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Ecological momentary assessment of environmental and personal factors and snack food intake in African American women

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Abstract

This study examined contributions of environmental and personal factors (specifically, food availability and expense, daily hassles, self-efficacy, positive and negative affect) to within-person and betweenperson variations in snack food intake in 100 African American women. Participants were signaled at random five times daily for seven days to complete a survey on a study-provided smartphone. Women reported consuming snack foods at 35.2% of signals. Easier food availability accounting for one's usual level was associated with higher snack food intake. Being near outlets that predominately sell snacks (e.g., convenience stores), while accounting for one's usual proximity to them, was associated with higher snack food intake. Accounting for one's usual daily hassle level, we found that on days with more frequent daily hassles snack food intake was higher. The positive association between within-person daily hassles frequency and snack food intake was stronger when foods were easily available. Public and private policies to curb ubiquitous food availability and mobile health interventions that take into account timevarying influences on food choices and provide real-time assistance in dealing with easy food availability and coping with stressors may be beneficial in improving African American women's day to day food choices.

Keywords

Stress; Affect; Diet; Self-Efficacy; Food availability; Food prices

Introduction

High intakes of energy, added sugars, and solid fats are of concern due to their association with obesity development, displacement of micronutrients, and chronic disease risk (Livingstone & Rennie, 2009; Wang, Steffen, Zhou, Harnack, & Luepker, 2013). Added

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sugars and solid fats now comprise 35% of U.S. adults' daily energy intake, even though guidelines from the World Health Organization (WHO) and the U.S. Department of Agriculture (USDA) suggest consumption be limited to no more than 15% (Krebs-Smith, Guenther, Subar, Kirkpatrick, & Dodd, 2010; US. Department of Agriculture & US. Department of Health and Human Services, 2010; World Health Organization, 2003). Studies based on national data suggest that African American women in the Unites States have higher intake of added sugars and solid fats as compared to white women (Kirkpatrick, Dodd, Reedy, & Krebs-Smith, 2012; Thompson et al., 2009) and experience an excess burden of obesity and related chronic health conditions (Flegal, Carroll, Kit, & Ogden, 2012; Jemal et al., 2008; Ma et al., 2012; Shai et al., 2006). In fact, the prevalence of obesity is higher in African American women compared to white women at every level of income, and the inverse association between income and obesity may be weaker in African American women as compared to white women (Freedman, Grafova, & Rogowski, 2011). Top sources of energy, added sugars, and solid fats are snack-type foods including grain-based desserts (e.g., cookies, cake), dairy desserts (e.g., ice cream), candy, and salty snacks (e.g., chips, crackers) (Applied Research Program, National Cancer Institute, 2013; Bachman, Reedy, Subar, & Krebs-Smith, 2008; Chun, Chung, Wang, Padgitt, & Song, 2010; Huth, Fulgoni, Keast, Park, & Auestad, 2013). Better understanding the circumstances of African American women's lives that contribute to increased consumption of snacktype foods could help develop effective intervention approaches.

Decisions throughout the day determine dietary intake, including snack food consumption. Most correlational research on diet exclusively focuses on identifying factors that contribute to between-person differences, and little is known about withinperson, time-varying influences on dietary intake (Dunton & Atienza, 2009). According to reciprocal determinism from social cognitive theory, the dynamic interplay of environmental and personal (e.g., cognitive, affective) factors influence health behaviors (McAlister, Perry, & Parcel, 2008). Such factors that fluctuate on a momentary basis (i.e., within-day or daily) may contribute to intra-individual variations in dietary intake.

In terms of environmental factors, both the food environment and social environment may influence dietary intake throughout the day. Research shows that living in a neighborhood with greater availability of unhealthy foods as measured directly by food products for sale or indirectly by outlet type (e.g., convenience stores and fast food outlets that predominately sell energy-dense, nutrient poor foods and beverages) is associated with snack food intake and higher body weight (Hickson et al., 2011; Reitzel et al., 2014; Rose et al., 2009; Zenk et al., 2013). Yet, few studies take into account changes in the food environment throughout the day based on where individuals conduct day-to-day activities such as work, school, social network members' homes, place of worship, and home (Kestens et al., 2012; Moore et al., 2013; Thornton, Lamb, & Ball, 2013; Zenk et al., 2011). In a sample of predominately white women (n = 39), one study using ecological momentary assessment (EMA) found that overeating was positively associated with the number of palatable foods available among those with a relatively high body mass index (BMI) (Thomas, Doshi, Crosby, & Lowe, 2011). While African American women are more likely to live in neighborhoods with a greater number of convenience or “corner” stores and fast food outlets (Morland, Wing,

Diez Roux, & Poole, 2002; Powell, Auld, Chaloupka, O'Malley, & Johnston, 2007), little is known about their food exposures throughout the day and their impacts on dietary choices.

As a component of the social environment, greater exposure to daily hassles, or relatively minor events or irritants that arise out of daily life (Kanner, Coyne, Schaefer, & Lazarus, 1981; O'Connor, Jones, Conner, McMillan, & Ferguson, 2008), may contribute to higher snack food intake. Consumption of snack foods, which are often high in fat, sugar, or salt, may alleviate stress by activating the endogenous opioid (reward) system, reducing the hypothalamic-pituitaryadrenal (HPA) axis stress response, or providing sensory pleasure, distraction, or escape (Adam & Epel, 2007; Gibson, 2012). African American women are exposed to more stressors, and some have proposed that intake of foods high in fat, sugar, or salt may be an accessible and inexpensive coping response to stressful life circumstances (Jackson, Knight, & Rafferty, 2010; Zenk et al., 2013).

At the personal level, self-efficacy (confidence in one's ability to perform a particular behavior) (McAlister et al., 2008) and affect (conscious feeling or mood that can be good or bad) (Kanning, Ebner-Priemer, & Schlicht, 2013) are two factors that may play a role in momentary dietary choices. Self-efficacy is a well-established cognitive factor that contributes to between-individual differences in dietary behaviors and mediates intervention effects on dietary change (Shaikh, Yaroch, Nebeling, Yeh, & Resnicow, 2008; Thomson, Zoellner, & Tussing-Humphreys, 2014; Watters, Satia, & Galanko, 2007). However, less is known about the extent to which self-efficacy varies on a momentary basis to affect within-individual dietary decisions throughout the day. Considerable research has focused on contributions of negative affect (e.g., feelings such as being afraid or nervous) to dietary choices, including snack food intake, with some studies showing that negative affect is associated with greater consumption of these foods (Fay & Finlayson, 2011; Ford, Jaceldo-Siegl, Lee, Youngberg, & Tonstad, 2013). The association between positive affect (e.g., feelings such as being excited or inspired) and dietary choices is the subject of less research. Yet, positive affect may contribute to eating by, for example, increasing hedonic pleasure, providing justification to indulge, and via an associative learning mechanism by which positive emotions become tied to eating (Evers, Adriaanse, de Ridder, & de Witt Huberts, 2013). Research suggests that positive affect may have a stronger impact than negative affect on unhealthy food choices (Bongers, Jansen, Havermans, Roefs, & Nederkoorn, 2013; Evers et al., 2013; White, Horwath, & Conner, 2013). To our knowledge, however, contributions of within daily and daily fluctuations in self-efficacy and affect to dietary intakes have generally not been studied in African American women.

Consistent with reciprocal determinism, it is possible that associations among environmental factors, personal factors, and dietary choices are interactive and dynamic. Daily hassles or affect may have a larger effect on snack food intake in environments where these food items are easily available or inexpensive than in environments in which these options are less physically and economically accessible (Diez Roux & Mair, 2010; Loxton, Dawe, & Cahill, 2011; Zenk et al., 2013). Dietary intake may also impact personal factors later in the day (Hendy, 2012; Macht, Gerer, & Ellgring, 2003; White et al., 2013). Specifically, consuming snack foods may erode selfefficacy to avoid these foods, diminish positive affect, or contribute to negative affect.

Using ecological momentary assessment (EMA), the purpose of this study was to examine contributions of fluctuations in environmental and personal factors (specifically, perceived food availability and expense, daily hassles, self-efficacy, positive and negative affect) to within-person and between-person variations in snack food intake in African American women. The hypotheses, focused on within-person associations, were: (1) Greater food availability and lower expense (e.g., availability of retail sources including convenience store, restaurant, bakery, or candy store; inexpensive foods) are associated with a greater (concurrent) likelihood of snack food intake; (2) Higher levels of daily hassles, negative affect, and positive affect, as well as lower self-efficacy, are associated with greater likelihood of snack food intake concurrently (at the same EMA signal, or during the same time period) and subsequently (at the next EMA signal several hours later); (3) Greater food availability and lower expense exacerbate positive associations of both daily hassles and (positive and negative) affect with snack food intake; and (4) Snack food intake contributes to subsequent lower positive affect, greater negative affect, and decreased self-efficacy (at the next EMA signal). Between-person associations between environmental and personal factors and snack food intake are also reported.

Methods

Sample

Our recruitment goal was a socioeconomically diverse sample of African American women aged 25 to 65 living in metropolitan Chicago, Illinois. It is important to understand dietary correlates in African American women of varying SES given that the likelihood of obesity and poor diet tend to be similar across all levels of individual SES in this group (Freedman et al., 2011). Exclusion criteria were self-reported inability to read and write English and full-time student status. Of the women who enrolled, 101 completed the study and one dropped out. Some women (n = 20) were recruited from a focus group study on daily hassles; the remainder (n = 82) were recruited through fliers and email announcements at a public university and fliers and in-person invitations at community sites (e.g., community centers, health fairs). One woman did not complete any EMA surveys; therefore, the sample for this analysis is 100.

Measures

Snack food intake—Snack food intake was the primary dependent variable. At each signal, intake of nine categories of snack and non-snack food and beverages since the last signal was assessed. Intake of snack foods was measured based on five of these categories: cookies or sweetened baked goods (e.g., cake, donut), chocolate or candy, ice cream or frozen dessert, salty snacks (e.g., potato chips), and French fries or other fried side dish. These categories were adapted from the Dietary Screener Questionnaire (National Health Interview Survey, 2014) based on focus groups with African American women (Unpublished results). Participants reported whether they consumed each of these food categories since the last signal (yes or no). Affirmative responses to these five items were summed and then dichotomized as none or one or more, due to negative skew in the distribution.

Food availability and expense—At signals when a participant reported eating or drinking since the last signal (75.9% of signals), she was asked (using a "mark all that apply" checklist): "Did any of the following make it easier for you to eat or drink?" (Hekler et al., 2012). The checklist included several items on food availability: easily available; near a fast food restaurant, other restaurant, or cafeteria; near a convenience store; near a bakery or candy store; and near a grocery store or supermarket. The checklist also included a single item on food expense: inexpensive food. Based on these items, we derived three environmental facilitators for food availability (easily available; near a restaurant, convenience store, bakery, or candy store; near a grocery store) and one environmental facilitator for food expense (inexpensive). We grouped restaurant, convenience store, and bakery/candy store because in general they tend to predominately sell energy-dense, nutrient poor food and the frequency of reporting each alone was low. Each of these four items was a dichotomous variable in the analysis. In addition, when a participant reported that (any) foods or beverages were "easily available," she was asked how many good-tasting, high-calorie foods or beverages were available. Based on the distribution, these responses were categorized as 0, 1–2, and 3 or more good-tasting, high-calorie foods or beverages for analysis.

Daily hassles—Three measures were used to assess daily hassles. Two of these measures were single items administered at each signal (Hekler et al., 2012). The first was "Have you experienced a stressful event since your last entry?" The second was "Have you experienced a stressful or problematic social interaction since your last entry?" As the third measure, an 89-item daily hassles checklist, adapted from DeLongis, Folkman, and Lazarus (1988), based on focus groups with African American women (Unpublished results), was administered at the last signal of each day. The checklist covered hassles related to work (e.g., meeting a deadline), family and friends, interpersonal issues (e.g., argued with someone), household activities (e.g., cooking), transportation (e.g., traffic), and unfair treatment. A daily hassles frequency measure was derived from the 89-item checklist using the Rasch measurement model with Winsteps, Version 3.79 (Linacre & Wright, 2013). The Rasch model is a probabilistic model in which the likelihood of an individual endorsing a given item is a function of the item's difficulty or severity and her/his position on the latent trait (i.e., daily hassles). The Rasch model was selected to estimate the measure as it has several advantages including sample-free measurement, equal interval scaling, and estimation of a person's position on a latent trait even when there are some missing data (provided that missing item responses are missing at random) (Andrich, 1988; Bond & Fox, 2001; Fisher, Harvey, & Kilgore, 1995; Wright, 1977).

Unlike raw scores, Rasch measures are on a logit scale. A logit is the natural log of the odds of endorsement for an item or person. In the case of rating scale items, the logit value representing a person's ability is approximated by log(S/(TP-S)), where S is the raw score and TP is the total points possible on the answered items. For instance, a score of 20 on 10 4-point Likert items would have a 40 total points possible and a logit equivalent of log(20/(40-20)) = log(1) = 0 logits. According to the Rasch model, a person with a logit measure of 0 on the daily hassles instrument would be predicted to have a 0.5 probability of endorsing a hassle with a severity or difficulty of 0 logits. This probability will trend towards 1 as the

person's measure increases, and trend towards 0 as the measure decreases. To the extent that the data fit the Rasch model, lower values on the daily hassles frequency measure will correspond to endorsement of relatively few hassles, whereas higher values will be associated with endorsement of many hassles.

Self-efficacy—Self-efficacy to avoid energy-dense foods and beverages was measured at each signal on a 10-point Likert scale, ranging from 1 (not at all confident) to 10 (completely confident), using a single item: “How confident are you that you can avoid eating good-tasting, highcalorie foods or drinks between now and the time you go to bed?” (Hekler et al., 2012).

Positive and negative affect—Positive and negative affect were measured at each signal with an adapted short-form Positive and Negative Affect Schedule (PANAS) (Mackinnon et al., 1999). Five items (e.g., inspired, enthusiastic) assessed positive affect; five items (e.g., upset, distressed) assessed negative affect. Participants reported (using a “mark all that apply” checklist) which of the 10 emotions “they had been feeling” since the last signal. Based on the distributions, positive affect was a count of the five positive emotions, while negative affect was dichotomized as none or 1 or more of the negative emotions in the analysis.

Covariates—Several person-level variables were included as covariates: age, education (high school diploma, GED, or less; associate's degree or some college; bachelor's degree; graduate or professional degree), employment status (unemployed/other including retired or disabled; employed part-time, employed full-time), annual per capita household income (approximate tertiles: <$7500, $7500-18,749, ≥$18,750), automobile ownership, and body mass index (BMI), calculated as interviewer-measured weight (kg/[height (m)]^2). In addition, we controlled for whether it was a weekend or weekday using a dummy variable, hunger status (i.e., whether the participant reported feeling hungry) since the last signal using a dummy variable, and the survey block or time of day using four dummy variables.

Data collection procedure

Data collection for each participant consisted of three phases: baseline interview, 7-day data collection period, and post-interview. Both interviews were conducted at a public university, for which participants were compensated for parking or public transportation costs. During the baseline interview, participants provided written informed consent, completed a questionnaire (e.g., demographics), and received training on equipment. During the 7-day data collection period, participants completed web-based momentary surveys via study-provided smartphones (Samsung Illusion). The post-interview consisted of a final questionnaire (e.g., perceptions of EMA), data downloading from equipment, and payment (up to $100). All data were collected July 2012 through January 2013.

Ecological momentary assessment (EMA) sampling

With regard to the momentary surveys, using signal-contingent sampling, participants were signaled at random once during five blocks of time daily for seven days (n = 35 signals) to complete a web-based survey. The five time blocks – 7–10 am, 10 am–1 pm, 1–4 pm, 4–7

pm, and 7–9 pm – were adjusted as needed based on typical wake/sleep pattern. The signals consisted of email messages for the first 7.9% of participants and, due to data coverage problems, text messages for the remaining 92.1% of participants. Surveys remained available for 1 hour, with a reminder sent after 45 minutes. On average, the momentary surveys took 10.1 minutes [standard deviation (SD) 5.1] to complete.

Data analysis

Descriptive statistics and regression models with random effects for person and day were estimated in Stata 11.2 (Statacorp, College Station, TX). All regression models controlled for the same set of covariates: demographics, BMI, hunger status, weekend/weekend day, and survey block. To test hypothesis 1 (greater food availability and lower expense are positively associated with snack food intake) and hypothesis 2 (higher levels of daily hassles, negative affect, and positive affect, as well as lower self-efficacy, are positively associated with snack food intake), binary logistic regression models were used to regress snack food intake on food availability and expense, daily hassles, positive and negative affect, and self-efficacy in separate models, as well as covariates.

Each model included both a within-person version (deviation from her own mean or proportion) and a between-person version (person-level mean or percentage across EMA signals) of each predictor of interest (Dunton et al., 2014; Hedeker, Mermelstein, & Demirtas, 2008). Functionally, the within-person version of a time varying variable X_{it} was calculated as $X_{it}–\bar{X}_t$, where X_{it} measures X for person i at time t, and $\bar{X}_t$ is the mean, averaged across time, for person i. For ease of interpretation, the between-person versions of dichotomous predictors were converted to percentages and scaled such that each unit represents a 10% change. In the regression models, the within-person effect (our primary interest) captures how change in a predictor for a given participant is associated with a change in her outcome, accounting for her usual level of the predictor (Neuhaus & Kalbfleisch, 1998). (For example, the effect of a one-unit increase in self-efficacy on snack food intake for a given woman, accounting for her average self-efficacy.) The betweenperson effect captures differences in the outcome between women who have different average predictor levels (Neuhaus & Kalbfleisch, 1998). (For example, the effect of a one-unit increase in a woman's average self-efficacy, relative to other women, on snack food intake.)

These initial models determined concurrent relationships between the within-person variable (e.g., self-efficacy) and snack food intake (i.e., during the same time period). Each model was then reestimated using a lagged version of the within-person variable (i.e., response from the immediate previous EMA survey) in order to determine if the main predictor of interest was associated with subsequent snack food intake (at the next EMA signal). However, because we thought food availability and prices would only affect intake concurrently (no lagged effect), only concurrent relationships were tested for those variables.

Hypothesis 3 (greater food availability and lower expense exacerbate positive associations between both daily hassles and affect with snack food intake) was tested through the addition of multiplicative interaction terms between each within-person environmental

variable and each within-person daily hassle and affect variable. (Interaction terms between the counterpart betweenperson variables were included as well.) To test hypothesis 4 (snack food intake contributes to subsequent lower positive affect, greater negative affect, and decreased self-efficacy), linear and binary logistic regression models with random effects for person were used to regress self-efficacy and affect, respectively, on snack food intake reported at the previous signal as well as covariates.

Results

Descriptive statistics

As shown in Table 1, the mean age was 44.3 years (SD 10.3); most women were employed full-time or part-time (74.0%); and 45.0% had at least a 4-year college degree, while 19.0% had a high school diploma, GED, or less. The median annual household income was $32,500 and ranged from <$5000 to >$125,000. On average, women completed 68.9% of the 35 surveys (SD 24.5). On average, women reported consuming snack foods at 35.2% of the signals (Table 1). On average, they reported easy availability, facilitated eating or drinking at more than half of the signals (57.4%) and at least 3 goodtasting, high calorie foods were available at 44.4% of these signals. Being near a restaurant, convenience store, bakery, or candy store (15.5%), inexpensive food (12.1%), and being near a grocery store (4.9%) were less frequently reported as facilitators. With regard to daily hassles, on average, women indicated experiencing a stressful event at 16.8% of signals and a stressful social interaction at 11.5% of signals. The mean daily hassles frequency measure was −3.1 logits (S.D. 1.3), suggesting that women typically reported relatively few of the 89 hassles on a given day. Not having enough money for a necessity (–2.22 logits; 32.4% endorsement), housework (–1.99 logits; 28.6% endorsement), too many things to do (–1.91 logits; 27.3% endorsement), and listening to others' problems (–1.85 logits; 26.5%) were among the most commonly endorsed hassles. Positive affect was more frequently reported than negative affect.

Hypothesis 1

Providing some support for hypothesis 1, being near a restaurant, convenience store, bakery, or candy store, accounting for one's usual proximity, was associated with a 2-fold higher likelihood of snack food intake (O.R. 2.02; 95% C.I. 1.48, 2.74), controlling for covariates (Table 2, Column 1). In other words, for a given woman, during times when she was near these outlets, she was twice as likely to consume snack foods compared to times for which she was not near these outlets. While not hypothesized, being near a grocery store, accounting for one's usual proximity, was associated with an 83% higher likelihood of snack food intake for a given participant (O.R. 1.83; 95% C.I. 1.03, 3.25). Easy availability of food, accounting for one's usual level, was associated with a 68% higher likelihood of snack food intake for a given participant (O.R. 1.68; 95% C.I. 1.32, 2.13). When number of “good-tasting, high calorie foods or beverages” was substituted for easy food availability, a graded relationship was observed. Compared to times when there was no goodtasting, high calorie foods or beverages available for a given woman, she was over 4 times as likely to consume snack food when one or two such products were available (O.R. 4.66, 95% C.I. 2.47, 8.80)

and she was more than 8 times as likely to consume snack food when three or more of these products were available (O.R. 8.61, 95% C.I. 4.38, 16.94).

Hypothesis 2

Regarding hypothesis 2, regression analysis revealed that a 1-logit increase on the daily hassles frequency measure, accounting for one's typical level, was associated with a 14% higher likelihood of snack food intake (O.R. 1.14, 95% C.I. 1.02, 1.28), controlling for covariates (Table 2, Column 1). No other significant associations were found between within-person stressful event, stressful social interaction, or affect and snack food intake. Furthermore, within-person daily hassles, affect, and self-efficacy were not associated with snack food intake later in the day (or the next day for daily hassles frequency) (Table 2, Column 2).

Hypothesis 3

Offering some support for hypothesis 3, relationships of daily hassles frequency and negative affect with snack food intake differed depending on food availability and expense, controlling for covariates (not shown). Specifically, a significant positive interaction was found between with-person daily hassles frequency and easy availability of food (O.R. 1.70; 95% C.I. 1.21, 2.39). As shown in Fig. 1a, at times when foods were less available, accounting for the usual availability for her, the association between daily hassles frequency and the probability of snack food intake was weak. However, when foods were more easily available to her, accounting for her usual level, daily hassle frequency was positively associated with snack food intake. There were also significant within-person interactions between availability of inexpensive food and the occurrence of a stressful event (O.R. 0.20; 95% C.I. 0.07, 0.59) and stressful social interaction (O.R. 0.27; 95% C.I. 0.08, 0.90). As illustrated in Fig. 1b, contrary to the study hypothesis, at times when inexpensive foods were less available, while accounting for the usual availability for her, the occurrence of a stressful event or stressful social interaction was associated with a somewhat greater probability of snack food intake for a given woman. When inexpensive foods were more available, accounting for the usual availability of these foods for her, the associations of both stressful events and stressful social interactions with snack food intake were negative.

Hypothesis 4

Table 3 shows results of analyses testing hypothesis 4 in which affect (positive and negative) and self-efficacy were regressed in separate models on snack food intake reported at the immediate prior EMA signal, controlling for covariates. Providing no support for hypothesis 4, no significant relationships were found, suggesting that snack food intake was not associated with either subsequent positive or negative affect or self-efficacy.

Between-person associations

With regard to between-person associations, we found that each 10% increase in time spent closer to a restaurant, convenience store, bakery, or candy store, compared to other women, was associated with a 24% higher likelihood of reporting snack food intake (Table 2; 95% C.I. 1.01, 1.25). Women who reported on average more stressful events (O.R. 1.16, 95% C.I.

1.06, 1.28), more frequent daily hassles (O.R 1.20, 95% C.I. 1.07, 1.35), and more positive affect (O.R. 1.18, 95% C.I. 1.03, 1.36), relative to other women, were more likely to consume snack foods (Table 2). Furthermore, higher self-efficacy, relative to other women, was associated with a lower likelihood of snack food intake (O.R. 0.89, 95% C.I. 0.83, 0.95) (Table 2). The results also suggested that women who consumed snack foods a greater percent of time compared to other women had higher levels of positive affect (b 0.17; $p = 0.01$) and lower self-efficacy (b −0.50; $p < 0.01$) (Table 3).

Sensitivity analyses

Several sensitivity analyses were conducted. First, results of models including multiple predictors of interest simultaneously plus covariates were generally consistent with those presented here. We presented models with one predictor of interest at a time plus covariates because inclusion of the environmental variables with other variables in the same model have limited results to only those times an individual reported eating or drinking (because environmental facilitators were only asked when an individual reported eating or drinking something). Second, for hypothesis 2, results of analyses including both concurrent and lagged predictors were similar to the models including lagged variables alone. Third, lagged results were consistent based on two alternative specifications: lags based on responses from the most recently completed prior EMA survey (not just the immediate prior EMA survey as presented) and lags based on the immediate prior EMA survey but excluding lags from the prior day (survey 5). Fourth, because effects of daily hassles and affect may depend on eating patterns, we tested interactions between each daily hassle variable and affect variable and each of three eating patterns as measured by the Dutch Eating Behavior Questionnaire: restrained, emotional, and external (Van Strien, Frijters, Bergers, & Defares, 1986). Relationships did not vary for any of the three eating patterns. Fifth, through the inclusion of interactions, we examined whether relationships differed by age, but found little evidence.

Discussion

This study provides some of the first evidence on withinperson influences on dietary intakes in African American women. Consistent with observations of the food environment (Farley, Baker, Futrell, & Rice, 2010), women perceived that food was ubiquitous. On average, women indicated that easy availability of foods facilitated eating over half the time. When easy availability facilitated eating, there were at least three good-tasting, high-calorie options from which to choose almost half the time (44.4%). While not directly comparable, this is similar to estimates from Thomas and colleagues who found that an average of three different goodtasting, high-calorie options were reported during eating events in a predominately white sample of women (Thomas et al., 2011). Higher availability seemed to contribute to frequent snack food intake. Specifically having easy availability of foods accounting for one's typical level was influential, while having easier availability on average compared to other women was not. Furthermore, at times when she was closer to retail outlets that predominately sell snacks (e.g. convenience stores), while accounting for her usual proximity, snack food intake was higher. In addition, women who on average spent more time closer to these outlets, relative to other women, also had higher snack food intake. Taken together, these findings suggest that prior studies only examining the role of the retail

food environment in between-person differences in diet may underestimate its importance. Our unexpected finding that being closer to a grocery store, accounting for one's usual proximity, was associated with snack food intake may reflect that supermarkets sell a wide selection of snack foods, in addition to healthy alternatives (Thornton, Cameron, McNaughton, Worsley, & Crawford, 2012; Zenk et al., 2014).

Consistent with prior studies showing a positive association between daily hassles and snack food intake (O'Connor et al., 2008), snack food consumption was higher on days when a woman experienced more frequent daily hassles, accounting for her usual level. One potential explanation for no relationship between experiencing a stressful life event or stressful social interaction and snack food intake is that it may be the accumulation of daily hassles throughout the day that influences snack food intake, rather than hassles in small windows of time during the day. Easier availability of foods than usual seemed to exacerbate effects of daily hassles frequency on snack food intake. This is consistent with some prior research suggesting that stressors may have larger effects on diet when highly palatable foods are available (Adam & Epel, 2007; Loxton et al., 2011; Torres & Nowson, 2007; Wallis & Hetherington, 2009), but not a prior empirical test of between-person associations between chronic stressors (and acute life events), food outlet availability, and snack food intake that found no relationship in a multiethnic sample (Zenk et al., 2013). Multiple methodological differences may have contributed to these inconsistencies in findings. Furthermore, contrary to our hypothesis, the probability of snack food intake tended to be lower with the occurrence of a stressful event or stressful social interaction when the presence of inexpensive foods was relatively high. Based on focus groups with AA women (unpublished findings), this may reflect some women indulging in expensive treats (e.g., designer cupcakes) in response to stress.

One strength of EMA is the ability to establish temporal relationships among factors of interest. We found little evidence that within-person variations in affect or self-efficacy influenced snack food intake later in the day or that snack food intake influenced subsequent affect or self-efficacy. It is encouraging that snack food intake did not erode subsequent self-efficacy to avoid good tasting, high calorie foods. This suggests that it may not be necessary for interventions to bolster self-efficacy in response to snack food intake. Overall, our findings suggest that the physical and social environment were more influential on momentary snack food intake than personal-level factors of affect and self-efficacy.

Strengths of this study include the repeated and detailed assessment in real-time of snack food consumption and a variety of environmental and personal factors; decomposition of influences on intake into those that contribute to fluctuations within individuals and differences between individuals; and focus on African American women, a population for whom new insights are needed to inform effective dietary interventions. Nonetheless, there are several limitations. First, the extent to which findings are generalizable to other African American women is unclear due to the nonprobability sample. Second, to make them appropriate for an EMA study and reduce respondent burden, some instruments were created or modified for this study (e.g., affect assessed using dichotomous response options rather than Likert scale, daily hassles checklist only administered at last signal of the day). Third, it is possible that relationships between food availability and expense and intake reflected the

context in which consumption occurred (i.e., restaurant proximity facilitated intake because the woman was in a restaurant rather than proximity prompting her to utilize it). However, the fact that a graded relationship was seen for number of good-tasting, high-calorie items and intake, help to minimize this concern. Fourth, food availability and expense were based on women's perceptions only and were only assessed for those who ate or drank since the last signal, although this captured most of the EMA signals (75.9%). Fifth, we conducted a large number of analyses, which increases the possibility of a type I error.

This study has multiple implications for future research on stress, the environment, and snack food intake in African American women. Testing hypotheses in population-based samples of African American women would yield more generalizable results. Further, because this is one of the first studies of its kind that uses EMA to understand correlates of dietary behaviors, our methodology could be improved in several ways. First, we recommend future studies ask about perceived food availability and expense at each EMA signal regardless of food or beverage intake and avoid framing environmental items as facilitators or barriers of eating. Second, a combination of event-contingent (completion of surveys when they eat or drink) and signal-contingent sampling at multiple random times per day may be useful in future studies. Such an approach would allow for an assessment of stress, affect, the environment, and eating at the time of consumption and eliminate any recall bias, therefore providing stronger data with which to examine antecedents and consequences of snack food intake. Third, while challenging in terms of keeping the EMA surveys brief, improving dietary assessment beyond a checklist of snack-type foods may provide a better understanding of how stress influences dietary intake. Some individuals may consume other foods or beverages, consume a larger amount of food, or avoid eating healthier foods (e.g., fruits and vegetables) in response to stress. We included three 24-hour dietary recalls as part of the study protocol, which we will combine with the EMA data for future analyses, but those data have drawbacks because of the longer recall period and coverage on only three of the seven days for which EMA survey data are available.

Conclusions

In conclusion, this study provides new insights into influences on day to day food choices in African American women. It suggests how factors that vary throughout the day may challenge women's ability to avoid energy-dense, nutrient poor snack foods. The results underscore the importance of public policies (e.g., fast food moratoriums) and private policies (e.g., within work sites) to curb ubiquitous availability of food, as well as addressing conditions of African American women's lives (e.g., financial vulnerability, discrimination, under-resourced neighborhood, underemployment, caretaking responsibilities) that give rise to daily hassles. Findings also suggest that mobile health (mHealth) interventions that take into account time-varying influences on food choices and provide real-time assistance in dealing with easy food availability and coping with stressors be beneficial in improving African American women's day to day food choices.

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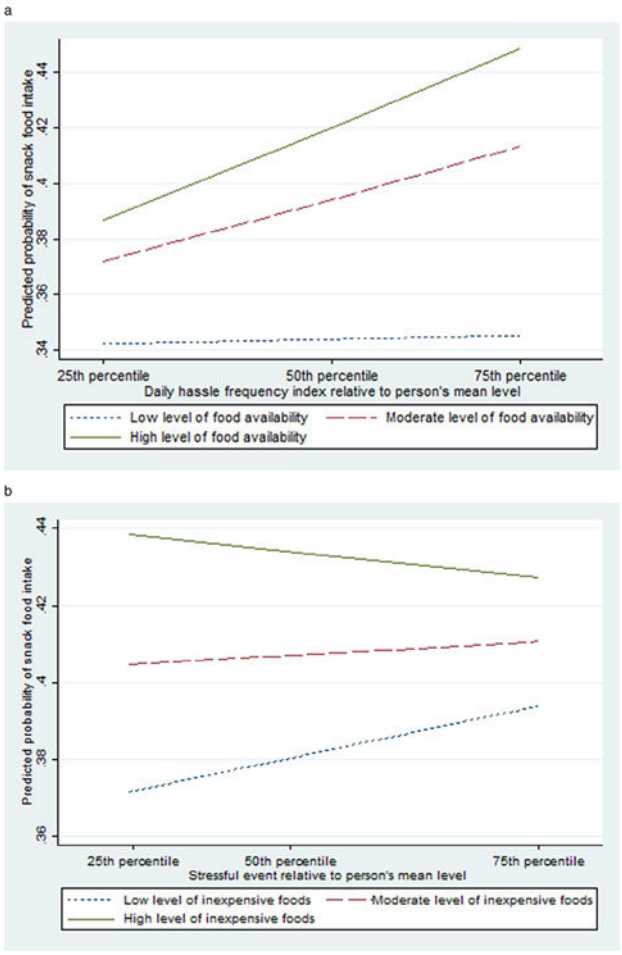

Fig. 1.

(a) Predicted probability of snack food intake by within-person daily hassles frequency and easy availability of food. (b). Predicted probability of snack food intake by with-person stressful event and inexpensive food availability.

Table 1

Descriptive statistics of sample characteristics and snack food intake, environmental factors, and personal factors (n = 100).

Age, mean and SD	**44.3**	**10.5**
Employment status, %		
Employed full-time	39.0	–
Employed part-time	35.0	–
Unemployed or other (e.g., disabled, retired)	26.0	–
Education, %		
High school diploma, GED, or less	19.0	–
Associate's degree or some college	36.0	–
Bachelor's degree	23.0	–
Graduate or professional degree	22.0	–
Annual per capita household income, %		
<$7500	33.0	–
$7500–18,749	35.0	–
≥$18,750	32.0	–
Automobile ownership, % Owner	65.0	–
Body mass index, Mean and SD	33.6	9.0
Body weight categories, %		
Underweight (<18.5)	0.0	
Normal weight (18.5–24.9)	14.4	
Overweight (25–29.9)	30.9	
Obese (>29.9)	54.6	
Snack food intake (0, 1), % One or more snack foods[a]	35.2	–
Food availability and expense (0, 1), % Yes[a]		
Easily available	57.4	–
Inexpensive	12.1	–
Near a restaurant, convenience store, bakery, or candy store	15.5	
Near a grocery store	4.9	–
Number of good-tasting, high-calorie foods or beverages available, %		
0 foods or beverages	9.8	–
1–2 foods or beverages	45.8	–
3+ foods or beverages	44.4	–
Daily hassles		
Stressful event (0, 1), % Yes[a]	16.8	–
Stressful social interaction (0, 1), % Yes[a]	11.5	–
Daily hassles frequency in logits (daily), Mean and SD[b]	-3.09	1.14
Affect		
Positive affect (0–5), Mean and SD[b,c]	0.89	0.95
Negative affect (0, 1), %[a]	9.3	–

Age, mean and SD	**44.3**	**10.5**
Self-efficacy (1–10), Mean and SD[b]	5.79	1.91
Hunger status (0, 1), % Hungry[a]	8.9	–

[a]These variables are interpreted as the average percent of the EMA signals a participant provided an affirmative response (e.g., On average, participants reported consuming snack foods at 35.2% of signals).

[b]These variables are interpreted as the average score across participants (e.g., On average, participants' mean self-efficacy across EMA signals was 5.79 on a 1–10 scale).

[c]Women reported at least one positive emotion at 44.3% of signals.

Table 2

Snack food intake regressed on environmental and personal factors.[a]

Variables	Concurrent relationships		Lagged relationships[b]	
	O.R.	95% C.I.	O.R.	95% C.I.
Food availability and expense[c,d]				
Within-person easily available[h]	1.68	(1.32, 2.13)	–	
Between-person easily availablej	1.01	(0.95, 1.07)	–	
Within-person inexpensive[h]	1.38	(0.96, 1.98)	–	
Between-person inexpensivej	1.07	(0.99, 1.15)	–	
Within-person near a restaurant, convenience store, bakery, or candy store[h]	2.02	(1.48, 2.74)	–	
Between-person near restaurant, convenience store, bakery, or candy storej	1.24	(1.01, 1.25)	–	
Within-person near a grocery store[h]	1.83	(1.03, 3.25)	–	
Between-person near a grocery storej	1.07	(0.94, 1.22)	–	
Within-person 1 good-tasting, high-calorie food or beverage available[h]	4.66	(2.47, 8.75)	–	
Within-person 2–3 good tasting, high-calorie food or beverages available[h]	8.61	(4.38, 16.94)		
Between-person 1 good-tasting, high-calorie food or beverage availablej	1.12	(0.95, 1.33)		
Between-person 2–3 good-tasting, high-calorie food or beverage availablej	1.15	(0.98, 1.33)		
Daily hassles [e,f]				
Within-person stressful event[h]	1.24	(0.97, 1.60)	1.29	(0.96, 1.73)
Between-person stressful eventj	1.16	(1.06, 1.28)	1.17	(1.04, 1.28)
Within-person stressful social interaction[h]	0.90	(0.67, 1.22)	1.08	(0.77, 1.52)
Between-person stressful social interactionj	1.10	(1.00, 1.22)	1.11	(1.00, 1.23)
Within-person daily hassle frequency[g]	1.14	(1.02, 1.28)	1.10	(0.96, 1.26)
Between-person daily hassle frequency[i]	1.20	(1.07, 1.35)	1.24	(1.08, 1.41)
Affect				
Within-person positive affect[g]	0.97	(0.88, 1.06)	1.05	(0.95, 1.17)
Between-person positive affect[i]	1.18	(1.03, 1.36)	1.21	(1.04, 1.40)
Within-person negative affect[h]	1.00	(0.71, 1.40)	0.80	(0.54, 1.19)
Between-person negative affect[j]	1.08	(0.97, 1.21)	1.11	(0.98, 1.25)
Self-efficacy				
Within-person self-efficacy[g]	0.96	(0.92, 1.01)	0.96	(0.90, 1.02)
Between-person self-efficacy[i]	0.89	(0.83, 0.95)	0.90	(0.84, 0.97)

[a] All models controlled for age, employment status, education, annual per capita household income, auto ownership, BMI, hunger status, survey block, and weekend or weekday.

[b] Within-person lagged predictors reflect responses from the immediate previous EMA signal. This includes lagged effects of survey 5 responses on snack food intake reported in survey 1 the next day. Observations were excluded if the immediate previous signal's survey was not completed.

[c] Number of observations for concurrent analyses with easy availability, inexpensive, near restaurant, and near grocery store were 1762.

[d] Number of observations for concurrent analyses within good-tasting, high calorie foods were 1061.

[e] Number of observations for concurrent analyses with daily hassles, affect, and self efficacy ranged from 1935 to 2339.

[f] Number of observations for lagged analyses ranged from 2224 to 2236 except daily hassles frequency, which was 1546 due to no lagged effects for day one.

[g] Within-person: deviation from her own mean. It is interpreted as the effect of a one-unit change for a given woman.

[h] Within-person: deviation from her own proportion. It is interpreted as a dummy, where the comparison group is within person moments when the dummy is 0. (For example, the within-person stressful event variable comparison group is times when she reported no stressful event.)

[i] Between-person: person-level mean. It is interpreted as the effect of a one-unit change at the person level where the comparison is to other women.

[j] Between-person: percentage across EMA signals for person scaled such that a one unit change represents a 10% change. It is interpreted as the effect of a 10% change at the person level where the comparison is to other women.

Table 3

Affect and self-efficacy regressed on snack food intake from the previous EMA signal.[a,b]

	Negative affect[c,d]		Positive affect[e,f]			Self-efficacy[e,g]		
	O.R.	**95% C.I.**	**b**	**S.E.**	**p-value**	**b**	**S.E.**	**p-value**
Within-person snack food intake[h,i]	0.90	(0.55, 1.49)	–0.01	0.05	0.86	0.01	0.10	0.92
Between-person snack food intake[j]	1.24	(0.93, 1.65)	0.17	0.06	0.01	–0.50	0.14	<0.01

[a] All models controlled for age, employment status, education, annual per capita household income, auto ownership, BMI, hunger status, survey block, and weekend or weekday.

[b] Number of observations: 1839.

[c] Estimated using binary logistic regression.

[d] Based on the distribution, negative affect was dichotomized as 0 and 1+ negative emotions.

[e] Estimated using ordinary least squares regression.

[f] Based on the distribution, positive affect was a count (0–5) of five positive emotions.

[g] Rated on a 10-point Likert scale.

[h] Within-person: deviation from her own proportion. It is interpreted as a dummy, where the comparison group is within person moments when a given participant did not report any snack food intake.

[i] Reflects responses from the immediate previous EMA signal and includes snack food intake reported in survey 5 on affect and self-efficacy reported in survey 1 the next day. Observations were excluded if the immediate previous signal's survey was not completed.

[j] Between-person: percentage across EMA signals for person scaled such that a one unit change represents a 10% change. It is interpreted as a 10% change at the person level where the comparison is to other women.