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Social status and biological dysregulation: The “status syndrome” and allostatic load

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Abstract

Data from a national sample of 1255 adults who were part of the MIDUS (Mid-life in the U.S.) follow-up study and agreed to participate in a clinic-based in-depth assessment of their health status were used to test the hypothesis that, quite part from income or educational status, perceptions of lower achieved rank relative to others and of relative inequality in key life domains would be associated with greater evidence of biological health risks (i.e., higher allostatic load). Results indicate that over a variety of status indices (including, for example, the person’s sense of control, placement in the community rank hierarchy, perception of inequality in the workplace) a syndrome of perceived relative deprivation is associated with higher levels of biological dysregulation. The evidence is interpreted in light of the well-established associations between lower socio-economic status and various clinically identified health morbidities. The present evidence serves, in effect, both as a part of the explanation of how socio-economic disparities produce downstream morbidity, and as an early warning system regarding the ultimate health effects of currently increasing status inequalities.

Keywords

Social status; Inequality; Perceived control; Allostatic load

1. Introduction

The centrality of social inequalities, and the concomitant sense of low personal control, has been an established motif regarding health behavior and health outcomes for more than thirty years (Langer, 1983; Rodin, 1986; Seeman and Seeman, 1983; Wilkinson and Pickett, 2009). In 1979, Norman Cousins, the former editor of the now-defunct *Saturday Review*, wrote in the diary of his life-threatening illness: “There is, first of all, the feeling of helplessness – a serious disease in itself” (Cousins, 1979). His work sparked a new field of

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Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.socscimed.2014.08.002.

psychoneuroimmunology; but at the time this close association between control and disease was largely metaphorical; and in a certain degree it remains so today. Though we know nowa good deal about the connection between the sense of control and a variety of morbidities (Lachman et al., 2011), it remains the case that the pre-clinical documentation that would help to support the “disease in itself” proposition is slim, indeed. If lack of control and its status counterparts constitute in any sense “a disease in itself,” the biological harms ought to be observable in dysregulation well before the obvious morbidities that we know are associated with low personal control. It is the purpose of this paper to provide evidence that leads in that direction.

The importance of such evidence is highlighted by the fact that Marmot’s work on “The Status Syndrome: How Social Standing Affects Our Health and Longevity” (Marmot, 2004) makes the sense of control a central feature of individual status (along with social engagement and opportunity more generally). As he notes, having low standing in the social hierarchy entails having less control over your life. There is no doubt that socio-economic status differences have a significant impact on morbidity, as the extensive work on health disparities along socio-economic lines amply documents (Adler and Stewart, 2010; Wolfe et al., 2012). But the subtler aspects of status distinction, as represented by the control concept and by the finer distinctions in status that people make in their daily life, are significant in their own right–one’s standing in the close as well as the larger community being putatively important elements in the health equation. It is our purpose to examine these status features as they bear on biological dysregulation in a national sample.

Though the bulk of the relevant literature has focused heavily on the health disparities associated with socio-economic status, it has not escaped attention that there are good grounds for proposing that status distinctions more generally have biological consequences. Such consequences have been explored in both animal and human models, focusing especially on the deleterious stressrelated cortisol effects of lower social status (Sapolsky, 2004, 2005). In a more microscopic way, brain imaging has provided evidence of neural pathways that may account, at least in part, for the health consequences of status differences. Such imaging shows evidence of potential early neural embedding of perceived low parental social status, with lower perceived standing being associated with greater amygdala reactivity to threatening facial expressions; see also, McEwen and Gianaros (2010). The authors argue that the stressful circumstances of low status environments may impair the development of stress regulatory systems and result in increased vigilance and sensitivity to potential social threats. In a similar use of the MRI model and the more expansive concept of social status beyond economic rank involved in our own study, Zink et al. (2008) demonstrate that experimentally-induced status differences in a performance setting (requiring visual discrimination in a simulated social context) engaged distinctly different emotional and cognitive neural processes. They conclude that the results “identify neural mechanisms that may mediate the enormous influence of social status on human behavior and health” (p. 273).

Here, we focus on parameters of physiological regulatory systems that lie between such detailed micro examination of brain and neural processing on the one hand, and the larger scale examination of disease outcomes on the other hand. We seek to discern whether, and how, status considerations are evidenced early on in the individual's major regulatory systems such as the autonomic nervous system, the hypothalamic–pituitary–adrenal (HPA) axis, and the cardiovascular system. We examine physiology from a cumulative, multi-systems perspective, drawing on the concept of allostatic load which has been demonstrated to be reliably measurable and to provide insight into the way in which status gradients get under the skin to affect health over the life course (Evans et al., 2012; Karlamangla et al., 2002; Seeman et al., 2001).

The concept of allostatic load, initially developed by McEwen and Stellar (1993), is based on the earlier treatment of allostasis by Sterling and Eyer (1988) referring to the process of maintaining stability (or homeostasis) through change over time—e.g., in the cardiovascular system as it adjusts to alternating demands on the person's resources. But this notion can be applied to other physiological mediators (e.g., the secretion of cortisol), and the concept of allostatic load was proposed to refer to the more general wear and tear that the body experiences due to repeated cycles of allostasis, including the result of inefficient initiation and completion of the homeostatic process over time. McEwen and Seeman present a detailed portrait of the physiological basis for this view of allostatic load as a comprehensive index of the cumulative cost of the varied adaptations that individuals make to their life circumstances (McEwen and Seeman, 1999). Most important for present purposes, they note in particular that the typical emergence of dominance hierarchies in human and other animal societies, and the associated stress they induce, not only can impair cognitive function but can also promote disease (e.g., atherosclerosis) among those vying for the dominant position. Thus, the struggle for control and the burdens of inferior status are presumably implicated in an on-going way in the development of potentially consequential physiological reactivity with negative health consequences in the long term.

The measure of "allostatic load" (AL) used here is a refinement of the initial index that was developed for use on broad-scale community samples (Seeman et al., 1997) — the present refinement being largely a matter of the inclusion of parameters of physiological function that were not available in earlier studies (Gruenewald et al., 2012). As noted, prior work has shown that measures of allostatic load are robust in predicting health-related outcomes (Juster et al., 2010; Seeman et al., 2001). Research has also shown that measures of AL are also related (as predicted) to factors such as socio-economic (SES) and aspects of social engagement (Brooks et al., in press; Seeman et al., 2004a, 2004b).

In sum, our hypotheses coordinate with the well-known connection between social class status and health, but probe the status issue from a broader-than-class perspective as far as status is concerned. We examine multiple status indices in relation to allostatic load – an index of multisystem physiological dysregulation. The broader canvas with respect to status leads to the hypothesis that (a) low scores on the sense of personal control over life events will be associated with high allostatic load, and (b) the person's sense of inequality and/or relative deprivation with respect to a variety of status domains (e.g., work, family, etc.) will likewise be associated with high allostatic load.

2. Methods

The present analyses use data from the Study of Mid-life in the US (MIDUS), a longitudinal study of health and aging in the United States. The initial wave of the study (MIDUS 1) was conducted in 1994–1995, when a national sample of 3487 individuals were surveyed via telephone using random digit dialing. All participants were non-institutionalized, English-speaking adults aged 25–74 living in the U.S. The original cohort was resurveyed approximately nine years later (range = 7.8–10.4 years); the longitudinal response rate at MIDUS 2, adjusted for mortality, was 75% (Radler and Ryff, 2010). Additional details about the sampling procedure are available elsewhere (Radler and Ryff, 2010).

The current analyses focus on the subset of individuals who participated in a biomarker sub-study at MIDUS 2, had enough data to be assigned an AL score, and had available data for at least one of the status indices considered in these analyses (N = 1239 of the initial 1255 biomarker study participants). Sample size decreased somewhat from this depending on the status measure in question (n = 875 to n = 1238; see Table 1). Participants were assigned to data collection sites based on their place of residence, and data were collected during a 24-h stay at one of three General Clinical Research Centers (Washington, DC; Los Angeles, CA; Madison, WI) between July 2004 and May 2009. The protocol included a physical exam,12-h overnight urine sample and fasting morning blood draw (for details of the protocol, see Dienberg Love et al., 2010). Individuals participating in the biomarker protocol were comparable with the larger MIDUS 2 sample on demographic and health characteristics with the exception that participants in the biological protocol were less likely to smoke, more likely to have a college degree, and less likely to have completed only high school or some college (Dienberg Love et al., 2010).

2.1. Allostatic load

Consistent with previous work, the measure of allostatic load (AL) was designed to summarize dysregulation across multiple physiological systems (Gruenewald et al., 2012). Biomarkers were selected based on two major criteria. First and foremost, biological parameters were selected on theoretical grounds (i.e., based on their known role as components of major regulatory systems). Second, selected parameters reflect those for which information could be collected within the logistical and financial constraints of the MIDUS project itself. Selection of subscale components was confirmed by results of factor analyses (Buckwalter et al., in preparation). Measures of (1) *cardiovascular* functioning included resting systolic blood pressure, pulse pressure, and resting pulse rate. Indicators of (2) *sympathetic nervous system* activity included overnight urinary measures of epinephrine and norepinephrine. Measures of (3) *parasympathetic nervous system* activity included the following heart rate variability parameters: low frequency spectral power, high frequency spectral power, the standard deviation of R–R (heartbeat to heartbeat) intervals, and the root mean square of successive differences. Indicators of (4) *hypothalamic pituitary adrenal axis activity* included an overnight urinary measure of the hormone cortisol and a serum measure of the hormone dehydroepiandrosterone sulfate. Measures of (5) *inflammation* included plasma C-reactive protein, fibrinogen, and serum measures of interleukin-6 and the soluble adhesion molecules Eselectin and intracellular adhesion molecule-1. Indicators of (6) *lipid/fat metabolism* included high density lipoprotein cholesterol, low density lipoprotein cholesterol, triglycerides, body mass index, and waist–hip ratio. Levels of glycosylated hemoglobin, fasting glucose, and the homeostasis model of insulin resistance served as measures of (7) *glucose metabolism*.

For each of these seven systems, a system risk score was computed by calculating the proportion of individual biomarker indicators for that system for which participant values fell into high-risk quartile ranges. High risk was defined as the upper or lower quartile of the biomarker distribution, depending on whether high or low values of the biomarker typically confer greater risk for poor health outcomes. System risk scores were continuous and could range from 0 to 1 (indicating 0–100% of system biomarkers in high-risk range for a given participant) despite differences in the number of biomarkers across systems. System risk scores were only computed for individuals with values on at least half of the system biomarkers. Rates of missing data were very low – 98% of participants had complete biomarker data for each system, with the exception of the parasympathetic system, for which 8% of respondents were missing data on the parasympathetic scale due to instrumentation failures and/or measurement difficulties. An allostatic load summary score was computed as the sum of the seven system risk scores (possible range from 0 to 7; see Gruenewald et al., 2012, for overview). Allostatic load scores were computed for participants with information on at least 6 of the 7 systems, and 90.5% of participants had data for all 7 systems. For those participants who were missing the parasympathetic score but had data on all other systems, we imputed the AL score from the participants' scores on the other six systems, age, gender, and race, using a regression equation derived from those with complete biomarker data. For participants who were each missing exactly one of the other six system scores, the missing system score was imputed as zero (since the sample median for five of the seven system scores was zero). All those with imputed scores were flagged (9.4%), and the AL imputation flag was included as a covariate in AL regressions. In addition, we incorporated medication data into three systems; cardiovascular, glucose metabolism, and lipid metabolism. Participants on relevant medications were scored as being in the high-risk quartile for those systems regardless of the measured biomarker values. Specifically, participants using (a) antihypertensive medication were considered high-risk for systolic blood pressure, (b) using heart rate reducing medications (e.g., beta blockers and atrio-ventricular nodal blockers) as high-risk for resting heart rate, (c) diabetes medications as high-risk for fasting glucose and glycosylated hemoglobin, (d) statins, cholesterol absorption inhibitors, niacin, and/or bile acid sequestrants as highrisk for LDL cholesterol, and (e) those on fibrates as high-risk for serum triglycerides.

2.2. Status indices

It is now commonplace to make reference to the social gradient in health—the association between one's level of health and the level of social standing as measured by income, education, occupation or related indicators of socio-economic rank. But, as noted earlier, one core of the "status syndrome" lies in the psychosocial aspects of status—chiefly, the person's sense of control over his or her outcomes, and the perceptions of one's standing in the varied spheres of lifetime activity such as work, family, friends, and the wider community. It is quite clear that a variety of illnesses are, indeed, related to one's sense of mastery or constraint in away that is generally consistent with the gradient—i.e., lower class groups typically have both poorer health (e.g. higher morbidity and mortality rates) and a poorer sense of control. Other work from the MIDUS study, focusing largely on self-rated health, chronic health problems, and depressive symptoms—found that lower income was associated with lower perceived mastery and higher perceived constraints, as well as poorer health (health being measured byway of self-reports) (Lachman and Weaver, 1998). In addition, control beliefs played a moderating role in that low income respondents with a high sense of control had health ratings that were comparable with the health scores of the high income group.

On the control side of the status question, we use measures of mastery and constraint that are similar to those used by Lachman and Weaver, adding an additional set of measures that broaden the perspective to include specific domains in which the respondent's sense of control can be assessed. The three types of control measures—mastery; constraint; and domain-specific control—are detailed as follows:

> *Perceived mastery* (4 items; coded on a 7-point scale, strongly agree to strongly disagree): I can do just about anything I really set my mind to; When I really want something I usually find a way to succeed at it; Whether or not I amable to get what Iwant is in my own hands; What happens to me in the future really depends on me (Alpha reliability: 70; Lachman and Weaver, 1998).
>
> *Perceived constraints* (8 items; same coding) There is little I can do to change the important things inmy life; I often feel helpless in dealing with the problems of life; Other people determine most of what I can and cannot do; What happens in my life is often beyond my control; There are many things that interfere with what I want to do; I have little control over the things that happen to me; There is really no way I can solve the problems I have; I sometimes feel I am being pushed around in my life." (Alpha reliability: 0.86; Lachman and Weaver, 1998).
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> *Domain control*: Through questionnaires, the respondent was asked to rate ("Using a ten-point scale where 0 means 'no control at all' and 10 means 'very much control') the amount of control you have over: a. your work situation these days; b. your financial situation these days; c. your contribution to the welfare and well-being of other people these days; d. your overall relationship with your children these days; e. the amount of control you have over your marriage these days". Cronbach's alpha was 0.60 for the 5-item scale.

There is, of course, a great deal more to the status question than the matter of perceived control over outcomes and we take account of both objective ranking in terms of income and subjectively perceived social status. Income is assessed in terms of family-adjusted poverty-to-income ratio (FPIR) for each participant, reflecting the ratio of the participant's total household income to the U.S. Census Bureau poverty threshold specific to the participant's age, whether the participant currently lived with a spouse or partner, the number of children in the family under age 18 living in the participant household, and the year of data collection. For example, an FPIR of 3 corresponds to a total household income 3 times the census bureau-defined poverty level for his/her family. The perceived status scores focus on the respondents' views concerning their position in general community standing and their perceived inequality in various aspects of their social life These constitute, in effect, indices of their subjective social class standing, and their sense of relative deprivation—meaning their subjectively perceived status disadvantage over comparable others in important domains of their social life: in their work setting, in the family, the neighborhood, and their sense of life-time discrimination (for an early but comprehensive review on relative deprivation, see Runciman, 1966).

We present here the full set of items that were used to measure "perceived inequality in work' and then (for reasons of space) illustrations of the items that measured perceived inequality in the home, the family, and lifetime discrimination (see online supplement for complete set of items for all scales). The perception of work inequality is based on the following six-item scale, with four-alternative responses (1: A lot; 2: Some; 3: A little; and 4: Not at all). The scale is constructed by calculating the mean of the six items (those marked R being reverse coded, so that high scores reflect higher standing in the scale—i.e., greater perceived inequality; alpha for the 6-item scale is 0.78).

1. I feel cheated about the chances I have had to work at good jobs (R)
2. When I think about the work I do on my job, I feel a good deal of pride
3. I feel that others respect the work I do on my job.
4. Most people have more rewarding jobs than I do (R)
5. When it comes tomy work life, I've had opportunities that are as good as most people's.
6. It makes me discouraged that other people have much better jobs than I do (R)

As noted, we also tapped the respondents' sense of perceived inequality by way of questions dealing with three more personal domains of the person's life: the home; family circumstances; and lifetime discrimination. In each case, the score is based on multiple questions and we provide here two examples in each domain to illustrate the nature of the perceived inequality score that is derived for each domain:

> "Inequality re the home": "I live in as nice a home as most people"; "Most people live in a better neighborhood than I do."
>
> "Inequality re the family": "I believe I have been able to do as much for my children as other people"; "It seems to me that family life with my children has been more negative than most people's."
>
> "Life-time discrimination": "How many times in your life have you been discriminated against in each of the following ways because of such things as your race, ethnicity, gender, age, religion, or other such characteristics?" There follows a list of twelve potential actions such as: not given a promotion; denied a scholarship; not hired for a job; hassled by the police; etc. The scale is constructed by taking the number of "1 or higher" responses to the items (Kessler et al., 1999).

The measure of "social class rank in the community" was derived by presenting the respondent with a nine-rung "social ladder" with the following descriptor: "Think of this ladder as representing where people stand in their communities. People define community in different ways; please define it in whatever way is most meaningful to you. At the top of the ladder are the people of highest standing in their community. At the bottom are the people who have lowest standing in the community. Where would you place yourself on this ladder? Please check the box next to the rung on the ladder where you think you stand at this time in your life, relative to other people in the community with which you most identify."

The ladder ranking measure has been effectively used in other studies bearing on the association of health and social status – e.g. higher placement on the subjective status scale was associated with less susceptibility to upper respiratory infection (Cohen et al., 2008); and lower perceived social standing of one's parents was associated with greater amygdala reactivity to explicitly threatening (angry) faces (Gianaros et al., 2008). Though the full range of scores over the nine rungs of the ladder are exhibited in the present sample, as expected the distribution clusters toward the upper end of the scale—i.e., toward what might be termed the middle and upper-middle class rank (the top two rungs, essentially the upper class, gathered 10% of the sample, the bottom four rungs having 12%; and the lower middle class and upper middle class having 35% and 25%, respectively).

2.3. Covariates/background variables

Age, sex, highest achieved education level, family-adjusted poverty-to-income ratio, and marital history were obtained from self reports. Race/ethnicity was self-identified as white, black/African American, other, or multiracial. If a participant reported a different primary race/ethnicity at the MIDUS I and II assessments, then the participant was classified as multiracial. Because the number of participants in the Other and multi-racial groups was small (n = 63), for the purposes of this analysis, we combined them with the African American group, and denoted the larger group non white.

3. Analysis

We initially examined bivariate correlations between the various social status indices in the total sample and their associations with AL. Primary analyses used mixed effects linear regression models to control for clustering within families (since MIDUS participants include siblings). These models were conducted separately for each social status measure (measures of mastery, constraint, 5 domains of control, social class ladder, and the 4 domains for perceived inequality) and adjusted for age, race/ethnicity (white vs. non white), gender, poverty-income ratio, and marital status (married, divorced/widowed/separated, vs. never married). We also included our indicator for an imputed AL score (yes vs. no) in all models. Though the latter shows a significant, positive association with our outcome (AL), results for other variables of interest are unaffected by inclusion or exclusion of this variable from the models. We also ran a set of models with additional adjustments for education. Finally, we tested for possible interactions between major status indices and major demographic factors (age, sex, race, income).

In initial analyses, we employed income as our primary index of socio-economic status as it more directly and cleanly represents the social class feature that we wished to control. We elected not to control for education in initial models since the person's sense of control was for us a fundamental aspect of the person's status dynamic, and a primary focus of interest in the current analyses, and since education is presumably one of the main contributors to the individual's control repertoire—knowledge is power, it is said. Thus, controls for education could risk over-controlling for something that is to a large extent more like an indirect representation of control skills than a pure index of SES. Our approach, controlling initialing for income but not education as our primary index of general SES parallels prior work in MIDUS (Lachman and Weaver, 1998). We did, however, also examine parallel analyses that incorporated education in a final model, and those results are presented as a separate line in Tables 3 and 4 and a separate column in Table 5. On the whole, the status variables are quite robust in their significance even with the inclusion of education as a background control.

4. Results

As shown in Table 1, the average age of our sample was 54, with a range from age 34–84. The sample was majority White (77.3%), approximately equally male (43.4%) and female (56.6%), and relatively well-off economically (average poverty-income ratio of 5.2 and 42.5% having completed college or more). Scores on the various status indices revealed moderately high status ratings (means are routinely above the mid-point of the range) and relatively low ratings of perceived inequality.

As a first step, we examined relationships among the various indices of control and status, hypothesizing that there would be significant associations between the several control measures and status indicators, but that these associations would be relatively modest since they tap different aspects of the status domains they represent. Table 2 presents the Pearson correlations obtained for the total sample (some 1000+ respondents).

As shown in Table 2, the correlations are generally consistent with what one might reasonably expect—e.g. perceived inequality in work (line 9) is negatively correlated with the sense of mastery ($r = -0.32$; column 1) and positively correlated with high constraint ($r = 0.42$; column 2); and high ranking on the social class ladder score is correlated with a relatively high score on mastery ($r = 0.25$) and low constraint (−0.35). The standard indices of SES (education and income) are negatively correlated with perceptions of constraint and with perceived inequality in all of the status domains measured. Education and income are also correlated with perceived control at work and in finances as well as with overall status as measured in leader rankings. At the same time, the *r*'s throughout tend to be modest (except, of course, for the part–whole correlations in column 8 which show the connection between the individual domain control items and the total score for these same five items) indicating that these status-related scores are tapping different aspects of the respondent's view of his or her circumstances. The relative disconnect between the sense of control exhibited in different domains of the respondent's life (e.g., the low correlations shown generally in column 6 dealing with the sense of control where children in the family are concerned) suggests that the responses that have been produced are reasonably discriminating rather than generalized or stereotypical replies.

4.1. Perceptions of control and AL

Table 3 shows the results obtained in regression analyses that depict the associations between allostatic load and the personal sense of control side of the status syndrome (both the generalized measures of mastery and constraint, and the five specific domains of control as well as the five-item score called “domain summary”), The analyses control for a variety of background variables that themselves are typically associated with allostatic load: age, race, sex and income—older, non-white, female, and lower income respondents being generally higher in allostatic load (Gruenewald et al., 2012; Seeman et al., 2010; Seeman et al., 2001). All show the expected relationships though income does not retain its significant association in the multivariate analyses presented in Table 3 as its relationship is partially explained by perceptions of control and/or education.

The results in Table 3 are consistent with the expectation that a low sense of control is associated with relatively high scores on allostatic load; and they are also consistent with the view that the participants are providing rather discriminating responses. High constraint is significantly associated with high allostatic load, but in the individual control domains the more private arenas of control over children and marriage are not associated with allostatic load while (for example) lack of control over one’s work is significantly tied to higher allostatic load. The measure of generalized “mastery” is not significant, a fact which is commented on below. It bears noting, in light of the emphasis recently on the significance for health of socio-economic rank per se, that the beta weights in Table 3 for the sense of control are regularly higher than those for income.

The main conclusion from Table 3 is that the sense of control is regularly associated with high allostatic load even when other clearly status-related factors – e.g., race, income, and sex are controlled. The last line in Table 3 also illustrates that further control for the respondent’s education does not alter the significance of the control variable with respect to AL.

4.2. Perceived inequality and AL

Table 4 presents results of parallel analyses examining the relationships of five measures of “perceived inequality” with allostatic load. With the exception of the ladder score (which is apparently heavily influenced by age; see the interaction results below), all of the “perceived status” variables are significantly related to AL: higher perceived inequality is regularly associated with higher AL. These results obtain irrespective of other statusrelated features such as income, age, race and sex–though the latter are themselves clearly pertinent for the respondent’s perceived class ranking since older white males, as well as the more highly educated, tend to place themselves (not surprisingly) in relatively higher social rank.

Two brief further comments on Table 4: (1) including education in the regression equations does not eliminate the significant association between perceived status inequality and allostatic load; but (2) including education does make a substantial difference where work inequality is concerned, reducing the size and significance of the connection with status issues.

4.3. Interaction and education

Though it is clear that the status indices are generally associated in a significant way with higher allostatic load, we have said very little thus far about the possibility that the status measures may exhibit an interaction with the key controls that were included in the regression analyses—namely, the respondent's income, age, sex, and race as well as education (all of these being matters of considerable importance in matters of status distinction in American society). It makes sense, for example, given the fact that race is regularly significant in relation to allostatic load, to expect that the complication of race may exacerbate the contribution of (for example) perceived work inequality to the respondent's biological dysregulation. Similarly, one might expect that the adjustment of expectations that come with age might modulate the potential allostatic load effects of perceived work inequality or of a lower sense of control.

We explored these interaction issues in a reasonably systematic way. The pertinent regressions examined an interaction term pairing, in turn, the four background variables (age; sex; race; and income) with four of the main status variables (constraint; ladder ranking; sense of control at work; and perception of inequality at work). Only one of the interaction terms was significant: the interaction of the respondent's age and ladder score in yielding a distinctive AL result. Table 5 presents the results for the two pertinent regressions, one including the education variable and the other without the inclusion of education, illustrating the mean AL scores that apply to the interaction term. Fig. 1 provides a depiction of the nature of the interaction at issue: it shows that, as implied earlier, the older workers—those at age 50 or above—show significantly less connection between their ladder score and allostatic load than do the younger respondents.

5. Discussion

The connection between health and socio-economic status has hardly been in doubt in recent years, demonstrable through multinational studies that document the association between economic status and a range of health consequences from susceptibility to infection to clinically diagnosed depression and mortality. As implied at the outset of this work, the absence of a sense of control is an integral part of the status syndrome since inequalities in rankings are deeply associated with a lack of autonomy and lead ultimately to deterioration in health.

Our analysis seeks to determine the extent to which various aspects of the status syndrome, such as perceived life constraints and inequalities, and self perceived social rank, help to explain known social gradients in health—the latter measured here by a multidimensional health system index. The major findings in the present work are first that, as expected, the person's generalized sense of low control over life outcomes is associated with higher allostatic load. That is true for the measure of sensed "constraints,'" but "mastery" is not a significant predictor of AL. There are two reasons as to why that might be. First, there is the fact that the constraint measure has double the number of items as the basis for the score (8 vs. 4 for mastery), and the alpha reliability is higher (0.86 vs. 0.70). Perhaps more important is the impression, on post-hoc review, that the mastery items carry a heavier emphasis on the idea of "persistence" as compared with the more straightforward idea of "control" that dominates the items that focus on constraints.

Second, the relevance of the sense of control for allostatic load is buttressed by the associations seen when we focus on the respondents' sense of control in specific domains of life experience, including control in the work setting, control with respect to finances or contributions to community welfare. Low control is regularly associated with high allostatic load (with related status measures like income, sex, and education as well, taken into account).

Third, the respondents' sense of relative deprivation with respect to work, the quality of home and family life, social class standing in the community, and lifetime discrimination are also associated with a higher level of allostatic load (again, with related status issues like income, etc. controlled; see, for example, Table 5).

Fourth, examination of possible interactions between the status measures and four key background factors (income, age, sex, and education) revealed little evidence for such interactions. Only one significant interaction was found, indicating that older individuals exhibit less connection than younger ones between their reported social ranking (community "ladder") and allostatic load, suggesting perhaps an age-based adjustment in coming to terms over the long run to one's community status. An alternative, perhaps additional, interpretation is that with advancing age the accumulation of allostatic load and other age-related physiological changes simply overrides the association that is seen in the younger group (for a similar age-related pattern bearing on social engagement and allostatic load, see Seeman, et al., 2011).

Strengths of the current analysis include our use of a nationally representative sample of adults. For this sample, there is also a wide range of objective, biological data on which to base assessments of health. Thus, it presented an opportunity to derive an early and broad-based portrait of the potential impact of status issues on the developing biological risk profiles. The MIDUS database offers a uniquely rich array of measures reflecting various perceptions regarding the individual's status and ability to control major domains of their life. We focus on multiple aspects of the person's sense of control and on varied domains of status-related experience ranging from close family standing to subjectively perceived social class position in the broader community.

There are, of course, limitations as well. Most important, perhaps, is the fact that we needed to recruit, from the original random sample, those who were willing to participate in the clinical inquiry portion of the study that led to the health assessment regarding Allostatic Load. The resulting cadre of respondents is, as noted earlier, skewed toward the better educated and higher income category, though the range in both income and education is a reasonable one under the circumstances. A second limitation, common enough in the literature on economic disparities and health, is that our evidence on the presumed effects of status discrepancies on biological dysregulation is cross-sectional; thus, strictly speaking, any casual imputation is unwarranted.

Still, our findings regarding the association between a variety of status issues and high allostatic load fits very well with the modest evidence from experimental settings, cited earlier, showing the negative health consequences of introducing low status concerns. It fits very well, too, with the more substantial body of literature showing the strong connection between both a low sense of control and social status gradients as they bear upon diagnosed morbidities and mortality (for excellent summations of the literature on control and status gradients, see the cited works by Marmot (2004) and Wolfe et al. (2012), respectively).

We have sought to examine the import of these control and status issues for earlier signs of developing health concerns than those normally canvassed in this established literature (i.e., by focusing on evidence of links to major biomarkers that serve as precursors to disease). Our evidence indicates that the footprint, as it were, of lack of control and of perceived status inequality is, it turns out, rather pervasive. The relationship of status issues and higher allostatic load is significant over a broad range of status inequalities. In effect, the sense of relative deprivation is significant whatever the objective socio-economic status of the person. There are clearly multiple inequalities that become involved in the health equation; and these were, for the most part, inequalities that are oriented not to close family but to rank in the larger society—to community standing, the work setting, and the like.

Perhaps the most crucial message is that relatively early in the health cycle—well before the serious signs of disease are evident—personal control matters and so do perceived status inequalities, with allostatic load serving in a sense as an early warning system regarding the potential health negatives associated with status inequality. It could be added that this message is all the more unsettling in view of the documented history of increasing inequality that has characterized the U.S. scene in the recent past.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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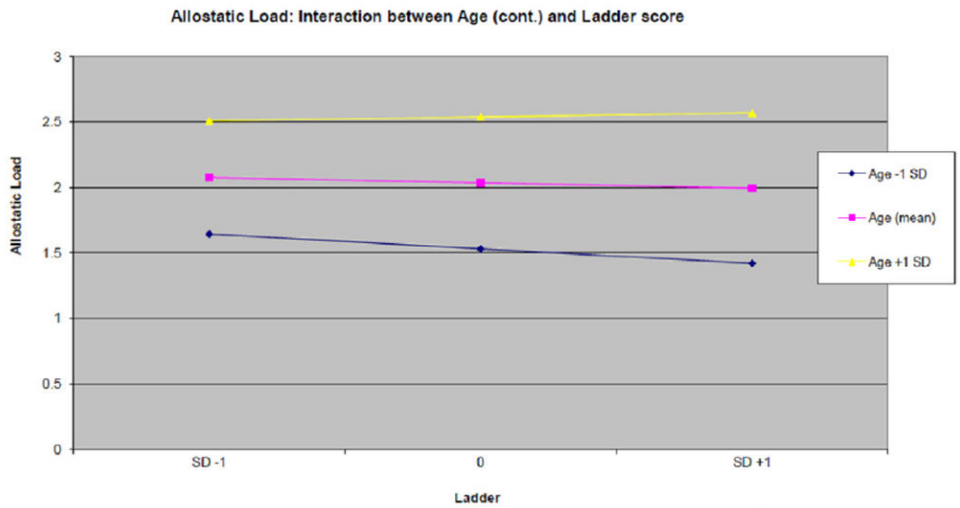

Fig. 1.
Age related differences in relationships between perceived social standing (ladder scores) and allostatic load.

Table 1

Sample characteristics, n = 1239.[a]

	n	Mean; median; std or %	Range
Background variables			
Age	1239	54.5, 54.0, 11.7	34–84
White	956	77.3%	
Non-white	281	22.7%	
Male	538	43.4%	
Female	701	56.6%	
Poverty–income ratio	1209	5.2, 4.2, 4.2	0–26.3
Married	804	65.0%	
Divorced/Widowed/Separated	284	23.0%	
Never married	149	12.1%	
Education	1227		
≤High school	342	27.9%	
Some college	364	29.7%	
≥College	521	42.5%	
Social status			
Social class ladder	1216	6.6, 7.0, 1.8	1.0–10.0
Perceived mastery	1235	5.8, 6.0, 0.9	1.0–7.0
Perceived constraint	1235	2.5, 2.4, 1.1	1.0–6.6
Perceived control regarding			
Work	1232	7.3, 8.0, 2.2	0–10.0
Finances	1238	6.8, 7.0, 2.2	0–10.0
Contributions to others	1237	7.6, 8.0, 1.9	0–10.0
Relationship with children	1083	7.6, 8.0, 2.2	0–10.0
Marital relationship	951	7.8, 8.0, 1.9	0–10.0
Domain summary score (based on 5 domains)	1238	7.4, 7.6, 1.4	0–10.0
Perceived inequality			
Work	875	1.6, 1.5, 0.5	1.0–4.0
Home	1235	1.5, 1.3, 0.5	1.0–3.5
Family	1077	1.6, 1.5, 0.5	1.0–4.0
Lifetime discrimination	1166	1.2, 0, 1.9	0–11.0
Outcome–allostatic load			
Allostatic load score	1239	2.0, 1.9, 1.1	0–5.6

[a]All MIDUS biomarker participants with assigned AL score, and at least one social status measure.

Table 2

Pearson correlations among "status syndrome" indices (control and perceived social status variables) for total sample.

	1	2	3	4	5	6	7	8	9	10	11	12	13
Generalized control													
1 Mastery	–	−0.50	0.20	0.24	0.19	0.11	0.16	0.28	−0.32	−0.22	−0.19	−0.03	0.25
2 Constraint	−0.50	–	−0.37	−0.36	−0.31	−0.17	−0.24	−0.45	0.42	0.31	0.36	0.12	−0.35
Domain control													
3 Work	0.20	−0.37	–	0.44	0.33	0.10	0.25	0.70	−0.36	−0.20	−0.25	−0.19	0.23
4 Finances	0.24	−0.36	0.44	–		0.11		0.74	−0.27	−0.25	−0.28	−0.16	0.23
5 Contributions to others	0.19	−0.31	0.33	0.38	–	0.12	0.17	0.63	−0.22	−0.21	−0.23	−0.04	0.24
6 Children	0.11	−0.17	0.10	0.11	0.12	–	0.26	0.51	−0.12	−0.06	−0.31	−0.06	0.06
7 Marriage	0.16	−0.24	0.25	0.33	0.17	0.26	–	0.64	−0.14	−0.15	−0.23	−0.05	0.14
8 Domain summary (five items)	0.28	−0.46	0.70	0.74	0.63	0.51	0.64	–	−0.35	−0.27	−0.41	−0.17	0.28
Perceived inequality													
9 Work	−0.32	0.42	−0.36	−27	−0.22	−0.12	−0.14	−0.35	–	0.35	0.32	0.28	−0.31
10 Home	−0.22	0.31	−0.20	−0.25	−0.21	−0.06	−0.15	−0.27	0.35	–	0.36	0.14	−0.26
11 Family	−0.19	0.36	−0.25	−0.28	−0.23	−0.31	−0.23	−0.41	0.32	0.36	–	0.15	−0.30
12 Lifetime Discrimination	−0.03	0.12	−0.19	−0.16	−0.04	−0.06	−0.05	−0.17	0.28	0.14	0.15	–	−0.06
Social class													
13 Ladder	0.25	−0.35	0.23	0.23	0.24	0.06	0.14	0.28	−0.31	−0.26	−0.30	−0.06	–
Background variables													
14 Income	0.08	−0.21	0.12	0.20	0.09	−0.03	0.01	0.15	−0.21	−0.26	−0.19	−0.11	0.19
15 Education	0.08	−0.20	0.10	0.11	0.14	−0.03	−0.08	0.10	−0.23	−0.19	−0.21	−0.01	0.18

Note: The Ns vary somewhat from cell to cell due to the respondent omissions but they are regularly above 1000, with the exception of "control in marriage" and "work inequality" due to variable work and family circumstances (the Ns in these cases being in the 900 range).

Table 3

Regression outcomes (beta weight and significance levels) for sense of control variables as predictors of allostatic load, accounting for commonly used background variables.

	Generalized control		Domain control					
	Mastery	**Constraint**	**Work**	**Finance**	**Contrib. to others**	**Children**	**Marriage**	**Domain summary**
Models without education								
Covariates[a]								
Age	0.042^{***}	0.042^{***}	0.043^{***}	0.043^{***}	0.042^{***}	0.041^{***}	0.044^{***}	0.044^{***}
Race	0.298^{***}	0.283^{***}	0.273^{***}	0.293^{***}	0.298^{***}	0.289^{**}	0.356^{***}	0.285^{***}
Sex	-0.128^{*}	-0.128^{*}	-0.131^{*}	-0.126^{*}	-0.135^{*}	-0.156^{*}	-0.133^{*}	-0.136^{*}
Income	−0.015	−0.012	-0.014^{*}	−0.012	−0.014	−0.014	−0.012	−0.011
Married	−0.098	−0.099	−0.305	−0.111	−0.110	−0.008	−0.098	−0.110
Divorced, Sep, Wid.	−0.199	-0.218^{*}	-0.222^{*}	-0.225^{*}	-0.219^{*}	−0.145	−0.240	-0.236^{*}
AL imputation flag	0.34^{***}	0.33^{***}	0.38^{**}	0.35^{***}	0.33^{***}	0.30^{**}	0.38^{***}	0.34^{***}
Generalized measures of control								
Mastery	−0.024							
Constraint		0.089^{**}						
Domain specific control								
Work			-0.036^{**}					
Finance				-0.037^{**}				
Contrib. to others					-0.041^{**}			
Children						−0.021		
Marriage							−0.020	
Domain summary								-0.066^{***}
Models with education								
Measures of control	−0.014	0.074^{**}	-0.031^{*}	-0.035^{**}	-0.034^{*}	−0.022	−0.025	-0.067^{***}

***Significant at 0.001 or beyond.

**Significant $0.001 < p \leq 0.01$.

[*] Significant at $0.01 < p \leq 0.05$.

[a] The beta weights for the covariates were derived from the models initially excluding education. Since those coefficients were minimally altered when education was added, only the initial beta weights from the model without education are presented.

Table 4

Regression Outcomes (Beta Weights and Significant Levels) for Measures of Perceived Inequality in Relation to Allostatic Load and Background variables.

	Social class ladder	Perceived inequality in:			
		Work	**Home**	**Family**	**Lifetime discrimination**
Background variables					
Age	0.043***	0.042***	0.043***	0.043***	0.043***
Race	0.291***	0.347***	0.275***	0.298***	0.21*
Sex	−0.126*	−0.123	−0.130*	−0.166**	−0.10
Income	−0.014	−0.002	−0.012	−0.008	−0.015*
Married	−0.123	−0.061	−0.076	−0.034	−0.144*
Divorced, Sep., Wid.	−0.242*	−0.146	−0.193	−0.197	−0.253*
AL imputation flag	0.31**	0.48***	0.34***	0.29**	0.34**
Independent variables					
Status perception (w/o Education)	−0.028	0.154**	0.139*	0.227***	0.050**
Status perception (w/Education)	−0.016	0.017~	0.122~	0.196**	0.055**

*** Significant at 0.001 or beyond.

** Significant 0.001 < $p < 0.01$.

* Significant 0.01 < $p < 0.05$.

~ Significant 0.05 < $p < 0.10$.

Table 5

Regression outcomes (Beta weights and significant levels) for outcomes of respondent's age and ladder score in relation to allostatic load and background variables, for regressions with and without education as a background variable.

Background variables	Without education	With education
Age	0.021*	0.019*
Race	0.281***	0.220**
Sex	−0.129*	−0.114
Income	−0.013	−0.005
Married	−0.113	−0.124
Divorced, Wid., Sep.	−0.231	−0.236*
Education (High school)	–	0.318***
Education (College)	–	0.285***
AL imputation flag	0.31**	0.28**
Ladder	−0.206**	−0.202**
Age & ladder	0.003**	0.004**

*** Significant at 0.001 or beyond.

** Significance (0.001 < *p* ≤ 0.01).

* Significance (0.01 < *p* ≤ 0.05.