



Social connectedness and hair cortisol in community-dwelling older adults

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ARTICLE INFO

Keywords:

Hair cortisol
Emotional closeness
Stress measures
Network size
Elderly

ABSTRACT

Purpose: Hair cortisol is emerging as a reliable biomarker for measuring retrospective stress hormone levels. Given that social connectedness can buffer psychobiological stress reactivity, increasing attention is being paid to the specific types of social networks associated with the stress response. This study investigated the role played by two components of social life, emotional closeness and network size, to probe which aspects of social networks were related to stress measures.

Methods: The scalp hair cortisol level was used to assess the cumulative cortisol production in 179 community-dwelling older adults, in the Korean Social Life, Health, and Aging Project (KSHAP). Multivariate regression approach was used to examine the link between the stress measures (cortisol and perceived stress scale) and social relationships (social network size and emotional closeness).

Results: Emotional closeness (the average level of what one feels about one's relationship) was significantly associated with decreased levels of hair cortisol, whereas no such relationship was found with the network size.

Conclusions: The current findings underscore the role of emotional support on reducing cumulative cortisol, thus providing potential resilience mechanisms for the psychobiological stress response.

1. Introduction

Social connectedness is essential for survival by promoting health, well-being, and longevity [1]. Conversely, a lack of satisfying interpersonal relationships (e.g., loneliness, social isolation) is detrimental to medical conditions such as cardiovascular diseases, stroke, low sleep quality as well as reduced life expectancy [2–4]. Among the various factors of social connectedness, individuals' social life can usually be characterized by structure (i.e., presence of social ties) and function (i.e., emotional support) of social networks [5].

The stress response—one of the psychophysiological processes linking social life to health outcomes—is assessed using cortisol levels regulated by the hypothalamic-pituitary-adrenal (HPA) axis. Scalp hair cortisol emerges as a proxy measure of the total retrospective cortisol levels over the preceding weeks to reflect chronic stress responses [6]. Whereas saliva cortisol captures real-time levels, hair cortisol represents accumulated, over longer period time (several months) levels of cortisol exposure. Recent studies using this innovative and practical approach revealed that increased hair cortisol is linked to academic stress [7], and risk factors for cardiovascular diseases [8]. Since research on hair cortisol is in its infancy, more results are needed to characterize and generalize

the findings.

This study aimed to examine whether social relationships can buffer chronic stress using hair cortisol levels as well as perceived stress levels. We hypothesized that the quality and/or quantity of social relationships would be associated with lower levels of chronic stress assessed by hair cortisol as well as perceived levels of stress in older adults. Given that an increasing amount of attention is being devoted to the specific types of social networks associated with the stress response, we specified the social relationship into the two components, emotional closeness and network size, to examine which aspects of social networks were related to stress measures.

2. Material and methods

2.1. Participants

The participants were a subpopulation of the Korean Social Life, Health, and Aging Project (KSHAP)—a longitudinal panel study that adopted a multidisciplinary approach, including detailed social network structures and comprehensive physical examinations of community-dwelling older adults [for details, please see Refs. [9,10]]. The KSHAP

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was designed to be comparable to the National Social Life, Health, and Aging Project (NSHAP) in the United States [11] to understand how social networks in the elderly are related to various health conditions. Hair samples were collected from a subsample ($n = 192$) of the total participants ($n = 573$) from wave 4 in 2016. All the participants provided their written informed consent prior to participation, and all the procedures were approved by the Institutional Review Board of Yonsei University.

2.2. Measures of social network

Social network items were adapted from general social network survey items [11,12]. To measure network size, the participants were asked to name up to five persons and a spouse (if applicable), with whom they had discussed important topics during the last 12 months (with a possible range of 0–6 members) by asking

“From time to time, most people discuss things that are important to them with others. For example, good or bad things that happen to you, problems you are having, or important concerns you may have. Looking back over the last 12 months, who are the people with whom you most often discussed things that were important to you?”

Emotional closeness (subjective intimacy) with each social network member was measured by asking “How close do you consider your relationships with (the network member)?” with ratings from 1 - “not very close” to 4- “extremely close”. The average intimacy level of a participant’s social support network was measured by calculating the average of these values.

2.3. Hair cortisol collection

Cortisol levels were assessed using hair samples. The participants were asked to sit comfortably and a section of hair (10 strands or 10 mg) from their posterior vertex scalp was isolated, cut as close as possible to the scalp, placed in a plastic bag, and then stored at room temperature until analysis. About 3 cm of hair samples from the scalp were used for further analysis (within less than 12 months). The samples were minced by surgical scissors, and the total proteins from the hair samples were extracted using the Minute™ Protein Extraction Kit (Invent Biotechnologies, USA). The total protein concentrations were further determined by the Pierce™ BCA Protein Assay Kit (Thermo Fisher Scientific, USA) to adjust the variance in the amount of proteins from each participant. Then, the level of hair cortisol was determined by an enzyme immunoassay using the Cortisol ELISA kit® (ALPCO Diagnostics, USA) [13]. The coefficient of variation of the test (intra-assay CV) is less than 5%.

2.4. Perceived stress level

The 10-item Perceived Stress Scale (PSS) [14] measured global personal stress across the past 30 days on a five-point scale (0-“never”, 1-“almost never”, 2-“once in a while”, 3-“often”, 4-“very often”). We used the Korean translated version of the PSS [15], which demonstrated validity and reliability in Korean elderly adults with proper relations with other psychometric measures (i.e., quality of life, depression).

2.5. Statistical analysis

The levels of hair cortisol were evaluated for normality using the Shapiro-Wilk test, and the values were log-transformed to reduce the skewness. After excluding participants with possible cognitive impairment—with Mini-Mental Status Examination for Dementia Screening (MMSE-DS) scores 1.5 SD below the normative data—179 participants were included in the final analysis. Multiple/multivariate regression model implemented in the psych package [16] of R studio was used to

estimate the relationship between the two stress measures—perceived stress and hair cortisol—and the two social relationship components—network size and emotional closeness—that were treated as dependent and independent variables, respectively. Our model controlled factors likely to be associated with both the stress measures and social networks, including sociodemographic information like age, gender, educational attainment, and marital status (living with a spouse or not), cognitive function (MMSE-DS), and self-rated depressive symptoms. Moreover, smoking behavior (current smoker or not), regular drinking (if the participants drank more than once a week or not) and sleep quality asked by “In the past month, how would you rate your sleep overall?” (0 - “Very good”, 1 - “Usually good”, 2 - “Usually bad”, 3 - “Very bad”) were also controlled for potential confounding behavioral factors. Standardized beta effect with adjusted p values were reported with the regression diagram.

3. Results

The stress measures and social network variables were assessed in a sample of 179 men and women between the ages of 56 and 96 years (mean 75 years) from the KSHAP. Table 1 shows descriptive statistics of the participants. The associations between the stress measures and the social network components are presented in Fig. 1. Emotional closeness significantly predicted the level of hair cortisol after adjusting for the covariates ($b = -0.17$, $SE = 0.08$, $p = .04$), while social network size did not ($b = -0.09$, $SE = 0.08$, $p = .23$). Regarding the level of perceived chronic stress, neither the quality nor the quantity of social connections was significantly predicted ($b = -0.08$, $SE = 0.08$, $p = .27$; $b = -0.04$, $SE = 0.08$, $p = .59$, respectively). Moreover, there was no significant correlation between the level of biological (cortisol) and perceived stress (Pearson’s coefficient = -0.04 , $p = .58$), but the quantity and quality of social relationships were correlated (Pearson’s coefficient = -0.17 , $p = .02$).

4. Discussion

The current findings revealed that the affective aspects of social relationships, the degree to which they evaluated the emotional closeness

Table 1
Characteristics of the participants.

	Overall (N = 179)
Age, Mean (SD)	75.0 (5.93)
Sex (n, % Female)	118 (65.9%)
Education attainment, n (%)	
No education	52 (29.1%)
Elementary school graduation	84 (46.9%)
Middle school graduation	21 (11.7%)
High school graduation	17 (9.5%)
College graduation	5 (2.8%)
Marital status, n (%)	
Married	135 (75.4%)
Widowed/Divorced ^a	44(24.6%)
Hair cortisol ^b , Median (IQR)	7.76 (4.48–12.35)
Perceived stress scale, Median (IQR)	10 (7–15)
Emotional closeness, Median (IQR)	3.75 (3.25–4)
Network size (0–6), Median (IQR)	4 (3–5)
CESD ^c , Median (IQR)	6 (2–11)
MMSE ^d , Median (IQR)	26 (24–28)
BMI ^e , Mean (SD)	24.26 (3.37)
Current Smoking, n (%)	11 (6.1%)
Regular alcohol drinking ^f , n (%)	30 (16.8%)
Sleep quality, Median (IQR)	1 (0–3)

^a Widowed = 43; Divorce = 1.

^b Unit = ng/μg.

^c Center for Epidemiologic Studies Depression scale.

^d Mini-Mental Status Examination for Dementia Screening.

^e Body mass index (kg/m²); from a subset ($n = 127$) of participants.

^f Drink alcohol more than once a week.

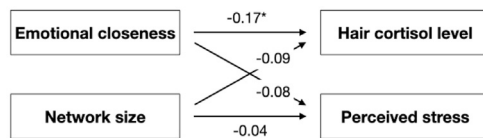


Fig. 1. Path (regression) diagram related to stress measures (hair cortisol and perceived stress levels) and social network variables (emotional closeness and network size). The effect of covariates (gender, age, marital status, education level, cognitive functions, smoking/drinking behavior, sleep quality and depressive symptoms) were controlled out from the regression model. *p values < .05.

to social ties, were significantly related to reduced scalp hair cortisol level, a retrospective chronic stress measure. In contrast, the network size did not have linkages to any of the stress measures. This finding can be partially explained by the fact that the network size is supportive and beneficial only when subjectively managed, rather than in a linearly increased way [17]. Moreover, the results are consistent since subjective feelings of social support have been consistently associated with promoting health outcomes [5]. Considering that the current participants were elderly adults, these results are also in line with the recent findings that when people grow older, the quality, rather than the quantity of social networks, contribute more significantly to well-being and health [18,19].

This study has some limitations. It did not detect robust links between the perceived and objective stress measures. Considering that the associations have not yet been well established (e.g., the recent finding revealed no significant association between perceived stress and hair cortisol [20]), more studies on hair cortisol and perception of stress will be needed. Moreover, since we found an unexpected reverse relationship between the size and quality of the social ties, there is a need for further research with well-designed experiments. Similarly, a lack of information on hair washing and dyeing hinders assessment of the correct level of cortisol secreted from the scalp, and could be a confounding factor. Furthermore, in addition to the covariates the current model considered, the more elaborated medical conditions related to HPA axis (i.e., Cushing's syndrome, medication) and behavioral factors (i.e., eating habits) are needed for the robust research design. Finally, given that the current data is from an older population with a cross-sectional design, we need to be cautious while generalizing its findings and examining a causal effect relationship between social networks and stress response.

5. Conclusions

Despite these caveats, the current findings underscore the potential of good-quality social relationships in promoting health outcomes in the elderly. Since our findings suggest that social intimacy can affect health by influencing the stress response, it can be useful for the prevention of illness and promotion of health among the elderly together with future research on biological mechanisms linking the stress responses and social life.

Funding

This work was supported by the Social Science Korea (SSK) Project

through the National Research Foundation of Korea funded by the Ministry of Education, Republic of Korea (NRF-2017S1A3A2067165).

Declaration of competing interest

The authors declare that they have no known competing interests or personal relationships that could have appeared to influence the work reported in this paper.

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