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Investigating the effects of rurality on stress, subjective well-being, and weight-related outcomes

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Abstract

Purpose: Rates of obesity are significantly higher for those living in a rural versus urban setting. High levels of stress and low levels of subjective well-being (SWB) have been linked to poor weight-related behaviors and outcomes, but it is unclear if these relationships differ as a function of rurality. This study investigated the extent to which living in a rural versus urban county ("rurality") moderated associations between stress / subjective wellbeing (predictors) and diet quality, dietary intake of added sugars, physical activity, and BMI (outcomes).

Methods: Participants were recruited from urban (n = 355) and rural (n = 347) counties in Washington State and self-reported psychological, demographic, and food frequency questionnaires while physical activity behavior was measured objectively.

Findings: After controlling for relevant covariates, levels of stress were positively associated with added sugar intake for those living in the urban county while this relationship was non-significant for those residing in the rural county. Similarly, SWB was negatively associated with added sugar intake, but only for urban residents. County of residence was also found to moderate

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Declaration of Competing Interest
The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

the relationship between SWB and BMI. Higher SWB was inversely associated with BMI for those living in the urban county while no relationship was observed for rural county residents.

Conclusions: These findings support the hypothesis that the relationships between stress / SWB and weight function differentially based on the rurality of the residing county. This work adds to the growing body of literature highlighting the role stress and SWB play in the rural obesity disparity.

Keywords

Stress; Subjective well-being; Obesity; Urban; Rural; Added sugar

Over the past several decades, rates of overweight and obesity have dramatically increased, particularly for those living in rural communities (Befort et al., 2012). The Centers for Disease Control and Prevention (CDC) (2016) estimate the prevalence of obesity to be significantly higher among adults living in rural (34.2%) compared to metropolitan counties (28.7%). Much of the research investigating the determinants of this disparity have focused on variations in individuals' weight-related behaviors and the socioeconomic and structural factors underlying them (Long et al., 2018; Congdon, 2017). Specifically, rural residents are more likely to be physically inactive and have unhealthier diets and these behaviors can be, at least partially, traced to reduced access to medical care, nutritional education, and facilities or amenities that foster healthy behaviors (e.g.,. recreations centers, grocery stores) (Hill et al., 2014). While these findings have aided in the development of tailored evidence-based interventions for rural communities, given the pervasive health disparities experienced by this population, identifying novel determinants of this disparity are needed. Investigations into psychosocial factors contributing to differential rates of obesity in rural versus urban settings has been limited and better understanding of how these factors operate may lead to more effective treatments. The purpose of this study is to shed light on two such psychosocial variables, perceived stress and subjective well-being (SWB), and investigate how their relationship with weight-related behaviors and outcomes may vary as a function of rurality.

Rurality and stress

Compared to rural localities, the urban physical environment tends to be marked by higher rates of pollution (both chemical and noise), lack of green/blue spaces, more traffic, and physical threats to safety (e.g., accidents, violence). Combined, these factors are believed to increase levels of stress and have a negative impact on mental health (Gruebner et al., 2017; Manning, 2019). Moreover, literature is emerging exploring how city living and urban upbringing may affect responses to stress. Compared to being raised in a rural area, growing up in an urban environment has been linked with a heightened response to acute stressors such as elevated cortisol responses and increased amygdala activity (Steinheuser et al., 2014; Lederbogen et al., 2011). Alternatively, compared to rural locales, the urban environment offers greater access to wealth and health services which may buffer the effects of stress on health behaviors and outcomes (Li et al., 2018; Dye, 2008). This contrasting evidence suggests that the relationship between stress and health behaviors and outcomes may be different among urban and rural residents.

Stress, weight, and weight-related behaviors

There is ample evidence linking stress with weight-related behaviors and outcomes. According to several reviews, chronic life stress has been positively associated with weight gain over time (Torres and Nowson, 2007; Wardle et al., 2011; Tomiyama, 2019). The mechanisms and pathways governing this relationship are complex, involving the interplay between cognition, behavior, physiology, and biochemistry (for a review see Tomiyama, 2019) (Tomiyama, 2019). For example, stress has been shown to undermine self-regulation (Pechtel and Pizzagalli, 2011) (cognition) which can lead to a heightened preference for energy-dense foods high in sugars and decreased levels of physical activity (behavior) (Adam and Epel, 2007; Stults-Kolehmainen and Sinha, 2014). Additionally, stressful events activate the hypothalamic-pituitary-adrenal axis (physiological) which promotes eating and fat deposition in the abdominal region (Tomiyama, 2019). Lastly, stress can lead to imbalances of the biochemical compounds that are relevant to weight and obesity. Specifically, leptin and ghrelin, two hormones that have been shown to suppress and stimulate appetite, respectively, have been found to be responsive to psychological stress (Daniels et al., 2023). It remains to be tested whether the relationships between stress, weight, diet, and physical activity function similarly for individuals living in an urban versus rural environment.

Subjective well-being and rurality

According to past research, rural residents have reported significantly higher SWB scores compared to their urban counterparts even after controlling for many possible confounds (Berry and Okulicz-Kozaryn, 2011; Requena, 2016). Although cities possess numerous attractions that produce satisfaction, these benefits appear to be outweighed by the cities' inconveniences (e.g., traffic, pollution, and high crime rates) which ultimately erode SWB (Glaeser et al., 2016). Additionally, rural localities have greater access to natural environments which have been linked to higher levels of both positive affect (McMahan and Estes, 2015) and SWB (White et al., 2017).

Subjective well-being, weight, and weight-related behaviors

The relationship between SWB and weight is conflicting in the literature. Older studies consistently identified a negative association between health related quality of life and obesity or BMI (Lean et al., 1998; Han et al., 1998; Hassan et al., 2003). However, more recent studies have challenged these findings suggesting the relationship may be curvilinear, depicted in an inverse U shape with peak happiness corresponding to an average healthy weight (Linna et al., 2013; Liu et al., 2022). Still others have identified a positive relationship where higher levels of body weight body were linked with higher overall psychological well-being (Archangelidi and Mentzakis, 2018).

Researchers have identified several psychological and behavioral mechanisms which may explain the relationship between SWB and weight. Healthy weights have been shown to affect happiness through appearance, health, and even income (Liu et al., 2022). Behaviorally, researchers have demonstrated a significant positive relationship between

SWB and a Mediterranean diet (Henríquez Sánchez et al., 2012; Moreno-Agostino et al., 2019) as well as with fruit and vegetable intake more specifically (Blanchflower et al., 2013; Ocean et al., 2019). While past studies have linked lower levels of SWB with soft drink consumption (Chang and Nayga, 2010), the relationship between SWB and added sugar specifically has yet to be determined. Moving to energy expenditure, a number of studies have found a positive correlation between SWB and higher level of physical activity (Panza et al., 2019; Pawlowski et al., 2011). Although these lines of research suggest a link between weight, added sugar intake, physical activity, and SWB, it is unclear if these effects differ based on the nature of the lived environment.

Study overview

The primary objective of this study is to examine the effect modification of county of residence (urban and rural) on the relationships between (1) stress or SWB, and (2) weight-related behaviors (added sugar intake and bouts of physical activity) and outcomes (BMI). To accomplish this goal, secondary analysis was performed on baseline data collected from the Seattle Obesity Study III whose broad objective was to compare and contrast weight-related behaviors and outcomes for participants living in two geographically and demographically distinct counties in Washington State. Based on previous research, we hypothesized that the effect of stress on BMI, diet quality, added sugar consumption, and bouts of physical activity will be more pronounced for urban versus rural participants. Similarly, it was also expected that the effect of SWB on weight, diet quality, added sugar intake, and physical activity will be stronger for those living in an urban compared to rural environment.

Method

Participants

Participants were recruited across two counties in Washington State: King (urban) and Yakima (rural). These geographical differentiations were based on the National Center for Health Statistics' (NCHS) urban-rural classification scheme for counties (Ingram and Franco, 2012) and were further validated by observed significant differences in population density between counties (*p's* < 0.001). Stratified, county-specific sampling was used to ensure all counties, as well as socioeconomic groups within each county, were equally represented. Inclusion criteria were defined as: 1) aged 21 – 59 years old, 2) not currently pregnant or breastfeeding, 3) had no mobility issues, and 4) identifying as being primary food shoppers in their households. The present analytical sample was based on $n = 624$ respondents for whome complete dietary, socioeconomic, psychosocial, and physical activity measures were available. All study procedures were approved by the Institutional Review Boards (IRBs) of respective study sites (University of Washington / Fred Hutchinson Cancer Research Center Human Subjects Division approval # 50,269; MultiCare Health Systems approval #16.07). Additional descriptions of recruitment and study procedures have been reported elsewhere (Buszkiewicz et al., 2020; Rose et al., 2020).

Procedure

Data were collected during in-person visits at study sites located at central locations within each county. Due to a large proportion of Yakima participants being unable to visit their respective site because of inflexible work schedules, 67% of study sessions from the rural site were completed in the participant's home. After consenting, participants self-reported sociodemographic, dietary, and psychosocial information via a computer-assisted survey tool. Questions were available in English and Spanish. Anthropometric measurements and accelerometer data were also collected. Participants were compensated for their time. Data was analyzed using IBM SPSS Statistics for Windows (Version 27).

Measures Predictor variables

Perceived stress was assessed by asking participants to report how frequently they felt stressed within the past 30 days (1= All the time…, 5= Not at all). Previous studies have found similarly worded single-item stress measures to be both reliable and valid and are considered an effective instrument for assessing stress in larger epidemiologic studies that lack space for multi-item measures (Littman et al., 2006). **Subjective well-being** was measured by having respondents indicate how often they felt happy in general (1 = All the time…, 5 = Not at all). A variation of this single-item measure has been used extensively in the literature, particularly in the field of behavioral economics (for a review see Helliwell & Barrington-Leigh, 2010 (Helliwell and Barrington--Leigh, 2010)), and its reliability has been deemed high enough to support analysis comparing group level means as in the current study (Krueger and Schkade, 2008).

Outcome variables

BMI scores were calculated using measured heights and weights obtained using calibrated scales (Tanita WB-110A digital body weight scale) (Tanita Corporation America, 2001) and stadiometers (Charder HM200P Portstad Portable Stadiometer) (Charder Medical, 2007) at the initial in-person visit by a trained staff member. **Diet quality** score was calculated by summing 13 components of the Healthy Eating Index (HEI) (2015) (Krebs-Smith et al., 2018). These components reflect the different food groups and key recommendations in the 2015–2020 Dietary Guidelines for Americans (DeSalvo et al., 2016). This measure has shown to be both reliable and valid (Reedy et al., 2018). HEI component scores were calculated from Food Frequency Questionnaires which asked participants to report their average consumption of >100 foods over the past year (Patterson et al., 1999). **Added sugar** scores were generated using the Added Sugar Subscale of the Healthy Eating Index (HEI) (2015) (Krebs-Smith et al., 2018). These scores were then reverse coded to aid in interpretation with higher scores corresponding to higher intake of added sugar. **Average bouts of moderate to vigorous physical activity (MVPA)** were assessed using objectively measured activity data taken from an Actigraph WGT3X accelerometers. Sustained bouts of MVPA were identified as having a duration of at least 8 consecutive minutes of elevated activity, or 10 min allowing for up to 2 min of rest within that timeframe (known as 'modified 10-min' bouts). Average bouts of MVPA were calculated by dividing the total number of bouts by valid measurement days (Buszkiewicz et al., 2020).

Demographic variables

Self-reported age, gender, ethnicity, marital status, education, and income were captured.

Plan of analysis

First, demographic differences were examined. Next, linear multiple regression analysis was performed to test the extent to which county of residence, stress, and their interaction predicted each outcome variable while controling for the following covariates: age, gender, marital status, education, Hispanic ethnicity, and income. However, issues were discovered with Hispanic ethnicity (issues of multicollinearity) and income data (data missing not completely at random between groups) and those variables were subsequently removed from analysis. Additionally, a total of $n = 3$ participants were excluded from analysis for missing data pertaining to marital status ($n = 1$) and SWB ($n = 2$), resulting in an effective sample of $n = 702$. Test of interaction was performed to examine significant stress x county interaction. Identical analysis was performed with SWB replacing stress as a predictor variable. Interest was paid to the magnitude of effect for each variable (standardized beta coefficient; β) as well as their statistical significance (p-value). Based on this proposed analysis, *a priori* power calculations indicated our sample size would afford at least 80% power to detect effects of small-medium size, $f = 0.145$ (where small = 0.10 and medium = 0.25) (Cohen, 1992).

Results

Sample demographic characteristics

Participant demographics are presented in Table 1. Those from the urban county were significantly older, more likely to be male, and less likely to be married compared to participants from the rural county. In contrast, most rural participants identified as Hispanic and reported significantly lower levels of education and income.

Descriptive statistics for predictor and outcome variables

Descriptive statistics for predictor and outcome variables are presented in Table 2. Urban residence had significantly lower BMIs and were less likely to be obese compared to participants living in the rural county. Moreover urban participants reported significantly higher diet quality scores and engaged in significantly more frequent bouts of MVPA relative to their rural counterparts. No significant differences were observed between the two groups in perceived stress, SWB, or added sugar intake.

BMI

Stress as predictor—Both perceived stress ($B = 1.332$, $\beta = 0.191$, $p = .020$) and county of residence ($B = 3.261$, $\beta = 0.464$, $p < .001$) significantly predicted BMI, but their interaction was non-significant. Additionally, age ($B = 0.070$, $\beta = 0.103$, $p = .007$) and marital status ($B = -1.088$, $\beta = -0.077$, $p = .036$) significantly predicted BMI. The regression model significantly predicted BMI scores, $R^2 = 0.143$, $p < 0.001$. A summary of significant main effects, interaction effects, and posthoc notes for each output variable as they relate to stress are presented in Table 3.

SWB as predictor—SWB (*B*= −2.519, β= −0.281, *p*= .003), and the SWB x county interaction (*B* = 0.923, β= 0.570, *p*= .006) were significant predictors of BMI. Age was the only significant covariate (*B* = 0.067, β= 0.098, *p*= .009) and county of residence did not significantly predict BMI scores. Posthoc analysis examining the SWB x county interaction showed SWB significantly predicted BMI only for those living in the urban county (*B*= −1.572, β= −0.150, *p*= .004), but not for those living in the rural county. The overall regression model significantly predicted BMI scores, R^2= 0.146, $p < 0.001$. A graphical depiction of the SWB x county interaction is presented in Fig. 1. A summary of significant main effects, interaction effects, and posthoc notes for each output variable as they relate to SWB are presented in Table 4.

Diet quality

Stress as predictor—County, stress, and the stress x county interaction were not significantly associated with diet quality. Gender (*B* = 2.725, β= 0.111, *p*= .003), marital status (*B* = 1.492, β= 0.076, $p < .040$), and education level (*B* = 1.380, β= 0.271, $p < .001$) emerged as the only significant predictors. The regression model significantly predicted diet quality scores, R^2= 0.126, $p < .001$.

SWB as predictor—SWB (*B* = 2.723, β= 0.218, *p*= .021), age (*B* = 0.072, β= 0.076, *p*= .046), gender (*B* = 2.491, β= 0.076, *p*= .007), and education level (*B* = 1.311, β= 0.257, $p < .001$) were found to significantly predict diet quality. County of residence and the SWB x county interaction did not significantly predict diet quality scores. The overall regression model significantly predicted diet quality scores, R^2= 0.129, $p < 0.001$.

Added sugar intake

Stress as predictor—Stress (*B* = 0.396, β= 0.220, *p*= .012), and stress x county interaction (*B*= −0.176, β= −0.337, *p*= .011) significantly predicted added sugar intake. County of residence and all covariates were non-significant. Posthoc analysis showed that for those living in the urban county, higher levels of stress were positively associated with added sugar intake (*B* = 0.211, β= 0.113, *p*= .030). However, this relationship was non-significant for rural participants. The overall regression model significantly predicted added sugar consumption, R^2= 0.021, *p*= .040. A graphical depiction of this stress x county interaction is presented in Fig. 2.

SWB as predictor—County (*B*= −1.015, β= −0.558, *p*= .0006), SWB (*B*= −0.577, β= −0.248, *p*= .013), and the SWB x county interaction (*B* = 0.213, β= 0.506, *p*= .022) significantly predicted added sugar intake. No covariates were significant predictors. Posthoc analysis showed that for those living in the urban county, levels of SWB were negatively associated with added sugar intake (*B*= −0.366, β= −0.132, *p*= .012). However, this relationship was non-significant for rural participants. The overall regression model accounted for a significant level of variance in added sugar intake, R^2= 0.020, $p = 0.049$. A graphical depiction of this stress x county interaction is presented in Fig. 3.

Average bouts of MVPA

Stress as predictor—County, stress, and the stress x county interaction were not significantly associated with bouts of MVPA. Age (B= −0.014, β= −0.115, p= .003), gender (B= −0.622, β= −0.196, p < .001), and education (B= −0.097, β= −0.149, p= .008) significantly predicted bouts of MVPA. The overall model significantly predicted bouts of MVPA, R^2= 0.090, p < 0.001.

SWB as predictor—County significantly predicted bouts of MVPA (B= −0.545, β= −0.432, p= .029), but SWB and the SWB x county interaction did not. Age (B= −0.015, β= −0.118, p= .003), gender (B= −0.620, β= −0.195, p < .001), and education (B= −0.111, β= −0.169, p= .002) were the only statistically significant predictors. The overall regression model significantly predicted average bouts of MVPA, R^2= 0.086, p < 0.001.

Discussion

The goal of this study was to examine the effect modification of county of residence (i.e., urban versus rural) on the relationships between stress / SWB and weight-related behaviors and outcomes. The results support the hypothesis that several of these relationships function differentially based on environment in which the participants live. To start, the relationship between stress and added sugar intake was moderated by county of residence. Specifically, stress was positively associated with added sugar intake for the urban participants, but was non-significant for those residing in the rural county. Past studies consistently show that higher stress increases preference for foods high in sugar (Torres and Nowson, 2007; Tomiyama, 2019). While this line of research would support the relationship observed in the urban county, the null effect observed among rural residents show that this relationship may actually be more complex. In our study, the majority of rural residents identified as Hispanic, and rural residents reported less added sugar consumption than their urban peers. This finding is inconsistent with other studies where Hispanic participants were found to consume higher levels of added sugar compared to their non-Hispanic White counterparts (Rosinger et al., 2017). Interestingly, across both counties, residents reported similar levels of stress, and stress was associated with increased added sugar consumption, consistent to previous research (Torres and Nowson, 2007; Tomiyama, 2019). This consistency and inconsistency of our findings to previous research suggest that the relationship between stress, rurality, and added sugar consumption maybe more complex and nuanced and begs for further exploration on why people may be reacting differently to stressors across rurality.

While future research is needed to uncover the specific mechanism(s) governing this relationship, a number of pathways merit consideration. One explanation may lie in the different types of stressors experienced by those on opposing ends of the socioeconomic ladder. While no significant differences were observed in the levels of perceived stress, it does not necessarily follow that participants from each county experienced the same stressors. For example, past research has shown that individuals lower on the socioeconomic ladder report a higher number of stressors related to finances, social relations, employment situations, and health complaints compared to their higher SES counterparts (Weyers et al., 2010; Senn et al., 2014). This notion may be supported in the current study as participants living in the rural county reported significantly lower incomes and educational level compared to their urban counterparts (Table 1). Additionally, as rural residents predominantly identified as Hispanic/Latino (95.4%), they may face unique stressors associated with immigration, acculturation, and racial discrimination not experienced by the majority White participants from the urban county (Torres, 2010). Even if we assume the different populations experienced the same stressors, it is possible they may differ in how these stressors are coped with or managed. For instance, cultural differences (i.e., collectivist versus individualist cultural orientations) (Kuo, 2014) and socioeconomic status (Caplan and Schooler, 2007) have both been found to moderate coping strategies. Based on this evidence, variations in types of stressors as well as how those stressors are managed represent two factors which may, at least partially, explain why stress was positively associated with added sugar intake for urban residents, while no such effect was observed for their rural counterparts. In addition to variation in stressors and coping strategies, differential access to food stores may partially explain differences in the relationship between stress and added sugar between urban and rural residents. Past research has shown significant differences in spatial access from the home to the food environment between urban/suburban and rural areas. Specifically, rural areas tend to have greater proximity, lower variety, and lower density of food stores compared to their urban counterparts (Sharkey, 2009). Given this evidence, it is possible the null relationship between stress and added sugar intake observed for rural residents may simply be due to barriers in access to high sugar foods.

These explanations for the differential relationships observed between stress and added sugar consumption may also be applicable to those of SWB and added sugar. Similar to stressors and coping strategies, determinants of SWB, as well as strategies people use to improve their SWB, have been shown to vary across populations and contexts (Fischer et al., 2021; Chen et al., 2021). Alternatively, limited access to food stores in the rural county may, at least partially, explain why SWB was not significantly associated with added sugar intake in this sample.

Across both counties, a significant negative relationship was observed between SWB and BMI. However, county of residence was found to moderate this effect where lower levels of SWB were significantly linked to higher BMIs for those in living in the urban county, but not for those residing in rural county. One explanation for this effect may reside in the baseline difference in BMIs between counties. Specifically, urban participants had significantly lower BMIs ($M = 27.7$) compared to those from the rural ($M = 32.5$) county. Based on this variance, the significant link between SWB and BMI in the urban county may have nothing to do with the ruralness of the county, but instead, indicate this relationship only exists at lower BMIs. Such an explanation has support in the literature where past studies have suggested the relationship between SWB and BMI is not linear, but an inverted U-shape (Linna et al., 2013; Robertson et al., 2015; Clark and Etilé, 2011). In other words, SWB increases with BMI up to a certain threshold and then turns negative. Starting with the positive side of the curve, it is theorized that some level of SWB is sacrificed to maintain a lower weight (e.g., ordering the healthier option instead of the higher calorie food you really want). At some point however, higher weights lead to physical ailments and stigmatization which negatively affect SWB. Applying this concept to the current study, it is possible that participants from the urban county, who have lower average BMIs, are on the ascending part of the curve while those from the rural county are closer to the apex point of the curve.

An alternative explanation for the moderating role of county in the relationship between SWB and BMI also resides in the base weights of the population groups, but focuses on how social comparisons affect individuals' perception of their own weight and in turn, how these perceptions affect SWB. Evidence suggests individuals adjust perceptions of their own weight based on the weight of those around them (Ali et al., 2011; Christensen and Jæger, 2018). Moreover, in settings where larger body sizes are common, a recalibration to the range of what body sizes are perceived as "normal" occurs and the threshold of what constitutes overweight is shifted upward (Robinson, 2017). In current study, 61.3% of rural participants were classified as obese and engaging in social comparisons with other community members may alter the perception of what a healthy weight is. In situations where higher weights become the new normal, being obese may be less stigmatized and exert less influence on an individual's SWB (Robinson, 2017). In contrast, obesity is significantly less common in the urban county (27.9% of the sample population) and in this context, carrying excess weight may be more noticeable and stigmatized and thus, have a greater impact on individuals' subjective well-being.

As the results of this study offer new insight into how the rurality of the lived environment impacts associations between stress, SWB, and weight-related behaviors and outcomes, they should be interpreted within the study's limitations. To start, these findings need to be considered within the broader scope of ethnic and sociodemographic differences between comparison groups. Specifically, in addition to differences in rurality, significant differences were observed based on gender, education level, household income, and ethnicity. While some factors were controlled for in the analysis, others (i.e., income and ethnicity) could not be. As a result, it is possible one or more of these characteristics may be contributing to the effects observed in the study, and thus, should be acknowledged when discussing potential mechanisms which may account for these relationships. Moreover, the unique socioeconomic characteristics of these counties may limit the generalizability of these findings to other regions of the country. Future studies should look to replicate these results across a number of sociodemographic and ethic contexts.

Although the authors conducted *a priori* power analysis and believed the sample size would be sufficient to detect the hypothesized effects, this assumption may have proved incorrect. For example, while a number of studies reported effect sizes that would be detectible in the current study (e.g., Mouchacca, Abbott, & Ball, 2013) others do not (e. g., Wardle et al., 2011). This limitation may explain why several relationships that were expected to be significant based on previous studies (e.g., a negative association between stress and MVPA) were not observed in the current study. Additionally, the single-item measures of stress and SWB may have lacked precision and obfuscate the complexities surrounding the relationships between stress, SWB, and weight. For instance, assessment of SWB used in this study may be adequate to assess a person's level of happiness in general, but lacks the exactitude to examine fluctuations across a time period. Experience Sampling Methods (also called Ecological Momentary Assessment (EMA), in which participants are prompted at random intervals to record their current circumstances and feelings) and the

Day Reconstruction methods (DRM) are two methodologies that may be useful in capturing granular changes to stress and SWB (Krueger and Schkade, 2008). Future studies should look to examine the relationships between stress, SWB, and weight using a variety of conceptualizations and measures.

Findings presented in this study have implications for both future research and public health practice. It is well established that tailoring weight management interventions to the unique characteristics of the target populations constitutes a key strategy for success (Gibson and Sainsbury, 2017). Furthering our understanding of the complex interplay between weight, diet, and psychological factors will allow for the development of more effective weight management interventions to address rural health disparities. The null relationship between SWB and BMI observed in the rural community may be particularly worthy of future investigation and application. Specifically, this lack of association may be indicative of low perceived benefit associated with maintaining a healthy weight (a key determinant of behavior change in the Health Belief Model (James et al., 2012)) and may serve as a possible point of intervention to be targeted in rural populations.

Conclusion

Living in a rural community significantly increases one's risk of becoming overweight and obese. Much of the research in this domain has focused on the differences in the physical environment and limited attention has been paid to the role psychosocial factors may play in explaining this health disparity. The goal of this study was to expand this literature and investigate the potential influence stress and SWB have on weight-related behaviors and outcomes between urban and rural individuals. Specifically, it was hypothesized that the relationships between stress, SWB, and weight-related outcomes would differ as a function of rurality. Results partially support this notion where county of residence was found to moderate the relationships between stress, SWB, and added sugar intake as well as between SWB and BMI.

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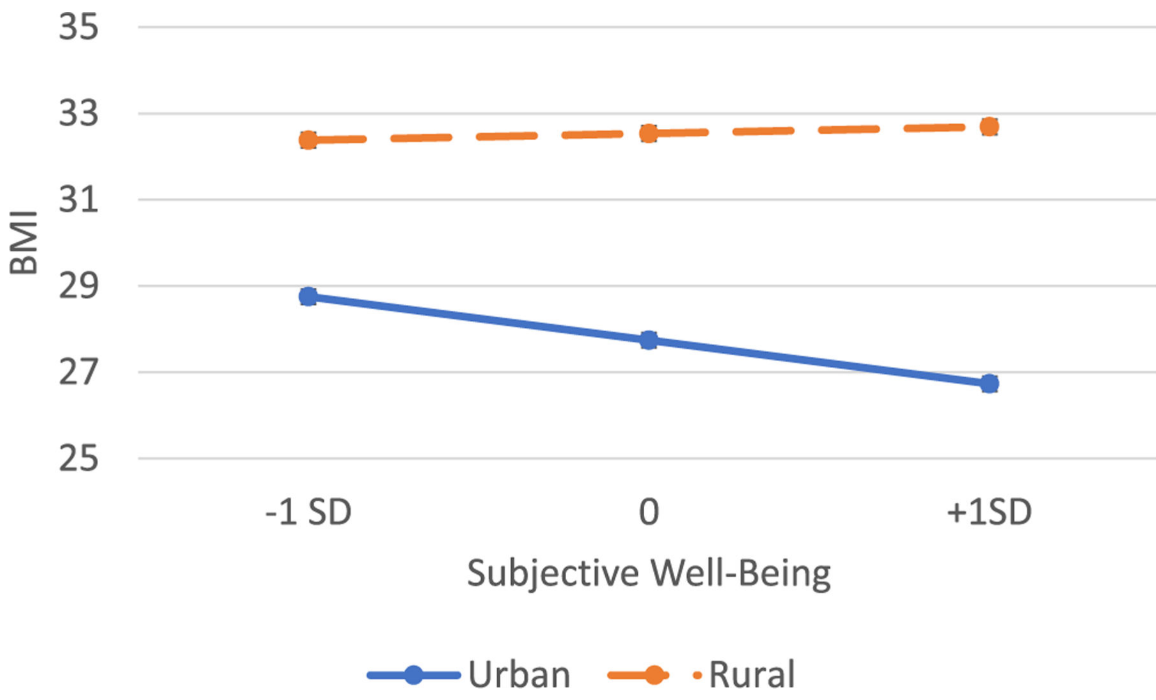

Fig. 1.
Relationship between subjective well-being and BMI urban (King) and rural (Yakima) counties. Regression line for the urban county is significant at $p < .05$. Regression line for the rural county is non-significant. Subjective well-being is expressed as z-scores. Error bars represent standard errors.

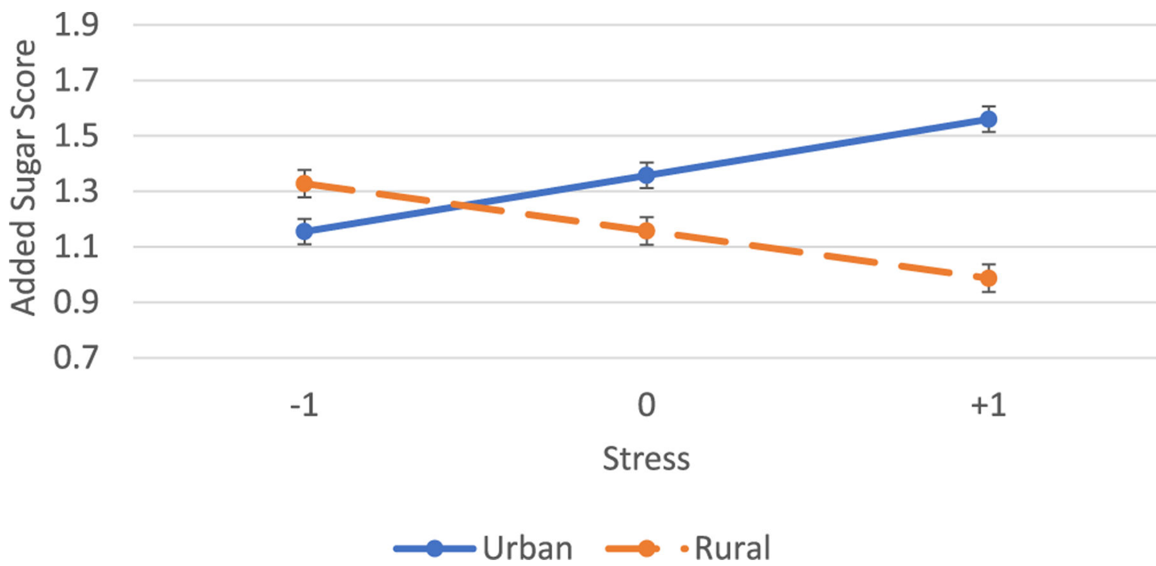

Fig. 2.

Relationship between stress and added sugar intake for urban (King) and rural (Yakima) counties. Regression line for urban county is significant at $p < .05$. Regression line for the rural county is non-significant. Stress is expressed as z-scores. Error bars represent standard errors.

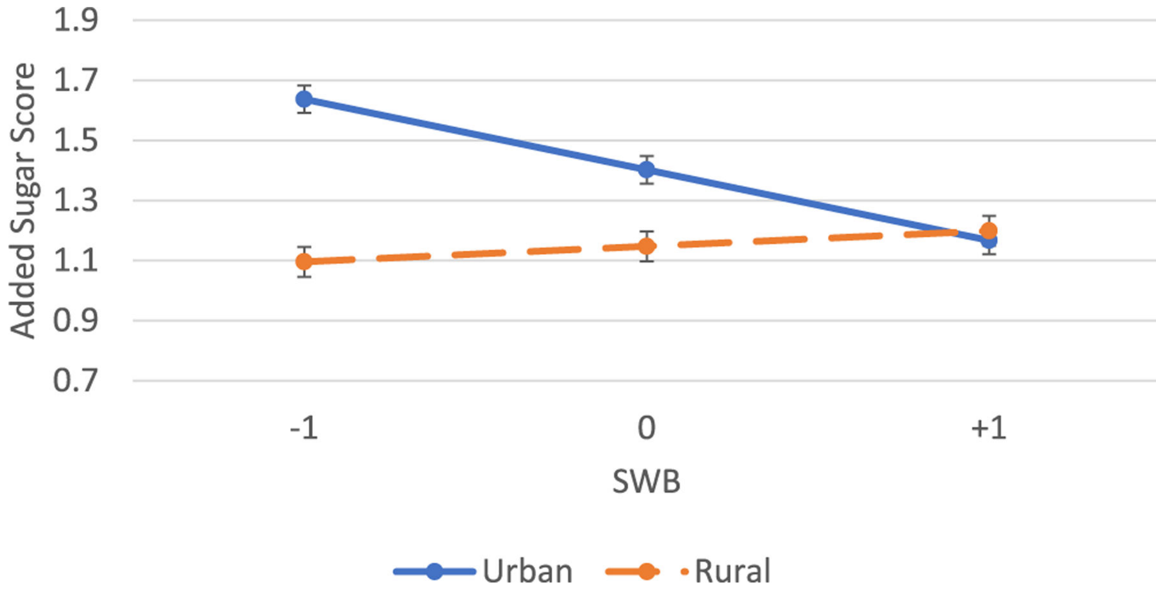

Fig. 3.

Relationship between SWB and added sugar intake for urban (King) and rural (Yakima) counties. Regression line for urban county is significant at $p < .05$. Regression line for the rural county is non-significant. SWB is expressed as z-scores. Error bars represent standard errors.

Table 1

Sample demographics across counties.

Variable	Urban (King)	Rural (Yakima)	Total
Participants, *n*	355	347	702
Age; mean (SD) *	46.9 (10.5)*	41.3 (9.4)	44.2 (10.3)
Gender; n (%)			
Male *	115 (32.4%)	24 (6.9%)	139 (19.8%)
Female *	240 (67.6%)	323 (93.1%)	563 (80.2%)
Education; n (%)			
High school or less *	21 (5.9%)	275 (79.3%)	296 (42.0%)
Some college *	84 (23.7%)	52 (15.0%)	136 (19.4%)
Bachelors or more *	250 (70.4%)	20 (5.8%)	270 (38.6%)
Income			
≤ $50,000 *	110 (31.6%)	248 (89.9%)	358 (57.3%)
> $50,000 *	238 (68.4%)	28 (10.1%)	266 (42.6%)
Marital Status; n (%)			
Not Married *	188 (53.0%)	126 (36.3%)	314 (44.7%)
Married *	167 (47.0%)	221 (63.7%)	388 (55.3%)
Race/Ethnicity; n (%)			
White, Non-Hispanic *	264 (74.4%)	12 (3.4%)	276 (39.4%)
Hispanic *	17 (4.8%)	329 (95.4%)	346 (49.4%)
Black, Non-Hispanic *	30 (8.4%)	0 (0.0%)	30 (4.3%)
Asian *	21 (5.9%)	0 (0.0%)	21 (3.0%)
Other *	22 (6.2%)	4 (1.2%)	28 (4.0%)

*Significant difference between groups, $p < 0.05$.

Table 2

Descriptive statistics for predictor and outcome variables for urban and rural counties.

Variable	Urban (King)	Rural (Yakima)	Total
Participants, *n*	355	347	702
BMI; mean (SD) *	27.7 (6.7)	32.5 (6.5)	30.1 (7.0)
Weight Status; n (%)			
Normal *	145 (40.8%)	35 (10.1%)	180 (25.6%)
Overweight	111 (31.2%)	99 (28.5%)	210 (29.9%)
Obese *	99 (27.9%)	213 (61.4%)	312 (44.4%)
Stress; mean (SD)	2.8 (1.0)	2.7 (1.2)	2.7 (1.0)
SWB; mean (SD)	3.7 (0.6)	3.8 (0.9)	3.8 (0.78)
Diet Quality score; mean (SD) *	69.0 (9.8)	64.2 (9.2)	66.6 (9.8)
Added sugar score inverse; mean (SD) *	1.4 (1.8)	1.1 (1.9)	1.3 (1.8)
Average bouts of MVPA; mean (SD) *	1.1 (1.2)	.78 (1.3)	.96 (1.3)

*Significant difference between groups, $p < 0.05$

Note. BMI = body mass index. SWB = subjective well-being. MVPA = moderate to vigorous physical activity.

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Table 3

Summary of significant main effects, interaction effects, and posthoc notes for the input variable of stress.

Outcome Variable	Main Effect of Stress	Main Effect of County	Stress x County Interaction	Posthoc Notes
BMI	Positive relationship, p=.020	Higher rural, p<.001,	–	
Diet Quality	–	–	–	
Added Sugar	Positive relationship, p=.012	–	p=.008	**Urban:** p=.030, positive relationship; **Rural**: Non-significant
MVPA	–	–	–	

Note. BMI = body mass index. MVPA = moderate to vigorous physical activity. - = Non-significant.

Table 4

Summary of significant main effects, interaction effects, and posthoc notes for the input variable of subjective well-being.

Outcome Variable	Main Effect of SWB	Main Effect of County	SWB x County Interaction	Posthoc Notes
BMI	Negative relationship, p=.003	–	p=.006	**Urban**: Negative relationship, p=.004,; **Rural**: Non-significant
Diet Quality	Positive relationship, p=.021	–	–	
Added Sugar	Negative relationship, p=.013	Higher urban, p=.029	p=.022	**Urban**: Negative relationship, p=.012,; **Rural**: Non-significant
MVPA	–	–	–	

Note. SWB = subjective well-being. BMI = body mass index. MVPA = moderate to vigorous physical activity. - = Non-significant.