Spring 2021

Buffering Effects of Support Resources on Perceived Stress And Socioeconomic Status in Predicting Longitudinal Physical Activity Among African American Women

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BUFFERING EFFECTS OF SUPPORT RESOURCES ON PERCEIVED STRESS AND SOCIOECONOMIC STATUS IN PREDICTING LONGITUDINAL PHYSICAL ACTIVITY AMONG AFRICAN AMERICAN WOMEN

by

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Bachelor of Science
University of South Carolina, 2017

Submitted in Partial Fulfillment of the Requirements

For the Degree of Master of Arts in

Psychology

College of Arts and Sciences

University of South Carolina

2021

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ABSTRACT

Physical activity (PA) plays an integral role in reducing risk for the leading causes of death, including cardiovascular disease, stroke, cancers, and type two diabetes. Lower rates of physical activity (PA) among African American women continue to perpetuate health inequities. Both perceived stress and low socioeconomic status (SES) negatively impact PA, but the presence of support resources may moderate these effects. Secondary data analyses of female African American caregivers (n = 143) were conducted using data from the Families Improving Together (FIT) for Weight Loss trial (R01DK067615; PI Wilson DK) to examine the moderating effects of supports (self-efficacy, perceived social support from friends, family, and significant other, and collective efficacy) on perceived stress and annual, unadjusted income in predicting PA over 16 weeks. Validated measures of stressors and supports were assessed at baseline. Light PA and moderate-to-vigorous PA were assessed using seven-day accelerometry estimates at three time points over sixteen weeks (baseline, 8 weeks, 16 weeks). Based on the stress-buffering hypothesis, the present study examined whether the presence of support resources at intrapersonal (self-efficacy), interpersonal (perceived social support from friends, family, and significant other), and neighborhood levels (informal social control) buffered the effects of perceived stress and low SES on PA overtime in underserved African American women under high, but not low, levels of stress. Results indicated that social support buffered the negative effect of stress on MVPA at baseline, such that under conditions of high social support, perceived stress was associated with greater MVPA.

For LPA, this relationship was not significant. However, there was a marginally significant three-way interaction between stress, self-efficacy and time for LPA. Specifically, at baseline under conditions of high self-efficacy, stress was associated with greater LPA, whereas under conditions of low self-efficacy for PA, stress was not significantly associated with LPA. Additionally, there was a time by collective efficacy (informal social control) interaction such that among those with higher perceptions of informal social control there was positive association with MVPA overtime. Finally, age demonstrated a negative main effect on MVPA, and income had a positive main effect on MVPA. For the income models, none of the models for LPA and MVPA significantly improved the model fit. The results of this study highlight the moderating effect of support resources on the relationship between perceived stress and PA among African American women. Findings from this study could inform future health promotion programs and the highlight the importance of integrated components of stress and resources for PA among African American women.

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CHAPTER 1

INTRODUCTION

There are numerous health benefits of physical activity (PA) that have been well-established that include reduced rates of all-cause mortality, coronary heart disease, type 2 diabetes, certain types of cancers, depression, and stroke (Benjamin et al., 2018; Lee et al., 2012). While the overwhelming majority of studies to date have focused on the health benefits of moderate-to-vigorous PA (MVPA), recent evidence has shown that light physical activity (LPA) may also reduce the risk for cardiovascular disease and all-cause mortality risk independent of MVPA (Chastin et al., 2019; Loprinzi, 2017). LPA promotion may be a more accessible means to increase PA among sedentary individuals because LPA does not require the same level of dedicated time commitment or planning as MVPA since it usually involves minor bouts of increases in movement during daily living. Despite these numerous and robust health benefits, only 49.7% of US adults report participating in adequate PA (Benjamin et al., 2018). Women in particular report significantly lower rates of PA (46.7%) compared to men (52.9%) (Benjamin et al., 2018). Notably, African American women have the lowest prevalence of PA among any sex and race demographic group (35.5%), placing them at a higher risk of developing chronic diseases related to physical inactivity (Centers for Disease Control and Prevention, 2017; Williams, Yore, & Whitt-Glover, 2018). Despite having higher risk for physical inactivity, African American women are underrepresented in PA research (Harley et al., 2009; Mama et al., 2018; Siddiqi et al., 2011). Thus, more studies are needed to better understand the various factors related to PA behavior among African American women to inform the development of more effective health promotion and prevention interventions for this high-risk group.

A factor that is a common barrier to PA among African American women is perceived stress (Stults-Kolehmainen & Sinha, 2014). Perceived stress refers to demands that threaten to exceed an individual's perceived resources (Cohen, Kamarck, & Mermelstein, 1983; Dunkel Schetter, Schafer, Lanzi, Clark-Kauffman, Raju, Hillemeier, et al., 2013; Lazarus & Folkman, 1984). A key element of stress is the individual's appraisal of threat (Lazarus & Folkman, 1984). When a situation or stressor is beyond an individual's perceived coping ability, they experience negative emotion that can lead to unhealthy behavior, such as physical inactivity and prolonged screen time (Hruby et al., 2016; Lazarus & Folkman, 1984). African American women are differentially exposed to contextual stressors (Geronimus, 2001; Hicken, Lee, Morenoff, House, & Williams, 2014; Jackson, Knight, & Rafferty, 2010) which could explain the disparity in PA participation. Specifically, because African American women continue to face stressors related to systemic racial and gender injustices in the US (Geronimus, 2001), it is especially important to identify factors that might mitigate the negative effect of stress on PA.

Socially-determined factors such as low socioeconomic status (SES) and neighborhood safety have been associated with an increased risk of death, non-communicable diseases, and poor health behaviors (Alcántara et al., 2020; Benjamin et al., 2018). These social determinants of health are not distributed evenly in the US and are associated with health inequities, which are defined as systematic, unjust, and avoidable differences in health between groups in a population that are based on risks and resources conferred by one's social standing (Williams et al., 2016). Structural and contextual factors related to SES have been shown to be important determinants of health. A significant source of stress among African Americans is the lack of financial resources. (Dunkel Schetter, Schafer, Lanzi, Clark-Kauffman, Raju, & Hillemeier, 2013; Guardino, Hobel, Shalowitz, Ramey, & Dunkel Schetter, 2018; Peirce, Frone, Russell, & Cooper, 1996). Previous research has consistently identified income and employment as two of the most salient factors in determining health and health behaviors (Alcántara et al., 2020; Bauman et al., 2012; Kepper et al., 2019). Further, the stress-inducing effects of low income have been hypothesized to be more salient among African Americans than among White populations due to the compounded effects of contextual factors (lack of access to health foods and spaces for PA, caregiving burden) (Geronimus, 1992). Researchers have called for the inclusion of multiple forms of stress in understanding the relationship between stress and health disparities (Åslund et al., 2014) to better capture the unique contributions of each factor in determining health behaviors. The current study aimed to address this gap in the literature by including measures of both financial (e.g. annual income) and perceived stress in understanding buffering effects on PA (Figure 1).

Importantly, some investigators have identified potential moderating factors that attenuate or buffer the effects of stress on health behaviors and health outcomes. These buffering effects can occur across psychological, social, community and environmental factors (Ayotte et al., 2010; Fan et al., 2011; Robinette et al., 2013; Schumacher et al., 2017). Thus, understanding resources that could buffer perceptions of stress among

African American women may be helpful for improving engagement for health behaviors such as PA.

The stress-buffering hypothesis purports that the presence of social support is protective during times of elevated stress (Cohen & Wills, 1985). That is, under high stress conditions, those with greater perceptions of supports should be protective against the negative effects of stress. Notably, the stress-buffering hypothesis has traditionally been applied to understanding negative health outcomes, such as cardiovascular disease (Bowen et al., 2014; Steptoe, 2000) and mental health outcomes (Stockdale et al., 2007). These deficit-based models typically hypothesize that those under high support will be buffered from stress and will maintain their current health status. Conversely, the current study assessed stress-buffering effects on PA, which is a protective health behavior. Thus, unlike traditional buffering studies, one might expect an increase in PA under conditions of high support during high stress. Further, in addition to social support, the present study expanded on the stress-buffering hypothesis to assess the moderating effects of buffering resources related to intrapersonal, social and community factors on perceived stress and income in determining PA outcomes among African American women over 16 weeks.

1.1 Theoretical Background

Perceived social support, perceived stress, and PA. The most well-established buffering factor—both in general and in the context of health behaviors—is perceived social support. Perceived social support has been defined as the extent to which important social network members such as friends, family, and significant other are perceived to be available to provide support, care and warmth (Cohen & McKay, 1984). Empirically, although the buffering effect of social support has been strongly supported in the area of cardiovascular outcomes, very few studies have assessed the buffering effects of social support on PA. While some studies have found that perceived social support from families, significant others, and partners in a PA group buffered stress in predicting PA outcomes (Ayotte et al., 2010; Brunet et al., 2014; Strom & Egede, 2012), others have shown null effects (Steptoe, Wardle, Pollard, Canaan, & Davies, 1996). This discrepancy in the literature highlights the need for more research to better understand for whom and under what circumstances stress-buffering effects on PA may occur. Since African American women are exposed to additional contextual stressors related to in the US relative to majority groups (Geronimus, 2001), it is especially important to identify factors that might mitigate the negative effect of stress on PA. The present study expanded on past literature by evaluating buffering effects of support resources on PA engagement in a sample of African American women.

Some research has shown that social support may be uniquely helpful for maintaining PA routines over time (Anderson et al., 2006; Harley et al., 2009; Israel et al., 2006; Kinnafick et al., 2014; Marcus et al., 2000; Schumacher et al., 2017; Strom & Egede, 2012). However, regarding social support as a buffer for stress on PA outcomes, there is much less evidence. One study investigated the cumulative impact of neighborhood greenspace, stress, and social support on PA engagement (Fan et al., 2011). The investigators found that access to park spaces (green spaces, public recreation, and socialization opportunities) directly increased engagement in PA and indirectly reduced stress through increased opportunities for social support. Another study among middle-age adults found that social support had an indirect, positive effect on PA through its negative effect on perceived barriers (Ayotte et al., 2010). Further, a study among young adults who had been treated for cancer evaluated the relationship of perceived stress and social support resources on PA outcomes (Brunet et al., 2014). A significant interaction effect of stress and social support indicated that support group involvement moderated the association between stress and PA. Thus, our study expands on past research by evaluating stress-buffering effects on PA over time in African American women.

Informal social control, perceived stress, and PA. Although neighborhood social-environmental factors can be sources of stress, they can also serve as important sources of supports for PA. Collective efficacy is defined as the overall ability of a community to instill trust and willingness to help or be helped by others in their community (Sampson et al., 1997). It consists of two subconstructs: informal social control and social cohesion and trust. Another study (Brown et al., 2011) found that individuals living in neighborhoods that are high in informal social control had more positive perceptions of their neighborhood which led to increased PA among older Hispanic adults. According to Berkman and Kawachi (2000), neighborhoods that are high in informal social control may be better able to reinforce positive social norms for health behaviors such as PA as well as enforce ordinances and laws restricting certain illicit or criminal behaviors around parks or recreation areas, thus increasing a sense of safety and collective support in communities/neighborhoods where individuals are likely to engage in PA. In addition, socially cohesive and trusting neighborhoods can influence behavior by decreasing stress and emphasizing shared goals (Ross & Jang, 2000). A longitudinal study among African American adolescents living in high-poverty neighborhoods found that neighborhood collective efficacy buffered stress across a variety of mental and physical health outcomes (Sharma et al., 2019). Another study among African American adults assessed the impact of gene-by-neighborhood social environment interactions on waist circumference (McDaniel, Wilson, et al., 2020). The authors found that a significant interaction between informal social control and genetic risk indicating that informal social control buffered genetic risk on waist circumference. Bures et al. (2003) found that neighborhood factors including informal social control improved health outcomes after adjusting for perceived social support with friends and family, suggesting that there are buffering benefits of informal social control on physical health.

Overall, there are few studies that have assessed collective efficacy as a buffer of stress on PA or related health outcomes. Among those studies that have, most have found support for the informal social control subscale of collective efficacy. Theoretically, informal social control may influence PA behavior by reinforcing positive social norms for PA and increasing a sense of safety and collective support in communities/neighborhoods. Thus, the current study will address the gap in the literature by assessing informal social control as a buffer of stress and income on PA outcomes among African American women.

Self-efficacy, perceived stress, and PA. While social environmental factors are important for determining exposure to both stressors and supports, individual factors also are important for understanding a person's appraisal and ability to overcome stressors. Self-efficacy, which refers to a person's belief about their ability to successfully accomplish a task in the face of challenges (Bandura, 1982), is a protective resource against stress (Edmonds, 2010; Piferi & Lawler, 2006; O'Leary, 1992) and has been repeatedly identified as one of the strongest psychological predictors of PA (Anderson et al., 2006; Bauman et al., 2012; Sallis et al., 1986). This is because more efficacious individuals are likely to use problem-solving strategies to generate a variety of coping strategies for overcoming difficulties (Bandura, 1982). Therefore, the presence of self-efficacy for PA can be thought of as a buffer that allows individuals to cope with increased stress in order to maintain and/or reengage in their PA routines.

Few studies have assessed the buffering effects of self-efficacy on stress in predicting PA outcomes. One study assessed the benefits of a PA intervention in women found that self-efficacy was related to less total lapses in PA throughout the week and return to PA the week following a lapse (Schumacher et al., 2017). While stress was not measured here, lapses in PA have been shown to correlate with perceived stress (Nigg et al., 2008). Further, individuals that are high in self-efficacy are more likely to use problem-solving strategies in the face of significant stressors rather than relapsing to inactivity because they have stronger beliefs in their capabilities to succeed (Bandura, 1982). Another study among working mothers assessed the impact of changes in PA and self-efficacy across the course of a brief PA intervention on subsequent levels of perceived stress (Mailey & McAuley, 2014). Higher self-efficacy predicted lower perceived stress and greater PA at follow up. The authors posit that increases in self-efficacy decrease the perception of stress by improving one's perceived ability to effectively cope. The present study integrated self-efficacy as a resource that may serve to buffer stressors on PA outcomes among African American women.

1.2 Study Purposes and Hypotheses

The purpose of the present study was to expand on existing research by taking an ecological approach to stress-buffering on PA among African American women (see

Figure 1). Specifically, this study tested the stress-buffering effects of intrapersonal (self-efficacy), interpersonal (social support), and neighborhood (safety, satisfaction, informal social control) resources on perceived stress and low SES (assessed as annual income) in predicting PA outcomes across 16 weeks. Additionally, to capture the multifaceted nature of stress, both perceived stress and annual income were included in the models. Both LPA and MVPA outcomes were examined as separate outcomes.

In the context of PA, the stress-buffering hypothesis purports that the presence of social support and resources buffers an individual from the negative effects of stress on PA, but only under high stress conditions (Cohen & Wills, 1985). Thus, it was hypothesized that the presence of social supports (self-efficacy, social support, and informal social control) would buffer the negative effects of perceived stress and low SES on PA (see Figures 2 and 3) under high stress but not low stress conditions among African American women.

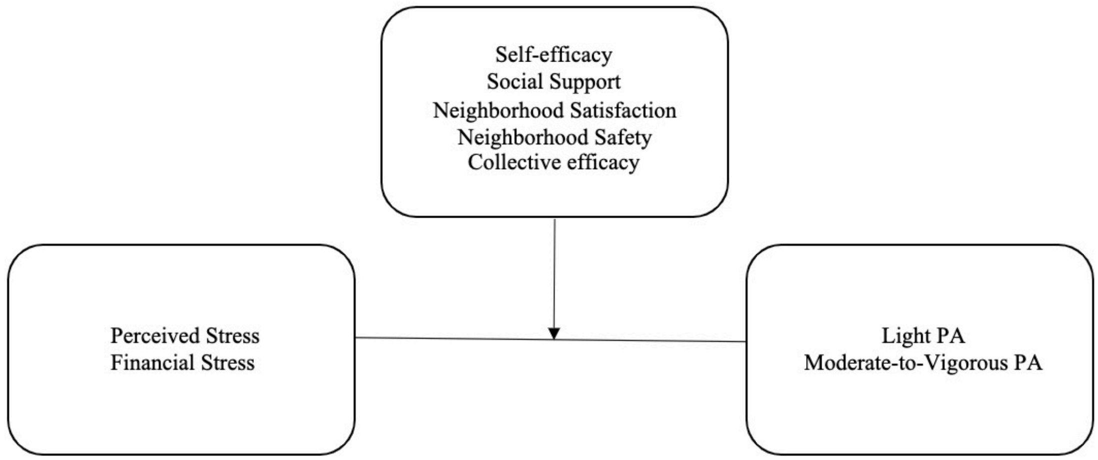

Figure 1.1 Conceptual diagram for the buffering relationship between support resources and perceived and financial stress on PA.

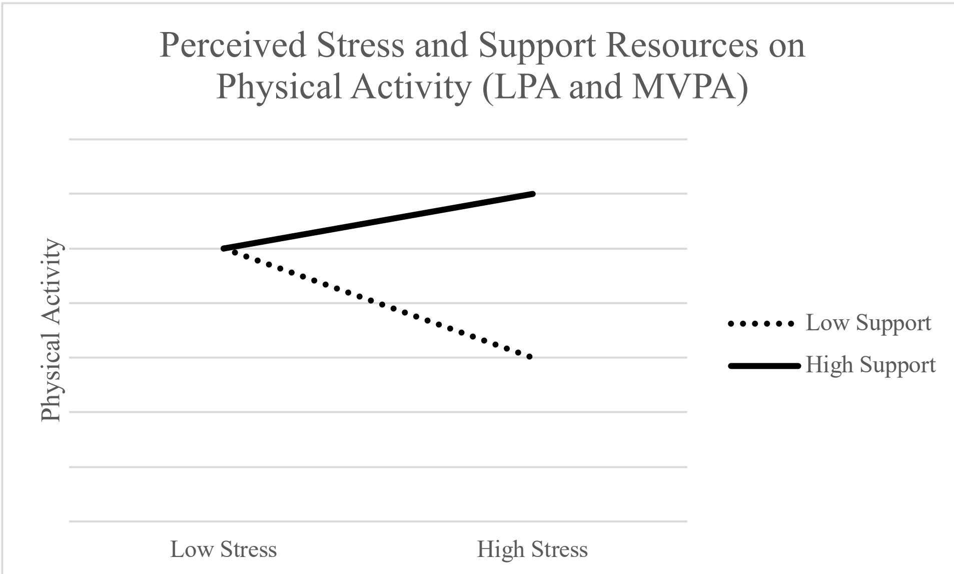

Figure 1.2 Hypothesized interaction between support resources and perceived stress on PA (both LPA and MVPA).

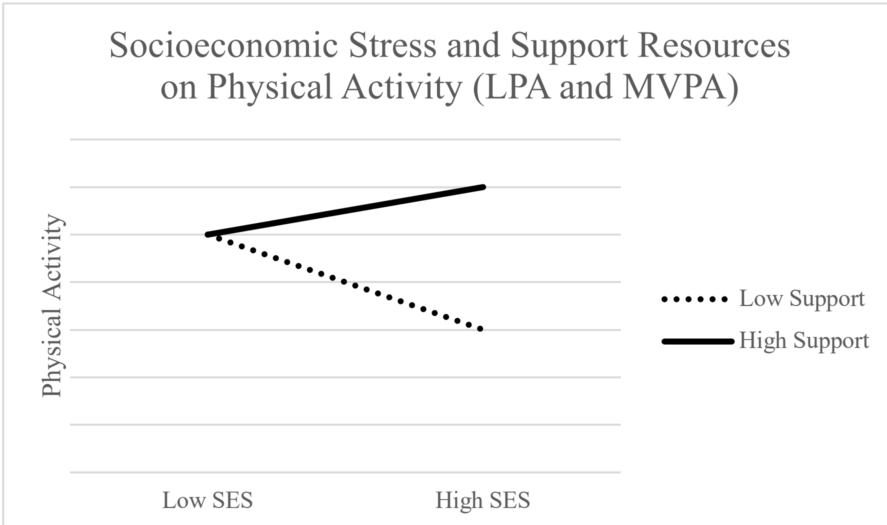

Figure 1.3 Hypothesized interaction between support resources and low SES on PA (both LPA and MVPA).

CHAPTER 2

METHODS

2.1 Participants

Data were collected from 143 African American women that were enrolled in the Families Improving Together (FIT) for Weight Loss randomized controlled trial (Wilson et al., 2015). Participants were recruited through culturally relevant local events, festivals, advertisements or through collaboration with local pediatric clinics and parks and recreation partners. Eligible families met the following criteria: 1) had an African American adolescent between 11-16 years of age, 2) participating adolescent was overweight or obese, as defined by having a BMI ≥85th percentile for their age and sex, 3) had a primary caregiver that was willing to participate in the program, and 4) had internet access. Families with an adolescent taking a medication that affected their appetite or ability to exercise were excluded. Families that were currently enrolled in another weight loss or health program were also excluded. All participants signed a University of South Carolina IRB approved informed consent prior to participation and were given compensation for their participation in the FIT program.

2.2 Study Design

The current study analyzed data obtained from the FIT trial (Wilson et al., 2015). The purpose of the FIT trial was to evaluate the efficacy of a group-randomized trial comparing a motivational plus family-based weight loss (M+FWL) intervention to a health education program on reducing BMI and improving diet and PA in overweight

African American adolescents and their caregivers. Phase 1 of the trial tested the efficacy of an 8-week face-to-face group randomized trial on reducing z-BMI and improving diet and PA in overweight African American adolescents and their caregiver. In phase 2 of the trial, participants were re-randomized to either an 8-week tailored online intervention or a control online program resulting in a 2 (M+FWL vs. BH group) x 2 (intervention vs. control on-line program) factorial design.

The current study is longitudinal and utilizes baseline psychosocial data as well as PA data gathered at three time points including baseline, post-group intervention (8 weeks), and post-online intervention (16 weeks). Psychosocial data was analyzed using a single time point because some psychosocial variables analyzed here were only collected at baseline as they were point as part of a secondary study (Coulon, Wilson, et al., 2016). Full methods and procedures for the FIT trial have been previously published (Wilson et al., 2015).

2.3 Procedures

At the start of the program, FIT families attended two orientation sessions. During this time, the parent-adolescent dyads completed anthropometric measurements and psychosocial surveys. PA was assessed via accelerometers that were worn for seven days. Weight and height measures were obtained using a Seca 880 digital scale and a Shorr height board, respectively; BMI was calculated using these measures. Self-efficacy, neighborhood variables, and annual income were assessed with psychosocial survey measures at baseline. Perceived stress, social support, and informal social control were assessed with psychosocial surveys as part of a subsequent study offered to FIT participants who were participating in the intervention. Participants were paid $100 for their time and participation ($20 at baseline, $20 at 8-weeks, $40 at 16-weeks, and $20 for participation in the subsequent study).

2.4 Measures

Demographics and Covariates. Intervention conditions and seasonal effects were dummy coded and controlled in all models. A questionnaire given at baseline assessed age, education, and perceptions of neighborhood access. Neighborhood access and education were measured categorically for ease of interpretation. Height and weight were objectively measured by trained staff and used to calculate BMI.

Stress Measures.

Perceived Stress. The 10-item version of the Perceived Stress Scale (PSS) was used to evaluate perceived stress (Cohen, Kamarck, & Mermelstein, 1983). The PSS was developed for use with community samples with at least an eighth-grade education. The PSS has been used as a stable measure of chronic stress among African American samples in both clinical and research settings (Sims et al., 2008). The questions are aimed at ongoing general life stress such as the degree to which one perceives their life to be unpredictable, uncontrollable, and overburdened over the past month (S. M. Coulon & Wilson, 2015; Troxel et al., 2003). Furthermore, scores on the perceived stress scale have been found to be stable over a period of 5 months, suggesting its nature as a trait measure of perceived stress (Dunkel Schetter et al., 2013). This measure has been used extensively to test whether stress predicts a variety of health behaviors including PA, smoking, and diet (Guardino et al., 2018; Ng & Jeffrey, 2003; Steinhardt et al., 2009; Steptoe et al., 1996) as well as health outcomes ranging from cardiovascular disease to diabetes to affective disorders (McCallum et al., 2006; Richardson et al., 2012; Steinhardt et al., 2009). Questions on the PSS are rated on a 5-point Likert scale and sample items include "In the last month, how often have you felt nervous and "stressed"?, "In the last month, how often have you been angered because of things that were outside of your control?", and "In the last month, how often have you been upset because of something that happened unexpectedly?". Answers are summed to create an index, with four positively worded items reverse coded. The PSS-10 had an internal consistency of 0.91 in national samples (Cohen & Janicki-Deverts, 2012). Additionally, the PSS has shown sufficient convergent and divergent validity with other measures of stress (Dunkel Schetter et al., 2013b; Roberti et al., 2006).

Annual Unadjusted Household Income. SES is a complex construct that has been conceptualized and measured in diverse ways. The traditional SES indicators are education, occupation, and income. Annual unadjusted household income was used as a proxy for SES in the current study. Income has been repeatedly identified as one of the most important determinants of overall wellbeing (Adler & Stewart, 2010; Deaton, 2008). Studies that have assessed SES as annual income have found it to be associated with subjective well-being, depressive symptoms, and physical activity (Deaton, 2008; Kari et al., 2015; Pereira & Coelho, 2013; Sinclair & Cheung, 2016). Annual household income was assessed using categorical responses ranging from "less than 10,000/year" to "85,000/year or more" for ease of interpretation.

Support Resources.

Self-efficacy for PA. Self-efficacy for physical activity was assessed using the Self-Efficacy for PA scale (Sallis et al., 1988). It assesses an individual's confidence in their ability to exercise in the face of barriers to PA including feeling tired or depressed, being on vacation, or being busier than normal. This scale has been previously validated in African American populations (Wilson et al., 2002) and has shown adequate reliability ($\alpha = 0.72$) and construct validity (Mendoza-Vasconez et al., 2018).

Perceived Social Support. The Multidimensional Scale of Perceived Social Support (MSPSS) evaluates three facets of social relationships: friends, family, and significant other. The scale consists of 12 items on a seven-point Likert scale, including items such as "I get the emotional help and support I need from my family". The MSPSS measure has been shown to have good psychometric properties, with a total Cronbach's alpha of 0.91. The reliability and validity of the MSPSS has been demonstrated with a wide range of populations including African American adults (Canty-Mitchell & Zimet, 2000; Cecil et al., 1995; Palmer, 2001).

Informal social control. The collective efficacy subscale for informal social control assessed an individual's perceptions of trust and willingness to help others for the overall good within their neighborhood (Sampson et al., 1997). This scale has two separate subscales (informal social control & social cohesion and trust), consisting of five items each. The informal social control scale was used for the present study due to its theoretical relevance and previous empirical support. An example from the informal social control subscale is "What is the likelihood that your neighbors could be counted on to intervene in various ways if children were skipping school and hanging out on a street corner?" Previous research has reported that the informal social control scale has strong construct validity (Sampson, et al., 1997) as well as high internal consistency ($\alpha = 0.87$; Parker et al., 2001).

Outcome Measures.

Physical Activity. PA duration and intensity were measured via Acticals, which are omni-directional accelerometers. The omnidirectional nature of Acticals provides a more sensitive measure of PA than traditional accelerometers, which detect movement on unidirectional and bidirectional planes (Esliger & Tremblay, 2006). Previous literature has shown that accelerometry measures of PA are less susceptible to bias than self-report data (Bassett et al., 2008; Sallis & Saelens, 2015). Actical accelerometers have demonstrated acceptable reliability in both laboratory (Welk et al., 2004) and clinical (Kayes et al., 2009) settings. In the current study, the Acticals were initialized with a sixty second epoch length in order to record counts per minute. They were given to participants on an elastic belt to wear for seven days on the right hip. In line with previous studies, sixty consecutive zero counts were coded as non-wear (Troiano et al., 2008; Trumpeter et al., 2012).

The cut points distinguishing LPA from MVPA were established in a calibration trial (Wong et al., 2011) and were used in the current study to reduce the Actical data into daily minutes of LPA and MVPA. A minute of MPVA was classified as counts at or above 1535 for each sixty-second epoch. A measure of 100 counts per minute distinguishes LPA from sedentary behavior; therefore, LPA was classified as counts between 100 and 1534.

CHAPTER 3

STATISTICAL ANALYSES

3.1 Data Analysis Plan

A growth curve analysis was used to allow for the estimation of within-person effects occurring at various time points. Models were developed and analyzed using R statistical software package version 3.1.2 (R Development Core Team). Because of the longitudinal design, random intercepts and random slopes were included in each model (Raudenbush & Bryk, 2002).

Models were built using a step-wise approach by comparing covariates only, main effects, and the addition of two-way and three-way interaction terms using a series of tests with increasing complexity to predict PA. To determine which model best fit the data, likelihood ratio tests were conducted. When a more complex model fit the data better than a more parsimonious model, as indicated by a significant chi-square test statistic, the more complex model was retained. Time was centered on the eight-week time point such that baseline = 0, 8 weeks = 0.5, and 16 weeks = 1. The inclusion of random effects in the model allowed people to differ from each other for mean PA and changes in PA over the sixteen-week timeframe.

Regarding covariates, age, seasonal effects (dummy coded, such that 1 = Winter), and treatment condition significantly contributed to the models and were retained; BMI, neighborhood access, and education did not contribute to the models and were dropped in order to have the most parsimonious models possible. Thus, the following growth curve analysis equation was used to assess two-way interactions between resources (self-efficacy, social support, and informal social control) and perceived stress and three-way interactions between resources, stress and time for predicting PA at sixteen weeks controlling for age, treatment conditions, and seasonal effects.

MVPA at 16 weeks = β_0 + β_1 Age +β_2 Treatment condition + β_3 Seasonal effects+ β_4 Time + β_5 Perceived Stress + β_6 Income + β_7 Self-Efficacy + β_8 Social Support+ β_9 Informal social control + β_{10} Time*Income + β_{11} Time*Stress + β_{12} Time*Self-efficacy + β_{13} Time*Social Support + β_{14} Time*Informal social control + β_{15} Perceived Stress*Self-efficacy + β_{16} Perceived Stress*Social support + β_{17} Perceived Stress*Informal social control + β_{18} Time*Stress*Self-efficacy + β_{19} Time*Stress*Social Support + β_{20} Time*Stress*Informal social control + ε

where β_0 is the intercept, $\beta_{1\text{-}3}$ are the effects of covariates, β_4 is the effect of time, $\beta_{5\text{-}9}$ are the main effects of stressors and supports, $\beta_{10\text{-}14}$ are time interaction effects, $\beta_{15\text{-}17}$ are stress-buffering effects, $\beta_{18\text{-}20}$ are stress-buffering effects across time, and ε is the residual. The same models were analyzed to predict LPA and to evaluate the interactive effects of income on PA outcomes. The coefficients for each of the variables were assessed to answer the research questions. To assess potential buffering effects, significant interactions were plotted using simple slopes analyses.

3.2 Preliminary Analyses and Assumptions

All continuous predictors were mean centered prior to conducting analyses. Bivariate correlations were used to assess the strength of the relationships between covariates, independent variables, and outcome variables (MVPA and LPA). If predictor or buffering variables demonstrated a strong significant correlation ($r \geq 0.8$), a conceptual decision was made to remove one of the two variables from the proposed modelling in order to reduce multicollinearity. However, none of the variables demonstrated multicollinearity, therefore all variables were kept in the model.

Assumptions for multilevel modeling were tested. To address the assumption of normality, histograms of the standardized residuals were assessed. Scatterplots of the standardized residuals and predicted values were evaluated to assess for homoscedasticity. Cook's distance measure was used to check for influential points in the data. MVPA was positively skewed and was normalized using a square root transformation.

Stability of the mean over time was tested by comparing means of MVPA and LPA at each time point. Equilibrium, which assumes temporal stability in the patterns of covariance and variance among variables, was tested by comparing variance and covariance scores across the measurements of MVPA and LPA. Stationarity, which assumes that the process of obtaining the measure of MVPA and LPA does not change over time, has been met due to the stable protocol of obtaining PA via accelerometer.

3.3 Missing Data

Missing PA data (i.e., non-wear time) was dealt with using a weighted mixed model approach with variance weighting by the inverse of the daily wear time proportions (Xu et al., 2018). This improves precision in estimating accelerometry-estimated PA by down-weighting cases with a higher proportion of missing data relative to cases with less missingness. Therefore, in the current study, a valid day of wear was defined as 10 hours of wear time, however, no limits were set on the number of required days of wear.

CHAPTER 4

RESULTS

4.1 Demographic Data

Table 1 shows the descriptive statistics for the current sample. The sample was made up of 143 African American women with a mean age of 44.11 years (*SD* = 8.65) and average BMI of 37.72 (*SD* = 8.54). 35.2% of the participants were married. Average MVPA was 8.69 minutes per day (*SD* = 13.67), while average LPA minutes per day was 182.00 (*SD* = 79.01).

4.2 Bivariate Correlation Analyses

Table 2 shows the bivariate correlations for the covariates, predictors, and outcome variables. Perceived stress and social support were correlated in the expected direction ($r = -.26$, $p < .01$). Income was correlated with both perceived stress ($r = -.23$, $p < .01$) and perceived social support ($r = .29$, $p < .01$).

4.3 Perceived stress and buffering variables on MVPA

Multilevel growth modeling was used to assess whether supports at baseline moderated the effects of stress at baseline on MVPA across 16 weeks while controlling for age, treatment conditions, and seasonal effects (Table 3). To examine whether the addition of the main effects (model 2) and the interaction terms (model 3) significantly contributed to the prediction of MVPA, likelihood ratio tests were conducted to compare the change between the models. The likelihood ratio tests revealed that the model fit was significantly improved through the inclusion of main effects (χ^2 (5) = 22.92, p < 0.001) and interaction terms (χ^2 (11) = 49.31, p < 0.001).

There was a significant stress-by-social support interaction (B = 0.26, SE = 0.11, p = .015), indicating that perceived stress moderated the effects of social support at baseline. Importantly, there was also a significant three-way interaction between stress, social support, and time (B = −0.34, SE = 0.19, p = .042), indicating that this moderated effect changed over 16 weeks. To further evaluate the interaction between perceived stress and social support at baseline on MVPA across time, simple slopes were computed for the interaction between baseline stress and social support on MVPA over each of the three time points (baseline, 8 weeks, and 16 weeks) as shown in Figure 5. At baseline, among participants with high social support (+1 SD) stress was positively associated with greater MVPA (B = 0.48, SE = 0.19, p = .014), whereas among participants with low social support (−1 SD), stress was not significantly associated with MVPA (B = −0.03, SE = 0.16, p = .852). However, at 8 weeks, stress was no longer significantly associated with MVPA for those with high social support (B = 0.22, SE = 0.19, p = .258) or those with low social support (B = −0.01, SE = 0.15, p = .961). Similarly, at 16 weeks, stress was not significantly associated with MVPA for those with high social support (B = −0.05, SE = 0.26, p = .86) or those with low social support (B = 0.05, SE = 0.22, p = .827).

There was also a significant interaction of time-by-collective efficacy on MVPA (B = 0.40, SE = 0.17, p = .019) (Figure 4). Simple slopes analyses revealed that among participants with low collective efficacy (−1 SD), MVPA decreased significantly over time (t = −1.89, SE = 0.24, p = .032). However, among participants with high collective efficacy (+1 SD), MVPA did not change overtime ($t = 0.55$, $SE = 0.22$, $p = .590$). Those with high collective efficacy were able to maintain MVPA while those with low collective efficacy saw a decrease in MVPA.

Age ($B = -0.03$, $SE = 0.01$, $p < .001$) and income ($B = 0.55$, $SE = 0.26$, $p = .007$) demonstrated significant main effects on MVPA. Specifically, age demonstrated a negative association with MVPA while income demonstrated a positive association on MVPA. There were no significant main effects on LPA.

4.4 Perceived stress, buffering variables, and LPA

A multilevel growth model was conducted to assess whether supports at baseline moderated the effects of stress at baseline on LPA across 16 weeks while controlling for age, treatment conditions, and seasonal effects (Table 4). Likelihood ratio tests were conducted between the covariate-only model and the main effects model, and between the main effects model and the interaction terms model. The likelihood ratio tests revealed that the model fit was significantly improved through the inclusion of main effects (χ^2 (5) = 29.26, $p < 0.001$) and interaction terms (χ^2 (11) = 80.77, $p < 0.001$).

There was a three-way marginally significant interaction between time, stress, and self-efficacy on LPA ($B = -18.90$, $SE = 10.31$, $p = .067$). To further evaluate this interaction, simple slopes were computed for the interaction between baseline stress and self-efficacy on LPA over each of the three time points (baseline, 8 weeks, and 16 weeks) as shown in Figure 6. At baseline, among participants with high self-efficacy (+1 SD) stress was trending in a positive direction with LPA ($B = 15.14$, $SE = 8.93$, $p = .092$), whereas among participants with low self-efficacy for PA (−1 SD), stress was not significantly associated with LPA ($B = -1.63$, $SE = 9.87$, $p = .873$). At 8 weeks, stress was not significantly associated with LPA for those with high self-efficacy (*B* = 0.54, *SE* = 8.61, *p* = .952) or those with low self-efficacy (*B* = 2.67, *SE* = 9.49, *p* = .787). Similarly, at 16 weeks, stress was not significantly associated with LPA for those with high self-efficacy (*B* = −14.06, *SE* = 12.43, *p* = .265) or those with low self-efficacy (*B* = 6.97, *SE* =13.77, *p* = .610).

4.5 Income and buffering variables on MVPA and LPA

Multilevel growth models were conducted to assess whether supports at baseline moderated the effects of income on both MVPA and LPA across 16 weeks while controlling for demographic factors. The overall model fit was assessed using likelihood ratio tests to assess for significant differences in the covariate only model, the main effects model, and the interaction model. The inclusion of the interaction terms did not significantly improve the model fit for either MVPA (χ^2 (11) = 4.93, *p* = .920) or LPA (χ^2 (11) = 8.31, *p* = .716). Therefore, the income models were not further evaluated.

Table 4.1 Demographic data for the total sample at baseline (*N* = 143)

Age *M (SD)*	44.11 (8.65)
BMI *M (SD)*	37.72 (8.54)
Married *n* (%)	50 (35.2%)
Education *n* (%)	
9 To 11 Years	5 (3.5%)
12 Years	18 (12.7%)
Some College	62 (43.7%)
4 Year College	23 (16.2%)
Professional	34 (23.9%)
Annual Income *n* (%)	
Less than $10,000	23 (16.2%)
$10,000-$24,000	26 (18.3%)
$25,000-$39,000	39 (27.5%)
$40,000-$54,000	19 (13.4%)
$55,000-$69,000	13 (9.2%)
$70,000-$84,000	6 (4.2%)
$85,000 or greater	24 (11.3%)
Physical Activity *M (SD)*	
MVPA minutes/day at baseline	8.23 (8.82)
MVPA minutes/day at 8 weeks	7.64 (13.9)
MVPA minutes/day at 16 weeks	9.76 (12.75)
LPA minutes/day at baseline	174.18 (62.34)
LPA minutes/day at 8 weeks	168.96 (58.15)
LPA minutes/day at 16 weeks	206.94 (63.65)

Table 4.2 Correlation Matrix

	1	2	3	4	5	6	7	8	9
1. Age	-								
2. BMI	-0.11	-							
3. Yearly Income	0.02	**-0.17****	-						
4. Stress	**-0.18****	**0.13****	**-0.23****	-					
5. Self-efficacy	**0.04****	**-0.11***	0.06	**-0.06****	-				
6. Social Support	**-0.12****	-0.04	**0.29****	**-0.26****	0.06	-			
7. Collective efficacy	0.06	**-0.19****	**0.14***	-0.06	0.01	**0.21****	-		
8. Light PA	**-0.06***	**-0.09***	-0.03	0.03	**-0.08****	**0.06***	**0.07****	-	
9. MVPA	**-0.05***	0.07	**0.06****	0.03	0.03	**0.07****	**0.06***	0.02	-

Note * indicates correlations significant with alpha criteria of 0.05; ** indicates correlations significant with alpha criteria of 0.01. Column headings correspond to row names.

Table 4.3 Multilevel growth model predicting moderate-to-vigorous physical activity across 16 weeks.

Model/Parameter	*B*	*SE*	*t*	*p*	X^2	*df*	*p*
Model 1 – Covariates							
Intercept	3.686	0.613	6.006	**0.000***			
Age	-0.030	0.013	-2.271	**0.000***			
Winter (baseline)	0.444	0.322	1.380	0.168			
Winter (8 weeks)	-0.237	0.212	-1.115	0.265			
Winter (16 weeks)	0.562	0.305	1.842	0.065			
Group Treatment	-0.363	0.233	-1.556	0.122			
Online Treatment	-0.011	0.232	-0.046	0.964			
Time	0.003	0.171	0.017	0.987			
Model 2 – Main Effects							
Intercept	3.619	0.667	5.424	0.000	22.92	5	**0.000***
-	-	-	-	-			
Perceived Stress	0.106	0.131	0.806	0.422			
Income	0.488	0.251	1.943	**0.007***			
Self-efficacy for PA	0.067	0.120	0.556	0.579			
Perceived Social Support	0.136	0.125	1.085	0.280			
Collective efficacy	0.193	0.123	1.573	0.118			
Model 3 – Interactions							
Intercept	3.675	0.671	5.473	0.000	49.31	11	**0.000***
-	-	-	-	-			
Time*Income	0.003	0.316	0.009	0.993			
Time*Perceived Stress	-0.210	0.184	-1.140	0.254			
Time*Self-efficacy for PA	-0.215	0.160	-1.329	0.184			
Time*Perceived Social Support	0.004	0.207	0.020	0.984			
Time*Collective Efficacy	0.396	0.169	2.333	**0.019***			
Stress*Self-efficacy	-0.054	0.159	-0.342	0.732			

Stress*Social Support	0.261	0.106	2.463	**0.015***
Stress*Collective efficacy	-0.007	0.140	-0.048	0.962
Time*Stress*Self-efficacy	-0.272	0.194	-1.405	0.160
Time*Stress*Social Support	-0.342	0.190	-1.800	**0.042***
Time*Stress*Collective efficacy	0.258	0.198	1.302	0.193
Random Effects				
Intercept	1.181			
Time	0.761			
Residual	1.393			

*significance with alpha criteria of 0.05

Note. Treatment condition was dummy coded and controlled for as covariates in all models. As indicated by dashes, all parameters from model 1 were included in model 2, and from model 2 were included in model 3; they are not duplicated because the results were very similar.

Table 4.4 Multilevel growth model predicting light physical activity across 16 weeks.

Model/Parameter	*B*	*SE*	*t*	*p*	X^2	*df*	*p*
Model 1 – Covariates							
Intercept	196.432	24.874	7.897	**0.000***			
Age	-0.261	0.542	-0.482	0.631			
Winter (baseline)	15.909	13.624	1.168	0.243			
Winter (8 weeks)	-10.990	6.886	-1.596	0.111			
Winter (16 weeks)	44.384	11.758	3.775	**0.000***			
Group Treatment	-12.289	9.418	-1.305	0.194			
Online Treatment	-4.380	9.383	-0.467	0.641			
Time	1.084	8.184	0.132	0.895			
Model 2 – Main Effects							
Intercept	188.03	28.084	6.695	**0.000***	29.26	5	**0.000***
-	-	-	-	-			
Perceived Stress	6.884	4.238	1.096	0.275			
Income	-5.504	10.497	-0.523	0.601			
Self-efficacy for PA	9.892	5.029	1.973	0.097			
Perceived Social Support	2.892	5.029	0.655	0.514			
Collective efficacy	11.056	6.485	1.377	0.142			
Model 3 – Interactions							
Intercept	189.285	28.255	6.700	**0.000***	80.77	11	**0.000***
-	-	-	-	-			
Time*Income	19.831	16.609	1.194	0.233			
Time*Perceived Stress	-10.301	9.318	-1.105	0.269			
Time*Self-efficacy for PA	8.158	8.527	0.957	0.339			
Time*Perceived Social Support	-1.961	10.478	-0.186	0.852			
Time*Collective Efficacy	10.96	8.300	1.184	0.239			
Stress*Self-efficacy	8.387	7.074	1.186	0.238			

Stress*Social Support	6.743	4.648	1.451	0.149
Stress*Collective efficacy	-1.803	6.185	-0.292	0.771
Time*Stress*Self-efficacy	-18.901	10.309	-1.833	0.067
Time*Stress*Social Support	-7.330	8.487	-0.841	0.388
Time*Stress*Collective efficacy	16.193	9.703	1.669	0.095
Random Effects				
Intercept	57.638			
Time	69.003			
Residual	51.417			

*significance with alpha criteria of 0.05

Note. Treatment condition was dummy coded and controlled for as covariates in all models. As indicated by dashes, all parameters from model 1 were included in model 2, and from model 2 were included in model 3; they are not duplicated because the results were very similar.

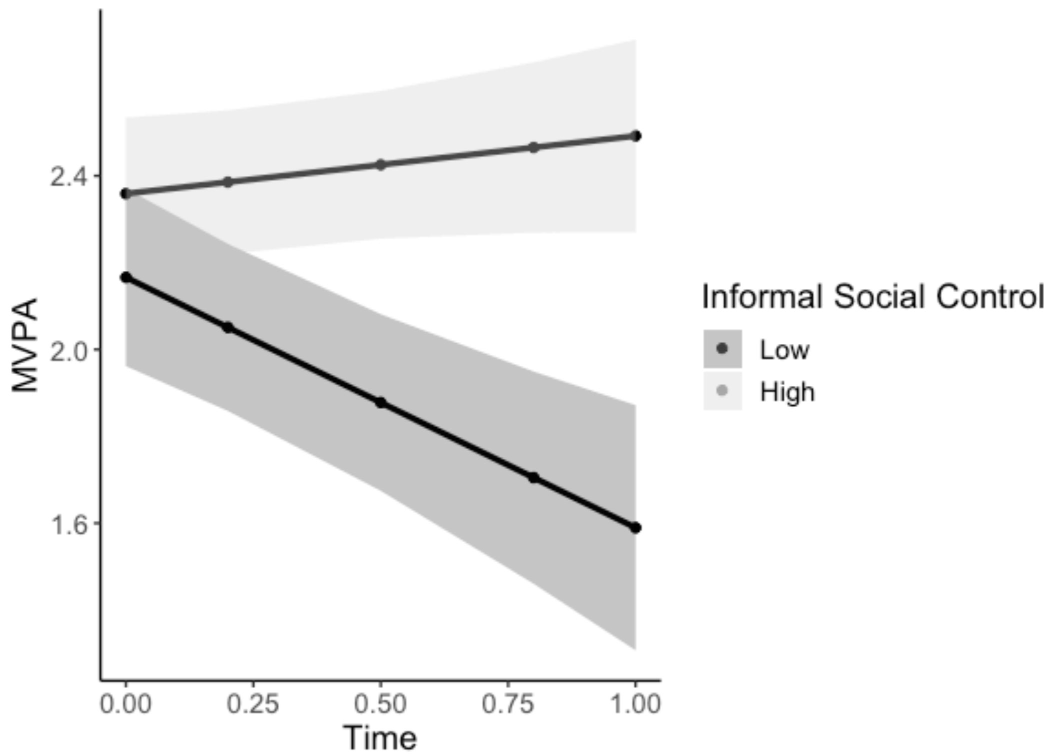

Figure 4.1 Interaction between time and informal social control predicting MVPA over time.

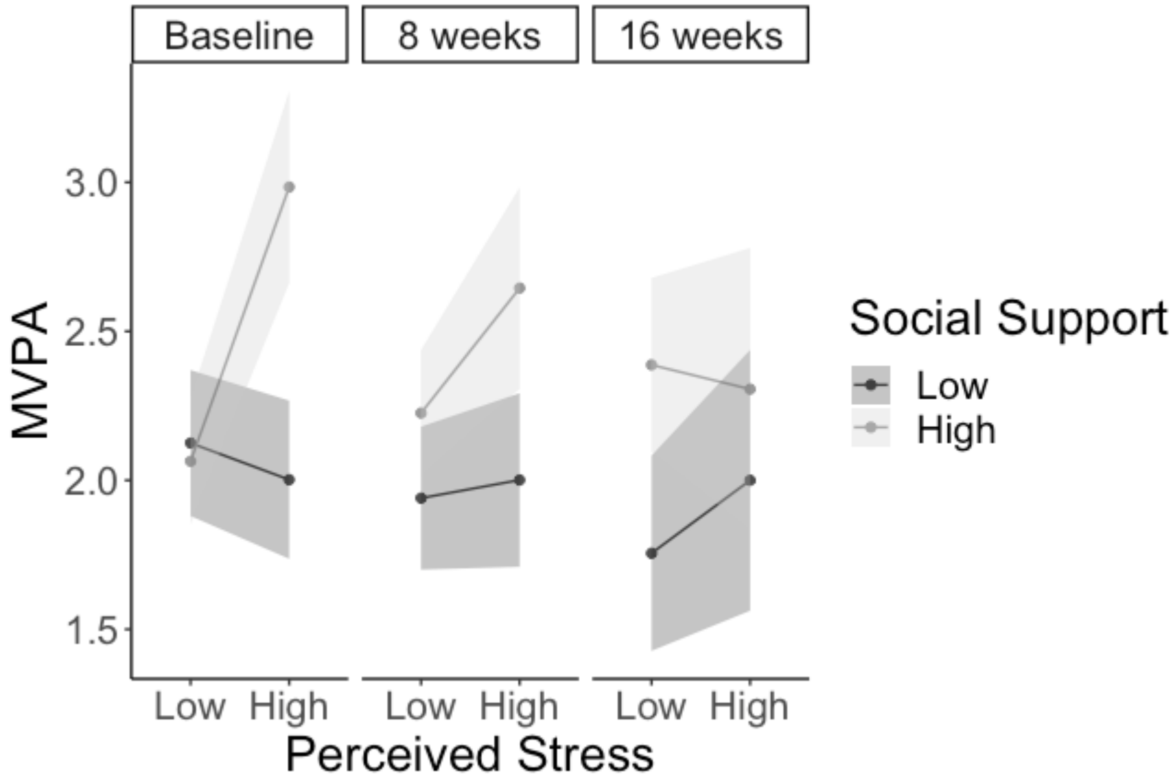

Figure 4.2 Interaction between stress, social support, and time on MVPA.

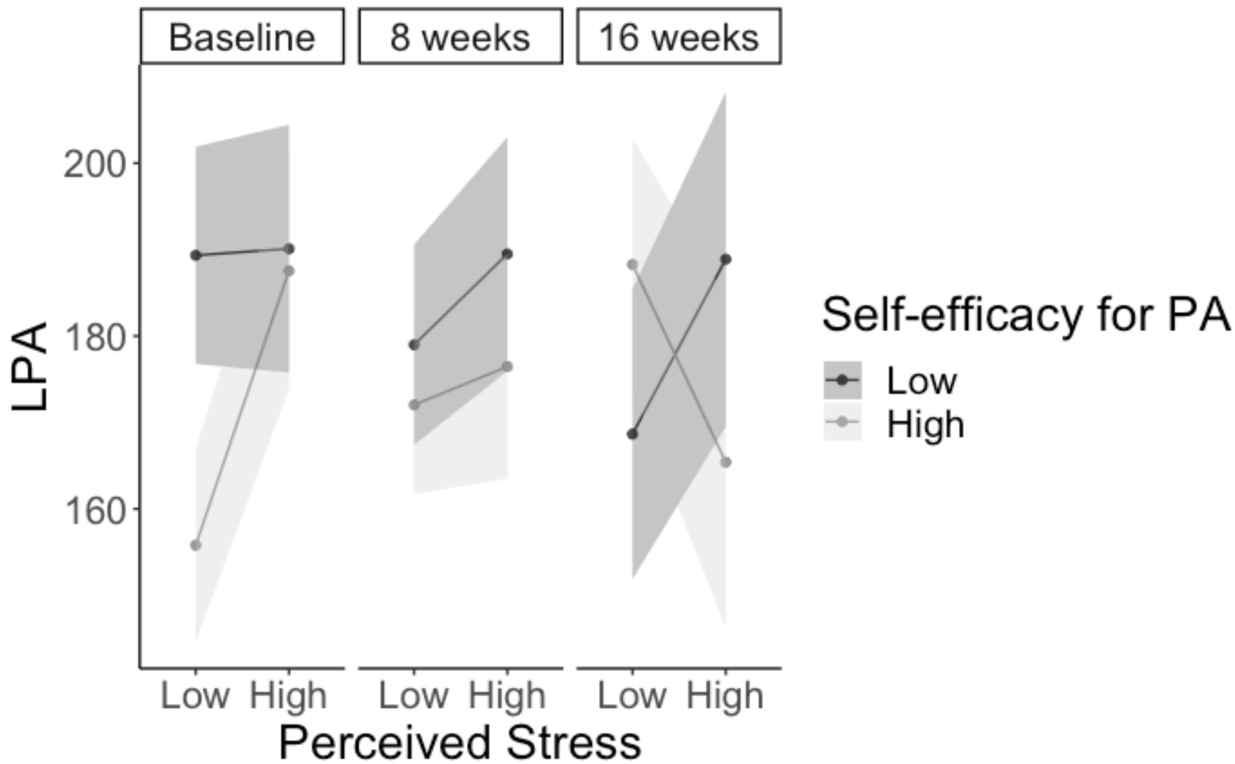

Figure 4.3 Interaction between stress, self-efficacy, and time on LPA.

CHAPTER 5

DISCUSSION

The primary aim of this study was to assess the stress-buffering effects of intrapersonal (self-efficacy), interpersonal (social support), and neighborhood (collective-efficacy) resources on perceived stress and annual income on predicting both MVPA and LPA outcomes at 16 weeks. For MVPA, there was a buffering effect of social support on stress at baseline indicating that under higher stress, higher social support was associated with greater MVPA. Interestingly, there was also a collective efficacy by time interaction on MVPA indicating that over time those with higher (versus lower) perceptions of social cohesion and trust were more likely to maintain MVPA levels. For LPA, there was a marginally significant interaction between perceived stress and self-efficacy indicating that under high stress, higher self-efficacy was associated with higher LPA at baseline. Main effects were also found indicating that higher income was associated with greater engagement in MVPA. Taken together, these findings provide preliminary support for the stress-buffering hypothesis for both MVPA and LPA at baseline.

This is the first study to the author's knowledge to show an interaction between perceived stress and social support on MVPA among African American women. The interaction of social support on perceived stress such revealed that, at baseline, there was a moderating effect of social support on the relationship between perceived stress and MVPA such that, under high levels of social support, perceived stress was positively associated with MVPA, whereas, under low levels of social support, perceived stress was not significantly associated with MVPA. These results suggest that, at baseline, high levels of social support and high levels of stress were associated with increases in MVPA. However, further analyses revealed that, at the later time points, the interaction between baseline levels of perceived social support and stress showed a leveling off in predicting PA at 8 and 16 weeks. The results expand on previous studies that have demonstrated associations between stress, social support, and PA (Ayotte et al., 2010; Brunet et al., 2014; Strom & Egede, 2012) and provide partial support for the stress-buffering hypothesis. Specifically, the majority of previous studies showed that social support and stress were positively related to MVPA; this study expands on these findings to suggest that social support was positively associated with MVPA among African American women who perceived high levels of stress. Findings highlight the importance of addressing constructs of stress and social support in future health promotion programs aiming to increase MVPA among African American women.

In the LPA stress-buffering model, self-efficacy trended in a positive direction for LPA among women who perceived high levels of stress. Simple slope analyses revealed that this effect was marginally significant at baseline but showed a leveling off at later time points. Specifically, for those with high levels of self-efficacy for PA, perceived stress was positively trending with LPA, whereas for those with low levels of self-efficacy for PA, perceived stress was not significantly associated with LPA. Research on LPA is relatively new, and to the best of our knowledge no previous study directly assessed stress-buffering effects on LPA. However, self-efficacy has been repeatedly identified as one of the strongest psychological predictors of total daily PA and MVPA (Anderson et al., 2006; Bauman et al., 2012; Sallis et al., 1986). Further, LPA has clinically meaningful benefits on a variety of health outcomes and may be a more accessible form of PA for overweight and/or sedentary individuals. Thus, the current study contributes to this gap in the literature and suggests that future studies should examine cognitive factors—specifically, self-efficacy for PA—as potential buffers of perceived stress on LPA.

There was also a significant effect of informal social control on MVPA over time. Those with high informal social control maintained MVPA, while those who with low informal social control showed a decrease in MVPA over time. This finding expands on past literature that have found positive effects of informal social control on PA (Ross & Jang, 2000) as well as weight-related outcomes (McDaniel, Wilson, et al., 2020). It replicates similar findings to that of Brown et al., (2011) who found that individuals living in neighborhoods that are high in informal social control had more positive perceptions of their neighborhood which led to increased PA. Taken together, these findings lend support to the importance of addressing perceived neighborhood factors on health behaviors and outcomes. Specifically, the current finding adds to this body of literature by suggesting that higher perceptions of informal social control may help to maintain PA over time.

Income demonstrated significant main effects on MVPA. Income was positively associated with MVPA such that those with higher income participated in greater MVPA. The non-significant finding of the income-buffering models could have a variety of explanations. One possibility is that using unadjusted annual income as a proxy for SES is too general and does not adequately capture the construct of SES. For example, many studies that have assessed SES have used census-level data which better captures neighborhood and contextual factors (Barber et al., 2016; Suglia et al., 2016). Further, simply measuring income may not adequately capture an individual's perception of stress related to SES. Because no previous studies have assessed buffering effects of resources on SES predicting PA, future studies should obtain more comprehensive measures of SES such as perceptions of financial strain.

This study had several limitations. First, stress, social support, and collective efficacy were measured at a single time point making it difficult to assess changes over time. Future studies should obtain repeated measures buffering resources to adequately assess stress-buffering effects overtime on PA. Second, the impact of self-reported perceptions of stressors and resources on PA may be qualitatively different than that of objectively measured factors. Census-tract data, for example, could provide an alternative perspective on the impact of neighborhood-level variables. Lastly, the relatively small sample size of the current study is also a limitation; thus, future studies are needed replicate these patterns and findings in larger sample sizes.

In conclusion, this is one of the first studies to our knowledge to assess stress-buffering effects on PA longitudinally among African American women. Further, this study expands upon previous stress-buffering studies by assessing intrapersonal, interpersonal, and neighborhood resources as moderators of stress on PA. The results of this study suggest that there is a need for PA interventions to consider resources that influence different intensities of PA; specifically, social resources may be more important for MVPA while cognitive resources may be more important for LPA. In conclusion, the findings from this study highlight the importance of integrating constructs of stress and resources into future PA intervention programs for African American women.

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