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Chronic Stress and Unhealthy Dietary Behaviors among Low-Income African-American Female Caregivers

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ABSTRACT

Background: Chronic stress increases the risk of excess intake of calorie-dense foods. Low-income minority caregivers in the United States are cumulatively exposed to stressors and unhealthy foods, but evidence of this association is limited in this population group. The objective of the current study was to assess the association between chronic stress and unhealthy dietary behaviors among low-income African-American caregivers in Detroit, Michigan.

Methods: Data came from Detroit Dental Health Project, a longitudinal study of pairs of African-American caregivers and children during 2002–2007. A sample of 912 female caregivers were included and their baseline (2002–2003) survey responses were analyzed to identify those with chronic stress and patterns of dietary behaviors. The likelihood of having unhealthy dietary behaviors was compared between chronically stressed caregivers and others, and the mediator role of depressive symptoms or current smoking was tested.

Results: Approximately 10% of caregivers experienced chronic stress as they all reported discrimination, residential movement, and lack of social support. Twenty-five percent of the caregivers were found to have an unhealthy dietary pattern characterized by excess intake of high fatty foods and soda. Chronically stressed caregivers were more likely to exhibit unhealthy dietary behaviors (prevalence ratio: 1.39; 95% CI: 1.05, 1.84), and this relation was significantly mediated by depressive symptoms, not current smoking.

Conclusions: These findings suggest that chronic stress played a role in negatively influencing dietary behaviors. As this association might be mediated by depressive symptoms, an intervention to reduce depressive symptoms can be considered as an effective strategy to promote healthy dietary behaviors among chronically stressed minority caregivers. *Curr Dev Nutr* 2020;4:nzaa029.

Keywords: stress, African American, diets, depression, caregivers

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Introduction

Repeated exposure to stressful events has been associated with a high intake of calorie-dense foods (1). Similar to drug dependence, individuals with experiences of a series of stressful events can develop a dependence on calorie-dense foods (1). This causal pathway is supported by the national study in the United States, which found that individuals with high psychosocial stress were more likely to report drinking soda and eating fatty foods (2). The increased risk of developing such unhealthy dietary behaviors is a serious public health concern because it could increase the risk of obesity, diabetes, and cardiovascular disease (3, 4).

Chronic stress is attributed to both individual- and neighborhood-level factors (5). At the individual level, experiences of ongoing stressful life events (e.g., caregiving, relationship stress, financial stress) and perceived discrimination due to minority status have been identified as chronic stressors (6). At the neighborhood level, living in deprived neighborhoods (i.e., neighborhood poverty) has been independently linked to high allostatic load, which is a biomarker of chronic stress (7).

Multiple studies report that African Americans are more likely to perceive racial discrimination in their daily activities and interactions, which is linked to chronic stress. Especially among African-American women from low-income, urban areas, chronic stress has been associated with increased risk of depressive symptoms, reflecting additional financial and psychological burdens from parenting challenges on top of chronic stress from discrimination (8, 9). Chronic stress has been also associated with unhealthy dietary behaviors (e.g., emotional eating, uncontrolled eating) (1, 2), particularly among low-income minority women with young children (10). Due to cumulative exposure to chronic stressors such as perceived racial discrimination and limited access to healthy foods, the relation between chronic stress and unhealthy diets may be more pronounced among low-income minority caregivers

from urban neighborhoods (11), but existing evidence is quite limited because of the small sample size. The current study, using data from a population-representative sample of low-income African-American female caregivers in Detroit, Michigan, aimed to test the association between chronic stress and an unhealthy dietary pattern. In addition, to better understand the mechanism of this association, the study tested a mediator role of depressive symptoms or current smoking, which have been strongly associated with chronic stress (12, 13).

Methods

Study population

Data came from the Detroit Dental Health Project, a longitudinal study conducted by the Detroit Center for Research in Oral Health Disparities. A multistage area probability sample design was used to create a sample representative of low-income African-American families living in Detroit, Michigan. Specifically, we constructed a stratified 2-stage area probability sample of households from the 39 census tracts with the highest percentage of residents living <200% of the poverty level in Detroit, Michigan, according to the 2000 US Census. There were 118 blocks within these tracts systematically selected with probability of selection proportionate to size. After the blocks were selected, other adjacent or nearby blocks were added to form segments of equal sizes, each with ~100 housing units. Housing and non–housing units were identified within each of the segments, and a random sample of households was selected. Each selected household was visited and screened for eligibility. We considered a household with ≥1 caregiver and 1 child ages 0–5 y to be eligible for the study. We identified and reached out to 1386 eligible families, and 1021 child–caregiver pairs participated in the baseline study (2002–2003). These baseline participants were followed over 4 y in 2 subsequent surveys and dental examinations (2004–2005 and 2007). While dental examination data were collected by dentists, sociodemographic characteristics, oral health status and beliefs, general health status and beliefs, access to care, food intake, and psychosocial and environmental factors were collected by trained interviewers (14). The study used the baseline data because food intake information for caregivers was only collected at baseline. Fifty-seven participants were excluded because their reported food intakes appeared to be improbably low or high. Fifty-two male caregivers were further excluded because they were different from female caregivers in many characteristics (15). This resulted in a total sample of 912 female caregivers.

The study protocol was approved by the Institutional Review Board for Health Sciences at the University of Michigan (H03-00001546-R1) and caregivers of all participants signed approved consent forms.

Measures

In this study, chronic stress was defined as an experience of minority stress and common stressful life events, which are 2 areas of construct of stress (16). Specifically, minority stress was measured by using the everyday discrimination scale (17, 18). A response option of each discrimination question was dichotomized into 0 = perceived discrimination that occurs less frequently than a few times a month or more and 1 = perceived discrimination a few times per month or more, and aggregated scores were then categorized into 3 categories (never, <5 areas, ≥5 areas). To capture common stressful life events, we used 2 variables: *1*) lack of social support, which was defined by responding "No" to ≥1 of 5 questions (help with errands, help with financial needs, help with childcare needs, help with transportation needs, availability for emotional support), and *2*) residential movement in the past 5 y. Having all 3 experiences (perceived discrimination, lack of social support, residential movement) constituted chronic stress. Dietary information was collected by trained interviewers from the community using the Block 98.2® food-frequency questionnaire (FFQ), developed by Block Dietary Data Systems, Berkeley, California, and validated in previous studies (19, 20). Interviewers were trained over a period of 1 mo, and the quality of the data collected was regularly reviewed during the 11-mo data collection period. Dietary intake interviews were videotaped, providing an objective review of the interviewing technique. Investigators also conducted periodic face-to-face meetings with the interviewers. This FFQ captured the frequency of consumption of a wide variety of food items as well as the number of servings and portion sizes during the last year, which were then converted into daily intakes of each food item in grams and total dietary intakes in kilocalories using Block's algorithm based on data from several USDA National Food Consumption Surveys. In addition to data about chronic stress and diet, caregivers' demographic (household income, educational attainment, number of children), clinical (self-rated health, diabetes, sexually transmitted diseases), and behavioral (current smoking, depressive symptoms) characteristics were collected via self-reported responses to survey questions. In particular, depressive symptoms were measured using the 20-item Center for Epidemiologic Studies–Depression Scale (CES-D) (21). CES-D scores of ≥16 were considered as presence of depressive symptoms (22).

Statistical analysis

We first combined 109 individual food items from the FFQ into 36 food categories based on similarities in nutrient contents using the American Diabetes Association Meal Planning Exchange Lists (23). These categories were further reduced to 13 food groups using the VARCLUS procedure in SAS software and 4 liquid groups (**Table 1**). We then performed cluster analysis to identify distinct dietary patterns using Ward's agglomerative approach (24). We determined the optimal cluster solution based on the pseudo *t* statistics.

Demographic, behavioral, and clinical characteristics of caregivers were then described and tested by chronic stress using chi-square tests or independent *t* tests. We also computed mean daily consumption of 13 food groups and 4 liquid groups by dietary patterns that were identified by cluster analysis. With independent *t* tests and Bonferroni correction for multiple comparison, we tested if the consumption of particular food or liquid groups was higher or lower in a particular cluster to characterize dietary patterns and identify an unhealthy dietary behavior. We conducted multivariable regression analysis to test whether chronic stress was associated with an unhealthy dietary behavior. To account for potential confounding, we included underlying characteristics that were significantly different between chronically stressed caregivers and others as covariates. A log-linear Poisson regression model was used to address bias due to common outcomes (25). In addition, a causal mediation analysis was performed to assess whether the association between chronic stress and an unhealthy food intake pattern was mediated by depressive symptoms or current smoking. This algorithm, which was implemented in the R mediation package (R Foundation), allowed us

TABLE 1 Weighted mean consumption of foods in grams by 3 dietary patterns among African-American female caregivers, Detroit, Michigan: 2002–2003[1]

	Total (n = 912)	Cluster 1 (n = 367)	Cluster 2 (n = 317)	Cluster 3 (n = 228)
Food groups				
Group 1. Low-fat meat, mixed cheese dishes, cheese	186.5 (5.0)	175.0 (8.3)	186.5 (9.0)	204.8 (13.7)
Group 2. FruitvitC, other fruit, Ojcalcium	211.2 (8.8)	156.2 (7.7)	285.5* (24.2)	200.2 (16.1)
Group 3. Bran, cereals, reduced-fat (skim) milk	131.2 (7.0)	105.7 (5.9)	194.0* (24.5)	88.0 (7.0)
Group 4. Other carbohydrates, caffeine, saturated fats	152.4 (10.8)	116.9 (11.8)	182.6 (17.3)	169.1 (21.6)
Group 5. Starchy low-fat, veggies, lower-fat milk	112.9 (5.1)	87.0 (3.8)	155.6* (9.5)	97.3 (6.2)
Group 6. Lower carbohydrates, fruit juice	306.1 (11.9)	153.9 (8.6)	477.5* (26.7)	321.2 (27.8)
Group 7. Starch and fat; medium fat meat, high-fat meat	355.2 (7.1)	324.6 (11.4)	349.3 (11.2)	412.3* (16.0)
Group 8. Fat and carbohydrate, chocolate	108.7 (4.3)	92.9 (7.5)	117.3 (10.7)	122.6 (10.1)
Group 9. Bread, pasta, monounsaturated fats	168.8 (3.7)	151.0 (6.1)	181.4 (9.8)	180.5 (9.4)
Group 10. Lowest-fat meat	24.1 (1.5)	20.1 (1.5)	34.5* (2.4)	16.8 (1.6)
Group 11. Starchy vegetables, beans, mixed dishes	142.1 (5.0)	135.0 (7.8)	165.9* (7.4)	121.8 (9.2)
Group 12. Whole milk	143.4 (11.4)	90.3* (6.6)	181.3 (17.0)	177.8 (18.3)
Group 13. Condiments	22.0 (0.7)	18.6 (1.1)	24.0 (2.1)	24.9 (1.8)
Beverages (water)	586.1 (13.0)	415.2 (17.5)	882.7* (21.2)	463.5 (30.2)
Alcohol	60.6 (3.5)	44.8 (5.7)	85.6 (14.3)	52.4 (9.8)
Drinks with vitamin C [such as Sunny Delight (Sunny Delight Beverages Co.), HiC (The Coca-Cola Co.)]	317.4 (16.2)	205.8* (9.6)	373.6 (26.0)	421.1 (31.8)
Soda	362.2 (19.7)	163.6 (9.1)	130.4 (13.4)	990.4* (31.5)
Total calorie intakes	3473.9 (52.4)	2895.0 (91.9)	3662.1 (92.7)	4150.6 (153.2)

[1]Values are means (SEs). *Different from those of the other clusters (P < .05 with Bonferroni correction). FruitvitC, fruits high in vitamin C (including oranges/tangerines, watermelon, strawberries, cantaloupe, grapefruit); Ojcalcium, orange juice with calcium.

to understand a specific causal mechanism by quantifying a proportion of association between exposure and outcome (total effect) explained by a pathway through a mediator (indirect effect) or not (direct effect) (26). All potential confounding between exposure and outcome as well as between exposure and mediator was accounted for, and 95% CIs of these estimates were calculated via quasi-Bayesian Monte Carlo approximation.

Statistical analyses were conducted using SAS version 9.1.3 software (variable reduction, cluster analysis; SAS Institute) and R software (cluster analysis, survey analysis, mediation analysis). Complex sample design and survey weights were accounted for. Statistical significance was set at 2-sided P values <0.05.

Results

Participating female caregivers were 28 y old (SE = 0.3), on average, and raising 2 children (SE = 0.03), on average, at the time of the survey (**Table 2**). Approximately 92% of the caregivers were biological mothers, followed by grandmothers (5%) and someone else (3%). Approximately half of the caregivers had a household income <$10,000 and did not have high school degrees. A majority reported to move at least once in the past 5 y, and 35% had a lack of social support. Sixty-six percent of the caregivers reported that they experienced discrimination a few times per month or more. Approximately 80% of the caregivers rated their health as good or higher, but many reported chronic health conditions (e.g., prevalence of depressive symptoms: 33%; prevalence of obesity: 47%) and a current smoking behavior (41%).

Ten percent of the caregivers met a definition of chronic stress. These caregivers reported lack of social support, frequent discrimination in >5 areas, and moving in the past 5 y. Compared with those without chronic stress, they were more likely to attain a lower education and to have more frequently moved in the past 5 y (4 vs. 2 times), whereas there was no difference in average age, household income, average number of children, and self-reported health conditions between the 2 groups. Chronic stress was strongly associated with current smoking (57% vs. 39%) and depressive symptoms (70% vs. 29%).

The cluster analysis identified 3 groups of caregivers who shared unique dietary patterns (Table 1). The tree plot shows 3 visible separations of the caregivers based on diets, which were determined to be optimal according to the pseudo t statistics (**Supplemental Figure 1**). According to the independent t tests, the first group (cluster 1: n = 367, 40%) was characterized as caregivers with a lower intake of fruits, vegetables, and whole milk compared with the other groups. The second group (cluster 2: n = 317, 35%) exhibited a more diverse dietary pattern than the other groups, including a higher intake of fruits, vegetables, grain products, reduced-fat milk, and low-fat meat, and a lower intake of soda. The last group (cluster 3: n = 228, 25%) was characterized as those with an excess intake of starch/fat food items and soda. However, there was no statistically significant difference in total dietary calorie intake across 3 dietary patterns.

Approximately 15% of the caregivers with chronic stress had a dietary pattern of excess fat and soda intake, whereas 7% of those without chronic stress exhibited this unhealthy dietary pattern. The average consumption of starch/fat food items was 435 g (SE = 56) and 354 g (SE = 19) among chronically stressed caregivers and others, respectively. After accounting for demographic characteristics and total dietary calorie intakes, chronic stress was associated with a dietary pattern of excess fat and soda intake (**Table 3**). Chronically stressed caregivers were 1.39 times more likely to exhibit this unhealthy dietary behavior (95% CI: 1.05, 1.84) than the others. We found a significant indirect effect (i.e., mediation effect) by depressive symptoms using the

TABLE 2 Selected characteristics of African-American female caregivers, Detroit, Michigan: 2002–2003[1]

		Chronic stress	
	Total (n = 912)	Yes (n = 88)	No (n = 824)
Age, y	28.7 (0.3)	28.7 (0.8)	28.7 (0.3)
Household size	4.1 (0.1)	4.2 (0.2)	4.1 (0.1)
Number of children	1.8 (0.03)	1.7 (0.1)	1.8 (0.03)
Relationship with child, %			
Biological mother	92	96	92
Grandmother	5	3	5
Someone else	2	1	3
Income, %			
Less than $10,000	45	53	44
$10,000~$19,999	27	29	27
More than $20,000	28	18	29
Education, %			
Less than high school	47	61*	45*
High school diploma	32	31*	32*
Some college or more	21	8*	23*
Has moved in the past 5 y, %	73	100*	75*
Frequencies of moving in the past 5 y	2.2 (0.2)	4.2 (1.1)*	2.0 (0.2)*
Lack of social support, %	35	100*	28*
Frequent discrimination, %			
Never	34	0*	38*
<5 areas	45	0*	50*
≥5 areas	21	100*	13*
Self-rated health, %			
Very poor–poor–fair	21	28	20
Good	30	33	30
Very good	27	22	27
Excellent	22	17	22
Current smoking, %	41	57*	39*
Depressive symptoms (CES-D ≥16), %	33	70*	29*
Ever diagnosed with diabetes, %	4	5	4
Ever diagnosed with asthma, %	17	25	16
Ever diagnosed with STD, %	8	12	8
Obesity (BMI ≥30 kg/m^2), %	47	44	48

[1]*Significant at $P < 0.05$. Figures in parentheses are mean (SE). CES-D, Center for Epidemiologic Studies Depression Scale; STD, sexually transmitted disease.

causal mediation method, but there was a nonsignificant direct effect (**Table 4**). This indicates that chronically stressed caregivers were more likely to be depressed (prevalence ratio: 2.21; 95% CI: 1.66, 2.94), which could lead to developing a dietary pattern of excess fat/soda intake. If there were no differences in depressive symptoms between chronically stressed caregivers and others, chronic stress would have not been associated with an unhealthy behavior. This indirect pathway through depressive symptoms explained ~41% of the relation between chronic stress and an excess fat/soda intake pattern. However, there was no significant mediation effect by current smoking. The association between current smoking and chronic stress was not statistically significant (prevalence ratio: 1.27; 95% CI: 0.94, 1.71), and the indirect effect via current smoking was very small and not statistically significant (−0.001; 95% CI: −0.02, 0.01).

Discussion

In this study, we examined the relation between chronic stress and an unhealthy dietary pattern among 912 low-income African-American female caregivers from Detroit, Michigan, who were mostly biological mothers (92%) and raising children ages 0–5 y. Using both individual-level and neighborhood-level stressors (perceived daily discrimination, lack of social support, and residential movement), we found that 10% of these caregivers experienced chronic stress. In addition, 25% of the caregivers reported an unhealthy dietary pattern characterized by an excess intake of high fatty foods and soda. This behavior was significantly associated with chronic stress where depressive symptoms played a significant mediator role.

A positive relation between stress and unhealthy diet in this study is consistent with that reported by previous studies (1, 2). By replicating the previous results using data from a homogeneous group of low-income African-American caregivers, we believe that our study contributes to strengthening and expanding the existing evidence on the chronic stress and unhealthy diets relation. The current sample design that only selected those living in deprived urban neighborhoods controlled for a neighborhood-level influence on both stress and diets (5, 27). Given challenges with measuring this potential neighborhood-level influence, this helped reduce confounding bias, and hence improved the validity of the extent to which chronic stress was associated with unhealthy dietary behaviors at the individual level.

TABLE 3 Weighted prevalence ratio for excess fat/soda intake pattern by chronic stress from the multivariable regression analysis among African-American female caregivers, Detroit, Michigan: 2002–2003[1]

	Prevalence ratio (95% CI)
Chronic stress: yes vs. no	1.39 (1.05, 1.84)
Age	0.99 (0.98, 1.00)
Household size	1.00 (0.93, 1.08)
Income	
Less than $10,000	Reference
$10,000~$19,999	0.85 (0.67, 1.08)
More than $20,000	0.63 (0.38, 1.06)
Education	
Less than high school	Reference
High school diploma	0.79 (0.59, 1.06)
Some college or more	0.80 (0.54, 1.19)
Dietary calorie intake	1.00 (1.00, 1.00)

[1]A categorical variable with a prevalence ratio >1 means that the category is associated with higher likelihood of having an unhealthy dietary behavior versus a reference category.

In addition, the current study provided evidence on a possible mechanism linking stress and unhealthy dietary behaviors through depressive symptoms. According to the mediation analysis, chronically stressed caregivers were more likely to feel depressed, which could, in turn, influence them to develop a behavior to crave high fatty foods and soda. By linking 2 well-established pathways (stress to depressive symptoms, depressive symptoms to unhealthy diets) (28–30), we found that this indirect path explained 40% of the main association. It implies that a program/intervention such as relaxation training may be considered a strategy for addressing depressive symptoms as an effective means to help develop a healthy dietary pattern among chronically stressed caregivers (31).

Unlike depressive symptoms, the data did not support a mediator role of current smoking in the relation between chronic stress and an unhealthy dietary behavior. The proportion of the total effect explained by an indirect effect via current smoking was −0.04%, which was not statistically significant. This was mainly attributed to the null association between current smoking and diets, suggesting that a positive relation between smoking and intakes of sugary and fatty foods in the previous studies cannot be generalized to the low-income African-American caregivers from urban areas (32, 33).

The prevalence of chronic stress in this study was lower than that reported in the 2000–2001 Multi-Ethnic Study of Atherosclerosis (10% vs. 35%) (34). We believe that this difference could be attributed to differences in measurements of chronic stress (individual- and neighborhood-level stressors vs. self-reported responses in chronic burden scale) and study populations (young African-American female caregivers vs. adults aged 45–84 y). Within this homogeneous population group living in deprived neighborhoods, we found that chronic stress was not equally reported. This may indicate that, despite material hardship and child-caring responsibilities, some caregivers were able to cope with life challenges. This trait, known as resilience, has been observed in the previous studies of the same population, and is associated with several positive health outcomes, including dental caries and child obesity (35, 36). Although a definition of lack of chronic stress might not completely correspond to the resilience construct, the current finding supports an idea of resilience and its health-promoting behaviors.

Despite some variations in dietary patterns among study caregivers, overall dietary calorie intake was 1.5–2 times greater than the recommended amount according to the national guideline (37). While average soda intake was similar to the 1999–2001 national average among African-American women ages 20–39 y (397.2 g) (38), an almost 2.5 times greater soda intake was reported among 25% of the caregivers who exhibited a pattern of excess fatty foods and soda intakes. On the other hand, any particular dietary pattern was not associated with BMI in this population, reflecting the relatively young age of the participants (e.g., 75% of caregivers were <33 y old).

A main strength of this study was the use of cluster analysis to identify dietary patterns. This data-driven method allowed for identifying caregivers who shared similar dietary behaviors by assessing complex dietary exposure to different foods. In addition, the study recruited a homogeneous sample of caregivers living in deprived urban areas, which effectively helped control for neighborhood-level confounding. However, several limitations should be noted. First, the participants could have over- or underreported certain types of foods. In particular, the use of the FFQ could have introduced bias due to recall error or social desirability. Second, the FFQ might not capture unique aspects of the food habits among African-American participants. However, the FFQ data provided sufficient variance to group participants into nonoverlapping dietary intake patterns. Finally, because only baseline data were used, temporality in the causal mediation analysis could not be established.

In conclusion, chronic stress was associated with a dietary pattern of excess soda and fatty food intakes among low-income African-American female caregivers. Almost 41% of this association was explained by an indirect pathway through depressive symptoms. This

TABLE 4 Weighted estimates of indirect, direct, and total effects and proportion of total effect explained by a mediator from causal mediation analysis among African-American female caregivers, Detroit, Michigan: 2002–2003[1]

	Estimate (95% CI)	
	Depressive symptoms	Current smoking
Indirect effect	0.05 (0.01, 0.12)	−0.001 (−0.02, 0.01)
Direct effect	0.07 (−0.04, 0.19)	0.10 (−0.001, 0.23)
Total effect	0.11 (0.01, 0.25)	0.10 (−0.004, 0.22)

[1]Direct, indirect, and total effects above were expressed as an increased probability associated with chronic stress. For example, overall having chronic stress was associated with an 11% increase in prevalence of unhealthy diets (total effect). Of these, a 5% increase in prevalence of unhealthy diets was explained by increased prevalence of depressive symptoms among caregivers with chronic stress (indirect effect).

finding provides evidence for developing a more targeted intervention to promote healthy dietary behaviors among chronically stressed minority caregivers.

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References

1. Adam TC, Epel ES. Stress, eating, and the reward system. Physiol Behav 2007;91(4):449–58.
2. Block JP, He Y, Zaslavs.ky AM, Ding L, Ayanian JZ. Psychosocial stress and change in weight among US adults. Am J Epidemiol 2009;170:181–92.
3. Malik VS., Popkin BM, Bray GA, Després JP, Hu FB. Sugar-sweetened beverages, obesity, type 2 diabetes mellitus, and cardiovascular disease risk. Circulation 2010;121(11):1356–64.
4. Ruanpeng D, Thongprayoon C, Cheungpasitporn W, Harindhanavudhi T. Sugar and artificially-sweetened beverages linked to obesity: a systematic review and meta-analysis. QJM 2017;110(8):513–20.
5. Steptoe A, Feldman PJ. Neighborhood problems as sources of chronic stress: development of a measure of neighborhood problems, and associations with socioeconomic status and health. Ann Behav Med 2001;23(3):177–85.
6. Bromberger JT, Matthews KA. A longitudinal study of the effects of pessimism, trait anxiety, and life stress on depressive symptoms in middle-aged women. Psychol Aging 1996;11:207–13.
7. Schulz AJ, Mentz G, Lachance L, Johnson J, Gaines C, Israel BA. Associations between socioeconomic status and allostatic load: effects of neighborhood poverty and tests of mediating pathways. Am J Public Health 2012;102(9):1706–14.
8. Ajrouch KJ, Reisine S, Lim S, Sohn W, Ismail A. Perceived everyday discrimination and psychological distress: does social support matter? Ethn Health 2010;15(4):417–34.
9. Manuel JI, Martinson ML, Bledsoe-Mansori SE, Bellamy JL. The influence of stress and social support on depressive symptoms in mothers with young children. Soc Sci Med 2012;75(11):2013–20.
10. Richardson AS, Arsenault JE, Cates SC, Muth MK. Perceived stress, unhealthy eating behaviors, and severe obesity in low-income women. Nutr J 2015;14(1):122.
11. Laraia BA, Leak TM, Tester JM, Leung CW. Biobehavioral factors that shape nutrition in low-income populations: a narrative review. Am J Prev Med 2017;52(2S2):S118–26.
12. Hammen C, Kim EY, Eberhart NK, Brennan PA. Chronic and acute stress and the prediction of major depression in women. Depress Anxiety 2009;26(8):718–23.
13. Slopen N, Kontos EZ, Ryff CD, Ayanian JZ, Albert MA, Williams DR. Psychosocial stress and cigarette smoking persistence, cessation, and relapse over 9–10 years: a prospective study of middle-aged adults in the United States. Cancer Causes Control 2013;24(10):1849–63.
14. Ismail AI, Sohn W, Tellez M, Willem JM, Betz J, Lepkowski J. Risk indicators for dental caries using the International Caries Detection and Assessment System (ICDAS). Commun Dent Oral Epidemiol 2008;36(1):55–68.
15. Reisine S, Ajrouch KJ, Sohn W, Lim S, Ismail A. Characteristics of African-American male caregivers in a study of oral health in Detroit—a brief communication. J Public Health Dent 2009;69(3):197–200.
16. Keyes KM, Hatzenbuehler ML, Hasin DS. Stressful life experiences, alcohol consumption, and alcohol use disorders: the epidemiologic evidence for four main types of stressors. Psychopharmacology 2011;218(1):1–17.
17. Jackson JS, Brown TN, Williams DR, Torres M, Sellers SL, Brown K. Racism and the physical and mental health status of African Americans: a thirteen year national panel study. Ethnicity Dis 1996;6(1–2):132–47.
18. Schulz A, Williams D, Israel B, Becker A, Parker E, James SA, Jackson J. Unfair treatment, neighborhood effects, and mental health in the Detroit metropolitan area. J Health Soc Behav 2000;1:314–32.
19. Boucher B, Cotterchio M, Kreiger N, Nadalin V, Block T, Block G. Validity and reliability of the Block98 food-frequency questionnaire in a sample of Canadian women. Public Health Nutr 2006;9(1):84–93
20. Johnson BA, Herring AH, Ibrahim JG, Siega-Riz AM. Structured measurement error in nutritional epidemiology; applications in the Pregnancy, Infection, and nutrition (PIN) Study. J Am Statist Assoc 2007;102(479):856–66.
21. Radloff LS. The CES-D scale: a self-report depression scale for research in the general population. Appl Psychol Meas 1977;1(3):385–401.
22. McDowell I, Newell C. Measuring health, a guide to rating scales and questionnaires. 2nd ed. New York: Oxford University Press; 1996.
23. Wheeler ML, Daly A, Evert A, Franz MJ, Geil P, Holzmeister LA, Kulkarni K, Loghmani E, Ross TA, Woolf P. Choose your foods: Exchange Lists for Diabetes, 2008: description and guidelines for use. J Am Diet Assoc 2008;108(5):883–8.
24. Milligan GW. Clustering validation: results and implications for applied analyses. In: Clustering and classification. Singapore: World Scientific; 1996. pp. 341–75.
25. Zou G. A modified poisson regression approach to prospective studies with binary data. Am J Epidemiol 2004;159(7):702–6.
26. Tingley D, Yamamoto T, Hirose K, Keele L, Imai K. Mediation: R package for causal mediation analysis. J Stat Soft 2014;59(5).
27. Diez Roux AV, Mair C. Neighborhoods and health. Ann N Y Acad Sci 2010;1186(1):125–45.
28. Dinan TG. Glucocorticoids and the genesis of depressive illness: a psychobiological model. Br J Psychiatry 1994;164(3):365–71.
29. Dolan RJ, Calloway SP, Fonagy P, De Souza FV, Wakeling A. Life events, depression and hypothalamic-pituitary-adrenal axis function. Br J Psychiatry 1985;147(4):429–33.
30. Post RM. Transduction of psychosocial stress into the neurobiology. Am J Psychiatry 1992;149:999–1010.
31. Manzoni GM, Pagnini F, Gorini A, Preziosa A, Castelnuovo G, Molinari E, Riva G. Can relaxation training reduce emotional eating in women with obesity? An exploratory study with 3 months of follow-up. J Am Diet Assoc 2009;109(8):1427–32.
32. Larson NI, Story M, Neumark-Sztainer D, Hannan PJ, Perry CL. Are diet and physical activity patterns related to cigarette smoking in adolescents? Findings from Project EAT. Prev Chronic Dis 2007;4(3):A51.
33. Pepino MY, Mennella JA. Cigarette smoking and obesity are associated with decreased fat perception in women. Obesity 2014;22(4):1050–5.
34. Everson-Rose SA, Roetker NS, Lutsey PL, Kershaw KN, Longstreth Jr WT, Sacco RL, Diez Roux AV, Alonso A. Chronic stress, depressive symptoms, anger, hostility, and risk of stroke and transient ischemic attack in the multi-ethnic study of atherosclerosis. Stroke 2014;45(8):2318–23.
35. Lim S, Zoellner JM, Ajrouch KJ, Ismail AI. Overweight in childhood: the role of resilient parenting in African-American households. Am J Prev Med 2011;40(3):329–33.
36. Sanders AE, Lim S, Sohn W. Resilience to urban poverty: theoretical and empirical considerations for population health. Am J Public Health 2008;98(6):1101–6.
37. Institute of Medicine. Energy. Dietary Reference Intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein, and amino acids. Washington (DC): National Academy Press; 2005.
38. Storey ML, Forshee RA, Anderson PA. Beverage consumption in the US population. J Am Diet Assoc 2006;106(12):1992–2000.