention. However, HCC does provide a general, long-term portrayal of the changes in the quality of life for a particular population.

Another significant limitation regarding ethical considerations should be reiterated. Measuring HCC, as with any biomarkers, needs to be deemed culturally acceptable and appropriate. MHPSS organisations run the risk of being ostracised from a community if HCC levels are assessed without the ethical consent from the population being studied.

Conclusions

At the current time there is no published data on HCC testing being conducted by humanitarian agencies working among displaced populations. Although, there has been work that has observed salivary and serum biomarkers (Worthman & Panter-Brick, 2008). Most of the cortisol hair testing to date has come from animal studies and human hair studies among athletes and persons suffering stress related mental disease in the global north. There are opportunities for the

psychosocial humanitarian aid community to develop studies incorporating HCC testing. With the call for more robust, long-term research on the effectiveness of psychosocial interventions in protracted refugee settings, it is necessary to understand how stress levels and quality of life change over time. Although it may be impossible to run randomised controlled psychosocial trials in humanitarian settings awash with confounders and unpredictability, quantitative cortisol measurements may help strengthen data regarding the effects of prolonged displacement.

By incorporating biomarkers as a measure of stress reduction or increase relating to long-term MHPSS, researchers may find more robust methodologies to understand the impacts of psychosocial interventions in communities enduring chronic stressors. Cortisol hair sampling is a minimally invasive, easy to store and safe to transport method of monitoring changes in cortisol levels among populations affected by physical and emotional stress. The fields of humanitarian aid, neuroscience, biological science and health sciences are all beginning to recognise the body/mind connection, and the complex interactions between one and the other. So long as it is done ethically and is culturally accepted, the act of incorporating HCC measurement into field studies and surveillance of MHPSS programming can contribute to ongoing developments that will make the evidence base of psychosocial intervention more robust and reliable.

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[1] Hormones released throughout the lifespan that regulate metabolic and immunologic functions in the body are considered to be corticosteroids. Cortisol, one of this type, is essential for survival, yet, when released in high levels or over long periods of time, can also have detrimental effects.

[2] ELISA tests utilise various antibodies that offer an affinity to the chemical being tested. The antibodies are attached to a solid surface during the test and then blood, urine, saliva or processed hair samples are added. The antibody in the ELISA test will attract or react to the chemical under investigation (in this case cortisol) and then quantify an estimation of the amount of cortisol in the sample.

[3] Double extraction occurs when the same sample is tested a second time, but in a different well or container so as to test internal validity.

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