Supplemental table 1: Publications using allostatic load scores from National Health and Nutrition Examination Survey data

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Author, year** | **Study years** | **Population**  Age, gender, race | **Association between:** | **Title:** |
| Allsworth1, 2005 | 1988-1994 | Women (17-30) | AL and age at menarche | Early age at menarche and allostatic load: data from the Third National Health and Nutrition Examination Survey |
| Bandiera 2, 2011 | 2001-2004 | 8-15 | Covariate: secondhand smoke and mental health | Secondhand smoke exposure and mental health among children and adolescents |
| Bird 3,  2010 | 1988-1994 | 20+ | AL and neighborhood socioeconomic status | Neighbourhood socioeconomic status and biological 'wear and tear' in a nationally representative sample of US adults |
| Borrell 4, 2010 | 1988-1994 | 25+ | AL and racial/ethnic disparities in mortality | Racial/ethnic disparities in all-cause mortality in U.S. adults: the effect of allostatic load |
| Borrell 5, 2011 | 1999-2004 | 18-85 | AL and periodontitis disparities | Social disparities in periodontitis among US adults: the effect of allostatic load |
| Chen 6,  2014 | 2005-2008 | 18+ | AL and sleep disorders | Associations of allostatic load with sleep apnea, insomnia, short sleep duration, and other sleep disturbances: findings from the National Health and Nutrition Examination Survey 2005 to 2008 |
| Chyu 7, 2011 | 1999-2004 | Women (18+ ) | AL and age, race and ethnicity | Racial and ethnic patterns of allostatic load among adult women in the United States: findings from the National Health and Nutrition Examination Survey 1999-2004 |
| Crimmins 8, 2003 | 1988-1994 | 20+ | AL and age | Age differences in allostatic load: an index of physiological dysregulation |
| Crimmins 9, 2007 | 1999-2002 | 40+ | AL and race, ethnicity and nativity | Hispanic paradox in biological risk profiles |
| Crimmins 10, 2009 | 1988-1994, 1999-2004 | 20+ | AL and poverty status | Poverty and biological risk: the earlier "aging" of the poor |
| Duru 11, 2012 | 1988-1994 | 35-64, black or white | AL and racial disparities in mortality | Allostatic load burden and racial disparities in mortality |
| Evans 12, 2014 | 2003-2004 | Women (15-44) | AL as effect measure modifier of race/ethnicity and chemical exposure | Joint exposure to chemical and nonchemical neurodevelopmental stressors in U.S. women of reproductive age in NHANES |
| Geronimus 13, 2006 | 1999-2002 | 18-64 | AL and age, race, poverty | "Weathering" and age patterns of allostatic load scores among blacks and whites in the United States |
| Hollar 14, 2013 | 2001-2010 | 20+ | AL and disability | Cross-sectional changes in patterns of allostatic load among persons with varying disabilities, NHANES: 2001-2010 |
| Hux15,  2014 | 1999-2006 | Women (17-35) | AL and history of low birthweight infants | Allostatic load in women with a history of low birth weight infants: the National Health and Nutrition Examination Survey |
| Kaestner 16, 2009 | 1988-1994 | 30-60 | AL and health of Mexican immigrants | Stress, allostatic load and health of Mexican immigrants |
| Merkin 17, 2009 | 1988-1994 | 20 + | AL and race/ethnic neighborhood socioeconomic status | Neighborhoods and cumulative biological risk profiles by race/ethnicity in a national sample of U.S. adults: NHANES III |
| Morrison 18, 2013 | 1999-2006 | Women (15-44) | AL and pregnancy | Allostatic load may not be associated with chronic stress in pregnant women, NHANES 1999-2006 |
| Nelson 19, 2007 | 1999-2002 | 40+ | Covariate: race/ethnicity and peripheral arterial disease | Peripheral arterial disease in a multiethnic national sample: the role of conventional risk factors and allostatic load |
| Parente 20, 2013 | 1999-2008 | Women (35-85 ), black or white | History of breast cancer and AL | Association between breast cancer and allostatic load by race: National Health and Nutrition Examination Survey 1999-2008 |
| Rainisch 21, 2013 | 1999-2008 | 12-19 | AL and age, race, socioeconomic status | Sociodemographic correlates of allostatic load among a national sample of adolescents: findings from the National Health and Nutrition Examination Survey, 1999-2008 |
| Rosenberg 22, 2014 | 1988-1994 | 45-64 | AL and serum carotenoid | Relationship of serum carotenoid concentrations with allostatic load as a measure of chronic stress among middle-aged adults in the USA |
| Sabbah 23, 2008 | 1988-1994 | 17+ | AL as a mediator between socioeconomic position and adverse health conditions | Effects of allostatic load on the social gradient in ischaemic heart disease and periodontal disease: evidence from the Third National Health and Nutrition Examination Survey |
| Seeman 24, 2008 | 1988-1994 | 20+ | AL and socioeconomic, ethnic differences | Education, income and ethnic differences in cumulative biological risk profiles in a national sample of US adults: NHANES III (1988-1994) |
| Slade 25,  2012 | 1999-2004 | 18+ | AL as a mediator between socioeconomic status and pain | Role of allostatic load in sociodemographic patterns of pain prevalence in the U.S. population |
| Theall 26, 2012 | 1999-2006 | 12-20 | Neighborhood psychosocial stress and AL | Cumulative neighborhood risk of psychosocial stress and allostatic load in adolescents |
| Yang 27,  2011 | 1988-1994, 1999-2006 | 17+ | AL and sex, age trajectories | Sex differences in age trajectories of physiological dysregulation: inflammation, metabolic syndrome, and allostatic load |
| Zheng28,  2014 | 1999-2004 | 60+ | Visual acuity and AL on mortality | Visual acuity and increased mortality: the role of allostatic load and functional status |
| Zota 29,  2013 | 1999-2008 | 40-65 | AL as mediator on lead levels and blood pressure | Allostatic load amplifies the effect of blood lead levels on elevated blood pressure among middle-aged U.S. adults: a cross-sectional study |

1. Allsworth JE, Weitzen S, Boardman LA. Early age at menarche and allostatic load: data from the Third National Health and Nutrition Examination Survey. *Annals of Epidemiology* 2005;**15**(6):438-444.

2. Bandiera FC, Richardson AK, Lee DJ, He JP, Merikangas KR. Secondhand smoke exposure and mental health among children and adolescents. *Archives of Pediatrics & Adolescent Medicine* 2011;**165**(4):332-338.

3. Bird CE, Seeman T, Escarce JJ, Basurto-Davila R, Finch BK, Dubowitz T, Heron M, Hale L, Merkin SS, Weden M, Lurie N. Neighbourhood socioeconomic status and biological 'wear and tear' in a nationally representative sample of US adults. *Journal of Epidemiology and Community Health* 2010;**64**(10):860-865.

4. Borrell LN, Dallo FJ, Nguyen N. Racial/ethnic disparities in all-cause mortality in U.S. adults: the effect of allostatic load. *Public Health Reports* 2010;**125**(6):810-816.

5. Borrell LN, Crawford ND. Social disparities in periodontitis among US adults: the effect of allostatic load. *Journal of Epidemiology and Community Health* 2011;**65**(2):144-149.

6. Chen X, Redline S, Shields AE, Williams DR, Williams MA. Associations of allostatic load with sleep apnea, insomnia, short sleep duration, and other sleep disturbances: findings from the National Health and Nutrition Examination Survey 2005 to 2008. *Annals of Epidemiology* 2014;**24**(8):612-619.

7. Chyu L, Upchurch DM. Racial and ethnic patterns of allostatic load among adult women in the United States: findings from the National Health and Nutrition Examination Survey 1999-2004. *Journal of Women's Health* 2011;**20**(4):575-583.

8. Crimmins EM, Johnston M, Hayward M, Seeman T. Age differences in allostatic load: an index of physiological dysregulation. *Experimental Gerontology* 2003;**38**(7):731-734.

9. Crimmins EM, Kim JK, Alley DE, Karlamangla A, Seeman T. Hispanic paradox in biological risk profiles. *American Journal of Public Health* 2007;**97**(7):1305-1310.

10. Crimmins EM, Kim JK, Seeman TE. Poverty and biological risk: the earlier "aging" of the poor. *The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences* 2009;**64**(2):286-292.

11. Duru OK, Harawa NT, Kermah D, Norris KC. Allostatic load burden and racial disparities in mortality. *Journal of the National Medical Association* 2012;**104**(1-2):89-95.

12. Evans AM, Rice GE, Teuschler LK, Wright JM. Joint exposure to chemical and nonchemical neurodevelopmental stressors in U.S. women of reproductive age in NHANES. *International Journal of Environmental Research and Public Health* 2014;**11**(4):4384-4401.

13. Geronimus AT, Hicken M, Keene D, Bound J. "Weathering" and age patterns of allostatic load scores among blacks and whites in the United States. *American Journal of Public Health* 2006;**96**(5):826-833.

14. Hollar D. Cross-sectional changes in patterns of allostatic load among persons with varying disabilities, NHANES: 2001-2010. *Disability and Health Journal* 2013;**6**(3):177-187.

15. Hux VJ, Catov JM, Roberts JM. Allostatic load in women with a history of low birth weight infants: the national health and nutrition examination survey. *Journal of Women's Health* 2014;**23**(12):1039-1045.

16. Kaestner R, Pearson JA, Keene D, Geronimus AT. Stress, Allostatic Load and Health of Mexican Immigrants. *Social Science Quarterly* 2009;**90**(5):1089-1111.

17. Merkin SS, Basurto-Davila R, Karlamangla A, Bird CE, Lurie N, Escarce J, Seeman T. Neighborhoods and cumulative biological risk profiles by race/ethnicity in a national sample of U.S. adults: NHANES III. *Annals of Epidemiology* 2009;**19**(3):194-201.

18. Morrison S, Shenassa ED, Mendola P, Wu T, Schoendorf K. Allostatic load may not be associated with chronic stress in pregnant women, NHANES 1999-2006. *Annals of Epidemiology* 2013;**23**(5):294-297.

19. Nelson KM, Reiber G, Kohler T, Boyko EJ. Peripheral arterial disease in a multiethnic national sample: the role of conventional risk factors and allostatic load. *Ethnicity & Disease* 2007;**17**(4):669-675.

20. Parente V, Hale L, Palermo T. Association between breast cancer and allostatic load by race: National Health and Nutrition Examination Survey 1999-2008. *Psychooncology* 2013;**22**(3):621-628.

21. Rainisch BK, Upchurch DM. Sociodemographic correlates of allostatic load among a national sample of adolescents: findings from the National Health and Nutrition Examination Survey, 1999-2008. *The Journal of Adolescent Health : official publication of the Society for Adolescent Medicine* 2013;**53**(4):506-511.

22. Rosenberg N, Park CG, Eldeirawi K. Relationship of serum carotenoid concentrations with allostatic load as a measure of chronic stress among middle-aged adults in the USA. *Public Health Nutrition* 2014:1-9.

23. Sabbah W, Watt RG, Sheiham A, Tsakos G. Effects of allostatic load on the social gradient in ischaemic heart disease and periodontal disease: evidence from the Third National Health and Nutrition Examination Survey. *J Epidemiol Community Health* 2008;**62**(5):415-20.

24. Seeman T, Merkin SS, Crimmins E, Koretz B, Charette S, Karlamangla A. Education, income and ethnic differences in cumulative biological risk profiles in a national sample of US adults: NHANES III (1988-1994). *Social Science & Medicine* 2008;**66**(1):72-87.

25. Slade GD, Sanders AE, By K. Role of allostatic load in sociodemographic patterns of pain prevalence in the U.S. population. *The Journal of Pain : official journal of the American Pain Society* 2012;**13**(7):666-675.

26. Theall KP, Drury SS, Shirtcliff EA. Cumulative neighborhood risk of psychosocial stress and allostatic load in adolescents. *American Journal of Epidemiology* 2012;**176 Suppl 7**:S164-S174.

27. Yang Y, Kozloski M. Sex differences in age trajectories of physiological dysregulation: inflammation, metabolic syndrome, and allostatic load. *The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences* 2011;**66**(5):493-500.

28. Zheng DD, Christ SL, Lam BL, Tannenbaum SL, Bokman CL, Arheart KL, McClure LA, Fernandez CA, Lee DJ. Visual acuity and increased mortality: the role of allostatic load and functional status. *Investigative Ophthalmology & Visual Science* 2014;**55**(8):5144-5150.

29. Zota AR, Shenassa ED, Morello-Frosch R. Allostatic load amplifies the effect of blood lead levels on elevated blood pressure among middle-aged U.S. adults: a cross-sectional study. *Environmental Health* 2013;**12**(1):64.

Supplemental table 2: Component biomarkers for each allostatic load score

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | | | | | |
|  | Scoring method 1 | Scoring method 2 | Scoring method 3 | Scoring method 4 | Scoring method 5 | Scoring method 6 |
| Allostatic load biomarker | Geronimus, 2006  Slade, 2012  Borrell, 2011 | Crimmins, 2009 | Chyu,  2011 | Parente,  2013 | Morrison, 2013 | Hux,  2014 |
| High risk group determined: | Quartile  cut-points | Clinical cut-points | Quartile cut-points | Clinical cut-points | Quartile cut-points | Quartile cut-points |
| Total number: | 10 | 9 | 10 | 9 | 10 | 9 |
| Inflammatory markers |  |  |  |  |  |  |
| C-reactive protein (mg/dL) | > 0.48 | > 0.3 | > 0.48 | > 0.3 | > 0.48 | > 0.48 |
| Serum albumin (g/dL) | ≤ 4.1 | < 3.8 | ≤ 4.1 | < 4.0 | ≤ 4.1 | ≤ 4.1 |
| Metabolic factors |  |  |  |  |  |  |
| Body mass index (kg/m2) | > 31.1 | ≥ 30 | > 31.1 | ≥ 30 |  | > 31.1 |
| Glycohemoglobin: (%) | > 5.3 | ≥ 6.4 | > 5.3 | ≥ 6.4 | > 5.3 | > 5.3 |
| Cardiovascular markers |  |  |  |  |  |  |
| Systolic blood pressure (mm Hg) a | > 117 | ≥ 140 | > 117 | ≥ 140 | > 117 | > 117 |
| Diastolic blood pressure (mm Hg) a | > 76 | ≥ 90 | > 76 | ≥ 90 | > 76 | > 76 |
| High-density lipoprotein (mg/dL) a |  | < 40 | ≤ 43 | < 50 | ≤ 43 | ≤ 43 |
| Total cholesterol (mg/dL) a | > 210 | ≥ 240 | > 210 | ≥ 240 | > 210 | > 210 |
| Triglyceride (mg/dL)ab | > 139 |  |  |  |  |  |
| Homocysteine (µmol/L) ac | > 7.8 |  | > 7.8 |  | > 7.8 |  |
| Pulse (beats/min) a |  | ≥ 90 | > 81 | ≥ 90 | > 81 |  |
| Other marker |  |  |  |  |  |  |
| Serum creatinine (mg/dL) |  |  |  |  | >0.80 |  |
| Urine creatinine (mg/dL) a | < 63 |  |  |  |  |  |
| Creatinine clearance (mL/min) a |  |  |  |  |  | ≤ 98.6 |

Supplemental table 3: Characteristics of non-pregnant reproductive aged women (20–44 years old) examined without and with telomere data NHANES, 1999-2002a

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Without telomere data | | With telomere data | |
|  | n | % (95% CI) | n | % (95% CI) |
| All | 341 |  | 1503 |  |
| Age |  |  |  |  |
| 20-24 | 86 | 21.4 (26.2, 17.1) | 286 | 18.3 (20.8, 16.0) |
| 25-29 | 67 | 18.3 (24.6, 13.1) | 260 | 15.8 (18.4, 13.4) |
| 30-34 | 53 | 16.7 (22.6, 11.8) | 290 | 20.5 (23.6, 17.6) |
| 35-39 | 60 | 19.7 (25.4, 14.8) | 323 | 22.8 (26.8, 19.2) |
| 40-44 | 75 | 23.9 (28.9, 19.4) | 344 | 22.6 (25.9, 19.6) |
| Hispanic origin and race |  |  |  |  |
| Mexican American | 88 | 9.1 (12.6, 6.2) | 416 | 8.9 (11.4, 6.7) |
| Non-Hispanic white | 113 | 56.0 (62.6, 49.3) | 643 | 66.9 (71.4, 62.1) |
| Non-Hispanic black | 105 | 20.6 (26.8, 15.2) | 308 | 11.8 (15.2, 8.9) |
| Other b | 35 | 14.4 (21.9, 8.7) | 136 | 12.5 (17.7, 8.4) |
| Marital status |  |  |  |  |
| Married | 150 | 46.9 (55.4, 38.6) | 728 | 52.2 (55.9, 48.5) |
| Living with partner | 23 | 7.8 (12.9, 4.3) | 125 | 8.3 (10.8, 6.1) |
| Separated, divorced or widowed | 38 | 11.7 (17.6, 7.2) | 212 | 14.6 (17.4, 12.1) |
| Never married | 111 | 33.6 (41.2, 26.7) | 379 | 25.0 (28.5, 21.6) |
| Smokingc |  |  |  |  |
| Current | 75 | 27.2 (33.5, 21.5) | 369 | 27.3 (30.9, 24.0) |
| Former | 36 | 14.0 (20.2, 9.2) | 182 | 14.1 (17.2, 11.4) |
| Never | 214 | 58.8 (66.6, 50.6) | 950 | 58.6 (63.0, 54.1) |
| Education |  |  |  |  |
| No high school diploma or GED | 96 | 20.7 (26.3, 15.8) | 405 | 17.0 (19.2, 14.9) |
| High school diploma or GED | 79 | 24.2 (31.7, 17.7) | 352 | 25.3 (29.0, 21.9) |
| Some college, no bachelor’s degree | 85 | 28.9 (35.4, 22.9) | 469 | 33.8 (37.3, 30.5) |
| Bachelor’s degree or higher | 65 | 26.3 (34.2, 19.4) | 275 | 23.9 (28.8, 19.5) |
| Percentage of poverty level |  |  |  |  |
| Less than 100% | 67 | 18.8 (25.1, 13.4) | 329 | 19.9 (23.1, 17.0) |
| 100%—199% | 88 | 29.7 (37.8, 22.5) | 340 | 21.4 (24.7, 18.3) |
| 200%—399% | 74 | 27.8 (35.1, 21.3) | 397 | 29.8 (32.8, 26.9) |
| 400% or more | 55 | 23.7 (33.7, 15.4) | 324 | 28.9 (32.9, 25.2) |

NHANES, National Health and Nutrition Examination Survey; CI, confidence interval; GED, general educational development

aExcludes 552 women aged 20-44 years who were known to be pregnant at exam (108 without telomere data and 444 with telomere data). Includes 140 women aged 20-44 years with unknown pregnancy status (63 without telomere data and 77 with telomere data).

b Includes Hispanic or Latina women other than Mexican American and non-Hispanic women of races other than black or white, including multiracial women.

cCurrent smoking includes any reported cigarette smoking at the time of interview. Former smoking includes no current cigarette smoking, but reported smoking at least 100 cigarettes over her lifetime.

Supplemental figure 1: Percent difference in mean telomere length per 1 unit increase in allostatic load score not adjusted for age among non-pregnant reproductive aged women (20–44 years old) in NHANES, 1999-2002



Allostatic load scores were constructed using biomarkers and cut-point methods previously implemented. See text, supplemental table and reference list for details. *P*-value for slopes from Wald test using linear regression model not adjusted for age. Of the 1503 observations with telomere data, the following biomarkers and number of observations were used for allostatic load score construction for each method: scoring method 1—SBP, DBP, BMI, A1C, ALB, CRU, TRI, CRP, HOM, TC (n=627); scoring method 2—SBP, DBP, BMI, A1C, ALB, CRP, TC, HDL, PLS (n=1417); scoring method 3—SBP, DBP, BMI, A1C, ALB, CRP, HOM, TC, HDL, PLS (n=1416); scoring method 4—SBP, DBP, BMI, A1C, ALB, CRP, TC, HDL, PLS (n=1417); scoring method 5—SBP, DBP, A1C, ALB, CRS, CRP, HOM, TC, HDL, PLS (n=1428); and scoring method 6—SBP, DBP, BMI, A1C, ALB, CRC, CRP, TC, HDL (n=1422). Abbreviations: SBP, systolic blood pressure; DBP, diastolic blood pressure; BMI, body mass index; A1C, glycosylated hemoglobin; ALB, serum albumin; TRI, triglycerides; CRP, c-reactive protein; HOM, homocysteine; TC, total cholesterol; HDL, high-density lipoprotein cholesterol; PLS, pulse; CRU, urine creatinine; CRS, serum creatinine; CRC, creatinine clearance.

Supplemental figure 2: Percent difference in mean telomere length per 1 unit increase in allostatic load score based on imputed values and adjusted for age among non-pregnant reproductive aged women (20–44 years old) in NHANES, 1999-2002



Allostatic load scores were constructed using biomarkers and cut-point methods previously implemented. See text, supplemental table and reference list for details. *P*-value for slopes from Wald test using linear regression model adjusted for age. Of the 1503 observations with telomere data, the following biomarkers (including imputed values) and number of observations were used for allostatic load score construction for each method: scoring method 1—SBP, DBP, BMI, A1C, ALB, CRU, TRI, CRP, HOM, TC (n=656); scoring method 2—SBP, DBP, BMI, A1C, ALB, CRP, TC, HDL, PLS (n=1503); scoring method 3—SBP, DBP, BMI, A1C, ALB, CRP, HOM, TC, HDL, PLS (n=1503); scoring method 4—SBP, DBP, BMI, A1C, ALB, CRP, TC, HDL, PLS (n=1503); scoring method 5—SBP, DBP, A1C, ALB, CRS, CRP, HOM, TC, HDL, PLS (n=1503); and scoring method 6—SBP, DBP, BMI, A1C, ALB, CRC, CRP, TC, HDL (n=1503). Abbreviations: SBP, systolic blood pressure; DBP, diastolic blood pressure; BMI, body mass index; A1C, glycosylated hemoglobin; ALB, serum albumin; TRI, triglycerides; CRP, c-reactive protein; HOM, homocysteine; TC, total cholesterol; HDL, high-density lipoprotein cholesterol; PLS, pulse; CRU, urine creatinine; CRS, serum creatinine; CRC, creatinine clearance.