

## **Introduction**

Significant gradients of health between levels of socioeconomic status and differing racial/ethnic groups exist among adolescents [1-3], contributing to the need for a conceptual framework that includes the biological understanding of how stressors during the life can “get under the skin” to affect health [4, 5]. The concept of allostatic load (AL) is an ideal framework for revealing the mechanisms by which the social environment and stressors can cumulatively contribute to poor health trajectories over time and later life health disparities [6, 7]. AL focuses on the interconnection of immune, metabolic and other biological systems as regulatory markers become unbalanced, a result from the wear and tear the body experiences from life’s stressors over time [8]. A growing body of literature has examined sociodemographic profiles of AL among adult and aging populations [7, 9-14], yet no studies to date have explored the sociodemographic differences in the levels of AL among a nationally representative sample of adolescents.

Using data from the National Health and Nutrition Examination Survey (NHANES), we aim to expand on the current health disparities research by focusing on a representative sample of adolescents in the United States. In this study we sought to examine the following: (1) sociodemographic correlates of AL among adolescent males and females; (2) varying age patterns of AL across racial/ethnic groups; (3) the effect of nativity status on AL; and (4) demographically significant groups of adolescents with a high risk of cumulative wear and tear later in life.

## **Methods**

### *Study Design and Analytic Sample*

The National Health and Nutrition Examination Survey (NHANES) is a bi-annual survey that monitors the health status of the U.S. civilian, non-institutionalized population. Details of the NHANES study design can be found elsewhere [15]. NHANES uses a complex, multistage, probability sampling design to collect information through interviews and physical examinations. All biomarker measures in NHANES were collected in fully equipped Medical Examination Centers (MEC) located within selected geographic regions [16, 17]. To ensure quality control, all procedures and protocols were developed by the National Center for Health Statistics (NCHS) [16].

As recommended by NCHS to increase statistical stability, this study utilized data from five NHANES cycles: 1999-2000, 2001-2002, 2003-2004, 2005-2006, and 2007-2008 [15]. The interview response rate across all five waves was 81%, with approximately 77% participating in the examination component [18]. The analytical sample included eight synthetic cohorts beginning with adolescents age 12 in the first cohort, ending with those age 19 in the eighth cohort. Each of the eight cohorts started in the first cycle ranged in age from 12-19 (1999-2000), and ended in the last cycle (2007-2008) with individuals ranging in age from 16-23. Only those age 12-19 starting in cycle 1999 who had valid data on all biomarkers used to create the allostatic load score, and completed the interview and examination elements were included in the sample cohorts (n=7,816).

## *Measures*

### *Dependent Variable*

Our dependent variable included the measures of AL, and was comprised of ten biomarkers. The biomarkers used for this study were selected for their high public health relevance, significant association with biological systemic functioning, and their availability in the data [15]. The 10 biomarkers used were: cardiovascular markers including diastolic and systolic blood pressure, and pulse rate; metabolic functioning markers including body mass index (BMI), waist-circumference, total cholesterol, high-density lipoprotein (HDL), and glycosylated hemoglobin (HbA1c); and inflammatory markers including serum albumin and C-reactive protein (CRP).

The operationalization of AL in this study is the group allostatic load index. The AL index uses empirical cut-points based on the sample distribution rather than clinical thresholds, because no clinical cut-points exist for a number of biomarkers, especially among younger age groups, and because distribution-based cut-points better capture sub-clinical dysregulation. For each of the ten indicators, empirical cut-points were determined by the 75<sup>th</sup> percentile value, identified as high risk, with the exception of HDL and albumin, whose high risk cut-points were defined as below the 25<sup>th</sup> percentile [14, 19]. Adolescents who exhibited high risk levels of biological markers received a score of one for that parameter. Therefore, a composite AL index was created by summing the number of parameters that fell into the high risk quartile. For a composite score with 10 biomarkers, the range of AL scores is 0-10, with values close to zero signifying few markers of systemic dysregulation.

### *Independent Variables*

Gender is coded as female. Race/ethnicity is coded into four categories, giving priority to Hispanic ethnicity: non-Hispanic White (reference category), non-Hispanic Black, Mexican American, and Other. The “Other” category included those who stated they were Hispanic but not Mexican, multiracial, Native American, and Asian. Adolescents who stated they were more than one race and then identified a main race as non-Hispanic white or non-Hispanic Black were coded as such. Nativity status was asked of respondents through the question, “In what country were you born?” coded as born in the 50 U.S. states or Washington, D.C.; born in Mexico; or born elsewhere. A dichotomous variable was then created of foreign born and U.S. born.

Age is defined by cohort, with those in the first cohort age 12 in the first cycle, 13 in the second cycle, and so on. Subsequent cohorts follow the same pattern, starting with age 13 in cohort two, age 14 in cohort three, and so on. Socioeconomic status (SES) was measured using two of the most commonly used variables, household family income and educational attainment of the household representative. Family income was ascertained by asking respondents the total combined income for all family members living in the household in the past 12 months. Eleven income categories separated by \$5,000 increments from \$0 to \$75,000 and over were provided. These groups were collapsed into five main categories: <\$20,000 (reference category), \$20,000-\$34,999, \$35,000-\$54,999, \$55,000-\$74,999, and  $\geq$ \$75,000. Educational attainment is based on the response of the household representative, as adolescent education level is not as useful a predictor of SES as parental education, and was categorized by NCHS as less than high school (reference category), high school graduate or GED, and more than high school. An interaction variable for race/ethnicity and age was also created.

Of the 7,816 adolescents included in the sample cohorts, there existed limited missing data for education, nativity status, and annual family income. Missing values (n=17) for nativity status numbered less than one percent, and were thus coded into the modal category of U.S. born. Results did not differ whether missing cases were coded to the modal category or dropped. Approximately 172 respondents (2.2% of the sample) reported a family income of >\$20,000, but no further information was provided to determine which income category they fell into. Thus they were coded as missing. An additional 208 respondents (2.7%) were missing family income data, along with 295 respondents (3.8%) missing household education information. One-hundred and two respondents (1.3%) were missing both education and income information. All individuals missing socioeconomic information (n=777) were excluded from the dataset to avoid data bias through imputation. The final sample size used for analysis was 7,039.

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