Preventive Medicine 63 (2014) 63–71

Contents lists available at ScienceDirect

Preventive Medicine

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

Association of education and receiving social transfers with allostatic load in the Swiss population-based CoLaus study

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ARTICLE INFO

Available online 19 March 2014

Keywords:
Allostatic load
Socioeconomic status
Chronic stress
Oxidative stress
Population-based
Education

ABSTRACT

Background. Allostatic load reflects cumulative exposure to stressors throughout lifetime and has been associated with several adverse health outcomes. It is hypothesized that people with low socioeconomic status (SES) are exposed to higher chronic stress and have therefore greater levels of allostatic load.

Objective. To assess the association of receiving social transfers and low education with allostatic load.

Methods. We included 3589 participants (1812 women) aged over 35 years and under retirement age from the population-based CoLaus study (Lausanne, Switzerland, 2003–2006). We computed an allostatic load index aggregating cardiovascular, metabolic, dyslipidemic and inflammatory markers. A novel index additionally including markers of oxidative stress was also examined.

Results. Men with low vs. high SES were more likely to have higher levels of allostatic load (odds ratio (OR) = 1.93/2.34 for social transfers/education, 95%CI from 1.45 to 4.17). The same patterns were observed among women. Associations persisted after controlling for health behaviors and marital status.

Conclusions. Low education and receiving social transfers independently and cumulatively predict high allostatic load and dysregulation of several homeostatic systems in a Swiss population-based study. Participants with low SES are at higher risk of oxidative stress, which may justify its inclusion as a separate component of allostatic load.

Introduction

An association between socioeconomic status (SES) and health, with lower SES being associated with poorer health in a dose–response manner, has been extensively documented and is consistently found across health outcomes, places and time (Adler et al., 1994; Marmot and Wilkinson, 2006). SES differences in health can be found even in prosperous countries such as Switzerland, which ranked 11th in the 2011 Human Development Index (UNDP, 2011) and has one of the highest gross domestic product per capita in the world (World Bank, 2012). The socioeconomic gradient in health seems to be even steeper in Switzerland than in other European countries, at least in men (Bopp and Minder, 2003).

Among the factors that have been proposed to explain social inequalities in health are a higher exposure of low SES individuals to environmental factors such as air pollution (Evans and Kantrowitz, 2002; Forastiere et al., 2007), psychosocial factors such as stress (Kristenson et al., 2004; McCartney et al., 2012; Pearlin et al., 2005) or health-risk behaviors such as smoking (Stringhini et al., 2010). Recently, research has started addressing the issue of how SES is biologically embedded to generate differences in health (Hertzman, 1999; Hertzman and Boyce, 2010; Seeman et al., 2010). In this context, the pathway of chronic stress has received a lot of attention.

The concept of allostatic load (AL) has been introduced in the early 1990s by McEwen and Stellar to represent the physiological consequences of exposure to chronic stress (McEwen, 1998, 2004; McEwen and Stellar, 1993). AL is generally operationalized through an index, which is an indicator of the cumulative physiological toll on multiple biological systems over the years (Seeman et al., 2010). Several studies have shown AL to capture the physiological dysregulation that occurs in response to chronic stress (Gallo et al., 2011; Juster et al., 2011). AL has also been associated with cardiovascular morbidity and mortality (Crimmins et al., 2003; Seeman et al., 2001, 2004), as well as with poorer cognitive and physical functioning (Juster et al., 2010; Seeman et al., 1997).

Studies that have investigated the relationship between SES and AL have generally observed strong SES gradients in cumulative

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http://dx.doi.org/10.1016/j.ypmed.2014.03.013
0091-7435/

physiological dysregulation (Gruenewald et al., 2012; Seeman et al., 2010). Moreover, in one study SES associated differences in AL were shown to explain up to one third of SES differences in mortality (Seeman et al., 2004).

Studies have examined a variety of indicators of SES in relation to AL (Dowd et al., 2009), including education (Hu et al., 2007; Seeman et al., 2004), income (Hu et al., 2007) and socio-economic disadvantage (Gruenewald et al., 2012). However, which component of low SES (i.e. financial adversity, lack of coping resources, or deleterious lifestyle) represent a challenge for physiological dysregulation is still not clear. Moreover, most studies in this area have been conducted in North American populations (United States) and it remains to be known if SES differences in AL exist even in prosperous countries where health insurance is mandatory and access to health-care is relatively universal.

Although there is still an ongoing debate on which is the best way to capture the multiple and interrelated components of AL (Seeman et al., 2010), studies have generally operationalized AL by creating an index aggregating cardiovascular, metabolic, dyslipidemic, neuroendocrine and inflammatory markers.

To our knowledge, no component specifically targeting oxidative stress has been used so far when generating AL, although mammalian organisms under chronic stress display increased oxidative stress at the cellular level (Devaki et al., 2013). Oxidative stress results from an imbalance between pro- and anti-oxidant molecules, which leads to cell damage. Reactive derivatives of oxygen or nitrogen are the hallmark of oxidative stress, but their instability precludes their use as biomarkers. Serum gamma-glutamyltransferase (GGT) is considered as a suitable marker for oxidative stress in epidemiological settings (Lee et al., 2004). Both homocystein (Liu et al., 2013) and uric acid (So and Thorens, 2010; Strazzullo and Puig, 2007) are considered as markers of oxidative stress and their circulating levels can be easily assessed in large scale population-based studies.

As most studies assessing the association between SES and AL have been conducted in North American populations, the first objective of the present study is to assess whether SES is associated with allostatic load also in a Swiss population-based study (CoLaus). In this context, we use two indicators of SES, education, which has been consistently found to be associated with AL in previous studies, and receiving social transfers, which we consider here as a proxy indicator of financial difficulties. The second objective of this study is to compare two indexes of allostatic load, a "classic" index aggregating cardiovascular, metabolic, dyslipidemic and inflammatory markers, and a novel index additionally including markers of oxidative stress, in relation to SES.

Data and methods

Study population

The CoLaus study was implemented in Lausanne, a French-speaking Swiss town counting approximately 120,000 inhabitants, after approval of the Institutional Ethics Committee of the University of Lausanne. Participants' recruitment took place between June 2003 and May 2006 at the University Hospital of Lausanne (CHUV). A random sample of 19,830 subjects (35% of registered Swiss citizens) was drawn, out of which 8121 subjects (41% of the random sample) agreed to participate. Individuals who had moved out of Lausanne, who had died in 2003 or who didn't meet the age criteria were considered as non-eligible. Out of the 8121 subjects, only 6738 completed the interview, from which 549 subjects were withdrawn because they were non-Caucasian and one person self-withdrew, reducing the final sample size to 6188. Further details on sampling, recruitment and inclusion criteria are provided in Firmann et al. (2008).

Data were collected by trained research nurses, supervised by a medical doctor and a senior research nurse. Venous blood samples were drawn after an overnight fast, and assays were performed by on fresh plasma samples within 2 h of blood collection in a Modular P apparatus (Roche Diagnostics, Switzerland). Information on demographic data, socioeconomic and marital status, lifestyle factors, personal and family history of disease, cardiovascular risk factors and treatment was collected through questionnaire.

Measures

Socioeconomic status (SES)

Two indicators of SES were used: receiving social transfers (ST) and educational level. *Social transfer status* was assessed with the question: "Do you receive social help (for instance for the health insurance, retirement benefits or the invalidity insurance)?" Answer: "Yes/No". In Switzerland, social transfers are provided as financial support by the government to people with disabilities, whose income is insufficient to support themselves or their family, or who are retired (Statistique suisse, 2012). Because all individuals residing in Switzerland receive financial compensation when they retire, the response to this variable is not informative beyond the retirement age. Therefore, men older than 65 years and women older than 63 or 64 years were excluded from the analyses (N = 1110). More precisely, because women's age at retirement changed over the recruitment period, if the examination took place before January 1st 2005, we dropped women older than 63, otherwise we dropped only those older than 64 (Jacques Méry, OFAS. Statistique de l'AVS, 2009, p. 26).

Educational level was categorized as (1) primary education (20.1%), (2) vocational secondary education (24.3%), (3) secondary education (36.6%) and (4) university (19%) as described in Firmann et al. (2008).

In order to examine the cumulative impact of low education and receiving social transfers on physiological dysregulation, we built a SES score combining both indicators. Only for constructing a SES score, education was further dichotomized as *high* (secondary education or university) or *low* (primary education or vocational secondary education). The *SES score* was then calculated as follows: (1) high education and no ST, (2) high education and ST, (3) low education and no ST and (4) low education and ST.

Other covariates

Marital status, that can be considered and indicator of social support (Stringhini et al., 2012), was categorized as single, married or living in couple, divorced, or widowed. Smoking was classified as current or non-current smoking. Alcohol consumption was categorized into regular alcohol intake (at least 1/unit of alcohol per day, corresponding to 10 g of alcohol) versus non-regular alcohol intake. Physical activity was dichotomized into never versus at least once per week with respect to leisure physical activity sessions (jogging, swimming, cycling, etc.) of at least 20 min.

Clinical and biological data

Body weight (kg), height (cm), and waist and hip circumferences (cm) were measured according to standard procedures (Firmann et al., 2008) (Lean et al., 1995). Body mass index (BMI) was defined as weight in kg divided by height in meters squared. Blood pressure (mm Hg) and heart rate were measured thrice on the left arm, with an appropriately sized cuff, after at least 10-minute rest in the seated position using an Omron® HEM-907 automated oscillometric sphygmomanometer (Matsusaka, Japan). The average of the last two measurements was used for analyses (Firmann et al., 2008).

Allostatic load

Constituting risk factors of AL are often analyzed in groups corresponding to five homeostatic systems or processes: cardiovascular system, metabolism, hypothalamic–pituitary–adrenal (HPA) axis, autonomic nervous system (ANS) and inflammation (Seeman et al., 2010). Two indices of AL were generated. The first "classic" index (AL1), described in eTable 1, was based on cardiovascular, metabolic, dyslipidemic and inflammatory markers. Compared to the markers usually