Greater Leisure-Time Physical Activity is Associated with Lower Allostatic Load in Midlife Women: Findings from the National Health and Nutrition Examination Survey, 1999-2004

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Author Descriptions

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Abstract

Background: Allostatic load is a useful construct to understand how social and environmental conditions get under the skin to affect health. To date, few studies have examined health-enhancing lifestyle behaviors and their potential benefits in reducing allostatic load. The purpose of this study was to investigate the contributions of leisure-time physical activity on level of allostatic load among midlife women.

Methods: Data were from the National Health and Nutrition Examination Survey (NHANES), 1999-2004 (n = 1,680, women ages 40-59). All analyses were weighted. Negative binomial regression was used to model a summative count measure of allostatic load (M = 2.30). Models were also computed to estimate adjusted predicted allostatic load for given levels of physical activity, and by race/ethnicity for each age category, controlling for other demographics.

Findings: Higher levels of physical activity were significantly associated with lower levels of allostatic load, independent of demographics. Compared to White women ages 40-44, all other racial/ethnic-by-age groups had significantly higher allostatic load. Higher socioeconomic status (SES) was associated with lower allostatic load. Adjusted prediction models demonstrated beneficial effects of physical activity on allostatic load regardless of level of activity for all ages and racial/ethnic groups.

Conclusions: Our findings suggest physical activity may ameliorate some of the effects of cumulative physiological dysregulation and subsequent disease burden in midlife women. Programs and policies that encourage and promote healthy aging and provide opportunities for a diversity of women to engage in health-enhancing lifestyle practices such as physical activity are recommended.

Introduction

Adverse environmental, social, and economic conditions are associated with numerous negative health outcomes and contribute to the generation and maintenance of health inequalities (Diez Roux, 2012; Link & Phelan, 1995; Phelan, Link, & Tehranifar, 2012; Taylor, Repetti, & Seeman, 1997). Allostatic load is a useful construct to understand how person-environment interactions accumulate over time to affect health and to identify possible physiological pathways through which these larger socioenvironmental conditions act (McEwen, 2004; Seeman et al., 2001; Seeman et al., 1997; Seeman et al., 2004). There is new interest in investigating and identifying health-enhancing lifestyle behaviors and their salutary effects on reducing allostatic load, and thus subsequent disease burden. The purpose of this study was to investigate the potential contributions of leisure-time physical activity on allostatic load among a nationally representative sample of midlife women. Secondarily, we were also interested in characterizing demographic differences in allostatic load, with a focus on examining the extent to which racial and ethnic effects depend upon women's age.

Allostatic Load

Allostatic load is a measure of cumulative burden of dysregulation across multiple physiological systems (McEwen & Stellar, 1993; McEwen, 1998; McEwen, 2007; Sterling & Eyer, 1988). It occurs with long-term exposure to environmental and social stressors, leading to overaction and dysregulation, resulting in biological wear and tear (McEwen, 2004; Seeman et al., 1997; Seeman et al., 2001; Seeman et al., 2004). Allostatic load is a stronger predictor of subsequent morbidity and mortality than single, system-specific biological indices (Karlamangla et al., 2002; Karlamangla, Singer, & Seeman, 2006; Seeman et al., 2004). This greater predictability is because it provides an index of cumulative risk, summarizing what may be small changes in individual parameters but whose combined effects reflect greater overall evidence for dysregulation (McEwen, 1998; McEwen, 2007; McEwen & Stellar, 1993). Consequently, these properties suggest allostatic load can be a useful 'early warning' marker to identify at-risk women and intervene earlier.

Midlife (roughly ages 40-59) is a pivotal period in women's lives marked by physiological changes and multiple social transitions (Kuh & Hardy, 2002; Willis & Reid, 1999). Much of women's lives are spent post-childbearing and postmenopausal and there is growing interest in identifying successful strategies for healthy aging (Bass & Caro, 2001; Kuh & Hardy, 2002). Because health problems accelerate during midlife and chronic diseases become increasingly prevalent, it is important to identify risk factors during this stage of life (House, Lantz, & Herd, 2005; Kuh & Hardy, 2002; Lantz et al., 1998; Lantz et al., 2005; Willis & Reid, 1999). Allostatic load may offer a concrete measure of women's risk at midlife and serve as a good index to track how lifestyle changes affect health risks and aging trajectories.

Lower SES is associated with higher allostatic load in the adult U.S. population (e.g., Seeman et al., 2008) and among women of all ages (Chyu & Upchurch, 2011). Social and economic conditions have been proposed as 'fundamental causes' of health inequalities (Diez Roux, 2012; Link & Phelan, 1995; Phelan, Link, & Tehranifar, 2010) and differences in allostatic load may be one pathway linking SES and health (Carlson & Chamberlain, 2005; Diez Roux, 2012; Phelan, Link, & Tehranifar, 2010). Specifically, the stresses of lower SES, including lack of resources (such as knowledge, money, power, prestige, and beneficial social conditions) contribute to health disadvantages (Link & Phelan, 1995; Phelan, Link, & Tehranifar, 2010; Rieker & Bird, 2005).

Moreover, allostatic load may accrue more rapidly for certain groups of women, particularly women who are racial or ethnic minorities. Long-term exposure to social adversity is proposed to elicit chronic stress responses, increasing cumulative physiological burden, and contributing to earlier health deterioration among minorities, especially Blacks (Braveman, 2011; Geronimus et al., 2006; Geronimus et al., 2010; Peek et al., 2010). These forces are distinct from those of SES in that they place additional constraints among individuals based on their race or ethnicity (Braveman, 2011). Fewer studies have analyzed Hispanics relative to other groups, however, there is evidence that they have higher allostatic load than Whites, but lower than Blacks (Crimmins, et al., 2007; Chyu & Upchurch, 2011; Peek et al., 2010). There is substantial variability in health status and disease risk according to country of origin and nativity status (Lara et al., 2005; Peek et al., 2010). Accordingly, in the current study, we focused exclusively on Mexican American women.

Physical Activity and Allostatic Load

Although few studies have investigated the impact of leisure-time physical activity on allostatic load per se, (see Gallo et al., 2011; Gay et al., 2013; Hampson, et al., 2009 as exceptions), there is support that leisure-time physical activity is related to the individual biomarkers that comprise allostatic load. Several recent studies, including systematic reviews, reported higher levels of leisure-time physical activity have beneficial effects on cardiovascular (Hamer, 2012; Luke, et al., 2011; Panagiotakos, et al., 2005), metabolic (Ford, et al., 2005;

Golbidi, Mesdahninia, & Laher, 2012; Holmes, Ekkekakis, & Eisenmann, 2010), and inflammatory (Kasapapis & Thompson, 2005; Panagiotakos, et al., 2005) markers.

The multiple and long-term benefits of regular physical activity are well established (e.g., Booth, Roberts, & Laye, 2012; Brown, Burton, & Rowan, 2007; Schoenborn & Stommel, 2011; USDHHS, 2008). The most recent 2008 national guidelines (USDHHS, 2008) recommend 150-300 minutes of moderate intensity (or 75-150 minutes of vigorous intensity) activity per week for adults to maintain health and reduce disease risk. Greater amounts of activity are recommended for greater health benefits, and there is a dose-response gradient between physical activity and health benefits (USDHHS, 2008). Unfortunately, many Americans, especially midlife and older women, do not meet these recommendations (Carlson, et al., 2010; Tucker, Welk, & Beyler, 2011). However, a review concluded that even modest gains in women's physical activity may lower risk for some health problems (Brown, Burton, & Rower, 2007).

Conceptual Framework and Hypotheses

The research presented here utilized a biopsychosocial approach that posits health status (here, allostatic load) is the product of social, psychological, behavioral, and biological processes. Thus, life conditions linked to characteristics of social placement result in variable exposure to social stressors with consequences to allostatic load. Similarly, lifestyle behaviors are shaped by social position and conditions. Because allostatic load is cumulative in nature, we proposed older women will have higher load values than younger women. Additionally, we incorporated an intersectional approach because of differential aging/weathering according to race and ethnicity. Thus, we hypothesized that the effect of race and ethnicity would be contingent on age, with Black women especially at a disadvantage vis a vis allostatic load level. We also hypothesized higher SES women would have lower allostatic load. Last, we hypothesized that higher levels of leisure-time physical activity would be associated with lower allostatic load, in a dose-response fashion, independent of demographics. We explicitly examined adjusted predicted allostatic load values at increasing levels of physical activity, using the 2008 national guidelines as a target.

Materials and Methods

Survey Description

NHANES is an ongoing, cross-sectional study used to assess the health and nutritional status of the civilian, non-institutionalized U.S. population (Centers for Disease Control and Prevention and National Center for Health Statistics, 2007a). It utilizes a stratified, multistage probability sampling design of households, thus allowing for national, population-level estimates. NHANES is collected on a continuous basis and released every two years. Clinical and laboratory components of the survey occur in Mobile Examination Centers (MEC) and standardized protocols are used (Centers for Disease Control and Prevention and National Center for Health Statistics, 2007b). The response rate for the full sample was 77% for the interview section and 71% for the MEC examination. For women, among those who completed the interview section, the response rate for the MEC examination was 92%. Data from the 1999-2004 cycles of NHANES were used for the current study. The analytic sample was all women ages 40-59 who had valid data on all biomarkers, were not pregnant, and completed both the interview and MEC sections of the survey. Women who identified as “other” races were excluded because of the heterogeneity of that category. The final sample size was n = 1,680. The research was approved by the institution's Investigational Review Board.

Description of Single Biomarkers and Composite Allostatic Load Score

Ten biomarkers were selected to reflect multiple physiological systems and disease risk, and included markers commonly used in previous research that were available in the data (Beckie, 2012; Carlson & Chamberlain, 2005; Chyu & Upchurch, 2011; Geronimus et al., 2006; McEwen & Stellar, 1993; Seeman et al., 1997). *Cardiovascular* markers included systolic and diastolic blood pressure, homocysteine, and pulse rate. *Metabolic* markers included body mass index (BMI), glycosylated hemoglobin (HbA1c), high-density lipoprotein (HDL), and total cholesterol. *Inflammatory* markers included serum albumin and C-reactive protein (CRP).

Composite allostatic load scores were created using empirical cutoff points based on the weighted distribution of the analytic sample, employing a count-based summation method, which has been used extensively in the literature (Beckie, 2012; Chyu & Upchurch, 2011; Crimmins et al., 2003; Geronimus et al., 2006; Karlamangla et al, 2002; Peek et al., 2010; Seeman et al., 1997; Singer, Ryff, & Seeman, 2004, among others). The 75th percentile was used as the cutoff for high risk for all biomarkers except albumin and HDL, for which the 25th percentile was used as the cutoff. Allostatic load scores were calculated by summing the number of biomarkers that fell into the high-risk quartile. Table 1 shows the descriptive statistics of the individual biomarkers and summary allostatic load score. Allostatic load score varied from 0-9 with M=2.30 (SD=1.29). Higher allostatic load indicates poorer health.

Table 1 here

Leisure Time Physical Activity

The data were drawn from the NHANES physical activity questionnaire which measures participation in leisure-time (and other) physical activities. Specifically, self-reported information was collected on the frequency and duration of moderate and vigorous intensity physical activities engaged in leisure time recreation during the past 30 days. Following recommended procedures, we first calculated the moderate and vigorous activity minutes per month for all activities mentioned and linked each activity with its pre-assigned Metabolic Equivalent Task (MET) (http://www.cdc.gov/nchs/tutorials/PhysicalActivity/Preparing/PAX/index.htm). A MET is a measure of intensity of physical activity and is the ratio of the rate of energy expended during an activity to the rate of energy expended at rest (USDHHS, 2008). Monthly summaries were then converted to weekly summaries by dividing by 4.33. The final variable is measured as MET minutes per week. (Additional detail on recommended coding can be found at http://www.cdc.gov/nchs/tutorials/PhysicalActivity/Preparing/PAQ/Task4_Step2c.htm).

Following recent work on leisure-time physical activity and allostatic load (Gay et al., 2013), and because we are interested in assessing potential dose-response relationship, we created a four-category measure. Women with no activity (0 MET minutes per week) were coded as "Inactive;" those with <600 MET minutes per week were "Low Active;" those between ≥600 and 1500 MET minutes per week were "Moderate Active;" and those with > 1500 MET minutes per week coded as "High Active."

Demographics

Race and ethnicity were coded according to women's self-report, with priority given to any mention of being Hispanic: Non-Hispanic White, Non-Hispanic Black, and Mexican

American. Age was coded into five-year categories. Educational attainment was coded into three categories (less than high school, high school graduate (including GED), and more than high school). Annual family income in the past year was coded into four categories (<$20,000, $20,000-44,999, $45,000-74,999, and ≥ $75,000). Current marital status was coded into three categories (married/cohabiting, separated/widowed/divorced, and never-married). Nativity status was dichotomous (U.S. born, foreign born). We also created a racial/ethnic-by-age interaction variable. There were no missing data for race/ethnicity or age and a very small number for education, marital status, and nativity status. For these variables, missing cases were coded into modal categories. Missing values for family income were imputed using a multinomial regression that included race/ethnicity, age, education, marital status, and nativity status. Substantive results did not change whether or not missing cases were dropped or included.

Analysis

All analyses were weighted using the NHANES individual-level sampling weights, which adjust for complex sample design, selection, and non-response. Mean differences for allostatic load for each covariate were assessed using bivariate regression and adjusted Wald F-test. Negative binomial regression models were used to investigate the combined effects of leisure-time physical activity and demographics on allostatic load. The functional form of negative binomial was used to account for over dispersion and to more accurately model the underlying count process (Winkelmann, 2008). In a separate analysis, allostatic load scores were predicted using estimates from the negative binomial model that included MET minutes per week, MET^2 minutes per week, racial/ethnic-by-age interactions, and controlling for remaining demographic variables described above. We assessed predicted values of allostatic load at increments of 250 METs between 0 and 1500. The control variables were set to the means. We then obtained adjusted predicted values (means) of allostatic load at each of the MET values for each racial/ethnic-by-age group. These results are presented graphically for ease of interpretation. All analyses were performed using Stata 12.0 (StataCorp, 2011).[1]

Additional Analyses to Be Conducted for PAA

For PAA, we will extend the analysis in several ways. First, we will develop structural equation models (SEMs) to investigate direct and indirect effects of levels of leisure-time physical activity on allostatic load. Second, we will include additional information on 'sedentary behaviors' that include television viewing time and time using the computer that is not work-related. Last, because midlife women tend not to engage in high levels of leisure-time physical activity, we will also investigate the contributions of 'active lifestyle' behaviors (e.g., biking to work) on allostatic load. These extensions will provide a more comprehensive pictures on the ways in which leisure-time physical activity, sedentary behaviors, and active lifestyle behaviors contribute to midlife women's levels of allostatic load. From this more detailed analysis, we will be able to provide a more nuanced set of programmatic recommendations.

Results

[1] Because this is one of the first investigations to consider leisure-time physical activity and allostatic load in a nationally representative sample, we investigated other possible specifications for our final model. We tested for moderation effects between leisure-time physical activity and race/ethnicity and with income, the omnibus tests for each were only marginally significant. We also performed structural equation modeling to examine direct and indirect effects of leisure-time physical activity on allostatic load. In this analysis, physical activity was assessed continuously as MET minutes per week. As expected, higher MET minutes per week was significantly associated with lower allostatic load. We also found that a portion of the effect of low income on higher allostatic load was explained by lower levels of physical activity among these women. No other indirect pathways were significant. (Data not shown; available from the authors.) Given the state of the science, we present what we felt were the most substantively compelling findings.

Population characteristics are represented in column one and mean allostatic scores by independent variables are shown in column two (Table 2). The majority (63%) of midlife women were either inactive or reported low level of physical activity in the past week. Only a minority (17%) reported a high level of physical activity. Almost two-thirds of women had more than a high school education, one-quarter were in the lowest category of family income, and one-third in highest family income. The majority of midlife women were currently married or cohabiting (71%) and more than one in ten were native born.

Table 2

As expected, mean allostatic load significantly was significantly lower with higher levels of leisure time physical activity. A negative dose-response relationship between levels of leisure time physical activity and mean allostatic load scores was observed, with an overall 48% reduction in mean allostatic load from the lowest to highest level of physical activity. Mean allostatic load increased with age for each racial/ethnic group. In each age category, White women had the lowest mean allostatic load and Black women the highest. Mean allostatic load decreased with increasing education and income and married women have the lowest allostatic load compared to other marital groups.

The relationship between increasing physical activity and lower allostatic load remained in the multivariate analysis (Table 3), although the dose-response pattern was significant only for moderate and high levels of physical activity. Compared to women with no activity, those with moderate or high levels had significantly lower allostatic load, with a greater benefit conferred for women engaging in high levels of physical activity. Compared to White women 40-44, all other racial/ethnic-by-age groups had significantly higher allostatic load, including

Black and Mexican American women of the same age (40-44). Allostatic load increased with age among each racial/ethnic group as well. Education was no longer significant and only women in the highest income category had lower allostatic load relative to the lowest income. Never married women had higher allostatic load than married women and foreign-born lower than native born.

Table 3

Figure 1 shows the adjusted predicted means of allostatic load for each racial/ethnic group within each age category. For all ages and all racial/ethnic groups, predicted values of allostatic load declined with higher levels of leisure-time physical activity. Predicted means were almost identical for Whites and Mexican Americans for all age categories except ages 40-44. For the oldest age group (55-59) White women had slightly higher predicted means than Mexican American women. As expected, women at the highest level of leisure-time physical activity had the lowest predicted allostatic load, for all ages, and for all racial/ethnic groups. For example, in the 40-44 year age group, increasing MET minutes per week from 0 to the maximum 1500 MET minutes per week reduced allostatic load by almost one-quarter. Using the 2008 guidelines as a reference, for the same age group, increasing MET minutes per week from 0 to 500 or from 0 to 1000 reduced allostatic load by almost 10 percent and 17 percent, respectively. (The Appendix shows the predicted adjusted means for all racial and ethnic groups and ages at each MET level computed.)

Discussion

This is one of the first studies to investigate the relationship between leisure-time physical activity and level of allostatic load in a nationally representative sample of midlife women. We find some support for a negative dose-response relationship between leisure-time physical activity and allostatic load, independent of demographic characteristics. In addition, our findings confirm racial and ethnic differences in allostatic load, that allostatic load increases with age, and that Black (and to a lesser extent Mexican American) women experience earlier aging (or weathering) than White women. Also, as expected, higher SES midlife women have lower allostatic load than less affluent women. Last, our prediction model demonstrates that all racial and ethnic groups and all age categories of midlife women theoretically benefit from increases in leisure-time physical activity to reduce levels of allostatic load.

Although there is a large literature addressing the relationship between leisure-time physical activity and single biomarkers (or markers from subsets of physiological systems) that comprise allostatic load (Ford, et al., 2005; Golbidi, Mesdahninia, & Laher, 2012; Hamer, 2012; Holmes, Ekkekakis, & Eisenmann, 2010; Kasapapis & Thompson, 2005; Luke, et al., 2011; Panagiotakos, et al., 2005; USDDH, 2008), to our knowledge, only three published studies have specifically examined physical activity and allostatic load with mixed results (Gallo et al., 2011; Gay, et al., 2013; Hampson, et al., 2009). Two investigated the relationship in Mexican American samples, one from a Texas-Mexico border area (Gay, et al., 2013), another of midlife women from a California-Mexico border area (Gallo et al., 2011), and one in an ethnically diverse sample of midlife Hawaiians (Hampson, et al., 2009). One study found a significant association between high levels of leisure-time physical activity (> 1500 MET minutes per week) and lower allostatic load in Mexican Americans, but not in a dose-response fashion (Gay, et. al, 2013). However, the researchers dichotomized allostatic load into high and low versus evaluating it as a count, which may in part explain the difference in findings from our own. In the study of midlife Mexican American women, higher levels of physical activity was associated with lower allostatic load at the bivariate level, but the effects were not significant in multivariate analysis (Gallo, et al., 2011). However, the authors acknowledge their analysis was likely under-powered. Physical activity was not associated with allostatic load in women in the Hawaiian sample, even at the bivariate level (Hampson et al., 2009). The discrepancies in the findings may be due to the nature of the samples used and measurement differences, especially leisure-time physical activity. Nevertheless, our findings from a nationally representative sample of midlife women are promising and suggest additional research on the contributions of leisure-time physical activity in potentially reducing allostatic load is warranted.

Our results regarding demographic effects on allostatic load are primarily confirmatory. However, a new contribution is our focus on midlife women. The observed racial and ethnic differences in levels of allostatic load are consistent with earlier studies investigating all adults and the elderly (Seeman et a., 2001; Seeman et al., 2004; Seeman et al., 2008) and one study examining women 18 and older (Chyu & Upchurch, 2011). We find for each age, Blacks have the highest allostatic load, followed by Mexican Americans, and last Whites. Thus our findings support the work of Geronimus and colleagues (2006; 2010) suggesting earlier aging, or weathering, especially among Black women. While Mexican American women have higher allostatic load than White women, there is also a protective effect of being foreign-born, and the majority of foreign-born in this sample is Mexican American. Work done by Crimmins and colleagues (2007) support the selective healthy immigrant hypotheses and more recent work by Peek and colleagues (2010) confirm selective immigrant effects. Our findings also point to the importance of considering intersectional approaches when investigating race and ethnicity (and undoubtedly other demographics).

Consistent with Link and Phelan's (1995; 2010) theory of social conditions as fundamental causes of health differences, we find midlife women with lower education and lower income have higher levels of allostatic load. The higher levels of chronic stresses associated with lower SES, including the lack of flexible resources potentially contribute to higher allostatic load, and ultimately poorer health (Karlamangla et al., 2002; 2006; Seeman, et al., 2004). The effects of education and income were somewhat reduced when leisure-time physical activity was added to our models, although the significant effects for the higher income level remain. As mentioned earlier, other ancillary analysis suggests part of the higher risk for allostatic load among lower income women is explained by their lower levels of physical activity. However, more research is needed to test the ways in which lack of resources, and which resources, specially, affect allostatic load. Additionally, work that focuses on how lifestyle behaviors may mediate these effects is recommended.

We acknowledge limitations of the current research. Importantly, the cross-sectional design of NHANES prohibits the investigation of level and change in allostatic load over time. We do find strong support that allostatic load increases with increasing age in this sample, but these are not 'within-woman' change estimates. We also cannot be certain about causal directionality with respect to physical activity and allostatic load. And although NHANES included a comprehensive set of biomarker measures and provides a good operationalization of allostatic load, there are key markers that would be useful to include (e.g., cortisol, epinephrine, norephephrine). Last, because we were interested in isolating possible physical activity effects on allostatic load, we did not consider multiple lifestyle behaviors that may simultaneously contribute to level of allostatic load. These questions remain for future research.

Implications for Practice and/or Policy

Midlife is a critical period in women's life course and helping women integrate strategies for healthy aging into their lives has high public health relevance as baby boomers age into midlife and beyond. Allostatic load can serve as an early warning indicator and marker of women's risk at midlife. The multiple health benefits of physical activity are well established and the results from this study demonstrate that leisure-time physical activity also has salutary benefits with regard to allostatic load. Thus our findings point to the importance of preventive health programs and interventions targeted at women during midlife that emphasize health-enhancing lifestyle behaviors like physical activity. Public policy efforts directed at developing exercise-friendly built environments will provide greater opportunities for a diversity of women to engage in these practices.

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Table 1. Descriptive Statistics of Individual Biomarkers and Summary Allostatic Load Score among Women 40-59, NHANES 1999-2004 (n = 1,680)

Biomarker	Range	Mean	SD	25%	50%	75%
Cardiovascular markers						
Systolic blood pressure (mm Hg)	76-202	121.7	12.2	110	121	133
Diastolic blood pressure (mm Hg)	22-110	74.6	7.06	68	74	81
Homocysteine (µmol/L)	1.65-60.74	7.97	2.18	6.23	7.32	8.87
Pulse rate (bt/min)	38-134	73.5	8.0	66	72	80
Metabolic markers						
Body mass index (kg/m^2)	14.70-66.44	28.78	4.99	23.36	27.45	32.99
Glycosylated hemoglobin (%)	4.0-14.6	5.45	0.58	5.10	5.30	5.60
HDL (mg/dL)	8-124	58.67	11.48	47	56	68
Total cholesterol (mg/dL)	85-410	208.62	26.96	183	206	256
Inflammatory markers						
Albumin (g/dL)	2.9-5.3	4.24	0.22	4.00	4.20	4.40
CRP (mg/dL)	0.1-10.7	0.52	0.55	0.10	0.27	0.64
Allostatic Load Score	0-9	2.30	1.29	1	2	3

For empirically-based AL score, 75% are the cutoff values and 25% for albumin and HDL. Abbreviations: SD=standard deviation; mm=millimeter; Hg=mercurcy; µmol= micromole; L=liters; bt=beats; min=minutes; kg=kilogram; m^2=meters squared; mg=millilgrams; dL=deciliter; g=grams.

Table 2. Weighted Percentage Distributions of Leisure Time Physical Activity and Demographics and Mean Allostatic Load Scores among Women 40-59, NHANES 1999-2004 (n=1,680)

	Percent %	Mean AL score
Leisure Time Physical Activity		
Inactive	34.4	2.85***
Low	28.9	2.32
Moderate	20.1	1.99
High	16.6	1.49
Demographics		
Race/ethnicity-by-age		
White 40-44	22.4	1.70***
White 45-49	23.3	2.14
White 50-54	21.6	2.37
White 55-59	14.7	2.63
Black 40-44	3.8	2.78
Black 45-49	3.9	3.31
Black 50-54	2.3	3.26
Black 55-59	1.9	3.49
Mexican American 40-44	2.2	2.26
Mexican American 45-49	1.7	2.32
Mexican American 50-54	1.3	2.61
Mexican American 55-59	0.7	2.80
Education		
Less than high school	15.3	2.85***
High school/GED	23.7	2.60
More than high school	61.0	2.05
Family income		
<$20,000	24.4	2.90***
$20,000-44,999	17.3	2.74
$45,000-74,999	24.3	2.27
≥$75,000	34.0	1.67
Marital status		
Married/cohabiting	70.8	2.13***
Separated/divorced /widowed	22.8	2.58
Never married	6.4	3.13
Nativity status		
US-born	92.4	2.31
Foreign-born	7.6	2.12

***p≤.001, adjusted Wald F-test.

Table 3. Weighted Negative Binomial Regression for Allostatic Load Score by Leisure Time Physical Activity and Demographics, Women 40-59, NHANES 1999-2004 (n = 1,680)

Characteristics	Coefficients	Estimated Count Ratios	95% Confidence Interval
Leisure Time Physical Activity			
Inactive	--	1.00	--
Low	-0.73	0.93	(0.82 – 1.06)
Moderate	-0.21**	0.81	(0.71 – 0.93)
High	-0.50***	0.61	(0.52 – 0.71)
Demographics			
Race-by-Age			
White 40-44	--	1.00	--
White 45-49	0.26***	1.30	(1.12 – 1.51)
White 50-54	0.33***	1.39	(1.21 – 1.59)
White 55-59	0.43***	1.54	(1.33 – 1.77)
Black 40-44	0.39***	1.48	(1.22 – 1.80)
Black 45-49	0.49***	1.64	(1.39 – 1.93)
Black 50-54	0.47***	1.59	(1.31 – 1.94)
Black 55-59	0.61***	1.84	(1.48 – 2.29)
Mexican American 40-44	0.21*	1.27	(1.00 – 1.53)
Mexican American 45-49	0.25*	1.28	(1.03 – 1.58)
Mexican American 50-54	0.40**	1.49	(1.12 – 1.96)
Mexican American 55-59	0.38*	1.46	(1.07 – 1.99)
Education			
< High school	--	1.00	--
High school graduate	0.03	1.03	(0.94 – 1.14)
> High school	-0.08	0.92	(0.83 – 1.02)
Family income			
<$20,000	--	1.00	--
$20,000-44,999	0.01	1.01	(0.89 – 1.15)
$45,000-74,999	-0.13+	0.89	(0.77 – 1.00)
≥$75,000	-0.35***	0.70	(0.59 – 0.84)
Marital status			
Married/cohabit	--	1.00	--
Separated, widowed, divorced	0.00	1.00	(0.87 – 1.15)
Never married	0.19*	1.20	(1.01 – 1.44)
Nativity status			
US born	--	1.00	--
Foreign born	-0.15*	0.86	(0.75 – 0.99)

+p≤.1; *p≤.05; **p≤.01; ***p≤.001

Appendix. Adjusted Predicted Mean Allostatic Load Values for Distinct MET Minutes per Week, by Race/Ethnicity and Age Groups, NHANES, 1999-2004

	0 MET	250 MET	500 MET	750 MET	1000 MET	1250 MET	1500 MET
40-44							
White	1.87	1.78	1.70	1.63	1.56	1.50	1.44
Black	2.78	2.65	2.53	2.42	2.32	2.22	2.14
Mex. Am.	2.34	2.23	2.13	2.04	1.95	1.87	1.80
45-49							
White	2.45	2.34	2.23	2.14	2.05	1.96	1.88
Black	3.08	2.94	2.81	2.69	2.57	2.47	2.37
Mex. Am.	2.40	2.29	2.19	2.09	2.00	1.92	1.84
50-54							
White	2.63	2.51	2.39	2.29	2.20	2.11	2.02
Black	3.00	2.86	2.73	2.62	2.50	2.40	2.31
Mex. Am.	2.77	2.64	2.52	2.41	2.31	2.22	2.13
55-59							
White	2.90	2.77	2.64	2.53	2.42	2.32	2.23
Black	3.46	3.31	3.16	3.02	2.89	2.78	2.66
Mex. Am.	2.78	2.66	2.54	2.43	2.32	2.23	2.14

Note: See text for further description.