Does lower subjective status yield riskier biomarker profiles?

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Abstract

Objectives: Both objective and, more recently, subjective measures of low social status have been linked to poor health outcomes. It is unclear, however, through which precise physiological mechanisms such standing may influence health, although it has been proposed that those of lower status may have biomarker profiles that are more dysregulated (and hence pose a greater risk for worse health). The objective of this paper, then, is to investigate whether lower subjective standing is associated with riskier neuroendocrine biomarker profiles in older Taiwanese.

Methods: This paper analyzes the SEBAS, a nationally representative survey of older Taiwanese men and women (ages 54-91), conducted in Taiwan in 2000. We focus on five neuroendocrine markers (cortisol, dehydroepiandrosterone sulfate (DHEAS), epinephrine, norepinephrine, and dopamine) in relation to self-reported levels of social status in Taiwan and in the community. The biomarkers are analyzed both separately and collectively in an index termed neuroendocrine allostatic load (NAL).

Results: With the exception of the biomarker DHEAS, we find little connection between low status and riskier profiles.

Discussion: The finding here is congruent with other studies of the same survey which highlight the difficulty in linking indicators of a stressful life history to indicators of an impaired neuroendocrine system.

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Introduction

Numerous studies of both humans and animals have shown a compelling association between lower status and worse health (Adler and Ostrove, 1999; Brunner, 2000; Marmot, 2006; Sapolsky, 2004). For example, in a nationally representative study (of humans) in the United States, the risk of dying during the study period for those in the lowest income group was nearly three times as high as for those in the highest income group, even after controlling for a number of relevant factors such as cigarette smoking and sedentary lifestyle (Lantz et al., 1988). The relationship between higher socioeconomic status (SES) and better health outcomes has also been found in non-Western and developing countries, such as in China and Taiwan (Liang et al., 2000; Liu, Hermalin, and Chuang, 1988; Zimmer et al., 2007; Zimmer et al., 2000). Turning to studies from the animal world, one discovered a gradient of risk among male cynomolgus monkeys for developing upper respiratory infections, with those monkeys at the highest rank having the least risk, those at somewhat lower rank having somewhat higher risk, and so on (Cohen et al., 1999). More broadly, findings supportive of the result of the study just described have been documented in research on animals as diverse as rats, pigs, wolves, and fish (Sapolsky, 2004).

Referring now to the literature on humans, many authors have suggested that one mechanism by which those with lower status come to have worse health is through the differential experience of chronic and acute stressors (Baum, Garofalo, and Yali, 1999; Cohen, Kaplan, and Salonen, 1999; Evans and English, 2002; Gallo et al., 2005; Sapolsky, 2004; Taylor, Repetti, and Seeman, 1997). Those with lower status might experience greater levels of stress because, in part, their environment produces more stressors, and of a more severe nature, and

fewer opportunities to engage in stress relieving activities, compared to their higher status counterparts. Stressors that may very well be experienced to a greater degree by those with lower status include those experienced at work (brought about by employment with high demands and low control), those experienced in the residential environment (brought about by such things as higher crime rates and greater prevalence of harder drugs), and those related to worse access to high-quality medical care, among many other sources (Baum, Garofalo, and Yali, 1999; Cohen, Kaplan, and Salonen, 1999; Evans and English, 2002; Gallo et al., 2005; Taylor, Repetti, and Seeman, 1997). Relatedly, lower status individuals may have less opportunity to enjoy attractive parks, sporting facilities, vacations, and other opportunities for relaxation (Baum, Garofalo, and Yali, 1999; Cohen, Kaplan, and Salonen, 1999; Evans and English, 2002; Gallo et al., 2005; Taylor, Repetti, and Seeman, 1997). In addition to the factors already described, the experience of higher stress might come about because of psychological factors independently related to feelings of lowliness or relative deprivation. That is, the feeling that one is of lower position, for whatever reason, may be in and of itself stressful, regardless of what "objective" indicators might suggest (Ellaway et al., 2004; Sapolsky, 2005; Wilkinson, 1999).

Physiologically, stressors are thought to cause worse health through repeated and/or sustained activation of the sympathetic nervous system (SNS) and the hypothalamic-pituitary-adrenal (HPA) axis, which, over time and through cascading effects, impairs the function of other important biological systems (McEwen, 1998; Timiras and Gersten, 2007). Purportedly the cost to the body in responding to challenges builds up over the life course, in what has been termed allostatic load (AL) (Day, 2005; McEwen, 2004; Seeman et al., 1997). According to allostatic theory, the buildup of AL is revealed in the dysregulation of a number of the body's systems (i.e. the neuroendocrine, immune, cardiovascular, and metabolic systems) that are key to

maintaining good health (Crimmins and Seeman, 2001; Timiras and Gersten, 2007). Further, AL is considered to be a precursor, or "early warning sign," of morbidity and mortality (McEwen, 1998; McEwen, 2004).

Of the various physiological systems thought to be impacted by AL, the neuroendocrine system has been one of the least studied (compared to, say, the metabolic and cardiovascular systems) in large-scale population studies. Nevertheless, despite the relatively recent inclusion of neuroendocrine biomarkers in such studies, mounting evidence from these investigations suggests that certain levels of baseline neuroendocrine markers predict more rapid decline in physical and cognitive functioning, greater incidence of cardiovascular disease, and earlier mortality (Goldman et al., 2006b; Karlamangla et al., 2005; Seeman et al., 2001). Although the consequences of high AL are becoming clearer, it remains far less clear whether a stressful life history is associated with a riskier neuroendocrine biomarker profile, as is predicted by allostatic theory.

The paper here, then, seeks to extend the literature on the connection between a stressful life history and baseline levels of the neuroendocrine markers by examining measures of subjective social status in a nationally representative survey of older persons conducted in Taiwan. Although two papers using the same data set have already analyzed a similar connection, the focus of these papers has been on objective, not subjective, measures of status (Dowd and Goldman, 2006; Seplaki, under review). The analysis here builds upon these studies in a number of important ways, including through close examination of the influence of three different measures of subjective social status (namely, that in the community, that in all of Taiwan, and the difference between the two) on biomarker levels.

Importantly, previous research using some of the same measures of subjective status that are used in this paper has shown that they are predictive of worse health, independent of objective measures of status such as respondents' own education, income, and the like (Collins and Goldman, working paper; Ostrove et al., 2000; Singh-Manoux, 2003; Singh-Manoux et al., 2005). Research also indicates that these subjective measures of status capture numerous salient features of respondents' lives that relate to the level of their resources and, importantly, life stress experienced (Adler et al., 2000; Franzini and Fernandez-Esquer, 2006; Goldman et al., 2006a; Singh-Manoux, 2003). We therefore assume that the measures of subjective status used here are multidimensional in nature and reflect much in the way of the respondents' lived experience over the life course and that those respondents reporting lower status likely have experienced more life stress then those reporting the obverse. Specifically, we hypothesize that lower subjective status is correlated with riskier neuroendocrine biomarker profiles.

Data and Methods

Overview of the data set

We analyze the Social Environment and Biomarkers of Aging Study (SEBAS), a population survey conducted in Taiwan in 2000 (for a more detailed description of the study consult Goldman et al., 2003). The survey is nationally representative of those 54 and older and includes the institutionalized population. The SEBAS drew its sub-sample of respondents from a larger, ongoing longitudinal study called the Survey of Health and Living Status in Taiwan. Among other things, the interview portion of the SEBAS included questions about cognitive and

physical functioning, psychological well-being, SES, and life stressors. With the respondents'

additional consent, they were scheduled for lab work and a physical exam several weeks after the

interview. Lab work included collection of blood and urine samples to produce a panel of

physiological measurements, and the physical exam recorded information such as height and

weight, blood pressure, and checked for a number of health problems.

Of those initially contacted for inclusion in the 2000 SEBAS, 92% gave interviews and

68% of these participants consented to the clinical examination, for a total of 1,023 respondents.

Analysis reveals that partly because those most and least healthy declined to participate in the

clinical exams, with controls for age, estimates derived from the clinical information are unlikely

to be seriously biased (Goldman et al., 2003). Of those respondents who participated in the

clinical examination, only 10 failed to fully comply (by not following the urine protocol, by not

providing a sufficient volume of blood suitable for analysis, or by not completing the medical

exam). In about 4% of all cases proxies helped answer some questions for the respondents. Most

often a spouse was the proxy and the reason most frequently given for needing the proxy's

assistance was hearing troubles. The survey over-sampled those 71 years and older and urban

residents.

Dependent variable

In this paper we focus on cortisol, DHEAS, epinephrine, norepinephrine, and dopamine,

a physiologically coherent class of neuroendocrine markers indicative of HPA axis and SNS

functioning (Bergquist et al. 2000; Sapolsky, 2004; Cohen et al., 1995; Crimmins and Seeman,

2001). When these markers are analyzed collectively in an index, the index is referred to as

neuroendocrine allostatic load (NAL), and it has been discussed in more detail elsewhere (Gersten, forthcoming a).

Twelve hour overnight urinary samples were collected from respondents for measurement of all markers save DHEAS, for which blood was drawn. Subjects provided samples while under basal (resting) conditions and fasted in advance of the blood draw. In part because dissimilar body size leads to differential concentration of the markers in the urine, total urine was standardized using grams of creatinine. Blood and urine specimens were sent to Union Clinical Laboratories (UCL) in Taipei, Taiwan. In addition to routine standardization and calibration tests performed by the laboratory, blind duplicate samples were submitted to UCL periodically throughout the fieldwork and a further set of duplicates were sent to Quest Diagnostics in the United States for analysis. Data from duplicate samples indicate intra-lab correlations (UCL and UCL) of 0.80 or higher and inter-lab correlations (UCL and Quest Diagnostics) of 0.76 or higher.

Independent variables

The three main independent variables of interest are all subjective status measures. The subjective SES measure asks respondents to place themselves on a ladder (a picture of which is shown to them) that corresponds to their SES relative to all others in Taiwan. The ladder has a total of 10 rungs, with the 10th rung corresponding to the highest level of status. Respondents are prompted to consider their educational level, income level, and the prestige of their job, in determining their SES. The subjective community standing measure also asks respondents to rate themselves on a ladder (which is identical to the one shown to them moments before), but this

time the respondents are instructed to rate themselves as regards their community status. Community is not defined for respondents, and the respondents are not given any prompts as to what might be important criteria to consider in making their decision.

The last main independent variable of interest is created from subtracting the subjective SES score from that of subjective community standing. The idea behind the creation of this variable is to try to capture the protective effect that might stem from those who in absolute terms rate themselves lowly on the subjective status measure, but who rate themselves more highly in the community. For example, someone with little education and a poor paying job might give himself a rating of two on the subjective SES measure, but might also at the same time highly value being a grandfather and participation in a local council and give himself a rating of five on the community measure. Thus, his scores would be low on each measure separately, but his score on the Community - Taiwan measure might very well be high. Such an improvement from one measure to the next could reflect an underlying psychological state and other factors that contribute to good health.

Other independent variables serve as controls. Since levels of the neuroendocrine biomarkers can be influenced by a wide variety of factors independent of stress (Gersten, 2005), all models control for variables pertaining to diet, exercise, smoking, alcohol consumption, betel nut chewing, and medication use. Age, sex, and health status are also used as controls since these phenomena may have important relationships with both the level of the neuroendocrine biomarkers and the status ratings (Gersten, forthcoming a).

Methods

Regarding extreme values, five outliers for dopamine have been removed that were all at least six standard deviations above the mean and one outlier for cortisol was removed that was nearly twenty standard deviations above the mean. Concerning other data transformations, cortisol had a distribution that exhibited the most skewness in one direction or the other (in its case, a right tail) and has been logged, creating a more normalized distribution and more normalized residuals.

The most popular approach to operationalizing AL has been to create a score that gives one point for every biomarker for which the subject can be considered at higher risk (i.e. the elevated risk zone approach). The literature most often represents high risk by greater values for cortisol, epinephrine, norepinephrine, and lower values for DHEAS; this convention is followed here. Relative to the other markers under study here, relatively little research has been conducted on dopamine, but results in the literature suggest that low levels are a risk factor for a number of health conditions and that it is reasonable to hypothesize (as we do in this paper) that chronic stress lowers baseline levels (Backman and Farde, 2001; Isovich, et al. 2000; Wood, 2004; Sapolsky, 2004, p. 295). Since there is no agreed upon standard for what biomarker values represent different risk levels, it has been most common to define risk as above or below distribution percentiles (e.g. 10th, 25th, 75th, 90th). Since subjects can be assigned 1 point on five biomarkers if they have high risk values, NAL scores can range from 0-5.

In addition to NAL scores based on cutpoints, a summed z-score is created for respondents, which is the total number of standard deviations from the mean in the direction of high risk for each biomarker. Unlike the cut-off approach, an index using the z-score method

allows for unequal weighting of the markers (e.g. a combined z-score of 3 could stem from being 2 SDs above the mean for cortisol, 1 SD above the mean for epinephrine, and the mean for the other three markers) and can range from zero to no pre-determined upper limit. Like the NAL score based on cutpoints, the combined z-score will be the dependent variable in an OLS regression. Descriptive statistics for the individual markers and for the different NAL constructs are presented in Table 1.

Lastly, the multivariate analysis makes use of weighted data.

Results

Table 2 depicts descriptive statistics (of the entire, unweighted sample) for independent variables that are used in this analysis. Notably, because of mainly male emigration to Taiwan shortly after World War II (sparked by conflict on mainland China), there are more men than women in the sample. Also noteworthy is that respondents, on average, tend to rate themselves more highly (by about half a rung on the ladder) in reference to community standing compared to standing in all of Taiwan. This difference is highly significant (p-value < 0.000), calculated using a paired t-test appropriate for weighted data.

Figure 1 presents the distributions of self-reported standing in Taiwan and in the community. Both distributions are right tailed, with comparatively few participants willing to rate themselves highly either relative to the Taiwanese population or relative to their communities. This type of skewed distribution, which may partially reflect Taiwanese modesty, contrasts with distributions stemming from surveys conducted in Western populations in which the data more resemble a normal curve (and sometimes even have a disproportionate amount of

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high values) (Adler et al., 2000; Singh-Manoux et al., 2005; Goldman et al., 2006a). As mentioned before, participants in the SEBAS are more willing to rate themselves higher in reference to their communities. As can be observed from the figure, nearly two times as many subjects are willing to give themselves a "7" rating in the community compared to that in Taiwan and such a proportional increase also applies to other ratings at the higher end (i.e. 8, 9, 10) of the ladder.

Table 3 presents unstandardized regression coefficients and associated p-values for OLS regressions in which different neuroendocrine biomarkers are the dependent variables and standing in the community, standing in Taiwan, and the difference in standing (community - Taiwan) are the key independent variables. An important finding revealed in the table is that higher self-reported status is correlated with higher (and thus less risky) DHEAS levels. This relationship holds whether one looks at status in Taiwan or status in the community, although the former exhibits a stronger relationship. Contrary to expectation, for norepinephrine, report of higher status in Taiwan is associated with higher (and thus more risky) levels of that biomarker. Additional analyses were carried out in which the biomarkers remained dependent variables in the analysis (as presented in Table 3), but this time the dependent variables were dichotomized into "risky" and "non-risky" values using the biomarker-specific cutpoints in Table 1 (i.e. the 10th and 25th or 75th and 90th percentiles) and analyzed using logistic regression. By and large, this method of analysis produced results (not shown) that were similar, although somewhat weaker, than those presented in Table 3. An important exception was for norepinephrine; its connection between status and biomarker levels as observed in Table 3 was considerably attenuated (e.g. a p-value of 0.269 for the "Status in Taiwan" variable in Model 1 in a fully saturated regression).

Table 4 presents data analyzed similarly to that presented in Table 3, but in this case the dependent variable is not individual neuroendocrine biomarkers, but NAL scores. As mentioned in the methods section, the NAL scores are indices of the five neuroendocrine markers constructed in somewhat different ways. As can be observed from the table, the coefficients for the different status variables are in the hypothesized direction, with higher status yielding lower (and thus less risky) scores. However, none of the associations reach conventional levels of statistical significance.

Numerous variants of the analysis thus far presented have also been carried out. For instance, instead of entering the status measures as continuous variables, they were entered as variables grouped into low, medium, and high categories (pertaining to rungs 1-4, 5, and 6-10, respectively). Also, instead of analyzing men and women together and using cutpoints based on the entire sample, analyses were rerun separately by sex and based on sex-specific cutpoints. Further, since there is a fair amount of evidence to suggest that for cortisol, not only high, but low values as well, pose risk (Loucks, Juster, and Pruessner, forthcoming; Raison and Miller, 2003; Fries et al., 2005), analyses were rerun examining both tails of cortisol's distribution for the marker analyzed separately and analyzed as part of the NAL constructs. All of the additional analyses just described produced results (data not shown) consistent with the main findings that have already been discussed.

Further analysis in progress: investigation of effect of subjective social status on biomarkers with the inclusion of objective indicators (i.e., educational level of respondents, educational level of the spouses of respondents, and socioeconomic index (SEI) scores for the main occupation during the lifetime of respondents (or their husbands, if female).

Discussion

To reiterate, the main goal of this paper was to investigate whether different measures of subjective social standing were linked to riskier neuroendocrine biomarker profiles. On the whole, the results have not supported such a link. That is, various indices of the biomarkers, termed here neuroendocrine allostatic load (NAL) scores, were not associated with status ratings and most of the biomarkers when analyzed separately were also not associated with status ratings. However, strong and consistent results linked low social standing with risky (i.e. low) DHEAS levels for both men and women.

In addition to being strongly associated with subjective social status, DHEAS is an interesting biomarker because when compared to the other neuroendocrine markers (at the very least as measured in overnight urine samples), levels of DHEAS easily show the greatest change with aging. From peak amounts at around 20 or 30 years old, DHEAS levels decline nearly 80 or 90% some 50 years later (Ferrari et al., 2001; Leowattana, 2004). In contrast, evidence is mixed on whether baseline levels of cortisol and epinephrine even change with age (Gersten, 2005). Despite DHEAS' marked declines with age, it is still controversial whether such declines are merely concomitant with aging or whether they play some role in accelerating the aging process (Goldman and Glei, 2007; Glei et al., 2004). For example, although dysregulated DHEAS levels have been associated with various types of illness (Cleare, O'Keane, and Miell, 2004; Kaufman and Vermeulen, 2005; Kroboth et al., 1999; Rasmusson et al., 2004), few studies have looked at the effects of chronic stress on the marker's levels uncoupled from such health problems (Clark, Bond, and Hecker, 2007; Littman et al., 1993). In part because of the dearth of such studies, it is hard to draw any consistent conclusion from them, but the results in the paper here would

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suggest that stress experienced over the life course does in fact hasten declines in the amounts of DHEAS in the body.

As regards the other neuroendocrine markers, the results in this paper agree with much of the work thus far using the same data set indicating the difficulty in linking indicators of chronic stress to indicators of an impaired neuroendocrine system (Dowd and Goldman, 2006; Goldman et al., 2005; Seplaki et al., under review; Gersten, forthcoming a). It might be tempting to reflect upon this lack of connection and conclude that the health consequences of stress likely do not operate through the neuroendocrine biomarkers. We feel that such a conclusion would be premature: negative findings such as found in this paper could stem from a number of sources, one of the more important being how biomarkers are collected and measured.

Ideally, instead of one overnight urine sample as collected in the study here, there would be about three per week over the course of two or three weeks (Loucks, Juster, and Pruessner, forthcoming). The necessity for so many measures stems from the possibility that "state factors" unrelated to stressor exposure (such as sleep duration and quality, diet, and exercise) influence the levels of the markers (Loucks, Juster, and Pruessner, forthcoming; Gersten, 2005). Further, it would be more ideal if (in surveys such as the one analyzed here) integrated urinary measures were complemented with those that provided information about how neuroendocrine levels change during the day. Salivary cortisol measures, for example, could provide such information with only a limited number of samples (about five or more). Having information on subjects' cortisol levels over the day is important since it appears that in older persons the diurnal rhythm tends to flatten, exhibiting less of a morning rise and less of a nighttime low, compared to younger persons (Van Cauter et al., 1996; Magri et al., 2000; Ice et al., 2004). Such a flattening of the rhythm may be harmful and might be more likely to come about with greater exposure to

stressors over the life course. Lastly, some measure of respondent reactivity to one or more stressors and the time needed to return to baseline levels would be valuable since it appears that those with a compromised neuroendocrine system are "sluggish" in returning to a basal state (Sapolsky, 2004; Seeman and Robbins, 1994). Allostatic theory would predict, although this has been little tested, that respondents with a sluggish recovery would differentially be those who have experienced greater stress over the life course.

As mentioned before, this paper analyzed two versions of a subjective status question (and analyzed another measure that derived from these two). The first question asked respondents to rate themselves relative to those in all of Taiwan and the second question asked respondents to rate themselves only in reference to their community, however they chose to define it. Of the two versions, we thought that respondents would rate themselves more highly in the community, and this was indeed the case. Lives are lived in particular geographic locations and communities and it is likely that people positively value the social relations and roles they assume in these spheres, translating into higher ratings on this version of the status question. Nevertheless, results from attempting to link levels of subjective status to biomarker levels did not differ much between the versions of the status questions used.

The similarity in responses to both questions might have something to do with the order in which they were presented to survey respondents and the fact that the question asked first (about status in all of Taiwan) was accompanied with a prompt (i.e. "At the top of the ladder are the people ... with the most money, the most education and the most resected jobs."). As we ourselves tried answering the two status questions the prompt remained salient in our thinking when trying to answer the second, even though the second question was worded differently and contained no prompt.

Should the status question not contain a prompt, another consequence might be that respondents are more likely to consider a wider array of factors in assessing their level of status, factors such as feelings of discrimination, appearance (e.g. being overweight), neighborhood traits (e.g. neighborhood safety and amenities), and characteristics of those that are close to them (e.g. educational levels and resources of their spouse and children). In other words, a promptless question might better capture general feelings of "lowliness" that authors such as Wilkinson (1999) have argued are detrimental to health. Indeed, it is interesting to note that one of the most predictive measures of a wide variety of future health outcomes is that of current, self-rated health, a question which typically has no prompts (Idler & Benyamini, 1997).

Whether the subjective status questions should or should not have prompts is, clearly, closely connected to what the measures are supposed to be measuring. If the subjective SES question is mainly a shortcut way of obtaining information on objective SES, without having to query about education, income, wealth, employment, and so on separately, then a question with a prompt seems preferable to its opposite. Used in studies to date, however, the subjective status question seem less a substitute for objective measures than a way to gauge feelings of relative deprivation; that is, studies often include objective measures of status along with responses to the ladder question in an attempt to measure, or so it seems, the "extra material" costs of low SES (Hu et al., 2005; Collins and Goldman, working paper; Ostrove et al., 2000; Singh-Manoux et al., 2005).

To conclude, the results here suggest that stress experienced over the life course does not influence basal levels of a number of neuroendocrine biomarkers or indices based on these markers in older subjects. However, to strengthen such a conclusion, more measures of these bioindicators should be collected as part of study designs. Of the neuroendocrine markers

investigated here, DHEAS is one of the more intriguing in part because of its sharp decline with age and, as found in this paper, its strong connection to two different measures of subjective social status – intriguing and likely important indicators of stress experienced over the life course.

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Table 1 **Descriptive statistics and cut-points for the neuroendocrine biomarkers and descriptive statistics for the neuroendocrine allostatic load (NAL) indices – sample population, Taiwan (ages 54 to 91, both sexes combined, year 2000)[a]**

	Mean	SD	Min	Max	N	10th	25th	75th	90th
							Percentile cutoffs		
Neuroendocrine markers									
Cortisol (logged)[b]	3.0	0.7	0.8	7.2	1019	--	--	29.9	47.9
DHEAS[c,d]	80.7	58.6	0	496.6	1021	20.9	40.8	--	--
Epinephrine[b,d]	2.6	2.6	0	19.9	1019	--	--	3.7	5.6
Norepinephrine[b]	21.9	9.9	1.6	74.7	1019	--	--	27.1	34.7
Dopamine[b]	152.0	61.7	6.0	796.5	1014	87.4	112.3	--	--
NAL indices									
10% cutoff points	0.5	0.8	0	5	1011	--	--	--	--
25% cutoff points	1.3	1.2	0	5	1011	--	--	--	--
Summed z-score	1.8	1.4	0	9.0	1011	--	--	--	--

Note: [a] The tabulations are based on unweighted survey data. The literature most often represents high risk by greater values for cortisol, epinephrine, and norepinephrine and lower values for DHEAS, a convention which is followed in this paper. Also based on the literature, we hypothesize that low dopamine values pose risk.
[b] (µg/g creatinine).
[c] (µg/dl).
[d] Values below assay sensitivity were coded in the original, publicly available data set as zero.

Source: Authors' tabulations based on the 2000 SEBAS (Goldman et al., 2003).

Table 2 **Descriptive statistics for all of the independent variables used in the analysis – sample population, Taiwan (ages 54 to 91, both sexes combined, year 2000)[a]**

	% or Mean (SD)	Range	N
Subjective standing			
Taiwan[b]	3.9 (1.9)	1-10	991
Community[b]	4.3 (2.1)	1-10	986
Difference (Community - Taiwan)	0.47 (1.3)	-6-7	984
Controls			
Demographic			
Age (years)	68.3 (8.5)	54-91	1023
Male sex	58%	--	1023
Health/behavioral			
Self-rated health	2.9 (.99)	1-5	1005
Takes medication	57%	--	1023
Chews betel nut daily	2%	--	1020
Smokes daily	22%	--	1022
Consumes alcohol daily	5%	--	1020
Exercises six times a week or daily	41%	--	1022
Diet of at least two fruits and three vegetables daily	53%	--	1021

Note: [a] The tabulations are based on unweighted survey data.
        [b] Ten represents the highest status and one the lowest.
Source: Authors' tabulations based on the 2000 SEBAS (Goldman et al., 2003).

Figure 1 **Distributions of self-reported standing in Taiwan and in the community -- sample population (ages 54 to 91, both sexes combined, year 2000)[a]**
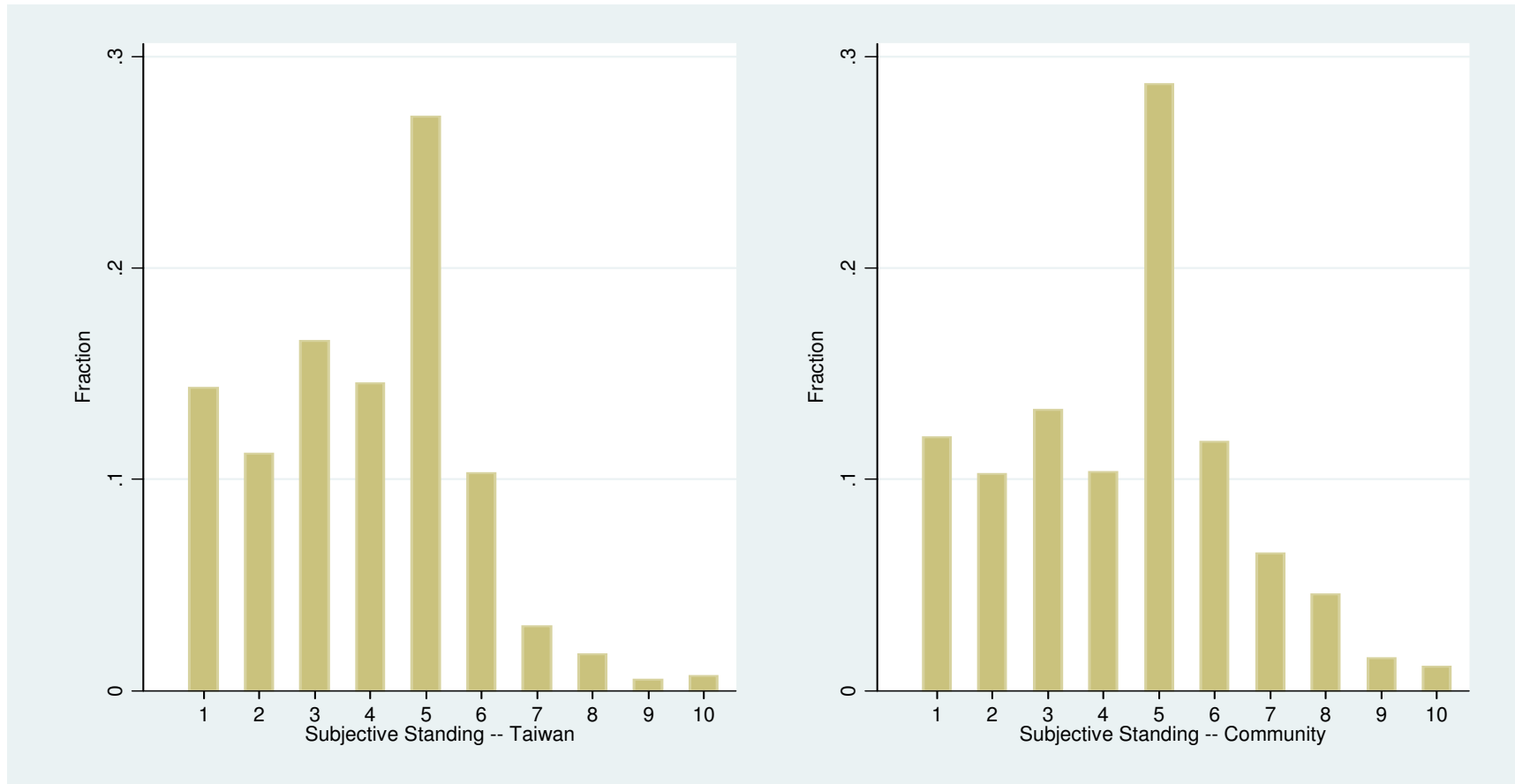
Note: [a] The tabulations are based on unweighted survey data. Ten represents the highest status and one the lowest.

Source: Authors' tabulations based on the 2000 SEBAS (Goldman et al., 2003).

Table 3 **Estimated regression results with different neuroendocine biomarkers as the dependent variables and reports of subjective status as the independent variables – Taiwan (ages 54 to 91, both sexes combined, year 2000)[a]**

			Dependent variables		
Independent variables	DHEAS[b]	Cortisol[c]	Epinephrine[c]	Norepinephrine[c]	Dopamine[c]
Model 1:					
Status in Taiwan[d]	**3.33 (0.003)**	-0.01 (0.312)	0.03 (0.363)	0.28 (0.072)	-1.11 (0.220)
Status in Taiwan[d,e]	**2.75 (0.010)**	-0.01 (0.459)	0.05 (0.239)	**0.36 (0.022)**	-0.28 (0.765)
Status in Taiwan[d,e,f]	**2.47 (0.006)**	-0.01 (0.488)	0.05 (0.223)	**0.38 (0.018)**	-0.41 (0.650)
Status in Taiwan[d,e,g]	**2.36 (0.023)**	-0.01 (0.641)	0.04 (0.274)	**0.38 (0.020)**	-0.39 (0.698)
Status in Taiwan[d,e,f,g]	**2.17 (0.015)**	-0.01 (0.665)	0.04 (0.262)	**0.39 (0.018)**	-0.48 (0.625)
Model 2:					
Status in Community[d]	**2.95 (0.009)**	-0.01 (0.503)	0.06 (0.118)	0.07 (0.624)	-1.14 (0.196)
Status in Community[d,e]	**2.40 (0.022)**	-0.01 (0.677)	0.07 (0.086)	0.15 (0.284)	-0.35 (0.702)
Status in Community[d,e,f]	**2.16 (0.028)**	-0.01 (0.702)	0.08 (0.082)	0.16 (0.246)	-0.46 (0.606)
Status in Community[d,e,g]	**2.12 (0.045)**	-0.00 (0.809)	0.07 (0.078)	0.15 (0.290)	-0.43 (0.653)
Status in Community[d,e,f,g]	1.95 (0.054)	-0.00 (0.829)	0.07 (0.075)	0.16 (0.261)	-0.51 (0.586)
Model 3:					
Difference in Status (C – T)[d]	0.75 (0.671)	0.00 (0.914)	0.09 (0.240)	-0.37 (0.175)	-0.71 (0.600)
Difference in Status (C – T)[d,e]	0.55 (0.772)	0.00 (0.846)	0.09 (0.218)	-0.34 (0.221)	-0.40 (0.769)
Difference in Status (C – T)[d,e,f]	0.54 (0.764)	0.00 (0.848)	0.09 (0.220)	-0.34 (0.207)	-0.40 (0.775)
Difference in Status (C – T)[d,e,g]	0.68 (0.724)	0.00 (0.896)	0.09 (0.217)	-0.34 (0.214)	-0.37 (0.786)
Difference in Status (C – T)[d,e,f,g]	0.65 (0.724)	0.00 (0.894)	0.09 (0.218)	-0.34 (0.203)	-0.38 (0.784)

Note: [a] Each column presents results from different OLS regressions in which a single neuroendocrine marker (measured continuously) is the dependent variable. The regression coefficients are unstandardized and precise levels of statistical significance are inside the parentheses.
[b] μg/dl.
[c] μg/g creatinine.
[d] Regression includes baseline controls (i.e. medication use, diet, exercise, alcohol consumption, betel quid chewing, and smoking).
[e] Regression also includes a control for sex.
[f] Regression also includes a control for age.
[g] Regression also includes a control for health status (as proxied by self-rated health).
Source: Authors' tabulations based on the 2000 SEBAS (Goldman et al., 2003).

Table 4   **Estimated regression results with neuroendocrine allostatic load (NAL), scored using different methods, as the dependent variable and reports of subjective status as the independent variables -- Taiwan (ages 54 to 91, both sexes combined, year 2000)[a]**

	Dependent variables		
	Cutpoint scoring		Summed z-score scoring
Independent variables	10%	25%	
Model 1:			
Status in Taiwan[b]	-0.03 (0.063)	-0.02 (0.240)	-0.03 (0.296)
Status in Taiwan[b,c]	-0.03 (0.092)	-0.01 (0.514)	-0.02 (0.503)
Status in Taiwan[b,c,d]	-0.02 (0.104)	-0.01 (0.699)	-0.01 (0.641)
Status in Taiwan[b,c,e]	-0.02 (0.119)	-0.00 (0.721)	-0.01 (0.589)
Status in Taiwan[b,c,d,e]	-0.02 (0.127)	-0.00 (0.888)	-0.01 (0.701)
Model 2:			
Status in Community[b]	-0.02 (0.178)	-0.02 (0.100)	-0.02 (0.402)
Status in Community[b,c]	-0.02 (0.246)	-0.01 (0.225)	-0.01 (0.634)
Status in Community[b,c,d]	-0.02 (0.272)	-0.01 (0.320)	-0.01 (0.772)
Status in Community[b,c,e]	-0.02 (0.317)	-0.01 (0.318)	-0.01 (0.736)
Status in Community[b,c,d,e]	-0.02 (0.335)	-0.01 (0.403)	-0.01 (0.846)
Model 3:			
Difference in Status (C – T)[b]	-0.00 (0.949)	-0.02 (0.298)	-0.00 (0.951)
Difference in Status (C – T)[b,c]	-0.00 (0.988)	-0.02 (0.367)	-0.00 (0.968)
Difference in Status (C – T)[b,c,d]	-0.00 (0.990)	-0.02 (0.317)	0.00 (0.962)
Difference in Status (C – T)[b,c,e]	-0.00 (0.949)	-0.02 (0.327)	-0.00 (0.993)
Difference in Status (C – T)[b,c,d,e]	-0.00 (0.957)	-0.02 (0.288)	0.00 (0.990)

Note: [a] Each column presents results from different OLS regressions in which the NAL score is the dependent variable. The regression coefficients are unstandardized and precise levels of statistical significance are inside the parentheses.

[b] Regression includes baseline controls (i.e. medication use, diet, exercise, alcohol consumption, betel quid chewing, and smoking).

[c] Regression also includes a control for sex.

[d] Regression also includes a control for age.

[e] Regression also includes a control for health status (as proxied by self-rated health).

Source: Authors' tabulations based on the 2000 SEBAS (Goldman et al., 2003).

★D1 [Show the figure on the right-hand side of this page to the respondent]

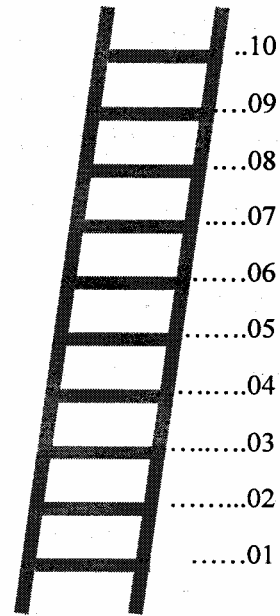Here is a ladder. There are also ten stairs in total from the bottom to the top.

Think of this ladder as representing where people stand in Taiwan. At the top of the ladder are the people who are the best off — those who have the most money, the most education and the most respected jobs. At the bottom are the people who are the worst-off — who have the least money, least education, and the least respected jobs or no jobs.

The higher up you are on this ladder, the closer you are to the people at the very top; the lower you are, the closer you are to the people at the very bottom.

If you consider your current situation and compare it with all other people in Taiwan, where would you place yourself on this ladder? Please indicate it to me.

[Please circle the rung that respondent indicates.]

☐ 66 Other response (Please specify)

..10
...09
....08
.....07
......06
.......05
........04
.........03
.........02
......01

★D2 [Show the figure on the right-hand side of this page to the respondent]

Here is another ladder. In total, there are ten stairs from the bottom to the top.

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 who have the highest standing in their community. At the bottom are the people who have the lowest standing in their community.

[Interview note: Please let respondents define community by themselves. If respondents really don't know or don't understand, please probe using the word neighborhood (where you live and the surrounding area).]

If you consider your current situation and compare it with all other people in your community, where would you place yourself on this ladder? Please indicate it to me.

[Please circle the rung that respondent indicates.]

☐ 66 Other response (Please specify)

..10
...09
....08
.....07
......06
.......05
........04
.........03
.........02
......01