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Socioeconomic Status, Ecologically Assessed Social Activities, and Daily Cortisol Among Older Urban African Americans

Samuele Zilioli, PhD[1,2], **Heather Fritz, PhD**[3,4], **Wassim Tarraf, PhD**[3,4], **Susan A. Lawrence, PhD**[5], **Malcolm P. Cutchin, PhD**[3,4]

[1]Department of Psychology, Wayne State University, Detroit, MI, USA

[2]Department of Family Medicine and Public Health Sciences, Wayne State University, Detroit, MI, USA

[3]Department of Health Care Sciences, Wayne State University, Detroit, MI, USA

[4]Institute of Gerontology, Wayne State University, Detroit, MI, USA

[5]School of Medicine, Wayne State University, Detroit, MI, USA

Abstract

Objectives: Higher socioeconomic status (SES) individuals report more social activities than their lower SES counterparts. Yet, SES and racial health disparities are often confounded. Here, we tested whether the frequency of engagement in social activities contributed to the association between SES and daily cortisol secretion among urban African American older adults.

Methods: Ninety-two community-dwelling African Americans aged 55 years and older reported what they were doing at regular intervals across the day on an Android smartphone for seven consecutive days. They also provided four saliva samples at four time points a day during the same period.

Results: Higher SES older adults engaged in proportionally more social activities than their lower SES counterparts. A greater relative frequency of weekly social activities was associated with a steeper diurnal cortisol decline. Higher SES was indirectly linked to a steeper cortisol decline via increased relative frequency of weekly social activities.

Discussion: Our findings suggest that engagement in weekly social activities represents a behavioral intermediary for SES health disparities in endocrine function among older urban African American adults.

Keywords

ecologically momentary assessment (EMA); social participation; minority aging; dysregulation

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Corresponding Author: Samuele Zilioli, Department of Psychology, Wayne State University, 5057 Woodward Avenue, Detroit, MI 48202, USA. fv0808@wayne.edu.

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The socioeconomic gradient—the linear and positive relationship between socioeconomic status (SES) and health—is one of the most robust phenomena in epidemiology (Adler et al., 1994), yet one of the least understood (Sapolsky, 2005). Part of this challenge is identifying the complex mechanisms responsible for this association (Matthews & Gallo, 2011). SES effects are evident in health-related biological processes (Cohen, Doyle, & Baum, 2006; Zilioli, Imami, & Slatcher, 2017). Mechanistically, brain areas involved in the appraisal of environmental threats and challenges project to the hypothalamus, which initiates a hormonal cascade along the hypothalamic–pituitary–adrenal (HPA) axis that ultimately results in cortisol secretion. Cortisol plays a crucial role in regulating many homeostatic systems in the body (e.g., cardiovascular, respiratory, immune; Sapolsky, Romero, & Munck, 2000). For this reason, dysregulation in the diurnal pattern of cortisol release compromises the proper functioning of various homeostatic systems, increasing morbidity and mortality over the long term (for a review, see Adam et al., 2017). Stressors involved in dysregulation are arguably more prevalent and acute for low-SES groups (Matthews & Gallo, 2011).

Cortisol secretion follows a diurnal rhythm characterized by high morning levels, an acute increase approximately 30 min after awakening (known as the cortisol awakening response [CAR]), and a steady decline throughout the day, referred to as the cortisol slope or cortisol decline (Tsigos & Chrousos, 2002). These parameters can be reliably estimated by assessing cortisol concentrations in saliva collected at several time points throughout the day, for several consecutive days. Among these parameters, cortisol decline has been found to be the most robust predictor of psychological and health outcomes (Adam et al., 2017; Saxbe, 2008), while the literature has been found to be largely inconsistent with regard to CAR associations with psychological well-being and physical health (Chida & Steptoe, 2009). Current evidence indicates that low-SES individuals experience more abnormalities (e.g., flattened cortisol declines) in their diurnal cortisol decline (Cohen et al., 2006; Zilioli, et al., 2017). Relatively little is known about how SES leads to cortisol dysregulation in older adults, especially in minority groups. Identifying protective factors that build resilience, potentially ameliorate the insidious effects of SES, and reduce known health disparities is a public health priority in the United States and would assist efforts to enhance healthy aging.

Recent scientific efforts have focused on psychosocial and behavioral pathways to better understand the socioeconomic gradient in health-related biological processes, such as immune function impairment (Chiang et al., 2015; Needham et al., 2013), elevated allostatic load (McCurley et al., 2017), and dysregulation of stress-responsive neuroendocrine axes (Cohen et al., 2006; Janicki-Deverts et al., 2007). Most of these studies have focused on health-related behaviors, such as smoking, exercise, and diet (Cohen et al., 2006; Needham et al., 2013), but they have largely neglected social participation despite clear evidence linking it to physical health (Chiao et al., 2013; Sundquist, Lindström, Malmström, Johansson, & Sundquist, 2004) and psychological well-being (Ellaway & Macintyre, 2007; Hong, Hasche, & Bowland, 2009).

The literature on social participation can be framed in the broader literature on social integration. Theories on social integration find their progenitors in the work of Durkheim and Faris who emphasized the role of poor social integration in the etiology of suicide (Durkheim, 1897/1951) and mental illness (Faris, 1934). More recent and detailed theories on the relationship between social integration and health have been developed by Thoits (1983) and Cohen (1988), who emphasized the behavioral and psychological mechanisms through which social integration exerts its beneficial effects on health. These theories also recognize that social integration is a multifaceted construct, including both behavioral and cognitive components. Social participation—the extent and frequency to which people engage in social activities—has been proposed as one of the multiple components of social integration (Brissette, Cohen, & Seeman, 2000). Among older adults, higher levels of social participation have been linked to increased physical activity (Legh-Jones & Moore, 2012), fewer depressive symptoms (Chiao, Weng, & Botticello, 2011; Roh et al., 2015), lower functional disability (Kanamori et al., 2014), better dental health (Takeuchi, Aida, Kondo, & Osaka, 2013), better self-reported health (Sirven & Debrand, 2008; Veenstra, 2000), and survival (Glass, De Leon, Marottoli, & Berkman, 1999).

More engagement in social activities might be particularly beneficial for minority older adults living in urban areas who are at greater risk of social isolation (Aneshensel et al., 2007; Nicholson, 2012). Although previous work has found a link between a person's SES and other components of social integration (e.g., *social network diversity*, Kahn, 1994; Krause & Borawski-Clark, 1995; *social network size*, Ajrouch, Blandon, & Antonucci, 2005, but see Kubzansky, Berkman, Glass, & Seeman, 1998), very few studies have linked SES to social participation (e.g., Herzog, Franks, Markus, & Holmberg, 1998), especially in the form of what people *do*—their daily activities that foster interaction and social integration. Furthermore, most of the existing studies have relied on global, retrospective self-reported measures of social participation (e.g., Glass et al., 1999; Kanamori et al., 2014; Veenstra, 2000). Using ecological momentary assessment (EMA) represents an innovative way to measure real-time participation and its link to SES and health. Finally, no work, to our knowledge, has examined how social participation relates to diurnal cortisol fluctuations in older adults (for similar work among younger adults, see Stetler, Dickerson, & Miller, 2004) and whether it acts as a mediator of the expected association between SES and diurnal cortisol. Studying the dynamics between SES, social participation, and physiological stress might be particularly relevant for urban African American older adults, who, compared with other racial groups, tend to experience higher rates of physical disability (Dunlop, Song, Manheim, Daviglus, & Chang, 2007), more financial burdens (Williams, Mohammed, Leavell, & Collins, 2010), and are more likely to dwell in disadvantaged neighborhoods (Williams et al., 2010) that might deter or impede social contacts (Ross & Jang, 2000).

To summarize, we used data from a sample of older urban-dwelling African Americans to test whether (a) higher SES participants report higher rates of daily social activities, (b) higher rates of social activities are associated with a more normative (i.e., steeper) cortisol daily decline, and (c) higher rates of social activities mediate the expected association between higher SES and steeper cortisol declines. In addition to these hypotheses, we also tested whether other diurnal cortisol parameters (i.e., morning cortisol and CAR) are associated with social activities. Our study focuses exclusively on African Americans. Doing so allows us to focus on the variability in the psychosocial and health variables within this population, which might go underexamined in multiracial studies. Moreover, because certain psychosocial stressors, such as socioeconomic disadvantage, are incommensurate across races (Kaufman, Cooper, & McGee, 1997), a single-race study might help avoid problems related to residual confounding. This work contributes to the growing literature on the psychosocial and behavioral pathways to health and resilience, particularly among higher risk older minority populations.

Method

Participants

The current study included 100 adults aged 55 and older (*M* = 69.83, *SD* = 8.73, 79.4% women) in Detroit who were capable of participating in activities without assistance from another person. Furthermore, to be eligible, participants did not need to have Cushing's disease, Addison's disease, or have used oral steroids in the past 2 weeks. Participants were recruited from a volunteer registry of approximately 1,400 African Americans aged 55 and older willing to participate in research of interest to them. From the registry, we drew a stratified random sample based on a census tract index of neighborhood quality (Table 1). The response rate for our random sample was 21%, meaning that among the 323 people who were initially contacted by phone, 69 ultimately participated in the study. We augmented the random sample with snowball sampling. The latter approach contributed 31% of the full sample. Eight people did not provide saliva samples and were therefore excluded from the analyses. The analytic sample consisted of 92 participants self-identifying as African Americans. We conducted a series of bivariate analyses, chi-squares for categorical and *t* tests for continuous measures, to test for differences in demographic characteristics between participants who provided cortisol data and who did not. Our results showed that the two groups did not differ in any of the demographics (i.e., gender, age, living status, income, education, and employment status; lowest *p* value = .651). The Wayne State University Institutional Review Board approved all study procedures.

Procedure

We used a smartphone-based EMA protocol as part of a multi-method data collection approach that included psychosocial instruments and saliva samples 4 times per day for seven consecutive days. The EMA data collection protocol has been described previously (Fritz, Tarraf, Saleh, & Cutchin, 2017). The average number of days EMA data were collected was 6.62 (*SD* = 1.25), with only one participant out of 92 not providing EMA data. Briefly, participants were asked to provide data about their activities and other dimensions of daily experience through the use of movisensXS, a smartphone-based EMA application. After training, all participants were lent a smartphone loaded with the application to use during the data collection period. Participants were asked to carry the phone with them during their waking hours. The EMA application was designed to sound an alarm 4 times per day (9 a.m., 1 p.m., 5 p.m., and 9 p.m.) to alert participants that it was time to complete the EMA question sets. At each alarm, participants were asked to respond to questions about the present. With the exception of the 9 a.m. alarm, participants were then also immediately asked corresponding questions about what they had been doing 2 hr prior to the alarm. By combining "current time" questions with "2 hr prior" questions, we were able to collect information specific to seven equally spaced time points across the day.

Measures

Social activities.—To measure this dimension of social participation, the EMA protocol included a question that asked participants to describe what they were doing at the referent time using text (or voice converted to text). Participants' descriptions of their activities were brief, ranging in length from a word or two to one sentence. We used the International Classification of Functioning, Disability and Health (ICF; World Health Organization, 2001) to code all activity responses into discrete nonoverlapping categories (Table 2). We coded participants' responses using the most fine-grained coding provided in the ICF, which has four levels of codes and subcodes. Because there is no universally accepted criterion for coding self-reports of activity as either "social" or "individual," we categorized each chapter within the ICF as being "social" or "individual" activity based on the likelihood that it represented activities that involved social interaction and therefore the type of doing in everyday life that denotes social participation. For example, Chapter 9 of the ICF includes "actions and tasks required to engage in organized social life outside the family, in community, social and civic areas of life" (World Health Organization, 2001). Based on the ICF description, we labeled activities falling under Chapter 9 as "social activity" because they are likely to include some degree of interaction with others. One trained coder assigned codes to each reported activity, and infrequent reports that were too difficult to classify or understand were decided by a majority vote among a team of three authors or coded as missing. For each participant, we then calculated the percentage of social activities from all reported activities during the week. One subject provided no data on this variable, and the rest of the participants provided an average of 36.75 (*SD* = 10.82) responses. Three participants provided responses at or below 3 *SD* (i.e., 4) of the average number of responses: Two participants provided only a single report during the week and a third one provided only three. The calculated percentages for these participants were treated as missing values. Thus, the total number of people with missing data per this criterion on the social activities variable was four. Overall, the average percentage of weekly social activities among all activities reported was 26.24% (*SD* = 13.47).

Presence of Others.—Distinct from what respondents were doing, we asked participants to use the EMA interface and report whether they were alone or with someone at each of the seven time points across the day. This variable provides a measure of being in the presence of others but is not about doing, and it allows a control for effects of sociality outside the nature of the activity one is doing. For instance, one might be washing dishes (an individual activity) while someone else is in the next room watching television (being with someone). For each participant, we calculated the percentage of time spent with someone from all reports during the week. Eighteen subjects provided no data on this variable, and the rest of the participants provided an average of 40.31 (*SD* = 10.94) responses. Two participants provided responses at or below 3 *SD* (i.e., 7) of the average number of responses: One participant provided only a single report during the week and another one provided only two. The calculated percentages for these participants were treated as missing values. The total number of people with missing reports on the Presence of Others variable for whom we were able to impute missing values was 20. Overall, the average percentage of time spent with someone from all Presence of Others reports during the week was 44.83% (*SD* = 26.34).

Smoking and medication status.—During saliva collection, participants answered a series of questions, including whether they smoked or took any medications. These data were used to create two person-level variables: smoking status (0 = currently not smoking, 1 = currently smoking) and medication status (0 = currently not taking medication, 1 = currently taking medications). In our sample, 26.1% of participants reported currently smoking, and 90.2% reported currently using medications.

SES and demographics.—Education was measured on a scale from 1 (i.e., eighth grade or less) to 6 (i.e., graduate degree), whereas income was measured on a scale from 1 (i.e., less than US$5,000 a year) to 10 (i.e., US$70,000 or more a year). In our sample, 17.6% of participants reported having completed high school or having passed the General Educational Development (GED) test, 51.6% reported having attended some college or technical school, 17.6% reported having completed an undergraduate degree, and 13.2% reported having completed a graduate degree. Slightly more than a third (34.6%) of participants reported having an average yearly income of less than US$20,000, 49.4% reported having an average yearly income between US$20,000 and US$50,000, and 16% reported having an average yearly income greater than US$50,000. Income and education were first z-scored and then added together to derive an SES Index. Daily-level covariates included day of the week (0 = weekday, 1 = weekend) and daily wake-up time, which have been shown to be related to diurnal cortisol (Kudielka & Kirschbaum, 2003; Kunz-Ebrecht, Kirschbaum, Marmot, & Steptoe, 2004). Person-level covariates included age ($M = 69.83$, $SD = 8.73$), gender (0 = male, 1 = female), medication status, smoking status, as well as two important demographic characteristics related to individuals' social life, living status (59.3% living alone), and employment status (9.1% currently employed), which correlated with our measure of social participation ($r = .344$, $p = .001$).

Cortisol.—For seven consecutive days, participants self-collected saliva samples at four time points each day: immediately upon waking, 30 min later to assess CAR, before dinner, and at bedtime. Participants were given verbal and written instructions about cortisol collection and storage in their own refrigerators. Our research team collected samples at their home and stored them in a cooler for transport to the laboratory where they were frozen at −20°C until shipment for analyses. Cortisol concentrations were quantified with a commercially available luminescence immunoassay (IBL International, Hamburg, Germany) at the laboratory of Dr. Kirschbaum at the Technical University of Dresden. Concordant with standard practice, cortisol values were log-transformed to correct for positive skew in the cortisol distribution (Adam & Kumari, 2009; Zilioli et al., 2017). To ensure that all transformed scores were positive, we added a constant of 1 before the transformation. Participants provided 2,387 saliva samples out of the 2,576 potential ones (92.7%). CAR compliance was high; of the available 610 CAR cortisol values, 111 self-reported deviating by 10 min or more from the requested 30-min interval (Adam, Hawkley, Kudielka, & Cacioppo, 2006). These cortisol values were treated as missing values at Level 1 in our multilevel models. Notably, hierarchical linear modeling (HLM) handles missing data at the lowest level of the hierarchy (in this case, the cortisol level) by using the maximum likelihood estimation method (Raudenbush & Bryk, 2002).

Statistical Analyses

When considering all variables measured at the person level, the percentage of missing data in our sample was 4.46%. To impute missing values, we used the expectation maximization (EM) algorithm, which provides unbiased parameter estimates and improves statistical power of analyses (Enders, 2001). All variables with missing data were continuous except for one individual who had a missing value for living status and four individuals who provided no data as to their employment status. Mode replacement was used to replace these missing data.

We used HLM to account for the nested structure of the data and to model diurnal cortisol as a function of the covariates of interest (Adam & Kumari, 2009). In line with standard practice, we modeled time (including Time Since Waking, Time Since Waking^2, and CAR, which was dummy coded 0 or 1) as a Level 1 measurement, daily-level covariates (e.g., day of the week) as Level 2, and person-level variables (e.g., age) as Level 3. The Time Since Waking variable reflected cortisol decline. First, we ran the model using SES only as the main predictor. Second, we refit the model adding percentage of weekly social activities as a predictor. Both models were fit first without and then controlling for covariates (i.e., daily wake-up time, day of the week, age, sex, living status, medication status, employment status, and percentage of presence of others). Continuous variables were left uncentered if they had a meaningful zero (i.e., percentage of social activities, percentage of presence of others, SES). We recoded age so that a zero value would represent the age of the youngest adults in the sample. We recoded education and income so that a zero value would indicate the lowest level of education and the minimum income reported in the sample. Daily wake-up time was grand-mean centered following recommendations by Enders and Tofighi (2007). HLM models fit without controlling for covariates are reported in the main text, whereas results of models that control for covariates are reported in Table 4. All HLM significance tests were two-tailed with robust standard errors. Third, we regressed social activities on SES with and without controlling for appropriate covariates (i.e., age, sex, living status, percentage of presence of others, and employment status). Finally, we estimated the 95% confidence interval for the indirect effect linking SES to cortisol parameters via percentage of weekly social activities using Monte Carlo simulation (Preacher & Selig, 2012).

Results

SES and Diurnal Cortisol

Bivariate correlations are reported in Table 3. HLM analyses without controlling for covariates showed that higher SES was associated with a steeper cortisol decline ($b = -0.006$, $SE = 0.002$, $p = .008$). The direction and magnitude of the association were consistent when considering income ($b = -0.005$, $SE = 0.002$, $p = .004$) and education separately ($b = -0.008$, $SE = 0.005$, $p = .065$), even though education did not reach statistical significance. We found no significant direct association between SES and morning cortisol (intercept) or CAR (lowest p value = .161).

After controlling for covariates, we found that SES was no longer associated with cortisol decline (Table 4, Model 1). This attenuation was likely due to the inclusion of potential mediators of the SES gradient in cortisol decline among our covariates. For example, previous studies have shown that smoking status is a robust mediator of the link between SES and cortisol decline (Matthews, Schwartz, Cohen, & Seeman, 2006). Notably, in our analyses, when smoking status was not included as a covariate in the analyses, the association between SES and cortisol was significant ($b = -0.005$, $SE = 0.002$, $p = .036$), confirming the possibility of a mediating role played by smoking status. Furthermore, although SES was not directly linked to cortisol decline after controlling for covariates, this does not preclude the possibility of mediation through social activities because indirect effects can exist in the absence of a significant total effect (Zhao, Lynch, & Chen, 2010).

SES, Social Activities, and Diurnal Cortisol

When SES and percentage of social activities were both included in an HLM with no covariates, we found that higher rates of social activities were also associated with a steeper cortisol decline ($b = -0.0005$, $SE = 0.0002$, $p = .022$). These associations remained significant after controlling for covariates (Table 4, Model 2). The estimates were consistent when income ($b = -0.0005$, $SE = 0.0002$, $p = .019$; $b = -0.0005$, $SE = 0.0002$, $p = .022$ after controlling for covariates) or education ($b = -0.0006$, $SE = 0.0002$, $p = .003$; $b = -0.0005$, $SE = 0.0002$, $p = .024$ after controlling for covariates) was used in place of SES. Regression analyses without controlling for covariates showed that SES was positively associated with percentage of weekly social activities ($b = 2.798$, $SE = 0.750$, $p < .001$; consistent for income: $b = 2.085$, $SE = 0.609$, $p = .001$; for education: $b = 4.185$, $SE = 1.444$, $p = .005$). The same effects were found in the covariates-controlled model (for SES, $b = 2.677$, $SE = 0.745$, $p = .001$; for income: $b = 2.184$, $SE = 0.615$, $p = .001$; for education: $b = 3.736$, $SE = 1.426$, $p = .010$). Monte Carlo analyses indicated a significant indirect effect of SES on cortisol decline via percentage of weekly social activities (95% CI = [−0.002964, −0.00009278]; 95% CI = [−0.00284, −0.0001927], without controlling for covariates). The same effects were consistent for income (95% CI = [−0.002556, −0.0001589]; 95% CI = [−0.002224, −0.0001431], without controlling for covariates) and education (95% CI = [−0.004551, −0.0001304]; 95% CI = [−0.005031, −0.0005009], without controlling for covariates).

Discussion

Several findings emerged from this work. First, both higher SES and higher rates of social activities were associated with a more normative daily cortisol decline. Second, higher SES was also directly and positively linked to higher participation in social activities. Finally, SES effects on cortisol fluctuations were partially realized through higher rates of social activities.

The positive association between SES and the relative percentage of social activities is in line with the broader literature on SES and social networks. For example, older adults with lower SES tend to have more modest (Ajrouch et al., 2005; Van Groenou & Van Tilburg, 2003) and less diverse (Krause & Borawski-Clark, 1995) social networks compared with their higher SES counterparts. Loneliness, the psychological distress associated with the perception of a withered social network, is more common among people living under conditions of socioeconomic disadvantage (Hawkley et al., 2008). Furthermore, individuals with lower educational attainment and income report participating in fewer social activities (de Leon, Glass, & Berkman, 2003; Herzog et al., 1998; Vroman, Arthanat, & Lysack, 2015).

We also discovered that social activity levels—as derived through our coding schema of self-reported activities—mediated the association between SES and diurnal HPA activity, such that older adults with a greater proportion of weekly social activities experienced a steeper cortisol decline throughout the day than older adults who had lower rates of social activities. This finding remained significant after controlling for the percentage of time our participants were in the presence of others. Interestingly, percentage of time spent with others and percentage of social activities were not correlated, suggesting that these two measures tap into two different constructs; to wit, social participation is about being engaged in social activities and is not the same as being in the presence of others. A handful of studies have linked social participation to physiological activity, such as blood pressure, total cortisol output (Pressman et al., 2009), and chronic inflammation (Friedman, 2011). However, these reports have not specifically looked at weekly social activities; rather, they defined social participation or engagement in terms of either self-reported leisure activities (Pressman et al., 2009) or self-reported social well-being (Friedman, 2011). An exception is the work by Stetler and colleagues who found that, among young adults, regular engagement in daily social activities (Stetler et al., 2004) and daily contact with familiar others (Stetler & Miller, 2008) were associated with steeper cortisol declines. Notably, our investigation extends findings of these previous studies to older adults, and older African Americans in particular. It is reasonable to suggest that social participation should be investigated further as a possible mechanism of reducing the burden of SES inequality and other social harms that affect older African American health (Forrester, Gallo, Whitfield, & Thorpe, 2018).

It is plausible to consider HPA modulation by social participation as one broad biological mechanism responsible for the protective effects attributed to social participation. Higher rates of social participation have been linked to better physical (Chiao et al., 2013; Sundquist et al., 2004) and mental health (Ellaway & Macintyre, 2007; Hong et al., 2009). For example, among adults of various ages, Sundquist et al. (2004) found that low social participation predicted risk of coronary heart disease (but see Ellaway & Macintyre, 2007), whereas Chiao et al. (2013) found that social participation positively predicted life expectancy in older adults. Recent evidence strengthens the hypothesis that dysregulation of daily cortisol secretion acts as a biological intermediary of these poor health outcomes (Zilioli et al., 2017; for a review, see Adam et al., 2017).

To our knowledge, the present study represents one of the first that speaks to how social activities—measured multiple times daily for a week via EMA—are related to daily activity of the HPA axis among minority older adults. Although lower SES is a well-established factor in older adult health (Grundy & Holt, 2001; Schoeni, Martin, Andreski, & Freedman, 2005) and racial health disparities (Williams & Mohammed, 2013; Williams et al., 2010), this study provides evidence of how the role of lower SES in health might be partially offset by higher social participation—a goal of many healthy and productive aging initiatives and interventions. We acknowledge that our coding schema for activities could have resulted in errors of classification of self-reported activity types, yet it was systematic, using a formal classification system designed to measure activities and participation. Another measurement limitation of our study was to ask participants whether they were in the presence of others only with regard to specific points in time and not over longer periods. Thus, we could have underestimated the proportion of time being with others, yet we used repeated measures for each day across a week for all participants. As such, we believe that the weekly average measure that we used captures a meaningful objective and is more precise relative to subjective recollection of the overall time spent in the presence of others.

Because cortisol decline has been prospectively associated with poor objective (Kumari, Shipley, Stafford, & Kivimaki, 2011) and subjective (Zilioli et al., 2017) clinical end points, an important inference from the current findings is that HPA activity may serve as one of the biological intermediaries through which SES and social participation disparities manifest their deleterious effects on physical health outcomes among older adults. In this regard, future longitudinal work should formally test this hypothesis. Future investigations might also benefit from implementing multiracial research designs. Although our study leverages the advantages of a single-race study design, multiracial research designs have the intrinsic value of clearly quantifying racial disparities. Moreover, because our participants were predominantly women, future investigation would benefit from including a more gender-balanced sample, with the added advantage of testing gender differences, which have been previously documented when linking social engagement to physiological activity (Friedman, 2011). Finally, although we recruited only adults capable of participating in activities without assistance from another person, our results do not rule out the possibility that certain health and functional problems may play a role in the association observed between social participation and cortisol decline. Unfortunately, because no measure of physical health was collected in the study, we could not control for this important confounder in our analyses. That said, this concern is mitigated by our inclusion of medication use and smoking, which have been found to be reliable predictors of physical heath.

In sum, in a sample of 92 African Americans between the age of 55 and 95 years, higher SES was associated with a greater percentage of weekly social activities reported through EMA. In turn, weekly engagement in social activities predicted a steeper diurnal cortisol decline. Evidence for an indirect effect linking SES to steeper cortisol decline via increased relative frequency of weekly social activities was found, suggesting that engagement in weekly social activities represent a behavioral intermediary for SES health disparities in endocrine function among older urban African American adults.

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Table 1.

Matching Between Final Sample and Stratification.

Neighborhood quality clusters	Tracts	2010 Population	Cluster proportion	Sample	Excluded participants	Analytic sample
First (best)	44	112,690	15.8	19	1	18
Second	79	228,512	32	43	3	40
Third	80	198,342	27.8	20	1	19
Fourth	54	115,823	16.2	12	2	10
Fifth (worst)	40	58,410	8.2	6	1	5
Total	297	713,777	100	100	8	92

Table 2.

ICF Activity Chapters, Descriptions, and Study Classifications.

Major ICF categories	General description	Second level subcategories	Individual/ social designation	Examples of coded text
Learning and applying knowledge	Learning, applying the knowledge that is learned, thinking, solving problems, and making decisions	Purposeful sensory experiences Basic learning Acquiring skills Applying knowledge Solving problems	Individual	“Watching TV” “Reading the newspaper”
General tasks and demands	General aspects of carrying out single or multiple tasks, organizing routines, and handling stress. These items can be used in conjunction with more specific tasks or actions to identify the underlying features of the execution of tasks under different circumstances	Undertaking a single task Undertaking multiple tasks Carrying out daily routine Handling stress and other psychological demands	Individual	“Making appointments” “Sorting out mail”
Communication	General and specific features of communicating by language, signs, and symbols, including receiving and producing messages, carrying on conversations, and using communication devices and techniques	Receiving communication Producing communication Conversation and use of communication devices	Social	“Reading my email on my computer” “Talking on the phone”
Mobility	Moving by changing body position or location or by transferring from one place to another; by carrying, moving or manipulating objects; by walking, running, or climbing; and by using various forms of transportation	Changing and maintaining body position Carrying, moving, and handling objects Walking and moving Moving around using transportation	Individual	“I’m sitting on the bed” “Driving”
Self-care	Caring for oneself, washing and drying oneself, caring for one’s body and body parts; dressing, eating and drinking, and looking after one’s health	Washing Caring for body Toileting Dressing Looking after one’s health	Individual	“Getting dressed” “Napping” “Washing”
Domestic life	Carrying out domestic and everyday actions and tasks. Areas of domestic life include acquiring a place to live, food, clothing and other necessities, household cleaning and repairing, caring for personal and other household objects, and assisting others	Acquisition of necessities Household tasks Caring for household objects and assisting others	Individual (except for assisting others subcategory)	“Making morning coffee” “Household chores”
Interpersonal interactions and relationships	Carrying out the actions and tasks required for basic and complex interactions with people (strangers, friends, relatives, family members and lovers) in a contextually and socially appropriate manner	General interpersonal interactions Particular interpersonal relationships	Social	“Playing with my grandbaby” “Visiting a friend in the hospital”
Major life areas	Carrying out the tasks and actions required to engage in education, work, and employment and to conduct economic transactions	Education Work and employment Economic life	Social	“At the bank” “Working”
Community social and civic life	Actions and tasks required to engage in organized social life outside the family, in community, social, and civic areas of life	Community life Recreation and leisure Religion and spirituality	Social	“Church meeting” “Celebrating a birthday”

Note. ICF = International Classification of Functioning, Disability and Health.

Table 3.

Bivariate Correlations Between Study Variables.

	1	2	3	4	5	6	7	8	9	10	11
1. Female	1	.185†	.129	.062	−.029	−.168	−.492**	.093	.111	.118	.103
2. Age		1	−.045	−.198†	−.205*	−.015	−.222*	.190†	.160	.203†	−.008
3. Living alone			1	−.062	−.722**	.028	−.068	−.273**	.056	−.125	−.063
4. Currently employed				1	.200†	−.288**	−.095	−.018	.084	.038	.344**
5. Presence of others (%)					1	−178†	−.016	.185†	−.037	.086	.139
6. Taking medication						1	.112	−.027	.011	−.010	−.073
7. Smoker							1	−.345**	−.244*	−.342**	−.173†
8. Income								1	.489**	.863**	.340**
9. Education									1	.863**	292**
10. SES										1	.366**
11. Social activities (%)											1
M (*SD*) or %	79.4	69.8 (8.7)	59.3	9.1	44.8	90.2	26.1	5.4 (2.2)	4.3 (0.9)	0 (1.7)	26.2

Note. Except for SES, descriptive statistics for study variables are based on non-imputed data. SES = socioeconomic status.

[†] $p < .10$.

[*] $p < .05$.

[**] $p < .01$.

Table 4.

HLM Models of Diurnal Cortisol Decline.

Fixed effect (independent variable)	Model 1			Model 2		
	Estimate	*SE*	*p*	Estimate	*SE*	*p*
Time Since Waking, $\pi 2$						
Average linear slope, $\beta 20$, $\gamma 200$	−0.1176	0.0244	<.001	−0.1085	0.0251	<.001
SES, $\gamma 201$	−0.0030	0.0023	.190	−0.0017	0.0025	.514
Social activities (%), $\gamma 202$	—	—	—	−0.0005	0.0002	.036
Female, $\gamma 203$	−.0004	0.0083	.957	0.0002	0.0083	.978
Age, $\gamma 204$	−0.0002	0.0005	.609	−0.0002	0.0005	.582
Living alone, $\gamma 205$	0.0135	0.0087	.124	0.0145	0.0079	.071
Currently employed, $\gamma 206$	−0.0015	0.0110	.896	0.0058	0.0110	.600
Presence of others (%), $\gamma 207$	0.0000	0.0002	.836	0.0001	0.000	.667
Taking medications, $\gamma 208$	0.0075	0.0093	.424	0.0085	0.0100	.399
Smoker, $\gamma 209$	0.0279	0.0102	.008	0.0284	0.0101	.006
Wake-up time, ($\beta 21$, $\gamma 210$	−0.0001	0.0020	.960	−0.0004	0.0019	.817
Weekend, ($\beta 22$, $\gamma 220$	0.0007	0.0038	.844	0.0008	0.0038	.824

Note. Intercepts indicate average cortisol values at wake up; average slopes of Time Since Waking indicate change in cortisol per 1-hr change in time; average slopes of Time Since Waking^2 indicate change in cortisol per 1-hr change in time^2. Although the table reports only predictors for the Time Since Waking variable, the same predictors were also included for Morning Cortisol and CAR, as described in the “Statistical Analyses” section. HLM = hierarchical linear modeling; SES = socioeconomic status; CAR = cortisol awakening response.