THE BIDIRECTIONAL RELATIONSHIP BETWEEN PHYSICAL ACTIVITY AND STRESS IN WORKING PARENTS

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ABSTRACT

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CLAIRE I. GROVES

Physical activity is widely known to have many physical and mental health benefits. Despite this, a large portion of the population fails to engage in regular physical activity. One commonly reported barrier to physical activity is stress. However, stress has also been shown to decrease when engaging in physical activity. Working parents are a subpopulation that has a relatively high risk for stressor exposure and limited available free time to engage in physical activity. Limited research has attempted to untangle the day-to-day associations between physical activity and stress among a working parent population. The purpose of this study is to examine the bidirectional relationships between daily physical activity and stressor frequencies and severity within working parents using a microlongitudinal approach, while simultaneously assessing differences between mothers and fathers. Using a subsample of 667 working parents (47.7% female, M_{age} 43, 81% married, 84.9% White) from the National Study of Daily Experiences, structural equations modelling was used to examine the dynamic links between daily stressors and physical activity. Overall, the models for fathers were not deemed a good fit, however, the models for mothers did have adequate fit. The measurement paths from the latent variables to their respective variables were significant, whereas the vast majority of the structural relations between physical activity and stressors were not significant. Due to poor fit for fathers' models, no conclusions can be made. It appears that daily physical activity and daily stress (both number of stressors and perceived severity) are not related among working mothers. Further, these findings suggest that for working mothers, encountering a stressor on one day may not be detrimental to the amount of physical activity that they perform the next day. And, if physical activity engagement is low on one day, both the number of stressors and their severity appear not to increase. Results of the aggregated linear regressions were not significant for number of stressors or the severity, providing further evidence for a lack of relationship between the variables. Future research should examine daily links between physical activity and stress among fathers utilizing a different model. Given the non-predictive relationships, future work should also examine the different methods for reducing daily stress and their severity among working parents.

Keywords: physical activity, daily stressors, working parents, bidirectional relationships, microlongitudinal, daily diary.

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Introduction

Physical activity has many known health benefits, including improved cardiovascular (Leon et al., 1987) and mental health (Moses et al., 1989), and lowered risk of certain cancers (Moore et al., 2016) and Type 2 diabetes (Helmrich et al., 1991). However, even with the well-known benefits of physical activity, the vast majority of U.S. adults do not meet recommended physical activity guidelines (U.S. Department of Health and Human Services, 2018). Common barriers to physical activity include lack of time, being too tired and experiencing high amounts of stress, including daily stressors (Allen & Armstrong, 2006). Although stress is a commonly reported barrier to physical activity, engaging in physical activity has also been shown to reduce stress levels (Aldana et al., 1996; King et al., 1993; Salmon, 2001; Schnohr et al., 2005). Interestingly, less research has been devoted to investigating the influence of stress on physical activity, compared to the influence of physical activity on stress, and some research suggests that the relationship between physical activity and stress may be bidirectional (Brockmann & Ross, 2020; Burg et al., 2017; Steptoe et al., 1989). However, as discussed below, most of the literature finds that stress impairs efforts to be physically active (Lutz et al., 2007; Stults-Kolehmainen & Sinha, 2013).

Although the bidirectional relationship between stress and physical activity has received some attention in the general population, the author of this manuscript has not been able to identify any published research examining the daily associations between stress and physical activity within a population that is at a relatively high risk of stressor exposure, working parents. Working parents are an important population to study in regard to this relationship as they have both time-intensive work and family commitments that require their time and attention. Parents' physical activity levels decrease after having a child compared to those without children (Brown & Trost, 2003; Hull et al., 2010), and parents often report higher levels of stressor exposure compared to their childless counterparts (Diener et al., 2010; Glass et al., 2016; Nelson et al., 2012). Importantly, there is also a difference in the time commitments between mothers and fathers, such that mothers perform more household and childcare duties than do fathers (Fetterolf & Rudman, 2014; Rhoads & Rhoads, 2012), as such, it is anticipated that this discrepancy will be evident in this study. Working parents are an important group to examine in relation to the interplay between physical activity and stress, as they have less free time and high-stress levels, which are common barriers to physical activity.

Findings from correlational research indicate there is a negative association between physical activity and perceived stress levels (Stults-Kolehmainen & Sinha, 2013). However, intervention research has shown that physical activity reduces self-reported stress (Kettunen et al., 2015). This apparent discrepancy indicates potential time-dependent bidirectional relations between two constructs, yet little research has attempted to untangle the day-to-day links between stress and physical activity. The purpose of this study is to examine the bidirectional relationship between physical activity and stress using a microlongitudinal approach. In the following sections, I will describe physical activity and its benefits, common barriers to physical activity, including stress, and the current evidence for a bi-directional relationship between these two variables. I will also describe why working parents are an important subgroup to study in relation to these variables and explore potential differences in the relationship between these variables for mothers versus fathers.

Definitions of Physical Activity

Physical activity has a well-established salubrious effect on many health outcomes. Physical activity improves cardiovascular health (Leon et al., 1987), decreases the risk of certain cancers (Moore et al., 2016), helps to manage diabetes (Helmrich et al., 1991), and improves mental health (Moses et al., 1989). The World Health Organization (WHO) defines physical activity as “any bodily movement produced by skeletal muscles that requires energy expenditure. Physical activity refers to all movement including during leisure time, for transport to get to and from places, or as part of a person's work" (WHO, 2020, para. 1). Total energy expenditure is dependent upon the duration, intensity, and frequency of physical activity. Duration is the amount of time a person engages in physical activity. The intensity of the activity refers to how hard the body is working. Intensity is usually reported as light, moderate or vigorous, but it can also be classified using metabolic equivalents (METs). Light physical activity refers to activities that require less than 3.0 METs, such as walking. Moderate-intensity physical activity is defined as activity requiring 3.0 to 5.9 METs, and vigorous-intensity physical activity is any activity requiring more than 6.0 METs (U.S. Department of Health and Human Services, 2018). A simple method individuals can use to measure the intensity of their physical activity is known as the "talk test." During moderate-intensity activities individuals are able to talk but not sing, and during vigorous activities individuals will not be able to say more than a few words without needing a breath. Frequency refers to how often someone performs physical activity. These three components vary substantially across different people, which makes physical activity quite complex to capture. In addition, measuring physical activity can be a challenge based on the vast array of activities that are classified as physical activity, as such no gold standard exists. Popular approaches to measuring physical activity include participant self-report, researcher observation, and laboratory and ambulatory heart rate monitoring and accelerometers (Sylvia et al., 2014).

Terms that are often used in conjunction with physical activity include: exercise, physical fitness, sedentary and inactive behavior. In lay language, the terms "exercise" and "physical activity" are sometimes wrongly used interchangeably. The term exercise refers to energy that is expended in which it was planned, purposive, structured, and repetitive. One of the largest differences between exercise and physical activity is the purposive element of exercise and how it has the goal of physical fitness (Caspersen et al., 1985). Physical fitness is the ability for a person to perform in work and leisure effectively, without unjustified fatigue (Caspersen et al., 1985). Physical inactivity is used to describe a person who does not meet the recommended physical activity guidelines. The U.S. recommended physical activity guidelines are at least 150 minutes to 300 minutes of moderate-intensity physical activity or 75 minutes to 150 minutes per week of vigorous-intensity aerobic physical activity, as well as muscle-strengthening activities on two or more days per week (U.S. Department of Health and Human Services, 2018). Comparatively, sedentary behavior encompasses activities performed in a seated position that require very low energy expenditure (Caspersen et al., 1985). It is possible for a person to be considered sedentary and still meet the recommended physical activity guidelines.

Importance of Physical Activity

As noted above, physical activity plays a crucial role in the primary and secondary prevention of many chronic diseases and death. Primary prevention refers to preventing the disease before it happens, such as engaging in physical activity in order to improve heart health and to reduce the risk of cardiovascular disease. In contrast to primary prevention, secondary prevention refers to reducing the impact of a disease that has already occurred, such as engaging in physical activity to help relieve the symptoms and severity of cardiovascular disease.

Engaging in physical activity reduces cardiovascular disease morbidity and mortality rates (Blair et al., 1996; Hu et al., 2004; Myers et al., 2004). In epidemiological studies, researchers have found that those who are physically active have fewer coronary events compared to their inactive counterparts (Stampfer et al., 2000; Wessel et al., 2004). Other studies examining cardiovascular disease mortality have found that low levels of physical activity are associated with an increase in death (Blair et al., 1996; Hu et al., 2004). Physical activity has also been found to help reduce the incidence of several different cancers (Moore et al., 2016). In particular, in a 2016 study consisting of 1.44 million participants in both the United States and Europe, engaging in leisure-time physical activity of moderate to vigorous intensity lowered the risk of 13 different types of cancers (Moore et al., 2016). Physical activity has also been shown to decrease the risk of Type 2 diabetes (Helmrich et al., 1994; Manson et al., 1992; Wei et al., 2000).

Along with the clear physical health benefits of physical activity, there are also mental health benefits. In a meta-analysis of 58 randomized controlled trials investigating the effects of physical activity on depression (n = 2982), there was an overall large effect size of 0.80 (Hedges' g), indicating that those who participated in physical activity had significantly lower rates of depression compared to those who received the control treatment (Rethorst et al., 2009). Similarly, a meta-analysis unpacking the association between exercise and anxiety found an overall medium to large effect size of -0.48 (Hedges' g), which indicates that those who participated in the exercise treatment had significant reductions in anxiety compared to the control groups (Wipfli et al., 2008). These bodies of research illustrate that physical activity has powerful mental health benefits, in addition to physical health benefits. Although the evidence for the health benefits of physical activity is clear, a large portion of the population does not engage in adequate physical activity to support optimal well-being (Centers for Disease Control and Prevention, 2020).

Promoting and Inhibiting Factors of Physical Activity

Despite the overwhelming evidence for the benefits of physical activity, only 1 in 4 adults aged 18 to 64 meet the recommended guidelines for physical activity (U.S. Department of Health and Human Services, 2018). As stated above, adults should engage in 150 minutes to 300 minutes of moderate-intensity physical activity or 75 minutes to 150 minutes of vigorous-intensity aerobic physical activity per week. Unfortunately, more than 15% of adults in the United States report they participate in no leisure-time physical activity (Centers for Disease Control and Prevention, 2020). Common reasons given for not engaging in physical activity include being too tired and not having enough time.

Although the health benefits of physical activity are widely known, they do not always motivate people to engage in physical activity. A study investigating same-sex twin pairs (both monozygotic and dizygotic) discordant for physical activity over 30 years found that enjoyment, physical fitness, and a person's psychological state (i.e., well-being, self-esteem, and stress release) were important motivations for engaging in physical activity (Aaltonen et al., 2012). Similarly, in a U.S. sample of older adults (50-75), the top motivating themes included health concerns for the future, enjoyment, and using physical activity to regulate stress (Burman et al., 2010). Across studies, stress regulation is a recurring motivation for physical activity.

Literature suggests, however, that stress can also be a barrier to physical activity (Stults-Kolehmainen & Sinha, 2014). Researchers have reported an inverse association between stress and physical activity, meaning that as stress levels increase, physical activity decreases (Brockmann & Ross, 2020; Burg et al., 2017; Stetson et al., 1997; Stults-Kolehmainen & Sinha, 2014). For example, in a community sample of women, results indicated that when respondents reported high levels of perceived stress, they engaged in fewer minutes of physical activity (Seston et al., 1997).

Another commonly reported barrier to physical activity is lack of time and energy (Aaltonen et al., 2012; Burman et al., 2010; Justine et al., 2013). Working parents have many conflicting roles and responsibilities that require their attention. For instance, they have work responsibilities, childcare, and domestic duties. This leaves them with limited time for themselves and limited time to engage in physical activity (Backett & Davison, 1995). After completing all their responsibilities parents often feel tired and do not have the energy to participate in physical activity (Brown et al., 2001).

Overall, lack of time and energy are consistently reported reasons that individuals, especially working parents, do not engage in physical activity. Stress is another factor that inhibits individuals from engaging in physical activity. However, physical activity is also shown to reduce stress levels.

Stressors and Their Effects on Health

Stress is a complex phenomenon, with little consensus regarding how it is operationally defined. One of the first stress researchers, Hans Selye, defined stress as "the state manifested by a specific syndrome which consists of all the nonspecifically induced changes within a biological system" (Selye, 1956, p. 54). Since then, stress research has grown across multiple fields of study, and definitions have become more inclusive. Selye revised his definition of stress in 1974 to include a more psychological conception of stress, "nonspecific response of the body to any demand made upon it" (Selye, 1974, p. 27). Lazarus and Folkman further elaborated this definition of stress to include how we cope with stress and our resources. Their theory, the Transactional Theory of Stress and Coping, has become one of the most influential theories of stress (Lazarus & Folkman, 1984). This theory states that stress is an imbalance between perceived demands and available coping resources of an individual. This theory is grounded in the idea that individuals experience stress differently depending on how they interpret and perceive both the event (i.e., exposure to the stressor) and the outcome (i.e., appraisals of the stress).

Higher perceived stress has negative health outcomes, including all-cause mortality (Fennell et al., 1981; Krueger & Chang, 2008; Lantz et al., 2005), and increases in biomarkers of inflammation (Knight et al., 2021). The severity of psychological stress can have adverse effects on health, which can be a key reason for the absence of maintaining health behaviors (Ng & Jeffrey, 2003; Stetson et al., 1997). High levels of perceived stress are associated with increases in unhealthy behaviors, such as poor diet choices, increased smoking habits and physical inactivity (Boutelle et al., 2000; Ng & Jeffrey, 2003), which moderate the relationship between perceived stress and the risk of death (Krueger & Chang, 2008). Perceived stress has also been associated with increases in heart disease and cancers (Baum & Posluszny, 1999), with part of the explanation for this association being nonadherence to health behaviors (Ng & Jeffrey, 2003). People may be motivated to engage in these unhealthy behaviors because it brings them pleasure during stressful times. Not maintaining good health behaviors, such as regular physical activity, can account for up to 40% of the risk of cardiovascular disease (Mokdad et al., 2004).

Value of a Microlongitudinal Design

Microlongitudinal designs refer to data that are collected on smaller time scales such as minutes, days, or weeks (Bolger & Laurenceau, 2013). The data for this study was collected using a daily diary approach which allows for measurement of short-term fluctuations in daily stress and the recording of same day minutes of physical activity. This intensive repeated measurement allows for better understanding of the dynamic nature of daily stress and physical activity. However, daily diaries do rely on end-of-day recall which can increase recall bias, and this approach provides limited temporal resolution in which to study some behaviors. Intraindividual variability (IIV) refers to potential fluctuations within individuals' performance over time (Nesselroade & Ram, 2004). The benefits of an IIV approach include increased precision when examining individuals' behavior, compared to data collected over a longer period, such as years (Nesselroade & Ram, 2004). IIV uses a person-centered approach in order to assess the ways individuals change over time.

Daily Physical Activity

A daily diary approach to measuring physical activity can help to reduce retrospective biases and gain better understanding of daily physical activity patterns (Shiffman et al., 2008). Daily time use approaches to studying physical activity are increasing in popularity due to their high reliability and validity with METs (Chau et al., 2019). Analyses of daily metabolic expenditures in the U.S. and UK show that individuals spend less than 5% of their day engaging in physical activity (Hams et al., 2019). Potential limitations to studying physical activity as a daily method could be the missed importance of within-day behavior (Shiffman et al., 2008). That is, the timeframe of a whole day may be too wide to capture the importance of daily physical activity.

Daily Stress

Daily stressors are small, unexpected events and routine challenges of daily living that disrupt everyday life (Almeida, 2005). Daily stress has been identified as different from the stress caused by major life events or chronic stressors (Kanner et al., 1981). Daily stress can have an influential impact psychologically as a result of the separate and immediate effects of the stress confined to a single day (Almeida, 2005). Research suggests that although daily stress is often trivial in nature, the cumulative effects can be as damaging as major stressful events (Almeida, 2005; Lazarus, 1999).

To help understand the significance of daily stress, researchers have examined it through two different models. One model, the stress suppressing model, proposes that when an individual has sufficient resources, this can reduce the probability of experiencing stress (Ensel & Lin, 1991). The other model, the exposure model, assumes that different socio-demographic, psychosocial and situational factors will lead individuals to experience more stress (Almeida, 2005). In both models, when an individual has higher indicators of socioeconomic status (income, education) they experience lower severity of daily stress (Serido et al., 2004).

Stressor Frequency

Stressor frequency refers to the number of daily stressors an individual experiences during a given time period. Daily stressors are prevalent in modern life. Almeida et al. (2002) analyzed a national sample of U.S. adults from a daily diary study and found individuals reported experiencing at least one daily stressor on nearly 40% of the eight study days and participants also reported multiple daily stressors on more than 10% of the eight study days. Daily diary approaches to assessing daily stress allow for participants to report the effects of the stress while still fresh in their minds (Almeida et al., 2020).

Engaging in higher amounts of physical activity can lead to lower levels of daily stress (Brockmann & Ross, 2020; Burg et al., 2017; Nguyen-Michel et al., 2006). However, some daily diary studies examining the influence of physical activity on stressor frequency have not found this association. For example, Steptoe et al. (1998) examined the relationship between exercise and stressor frequency and found no significant differences in the number of reported daily stressors when participants exercised compared to when they did not exercise.

Stressor Severity

Stress severity refers to an individual's perception of stressor intensity. Researchers have found differences in the effects of daily stressors when examining their severity compared to their frequency. The perceived severity of daily stress seems to have a greater impact on well-being compared to the number of daily stressors (Grzywacz et al., 2004).

Previous microlongitudinal studies have shown a small reduction in stressor severity due to previous and same-day physical activity, and a similar association is shown in physical activity on stress the following week (Brockmann & Ross, 2020; Burg et al., 2017). Examining previous microlongitudinal studies on the influence of daily stressors on physical activity shows that people are less likely to engage in physical activity when reporting high levels of stressor severity (Brockmann & Ross, 2020; Burg et al., 2017). More specifically, when individuals were asked about the perceived stress experienced throughout the day, (morning, afternoon and evening) it was found that when stress was reported the previous night or the same morning, it predicted less physical activity that day (Burg et al., 2017). Furthermore, an examination of the weekly association between stress and physical activity, indicated an increase in stress predicted less physical activity that same week as well as less physical activity the following week (Brockmann & Ross, 2020).

Daily stress is a common experience of individuals today and is an important type of stress to examine as it is different from stressful major life events and chronic stressors. The perceived severity of daily stressors seems to be more influential on both health behavior and overall health than the number of reported stressors. Daily stress severity negatively impacts physical activity engagement, while physical activity reduces daily stress severity.

The Microlongitudinal Interrelationships of Physical Activity and Stress

Previous research has suggested that there may be a bidirectional relationship between physical activity and stress (Brockmann & Ross, 2020; Burg et al., 2017; Schultchen et al., 2019). In a sample of overweight and obese people, Brockmann and Ross (2020) investigated the bidirectional association between physical activity and stress in a 12-week internet-based weight loss program. They analyzed the data on a week-to-week basis and found that with an increase in reported stress, there was a reduction in physical activity during the same week as well as predicting fewer minutes of physical activity the following week. They also found that people who report one more hour of physical activity during the week, exhibit a small decrease in reported stress levels the following week. Comparably, Burg and colleagues (2017) tested the bidirectional relationship between stress and physical activity by examining healthy young adults over 12 months using an EMA approach at three-time points. The researchers found exercise was associated with a reduction in perceived stress and that an increase in anticipated stress from the previous day resulted in a decrease in exercise the next day. In a separate EMA design using a sample of university students, evidence for a bidirectional relationship was also found (Schultchen et al., 2019). Students were prompted six times a day, via their smartphone, to report perceived stress and physical activity. Results showed that reports of higher perceived stress led to a reduction in subsequent physical activity, as well as higher levels of physical activity resulted in lower subsequent perceived stress.

There is limited research on the bidirectional relationship between physical activity and stress; however, a large body of research has investigated the influence of physical activity on stress. The influence of stress on physical activity has not received as much attention. In the next sections, I will review the evidence for the association between physical activity on stress and the influence of stress on physical activity.

The Influence of Physical Activity on Stress

A variety of correlational and experimental studies have found evidence that physical activity is protective against stress (Aldana et al., 1996; King et al., 1993; Salmon, 2001; Schnohr et al., 2005). Correlational evidence suggests, this relationship is true for a range of different populations, from older adults to veterans with post-traumatic stress disorder (Buckley et al., 2004; King et al., 1993). Research indicates that those who participate in higher amounts of physical activity are less likely to report moderate to high-stress levels, compared to those who engage in low amounts of physical activity (Salmon, 2001). Large, adequately powered studies of working adults, investigating the effects of leisure-time physical activity on stress have determined employees who participate in moderate amounts of physical activity are less likely to have moderate and high amounts of perceived stress (Aldana et al., 1996; Schnohr et al., 2005).

Experimental research also suggests that physical activity helps reduce stress. For example, 357 people were randomly assigned to different levels of exercise intensity and formats, or a control group in order to test the effects of exercise on perceived stress and anxiety (King et al., 1993). It was found that regardless of the exercise structure, participants showed reductions in perceived stress compared to the control group. Other randomized clinical trials have found similar results for physical activity improving stress levels (King et al., 2002; Throne et al., 2000; Wilcox et al., 2008). For instance, Throne and colleagues (2000) examined how an exercise intervention, which consisted of 40 minutes of exercise 4 times per week, affected stress. They found that the exercise intervention had positive effects on stress reactivity. These causal research studies provide evidence for the positive effects that physical activity has on stress.

However, a small number of studies have reported no association between physical activity and stress (Brown, 1991; Hubbs et al., 2012). In a correlational study of college students, Hubbs et al. (2012) found that there was no significant association between self-reported physical activity and perceived stress. Similarly, using a sample of undergraduate students, Brown (1991) investigated the buffering effects of physical fitness on life stress, specifically examining objective vs. subjective measures of fitness. He found that only objective measures buffered the effects of physical fitness on life stress. These studies both examined college-aged students, who experience different life stress compared to a working parent population, which may explain differences in results.

The overall effects of physical activity on stress, and the relationship between the two variables, provides evidence for its protective effect. The majority of research shows when individuals participate in regular physical activity, they experience lower levels of reported stress (Carmack et al., 1999).

The Influence of Stress on Physical Activity

The relationship of stress on physical activity has been studied to a lesser extent. However, existing research indicates a negative association between stress and physical activity participation (Lutz et al., 2007; Oaten & Cheng, 2005; Stults-Kolehmainen & Sinha, 2013). A recent systematic literature review (*N* = 55) investigating the effects of stress on physical activity and exercise found that more than three-quarters of the studies (76.4%) reported that psychological stress impairs physical activity engagement (Stults-Kolehmainen & Sinha, 2013). Of these studies, about one third examined employee populations and found that stress was related to less physical activity. For instance, Lutz et al. (2007) studied employed individuals who completed measures of perceived stress and their leisure-time physical activity and found that stress was related to reductions in physical activity from time 1 stress to two months later at time 2 physical activity. Similarly, a study examining the influence of work-family stress on physical activity in employed individuals found lower rates of physical activity when individuals reported high levels of work-family conflict (Allen & Armstrong, 2006). However, in a study examining racial and ethnic differences in work strain and leisure-time physical activity, work strain lessened the amount of physical activity, but only for White participants (Bennett et al., 2006).

It should be noted that limited studies have found that stress increases physical activity in some cases (Steptoe et al., 1998). For these individuals, exercise is used as a means to reduce stress and as a form of emotion-focused coping. These people do tend to engage in higher levels of physical activity in order to relieve their stress (Rodgers & Gauvin, 1998; Steptoe et al., 1998). In comparison, qualitative research has shown that exercise enjoyment decreases during highly stressful weeks (Stetson et al., 1997). Although this direction of the relationship, the influence of stress on physical activity, has received less attention and has produced more conflicting results, the strongest evidence suggests individuals engage in less physical activity when experiencing high levels of stress (Stults-Kolehmainen & Sinha, 2013).

Physical Activity and Working Parents

Despite being an at-risk group due to their many roles and responsibilities, there is surprisingly little research that has been conducted on physical activity among working parents (Allen & Armstrong, 2006). A meta-analysis found that parents engaged in significantly less physical activity compared to non-parents (Bellows-Riecken & Rhodes, 2008). In over 80% of the studies reviewed, non-parents were more active than parents (Cohen's $d = .41$). Even less research has focused on physical activity among working mothers and fathers (Mailey et al., 2014). Recent research does indicate that the physical activity participation of both men and women declines after becoming parents (Gaston et al., 2014; Hull et al., 2010; Nomaguchi & Bianchi, 2004; Rhodes et al., 2014).

The likely reason for the decline in physical activity participation among working parents is the multitude of barriers they face. Mailey et al. (2014) conducted a focus group with working parents to determine the common barriers to and facilitators of physical activity. Barriers included family responsibilities, guilt, lack of support, scheduling constraints, and work, whereas the facilitators included being active with children or during children’s activities, being a role model for children, making time/prioritizing, benefits to health and family, and having support available. In accordance with the time availability perspective, which states that couples divide up household duties based on the amount of time spent in paid labor and the amount of housework to be done (Bianchi et al., 2000; Coverman, 1985; England & Farkas, 1986), similar qualitative studies have revealed that participants commonly reported there were so many demands on their time that they did not have the energy to engage in physical activity (Backett & Davison, 1995; Brown et al., 2001).

Family and work obligations take priority over time to engage in physical activity (Backett & Davison, 1995; Brown et al., 2001; Nomaguchi & Bianchi, 2004).

Thus, research on working parents indicates that there are so many more barriers to engaging in physical activity after having children, which results in low rates of physical activity participation. Parents are an at-risk group for engaging in enough physical activity, mainly due to a lack of time, energy, and high-stress levels (Allen & Armstrong, 2006; Backett & Davison, 1995; Bellows-Riecken & Rhodes, 2008).

Stress Among Working Parents

Parents often report high levels of stress (Diener et al., 2010; Glass et al., 2016; Nelson et al., 2014). Most of the research conducted on stress in working parents has focused on life stress, as opposed to daily stressors. According to Pearlin's (1989) sociological approach to the study of stress, having children increases individuals' exposure to stressors. Because of this increase in exposure to stressors, parents report higher levels of distress and lower levels of happiness. Although parenthood provides individuals with meaning and identity the stress that parenthood brings may overturn the positive emotional rewards (Glass et al., 2016).

Parents report increased stress due to work-family conflict, difficulties with childcare, sleep deprivation, lack of time for leisure and financial strain (Begall & Mills, 2011; Håkansson et al., 2016; Kravdal, 1996; Nelson et al., 2014). A study examining the leisure time of working mothers and fathers indicated insufficient time for themselves led to higher rates of daily perceived stress (Håkansson et al., 2016). In comparison to married or cohabiting parents, single parents report even higher stress levels (Aassve et al., 2012). Not surprisingly, parents of low socioeconomic status report additional stressors, including food insecurity, lack of access to health care, under-resourced schooling and living in disadvantaged and unsafe neighborhoods (Edin & Kefalas, 2005; Heymann & Earle, 2000).

Consequently, working parents exhibit higher levels of stress due to the double responsibilities of both work and family life. This extra strain can have a negative impact on their well-being and leave them with limited time for themselves.

Working Parents, Physical Activity and Stress

Little research has focused on physical activity engagement in working parents who are stressed. The lack of time that working parents have seems to be one of the leading factors in their scarce physical activity engagement and increases in stress levels (Nomaguchi & Bianchi, 2004). The long hours of employment that are typical in today's society are also related to less time spent on exercise (Nomaguchi & Bianchi, 2004). Working parents have less time for leisure, leading to increased daily stress and insufficient time to exercise (Håkansson et al., 2016). One construct used to describe the incompatible demands between work and family life is work-family conflict (Greenhaus & Beutell, 1985). In regard to work-family conflict as a stressor, it has been found that when individuals report less work-family stress they engage in greater amounts of physical activity (Grzywacz & Marks, 2001).

Although physical activity participation is relatively low within a stressed working parent population, engaging in physical activity can help relieve the stress (Limbers et al., 2020). Compared to their counterparts who engaged in less physical activity, working mothers who engaged in moderate-intensity physical activity reported fewer negative effects of stress. Physical activity has been shown to help reduce stress, however, barriers such as lack of time and energy as well as stress itself, prevent working parents from engaging in the recommended amounts of physical activity.

Time Commitments for Mothers and Fathers

Research indicates that available free time for mothers and fathers is different. Despite more women entering the workforce and becoming more successful, they are still disadvantaged in the share of domestic labor. On an average day, working, married mothers are more likely to perform household duties and take care of children compared to working, married fathers (U.S. Bureau of Labor Statistics, 2008). Because of this, the term the *second shift* was coined to recognize the domestic burden that many women face (Hochschild & Machung, 2012).

Fathers tend to spend less time being involved in the childcare needs of their children (Deutsch et al., 1993; Laflamme, 2002; Rhoads & Rhoads, 2012). When both parents are equally available to tend to their child, fathers report being less likely to provide basic essential care (Laflamme, 2002). Even in highly educated fathers who believe in nontraditional gender roles, the differences persist (Rhoads & Rhoads, 2012).

With mothers and fathers' childcare and household duties different, there is a difference in the amount of time one can dedicate to physical activity (Nomaguchi & Bianchi, 2004). Nomaguchi and Bianchi (2004) found that mothers spent less time exercising compared to fathers due to the number of domestic duties and childcare they perform. The association between working parents having less time for leisure resulting in an increase in daily stress levels was stronger for mothers compared to fathers (Håkansson et al., 2016). Working mothers and fathers perform household tasks (89 versus 64 percent) and childcare duties (71 versus 54 percent) at different rates (U.S. Bureau of Labor Statistics, 2008). This discrepancy between mothers and fathers' results in mothers having less time to devote to physical activity and higher stress levels (Håkansson et al., 2016).

Current Knowledge and Literature Gaps

The majority of the research on the daily relationships between physical activity and stress suggests physical activity helps relieve stressors, and stressors negatively impact physical activity participation. However, there are some contradictory findings regarding the influence of stress on physical activity. Whereas the literature conclusively indicates physical activity is associated with a reduction in stress (King et al., 1993; Salmon, 2001; Schnohr et al., 2005), the reciprocal relationship, involving the influence of stress on physical activity shows conflicting patterns (Burg et al., 2017; Nguyen-Michel et. al., 2006; Stults-Kolehmainen & Sinha, 2013). This is not surprising as some people use physical activity as a way to help relieve stress (Burman et al., 2010). While this bidirectional relationship has been tested micolongitudinally in samples of healthy young adults (Burg et al., 2017), and overweight and obese people (Brockmann & Ross, 2020), no microlongitudinal research has investigated this relationship in working parents. In fact, limited research has utilized an EMA approach to studying the relationships between these two variables. This study aims to fill this gap by utilizing an intensive repeated measures design in order to appropriately assess the dynamic nature of the relationship between stress and physical activity. A microlongitudinal approach to studying these relationships allows for more precision when measuring daily stress. Because working parents have less time to devote to physical activity and report higher levels of daily stress (Hull et al., 2010; Woollett & Parr, 1997), this specific population is an important one to investigate in regard to the bidirectional relationship between physical activity and stress.

Current Study

The current study is a secondary data analysis that uses a microlongitudinal approach to study a sample of working parents to investigate the bidirectional, daily associations between stress and physical activity levels. Using the National Study of Daily Experiences dataset (NSDE II) data from the second wave of Midlife in the United States (MIDUS) as well as the NSDE Refresher and MIDUS Refresher, the current study applied path analyses to examine the bidirectional relationship between physical activity and daily stressors among a national sample of working mothers and fathers over the course of eight days. The current study addressed the following research questions:

1. How are physical activity and daily stress related within each day?

2. Do daily stressors reduce physical activity on following days, and does physical activity reduce daily stressors on the following day?
3. How do the relationships between stressors and physical activity differ for mothers and fathers?
4. Does stressor severity or stressor frequency have a greater effect on physical activity? And does physical activity have a greater effect on stressor frequency or stressor severity?

In order to address these questions, models were run for mothers and fathers, and for both stressor frequency and severity.

Because the literature review suggested substantial differences in the time commitments of mothers and fathers it was expected that there would be a difference in the structural relationships among the variables in the model due to parental gender. However, since prior research on this topic was limited, directional hypotheses were not specified. The current study hypothesized that:

H1: Higher physical activity will predict decreased daily stress on the next day.

H2: Higher daily stress will predict lower levels of physical activity on the next day.

H3: Daily stress will have a greater effect on physical activity when compared to the effect of physical activity on daily stress.

H4: The structural relationships will be different for mothers and fathers.

H5: The structural relationships will be different for stressor severity compared to stressor frequency.

Methods

Participants

Participants were from the National Study of Daily Experiences (NSDE; Ryff & Almeida, 2010), a daily diary subproject of the larger Midlife in the United States (MIDUS) study. Data from MIDUS Refresher (Ryff et al., 2014) and Project 2 (NSDE) Refresher (Ryff & Almeida, 2014) was also utilized. In 1995-1996 the original MIDUS I data was collected using working telephone banks to identify potential participants, with its purpose being to examine successful aging in terms of physical health, psychological well-being, and social responsibility. The national sample included 7,108 individuals aged 25-75. In 2005-2006 MIDUS II was conducted as a follow up of the original participants. The MIDUS II sample consisted of 3,487 individuals aged between 35 and 86. For MIDUS II an additional sample was taken from Milwaukee, Wisconsin which added 592 African American participants. MIDUS Refresher study was conducted in 2011-2014 and was designed to replenish the original MIDUS survey. The sample consisted of 3,577 adults aged between 25 and 74.

MIDUS II is composed of five different projects. The majority of the data for this thesis was taken from the second project, the national study of daily experiences (NSDE II). The first project consisted of participants from the original MIDUS I study who were contacted for follow-up questions pertaining to psychosocial, sociodemographic, and health variables via telephone interview (about 30 minutes) and self-reported questionnaires that were returned by mail. Participants were compensated $60 for their participation. The second project (NSDE II) was a daily diary study that consisted of a short telephone interview for eight consecutive days with questions relating to participants' daily stressors, time use behaviors, health, and well-being. The NSDE II is a microlongitudinal study that collected a nationally diverse sample of 2,022 adults (57.20% female) ranging in age from 33 to 84 (M = 56.24, SD = 12.20) between 2004 to 2009. Participants were compensated $25 for their time. Project 2 (NSDE) Refresher contains data for a random subsample of the MIDUS Refresher Survey data and had 782 respondents aged between 25 and 75 (55.6% female, 85% White).

For purposes of this study, a subsample of the NSDE and NSDE Refresher projects was used, such that only participants who work 20 hours or more per week and have at least one child under 18 years old living at home were included in analyses.

Procedure

The MIDUS II sample includes a longitudinal group, expanded group, and Milwaukee group. The longitudinal group consists of participants from wave one, the expanded group contains participants who did not participate at wave one, and the Milwaukee group includes participants from the original Milwaukee sample. Respondents were randomly recruited from the MIDUS II sample. In order to be eligible to participate in wave two of the MIDUS, participants needed to be English speaking, living in the United States and aged 25 to 74 when partaking in MIDUS I. MIDUS Refresher employed the same assessments as the original MIDUS survey.

Data collection for the daily diary consisted of a phone interview at the end of each day, pertaining to the previous 24 hours, for eight consecutive days. Both phone interviews and self-administered questionnaires were utilized in MIDUS II to obtain repeated baseline assessments. The interview asked questions related to different areas such as stressful events, well-being, sleep and health. The data collection for the NSDE II was spread across multiple years in order to collect the data on all participants for the eight consecutive days. Again, MIDUS Project 2 (NSDE) Refresher employed the same design as the original NSDE.

Researchers contacted participants one week before the interview sessions to inform them of the time in which they would be called to increase participation rates. Participants could change their interview times by phoning a toll-free number. Participants reported demographic information, such as age, gender, employment, and marital status in the phone interview. In the self-administered survey, participants reported their income, health status, and personality traits.

Before data analysis for this thesis began, an IRBNet application was submitted to the Northern Arizona University Institutional Review Board for determination of human research. This research received a “non-human subjects” determination. Prior to analyzing the data, a power analysis was run using Preacher and Coffman’s software to calculate the minimum sample size required for RMSEA (Preacher & Coffman, 2006). Results indicated that a minimum sample size of 276 was needed with power set at 0.80.

Measures

Physical activity

To capture physical activity, participants were asked how much physical activity they had participated in over the previous 24 hours. They were asked, “How much time was spent on physical activity in hours.” They were also asked this question for the number of minutes spent on physical activity, “How much time was spent on physical activity in minutes?”. Respondents could also have answered *don’t know, refused/missing or inapplicable*. In order to capture the combined total of physical activity (minutes and hours), the hour variable was rescaled (i.e., the variable was multiplied by 60 in order to be on the same scale as the minutes variable). The new variable, plus the original minute’s variable, was combined to form a new variable that assessed the total number of minutes of physical activity per day.

Daily stressor frequency

To measure daily stressor frequency, the semi-structured Daily Inventory of Stressful Events (DISE, Almeida, et al., 2002) was used. Participants were asked if they had encountered any of the following seven stressors in the past 24 hours: an argument, tension (could have had an argument but avoided), work stressor, home stressor, network stressor (a stressor that involves the respondent’s network of relatives or close friends), discrimination, or any other stressor. For each day, respondents received a 1 for each of the stressors they reported experiencing, and received a 0 for each stressor they did not experience. Scores were summed for the seven stressors and ranged from 0-7.

Daily stressor severity

In order to assess appraisals of the experienced stressor, participants were asked a series of follow up questions. One of these questions pertained to the perceived severity of the stressor. If participants indicated they had experienced any of the seven stressors they were asked, "How stressful was this for you – very, somewhat, not very, or not at all?". It was treated as a Likert-type scale with 0 = *not at all*, 1 = *not very*, 2 = *somewhat*, 3 = *very*. For each daily interview, the summed total of the stressor severity was calculated. The total for each day ranged from 0-21. Higher scores reflect higher levels of stressor severity.

Inclusion and Exclusion Criteria Variables

Employment status

To assess the number of hours the participants worked, they were first asked about their employment status. They were asked "What about your current employment situation - are you working now for pay, self-employed, looking for work, temporarily laid off, retired, a homemaker, a full-time or part-time student, or something else*?*" as well as "Are you doing ANY work for pay at the present time?". To assess the number of hours the participant worked in a week, they were asked "When you are working, about how many hours do you work for pay in an average week on your main job*?*" as well as "When you are working, in an average week, how many hours do you work for pay at any other jobs?". Participants were considered 'working' if they recorded a total of 20 hours or more in an average week. Participants were included in the study if they indicated they were currently employed and working at least 20 hours per week.

Parents

To assess whether the participants had a child under the age of 18 living in their home, a series of four questions were asked. First, they were asked "How many children do you have? Include biological, adopted, step and foster children living with you or elsewhere. Also include all living children you have [given birth to/fathered]. (Please include only living children)." In order to understand the specific relationship between the participant and the child they were asked "How is [name] related to you?". If participants responded with either: *biological child, adopted child, step-child, foster child, child of lover/partner or other child,* they were considered to have a child. For each child that the participant indicated they had they were asked to report the child's age and if the child was
living in the household, "Does [name] currently live in your household?". Respondents were included in the analysis if they indicated they had one or more children under the age of 18 that were living in the household.

Multi-group Analysis Variable

Sex

The MIDUS II data set asks respondents to state their "gender" as "male" or "female". Because sex was not measured in MIDUS II, the "gender" variable will be used to represent the sex of the respondent in order to determine whether the respondent is a mother or father.

Statistical Analysis

Proposed analysis

The a priori analytic plan was to analyze the relationship between physical activity and stressor frequency and severity was to run two separate structural equations models (SEM). First, a SEM would be generated simultaneously for mothers and fathers, to evaluate the possible effects of physical activity on stressor frequency and the possible effects of stressor frequency on physical activity. Autoregressive relationships were depicted in the model by examining the paths from physical activity on one day predicating next day physical activity, and daily stressor frequency on one day predicting next day daily stressor frequency. The model depicting the hypothesized associations between physical activity and stressor frequency is represented in Figure 1. Next, a SEM would be generated simultaneously for mothers and fathers, to evaluate the possible effects of physical activity on stressor severity and the possible effects of stressor severity on physical activity. Autoregressive relationships were depicted in the model by examining the paths from physical activity on one day predicating next day physical activity, and daily stressor severity on one day predicting next day daily stressor severity. The model depicting the hypothesised associations between physical activity and stressor severity is represented in Figure 2. In these models, daily stressors are predicted by stressors on the previous day and by physical activity on the previous day. The paths across days were set to be equal. This would address the question of whether physical activity engagement during any given day predicts changes in daily stressors. Additionally, physical activity is predicted by physical activity on the preceding day and by daily stressors on the previous day, which would address the question of whether daily stressors predict change in physical activity. The models provide five pathways of interest for both the stress severity model and stress frequency model, for both mothers and fathers, which would be estimated simultaneously:

1. Physical activity predicting subsequent physical activity
2. Stress predicting subsequent stress
3. Physical activity predicting subsequent stress
4. Stressors predicting subsequent physical activity; and
5. The within day, covariance for physical activity and stressors

The models would also control for four covariates, age, race, marital status, and education. These four variables were chosen as covariates as they have been shown to influence physical activity participation and stressors (Edin & Kefalas, 2005; Heymann & Earle, 2000; Serido et al., 2004; Tucker et al., 2011). We assessed global fit through the Chi Square test of overall model fit, root mean-square error of approximation (RMSEA; >.08 is considered poor fit; .05–.08 is considered acceptable; Brown, 2015), and the comparative fit index and Tucker-Lewis Index (CFI and TLI, respectively; .90–.95 is considered acceptable fit; >.95 is considered good fit; Brown, 2015).

Data Set

Dataset Creation

The first step in the dataset creation process was to merge the MIDUS II Project 1 survey dataset with the NSDE II daily diary dataset. A similar process was completed to merge MIDUS Refresher Project 1 data with the NSDE Refresher daily diary dataset. The two combined new datasets (i.e., Wave 2 and Refresher Wave) were then combined together to create the analytic sample.

Since the variable names within the MIDUS refresher dataset and the MIDUS II dataset were not aligned, all variable names had to be changed. The process involved renaming all variables to have a common variable name. For example, the variable in the MIDUS 2 dataset pertaining to work status was “B1PBWORK” and within the refresher dataset was “RA1PB3WK”. These variables were both renamed to “workstatus” to be uniform across the dataset.

The next step was to trim the dataset set to the analytic sample of working parents. This involved first creating a new variable, “workhours”, that combined participants hours of work at their main job (“workpb12”) with the hours of work at any other job (“work_hoursotherjob”), to create a variable that represented the total number of hours worked. The employment status inclusion criteria was to work 20 or more hours per week, so a new dataset was created to only include participants who worked 20 or more hours per week and delete participants who did not meet this requirement. The next inclusion criteria, parental status, was to have at least one child, under the age of 18, living in the household. Next, a new dataset was created that only included participants who reported having at least one child. In order to do this, a new child variable was created for each child (1-17), that assigned a 1 if the "child age" variable was less than 19 and the "child household" variable indicated they lived at home, and a 0 for all other responses. A new dataset was created that only included respondents who had at least one child variable that had been assigned a 1, indicating they had at least one child under the age of 18, living at home. The final dataset only included individuals who reported working 20 or more hours per week and have at least one child, under the age of 18 living at home. This reduced the sample size to 5,181 observations, and 667 participants.

A new variable for physical activity was also created that multiplied the physical activity hours variable by 60 and combined it with the physical activity minutes variable. This created a new variable that was the total number of minutes of physical activity.

Data Screening/ Cleaning

The first step in this process was to assess normality. Analysis of histograms, box plots and values of skewness and kurtosis indicated non-normality in the physical activity, stressor severity and stressor frequency variables. The physical activity variable indicated positive skew (ranging from 3.63 to 4.62) and kurtosis (ranging from 15.55 to 25.82). Descriptive statistics are shown in Table 1. Although the data are not normally distributed, this reflects the distribution of the population. It shows that the majority of adults do not engage in high amounts of physical activity, whereas some adults do. Stress frequency and stress severity variables had slight positive skew and kurtosis (see Table 2 and 3). Although this does violate the assumption of normality, the large sample size and robust MLR estimator were deemed acceptable corrections, and therefore no transformations were performed.

Univariate outliers were screened for by converting each variable to z-scores to search for extreme values. Some large outliers were detected in the physical activity variables, however these participants were deemed as cases of interest and therefore recoding their scores did not reflect the goals of the current study. With the non-normal physical activity variable, the MLR estimator was utilized as it was considered sufficient (Li, 2014).

Results

The models that were specified a priori did not provide a good fit for the data. The chi-square test of model fit for the stressor frequency model was a poor fit, $\chi 2$ (244) = 818.70, $p < .001$. Other indices of fit also indicated poor model fit, RMSEA = .08, CFI = .61, TLI = .57. The first run of the stressor severity model did not provide fit indices. Because of these results, both models were altered in several ways in order to try and specify a model that did provide a good fit for the data.

First, due to the poor model fit, the originally specified covariates were not included in the model. Similarly, due to poor model fit the models were run separately for mothers and fathers, instead of simultaneously. Next, latent variables for both physical activity and stress were included in the model in order to better capture these constructs. Fourth, due to the large differences in the variances between minutes of physical activity and the stressor scores, the physical activity variable was divided by 30. Fifth, because of the nature of the follow-up question style of the stressor severity variable, there was a lot of missing data. To accommodate this, the stressor severity variable was recoded such that if a participant indicated they had encountered 0 stressors they were coded as 0 on the stressor severity variable, rather than missing data. This did alter the meaning and interpretation of the stressor severity variable. Next, all estimated paths were free to vary to help with model fit. Lastly, in order to better understand the unexpected relationships between the variables, several supplementary analyses were run. Bivariate correlations were run to inspect the relationships between physical activity and stressor frequency, as well as physical activity and stressor severity. Linear regressions were run with aggregated results to describe the impact of stressor frequency and severity (averaged across 8 days) on physical activity (averaged across 8 days).

The final analysis analyzed the relationship between physical activity and stressor frequency and severity in four separate SEMs. First, a SEM was generated for fathers, to evaluate the effects of physical activity on stressor frequency and the effects of stressor frequency on physical activity, with the inclusion of latent variables for both physical activity and stress. The model depicting the hypothesized associations between physical activity and stressor frequency is represented in Figure 3. Next, a model depicting the same relationships between physical activity and stressor frequency was run for mothers. This is also represented in Figure 3. Thirdly, a SEM was generated for fathers, to evaluate the effects of physical activity on stressor severity and the effects of stressor severity on physical activity, with the inclusion of latent variables for physical activity and stress. The model depicting the hypothesized associations between physical activity and stressor severity is represented in Figure 3. Lastly, a model depicting the same relationships between physical activity and stressor severity was run for mothers. This is also represented in Figure 3. In these models, daily stressors are predicted by stressors on the previous day and by physical activity on the previous day. This addresses the question of whether physical activity engagement during any given day predicts subsequent daily stressors. Additionally, physical activity is predicted by physical activity on the preceding day and by daily stressors on the previous day, which would address the question of whether daily stressors predict change in physical activity. The models provide six pathways of interest for both the stressor severity model and stressor frequency model, for both mothers and fathers, which was estimated separately:

1. Physical activity predicting subsequent physical activity
2. Stress predicting subsequent stress
3. Physical activity predicting subsequent stress
4. Stressors predicting subsequent physical activity
5. The path from the latent variable, physical activity, to their respective factors; and
6. The path from the latent variable, stress, to their respective factors

Additionally, post-hoc bivariate correlations and linear regressions were run to evaluate the relationships between physical activity and both stressor frequency and stressor severity.

Descriptive Statistics

The sample included 667 working parents (47.7% female) who were between 25 and 69 years of age (*M* = 42.71, *SD* = 7.04). The majority were married (*n* = 540, 81.0%). Few people had not graduated high school (*n* = 19, 3.7%), and some participants had only graduated high school (*n* = 111, 16.6%). Many had received some college education (*n* = 192, 28.7%), had a bachelor's degree (*n* = 181, 27.1%) or graduate education (*n* = 154, 23.0%). The sample was not very ethnically diverse, with the majority of the sample identifying as non-Hispanic (*n* = 642, 96.7%), followed by Mexican (*n* = 6, 0.9%), Mexican American (*n* = 3, 0.4%). Most participants identified as White (*n* = 566, 84.9%), followed by identification as Black and/or African American (*n* = 62, 9.3%). The average number of children living at home was greater than 2 and ranged between 1 to 17 (*M* = 2.58, *SD* = 1.52). Participants worked an average of 43.86 hours per week (*SD* = 12.53), and the most common work status included 'working now' (*n* = 576, 86.4%), followed by 'self-employed' (*n* = 82, 12.3%). For full demographic information, see Table 4.

Participants' average daily physical activity was 42.06 minutes per day (*SD* = 93.74) and ranged from 0 minutes to 1020 minutes. On any given day over 50% of the sample did not engage in any physical activity. The U.S. National Physical Activity guidelines are 150-300 minutes of moderate intensity physical activity each week. This equates to roughly 30 minutes of physical activity per day. Although intensity of physical activity was not measured in this study, on any one day less than 40% of participants did not meet the recommended moderate intensity physical activity guidelines. This is shown in Table 2. The number of daily stressors ranged from 0 to 5 with an average daily stressor frequency of 0.60 (*SD* = 0.76). In this sample, between 42.6% and 70% of individuals reported at least one daily stressor, and 5.7% to 29.5% of individuals reported multiple daily stressors on any one of the eight days of data collection. Total stressor severity ranged from 0 to 14 and average severity was 1.19 (*SD* = 1.77). Descriptive results for these two variables are represented in Tables 6 and 7.

Confirmatory Factor Analyses

Separate confirmatory factor analyses (CFA) were run for physical activity, stressor frequency and stressor severity using Mplus Version 7.4. The CFA for physical activity did not provide good model fit, χ^2 (20) = 55.26, $p < .001$. Other indices of fit also indicated less than adequate model fit, RMSEA = .05, 90% CI [0.04, 0.07], CFI = .90, TLI = .86. All standardized factor loadings are shown in Figure 4. Results from the CFA for stressor frequency indicated good model fit, χ^2 (20) = 34.42, $p = .023$. Other indices of fit also indicated excellent model fit, RMSEA = .03, 90% CI [0.01, 0.05], CFI = .97, TLI = .95. All standardized factor loadings are shown in Figure 5. The CFA for stressor severity also indicated good model fit, χ^2 (20) = 30.49, $p = .062$. Other indices of fit also indicated excellent model fit, RMSEA = .03, 90% CI [0.00, 0.05], CFI = .97, TLI = .96. All standardized factor loadings are shown in Figure 6.

Physical Activity and Stressor Frequency Model

Fathers

SEMs evaluating the effects of physical activity on stressor frequency and the effects of stressor frequency on physical activity for fathers were run in Mplus Version 7.4. The chi-square test of model fit did not indicate good model fit, χ^2 (68) = 172.79, $p < .001$. Other indices of fit also indicated poor model fit, RMSEA = .07, 90% CI [0.05, 0.08], CFI = .87, TLI = .77. Full model results and standardized model estimates are reported in Figure 4.

As previously stated, the model predicted six pathways of interest for fathers: Physical activity predicting subsequent physical activity, stress predicting subsequent stress, physical activity predicting subsequent stress, stressors predicting subsequent physical activity, and the two paths from the two latent factors, physical activity and stressor frequency, to their respective variables. I report the preliminary results of these models below, however; the poor model fit for all models run on fathers precludes me from making conclusions regarding hypotheses for fathers.

The paths from the latent variables to their respective variables were significant. However, the majority of the paths within the model were not significant. Importantly, on 75% of the days, the pathways from physical activity to stressor frequency had little to no effect (b = .00 to .01, p > .352, β = .00 to .05), suggesting that physical activity does not influence the subsequent number of stressors on the next day. On two of these days, day 1 physical activity leading to day 2 stressors and day 3 physical activity leading to day 4 stressors, these relationships were significant (b = -.02, p = .019, β = -.01; b = .04, p = .023, β = .16, respectively). Although the path from day 1 physical activity leading to day 2 stressors and the path from day 3 physical activity leading to day 4 stressors was significant and in the hypothesized direction, the strength of the relationship was very small.

The pathways from stressor frequency to physical activity showed no significant effects (*b* = -.43 to .41, $p > .081$, β = -.06 to .08), which indicates that the number of stressors does not significantly result in less physical activity on the next day. This does not provide support for hypothesis two. However, on most days, the pathways from physical activity to physical activity had no significant effect (*b* = .07 to .28, $p > .103$, β = .07 to .31), suggesting that amount of physical activity on one day does not influence physical activity on the next day. However, there were two pathways that were significant. Physical activity on day 2 leading to physical activity on day 3 (*b* = .44, $p = .005$, β = .44), and physical activity on day 3 leading to physical activity on day 4 (*b* = .53, $p = .006$, β = .44) showed a strong, positive relationship, suggesting that for these days, physical activity significantly predicted physical activity on the subsequent day.

The pathways for stressor frequency predicting the subsequent number of stressors were not significant (*b* = -.12 to .14, $p < .052$, β = -.12 to .15), suggesting that the number of stressors does not predict next day's number of stressors. The full model results for stressor frequencies for fathers are presented in Figure 4. The overall model was not a good fit and although there some significant relationships found between physical activity and stress frequency across days, the majority of the evidence does not provide support for the hypotheses.

The results indicate that the model is a bad fit to the data among fathers, suggesting that future work examining daily links between physical activity and stressors among fathers should examine a different model.

Mothers

Next, SEMs evaluating the effects of physical activity on stressor frequency and the effects of stressor frequency on physical activity for mothers were run. Tests of model goodness-of-fit indicated adequate model fit, χ^2 (68) = 110.02, $p = .001$, RMSEA = .04, 90%

CI [0.03, 0.06], CFI = .93, TLI = .88 (Brown, 2015). Full model results and standardized model estimates are reported in Figure 5. The model also predicted the same six pathways of interest for mothers. Similarly to fathers, the paths from the latent variables to their respective variables were significant. However, none of the paths within the model were significant.

The pathways from physical activity to stressor frequency had no effect (b = -.03 to .02, p > .150, β = -.08 to .06), suggesting that physical activity does not influence the number of stressors on the next day. This does not provide support for hypothesis one which stated that higher levels of physical activity would predict decreased daily stressors on the next day. The pathways from stressor frequency to physical activity was negative but not significant (b = -.23 to .23, p > .096, β = -.07 to .07), which indicated that the number of stressors does not significantly result in less physical activity on the next day. This does not provide support for hypothesis two which stated that higher daily stressors would predict lower levels of physical activity on the next day.

The pathways for physical activity predicting subsequent physical activity had no significant effect (b = -.04 to .27, p > .075, β = -.04 to .32), suggesting that the amount of physical activity on one day does not influence physical activity on the next day. The pathways for stressor frequency predicting the subsequent number of stressors were not significant (b = -.03 to .12, p < .150, β = -.04 to .11), suggesting that the number of stressors does not predict next day's number of stressors. The full model results for stressor frequencies for mothers are presented in Figure 5. The overall model provided adequate fit, however, none of the paths within the model across days were significant.

Comparison of models between mothers and fathers

A descriptive evaluation comparing the structural relationships for mothers and father's stressor frequencies, revealed that they were similar. Within the model for fathers, there were some significant paths for the cross-variable and auto-regressive paths, however, they were small effects and not the majority. This does not provide support for hypothesis four, which stated that the structural relationships would be different for mothers and fathers. Overall, there were similar results for mothers and fathers for the stressor frequency model.

Physical Activity and Stressor Severity Model

Fathers

The model for stressor severity was also run separately for mothers and fathers using Mplus Version 7.4. The chi-square test of model fit did not indicate good model fit, χ^2 (68) = 167.92, $p < .001$. Other indices of fit also indicated poor model fit, RMSEA = .06, 90% CI [0.05, 0.08], CFI = .87, TLI = .77. Full model results and standardized model estimates are reported in Figure 6. As previously stated, the model predicted six pathways of interest for fathers: Physical activity predicting subsequent physical activity, stress predicting subsequent stress, physical activity predicting subsequent stress, stressors predicting subsequent physical activity, and the two paths from the two latent factors, physical activity and stressor severity, to their respective variables. The paths from the latent variables to their respective variables were significant, however, none of the paths within the model were significant.

The majority of the pathways from physical activity to stressor severity were not significant (b = -.01 to .05, $p > .171$, β = -.02 to .09), suggesting that physical activity does not influence the severity of stressors on the next day. There was a small significant relationship in the path for physical activity day 1 predicting stressor severity day 2, (b = -.05, p = .027, β = -.10). Overall, the majority of results for these paths did not provide support for hypothesis one. The pathways for stressor severity predicting next day physical activity were not significant (b = -.07 to .24, p = .063, β = -.04 to .10), indicating that the severity of stressors does not result in subsequent less physical activity. This does not provide support for hypothesis two.

On most days, the pathways for physical activity predicting subsequent physical activity had no significant effect (b = .06 to .26, p > .099, β = .06 to .31), suggesting that amount of physical activity on one day does not influence physical activity on the next day. However, there were pathways that were significant. Physical activity on day 2 leading to physical activity on day 3 (b = .44, p = .005, β = .44), and physical activity on day 3 leading to physical activity on day 4 (b = .53, p = .005, β = .45) showed a positive relationship, suggesting that for these days, physical activity significantly predicted physical activity on the next day.

The pathways for stressor severity predicting the subsequent severity of stressors were not significant (b = -.06 to .14, p < .111, β = -.07 to .14), suggesting that the severity of stressors does not predict next day's stressor severity. The full model results for stressor severity for fathers are presented in Figure 6. The overall model was not a good fit, and although there were some significant relationships found between physical activity across days, the majority of the evidence does not provide support for the hypotheses one and two.

Mothers

SEMs evaluating the effects of physical activity on stressor severity and the effects of stressor severity on physical activity for mothers were run. Tests of model goodness-of-fit indicated adequate model fit, χ^2 (68) = 102.65, p = .004, RMSEA = .04, 90% CI [0.02, 0.06], CFI = .94, TLI = .90 (Brown, 2015). Full model results and standardized model estimates are reported in Figure 7. The model also predicted the same six pathways of interest for mothers.

All the paths, except for day 4 stressor severity, from the latent variables to their respective variables were significant. However, none of the paths within the model were significant. The pathways from physical activity to stressor severity had no effect (b = -.05 to .07, p > .243, β = -.05 to .08), suggesting that physical activity does not influence the severity of stressors on the next day. This does not provide support for hypothesis one. The pathways from stressor severity to physical activity were not significant (*b* = -.07 to .09, *p* > .088, β = -.06 to .06), which indicated that the severity of stressors does not significantly result in less physical activity on the next day. This does not provide support for hypothesis two.

The pathways for physical activity predicting subsequent physical activity had no significant effect (*b* = -.04 to .27, *p* > .077, β = -.04 to .32), suggesting that the amount of physical activity on one day does not influence physical activity on the next day. The majority of the pathways for stressor severity predicting the subsequent severity of stressors were not significant (*b* = -.19 to .17, *p* > .113, β = -.14 to .18), suggesting that the severity of stressors does not predict next day's stressors severity. However, there was one significant path in stressor severity on day 7 predicting stressor severity on day 8, (*b* = .20, *p* = .037, β = .20). The full model results for stressor severity for mothers are presented in Figure 7. The overall model provided adequate fit, however, the majority of the paths across days were not significant. Instead, the paths for the latent variables were mostly significant.

Comparison of mothers and fathers

A descriptive evaluation of the structural relationships revealed that there were no differences for mothers and fathers' stressor severity. Despite some different significant paths within the models for mothers and fathers, these were small effects and the majority of the paths showed similar patterns. This does not provide support for hypothesis four. Overall, there were similar results for mothers and fathers for the stressor severity model.

Differences between stressor frequency and severity

Examining the differences in the structural relationships for stressor frequency compared to stressor severity, observationally, there were no differences. The estimated coefficients for the paths within the models were very similar for number of stressors and the severity of the stressors. Even though there were differences in some specific paths being significant in one model and not the other, they were small effects, and the overall evidence was similar. Due to such similarities, this does not provide support for hypothesis five which the structural relationships would be different for stressor severity compared to stressor frequency.

Comparisons in the effects of daily stressors and physical activity

Again observationally, there were not differences in the effects of daily stressors on physical activity, compared to physical activity on daily stressors. Due to mostly nonsignificant paths within the models, there were very few differences in the effects of physical activity on daily stressors and daily stressors on physical activity. With very few overall differences in the direction of the effects in these variables, no support was provided for hypothesis three which stated that daily stressors will have a greater effect on physical activity when compared to the effect of physical activity on daily stress.

Supplementary Analyses

Due to the overall inadequate fit of the SEMs, three additional analyses were completed. First bivariate correlations were run for physical activity and stressor frequency, as well as physical activity and stressor severity. These results are presented in Tables 8 and 9, respectively. The results show that the relationships for the physical activity variable (days 1-8) and stress variables (days 1-8) were strong and significant, however, the correlations between the physical activity and stress variables are weak and nonsignificant.

Next, two linear regressions were run with aggregated results to describe the impact of the number of stressors (averaged across 8 days) on physical activity (averaged across 8 days), and the impact of severity of stressors (averaged across 8 days) on physical activity (averaged across 8 days). To do this, data was retained in long format and person means across the 8 days were created for all three variables. The average number of reported stressors was not significantly associated with a decrease in minutes of physical activity (b = -5.07, SE = 5.14 p = .324, β = -.04). The average stressor severity score was also not significantly associated with a decrease in minutes of physical activity (*b* = -2.25, *SE* = 2.10 *p* = .287, β = -.04). These results provide further evidence for physical activity and both the number of stressors, and the severity of stressors not being significantly associated.

Lastly, the previously described SEMs were run with the exclusion of extreme outliers on the physical activity variable. The 8 days of data for physical activity were converted to z-scores within each gender, and any respondent that had an absolute value of 3.29 or higher was removed from the analysis. This removed 46 participants from the analyses, resulting in 611 participants. Results revealed no improvement in model fit for father's stressor frequency or severity. For the model for father stressor frequency, the model continued to indicate poor model fit χ^2 (68) = 127.42, $p < .001$, RMSEA = .06, 90% CI [0.04, 0.07], CFI = .87, TLI = .78. Similarly for the father model of stressor severity, the model retained a poor model fit χ^2 (68) = 167.92, $p < .001$, RMSEA = .07, 90% CI [0.05, 0.08], CFI = .87, TLI = .77. For mothers, both the stressor frequency and stressor severity models improved after removing the extreme outliers. The model for mother stressor frequency indicated good model fit χ^2 (68) = 85.93, $p = .070$, RMSEA = .03, 90% CI [0.00, 0.05], CFI = .95, TLI = .92. The stressor severity model for mothers also indicated good model fit, χ2 (68) = 80.35, $p = .145$, RMSEA = .03, 90% CI [0.00, 0.05], CFI = .96, TLI = .94. Even though, the models for mothers improved in model fit, there was no change in the paths within the models. The significant and nonsignificant paths within the models remained the same.

Discussion

Overall, it does not appear that physical activity and stressor frequency or severity are related in a daily context. Results from the SEMs, correlations and aggregated regression analyses demonstrate a lack of relationship between physical activity and daily stress. Physical activity on one day did not predict next day number of stressors or their severity, nor did daily stressor frequency or severity on one day predict subsequent physical activity.

Interestingly, physical activity did not predict next day physical activity, nor did daily stress predict next day daily stress. However, the stressor frequency model and the stressor severity model for mothers provided adequate fit, but, these models provided a poor fit for fathers. Furthermore, the SEMs applied in the current study did not provide support for any of the hypotheses, and the supplementary analyses also highlighted the lack a relationship between these variables. In examining the table of correlations (see Table 8), the associations between physical activity and the number of stressors, are both small and non-significant. Similarly, the correlations between physical activity and stressor severity (see Table 9), are small and non-significant. These non-significant associations between physical activity and daily stressors are further seen in the results of the aggregated linear regressions. Thus, despite substantial evidence linking physical activity and stress, this was not evident in this study. The combined results of the SEMs, correlations, and linear regressions show no evidence for an association for the daily relationships between physical activity and both the number of stressors and their severity for working parents.

This is contradictory to what has been found in similar microlongitudinal studies analyzing these relationships in varying populations (Brockmann & Ross, 2020; Burg et al., 2017; Schultchen et al., 2019). In the first study, Brockmann and Ross (2020) analyzed the weekly associations of self-reported weekly minutes of physical activity and a singular question of perceived stress. Their results indicated that an increase in reported stress one week decreased physical activity participation during the same week, as well as predicted fewer minutes of physical activity the following week. It was also found that people who report one more hour of physical activity during the week exhibit a small decrease in reported stress levels the following week. This study analyzed the weekly associations between physical activity and stress and measured perceived stress, in comparison to daily number of stressors and stressor severity, which was measured in the current study.

The next two studies analyzed the associations between physical activity and stress utilizing an EMA design. The first of the two analyzed objectively measured minutes of physical activity via Fitbit and perceived stress at three different time points throughout the day (start of day, middle of day, and end of day; Burg et al., 2017). It was found that physical activity was associated with a reduction in perceived stress, as well as an increase in anticipated stress from the previous day resulted in a decrease in exercise the next day. The objectively measured physical activity and the utilization of the Perceived Stress Scale (PPS) was distinctly different from the current study. The last study utilized an EMA design which promoted participants to report minutes of physical activity and two items of perceived stress, six times per day (Schultchen et al., 2019). Results demonstrated that higher perceived stress led to a reduction in subsequent physical activity, as well as higher levels of physical activity resulted in lower subsequent perceived stress at the next time point. This study again measured perceived stress and asked participants to report minutes of physical activity in which they were "sweaty and out of breath", in comparison to not measuring intensity of physical activity. These three studies, although all slightly different, measured perceived stress, as opposed to number of stressors and stressor severity. Perceived stress may be the component of daily stress that is most influenced, and influences, physical activity. It appears that, in this sample of working parents, physical activity is not predictive of number of reported stressors or stressor severity.

It was also unexpected that there was no relationship between these variables in the population understudy, working parents. It appears that for parents in our national sample who are working 20 or more hours per week, physical activity and number of stressors or stressor severity are not related within a daily context. One possible reason for this is the measurement of the physical activity variable. Within the study population over half of participants, each day, did not engage in any amount of physical activity. If these individuals never partake in physical activity, regardless of daily stressors, it may be informative to remove them from analysis. The constant reporting of 0 minutes of physical activity each day, does not allow for the relations between stress and physical activity to be detected. In this study, the U.S. national physical activity guidelines are 150 - 300 minutes of moderate intensity physical activity each week. This equates to approximately 30 minutes per day of physical activity. Although the intensity of physical activity was not measured in this study, less than 40% of participants, each day, did not meet the recommended moderate intensity physical activity guidelines. Removing participants who did not record any minutes of physical activity over the eight days may allow for the discovery of how daily stress is influencing those who do participant in physical activity.

Although the current study limited the sample to working parents, the parameters that were used may have still been too broad. There is the potential that the daily relationships between physical activity and stress exist within in different samples. Some different potential subsamples that could be examined include parents who work full time (40+ hours per week), parents of young children, or parents of low socioeconomic status. Research has also found that those who have younger children report facing additional barriers to exercise (Mailey et al., 2016). Examining these associations in parents of young children may also yield interesting results. Parents who work a minimum of 40 hours per week, compared to a minimum of 20 hours per week, may have different relationships with physical activity and daily stressors.

It appears that the best way to explain the associations among variables is the measurement portion of the model. The paths from the latent variables to the respective variables were significant for physical activity, stressor frequency and stressor severity. This shows that the constructs themselves were measured appropriately. The CFA results, however, were only a good fit for the stressor frequency and stressor severity models.

Examining the constructs of stressor frequency and stressor severity is an important aspect in ensuring the items are accurately measuring the different types of stress. Although the items appear to be measuring the constructs appropriately, the items themselves may not have been capturing the type of stress that is associated with physical activity. Stress was measured in this study in regard to stressor frequency and severity. However, in previous studies, stress has been measured utilizing perceived stress, the items measuring stressor frequency and severity of stress may not have captured the component of stress that is most influenced by physical activity. Additionally, across all days there were high numbers of participants (30.30% - 57.40%) who did not report any stressors and did not indicate that any stressors were severe (30.60% - 62.10%). This lack of experiences in daily stress may have contributed to the lack of associations between physical activity in this study.

Similarly, physical activity is often regulated by automatic processes, such as habits (Aarts et al., 1997). It may be that this habitual routine was observed in the latent construct of physical activity. Since physical activity was not predicated by the number of stressors a working parent experiences or its severity, it may be that physical activity participation in working parents is best conceptualized by a routine. This would be particularly evident for those who either consistently engage in physical activity, or who not perform any physical activity. Evidence for this possible relationship may be similar to what was found in a meta-analysis that discovered a medium to strong relationship between physical activity and habit strength (Gardner et al., 2011). It has also been found that prioritization and planning of physical activity mediates the relationship between perceived barriers and exercise in working parents (Mailey et al., 2016), thus these concepts should also be examined. With this, physical activity may be best predicted by habits, planning and prioritization.

In sum, it appears that for working parents, encountering a stressor on one day may not be detrimental to the amount of physical activity that they perform the next day.

Similarly, if physical activity engagement is low on one day, daily stressors the next day will not be influenced in a negative way.

Limitations

The current study had multiple limitations. These limitations included issues in measurement, design, statistical issues, and sample. Below I will discuss how these limitations may have influenced the current study and some potential solutions to these in the future.

First, is the measure of the three variables: physical activity, stressor frequency and stressor severity. The physical activity variable asked participants to report the number of minutes and hours they spent on physical activity. It did not measure the intensity or type of activity that was completed. Previous research has shown that higher intensity physical activity has a greater influence on reducing stress levels (Föhr et al., 2017). With no measure of intensity of physical activity, it is not known how the intensity of physical activity contributes to these relationships. With the broad nature of this question, it is possible that some respondents inferred they should report just the amount of time they spent purposefully engaging in physical activity, whereas other participants may have reported minutes of activity accumulated during an active job. This may be a reason the means and standard deviations for the physical activity variable are so high considering the population under study. The variability in the minutes of physical activity was large and this was reflected in the high standard deviations. The measurement of the stressor frequency variable may not have been specific enough for the population understudy. To assess the number of stressors participants encountered, they were asked if they had experienced seven different stressors as assessed by the DISE. Included in the DISE were home stressors and work stressors. This study aggregated the seven stressors to have a combined total of number of stressors. However, it is possible that the stress among working parents is specific to their home and work life. Examining just the home and work stressors may be an important aspect to study. The stressor severity variable in this study was recoded in order to account for missing data. The recoding of the stressor severity variable did change the meaning and interpretation of a score of 0 on stressor severity. This limitation confounds a person who reported their stressor as 'not at all stressful' and had a true score of 0 on stressor severity, with an individual who reported 0 stressors. A potential way to adjust for this in the future would be to make stressor severity a 5-point scale. Somebody who does not report any stressors would have a 0 on stressor severity and the scale of the original stressor severity would add one to each score (i.e. 0 would become 1, 1 would become 2 etc.).

Next, all variables were measured using self-report. Self-report has the risk of bias when participants reported their physical activity levels, number of daily stressors and the severity of those stressors. This could be addressed by objectively measuring physical activity via accelerometers or Fitbits, a measure that has been done in previous microlongitudinal studies (Schultchen et al., 2019).

An additional consideration is the variable 'sex' asked individuals to state their 'gender' as either 'male or 'female'. Confounding sex and gender is problematic with longitudinal datasets as it does not recognize the capacity for gender to be time varying (Hanes & Clouston, 2019). In the future, longitudinal dataset should repeatedly include questions pertaining to both gender a sex, so that participants can express their gender identity overtime.

Another limitation of this study was the daily diary design of the NSDE may be too wide of a time scale to capture the dynamic, within-person processes of physical activity and daily stressors (Shiffman et al., 2008). Previous research utilizing an EMA design prompted participants six times a day to report perceived stress levels and physical activity minutes and found bidirectionality between these variables (Schultchen et al., 2019). The current study's design of assessing stress and physical activity at the end of each day may have been too wide of a time frame to capture the influence of these variables.

Next, the between variable bivariate correlations were very strong and the cross-variable relationships showed weak correlations. Within variable correlations and between variable correlations are shown in Tables 8 and 9. This was detrimental to studying the relationships between physical activity and both stressor frequency and severity using such specific models as they were not related.

Lastly, the sample characteristics were relatively homogenous. Even with the inclusion of the Milwaukee sample for MIDSU II which over sampled for African American participants, the study was mostly white. The study participants were also mostly highly educated. With this, it is not clear how the results would replicate in a sample with more diverse participants. It is possible that in a sample with more racially and educationally diverse, the relationships between physical activity and stressors may yield different results.

Strengths

Despite the current study's multiple limitations there were also numerous strengths. First, this is the first study to use a microlongitudinal daily diary approach to studying physical activity within a population that is at risk for a high number of stressors, working parents. In choosing this subsample, the study was able to control for different facets of the sample, such as the amount of hours participants work and their home life as it pertains to children, to be specific in trying to find relationships among the variables.

Secondly, this novel idea also utilized the MIDUS data which are large, publicly available datasets that are methodologically sound. MIDUS data are very well-known and increasingly popular within the social and behavioral sciences and have been utilized for three decades. Thirdly, the study utilized a large, national sample in order to assess the relationships between physical activity and stressor frequency and severity. This large sample of working parents was adequately powered to detect an effect, if present.

Fourth, the statistical approach was chosen because it appeared to be the best method for evaluating the relationships between these variables. Utilizing structural equations modeling to test these hypotheses was the best approach for evaluating the cross-variable relationships. Finally, there were fairly equal sample sizes for mothers and fathers within the stressor frequency and stressor severity groups. This is important as testing the differences between mothers and fathers was a critical focus of the study.

Implications and Future Directions

These findings reveal that the complex relationships between physical activity and daily stressors do not appear to exist for working parents in this sample. Despite not having predictive relationships between these variables, there is conclusive evidence for the importance of physical activity, and as such, public health interventions should continue to promote its importance for both physical and mental health benefits. Physical activity plays a crucial role in the primary and secondary prevention of many chronic diseases and death (Helmrich et al., 1991; Leon et al., 1987; Moore et al., 2016; Moses et al., 1989). To promote physical activity engagement in working parents, campaigns should focus on the construct as a whole to ensure that working parents achieve the recommended national physical activity guidelines. Even though results from this study indicate that for working parents, physical activity may not be the best method for reducing the number of daily stressors or their severity. Working parents report high levels of daily stress, as such, future research should investigate the best daily methods and practices for reducing the number of daily stressors their severity. For example, research could investigate how sleep, positive thinking or being outdoors, all of which have been found to reduce stress (Hunter et al., 2019; Norman et al., 2014), reduce stress on a daily level.

Future research could explore differences in the scales being used to measure the variables and the constructs themselves. Future research could examine the daily associations between these variables utilizing scales that are more tailored towards working parents. It is possible that working parents have unique daily stressors, such as work-family conflicts, that may be more influenced by physical activity. The DISE survey that assessed daily stressors in the current study included questions pertaining to a work stressor and home stressor. For the purposes of this study, the seven stressors included in the DISE were aggregated together. Future research could seek to only examine working parents' daily stress when they report work or home stressor. This could also allow for the inclusion of potential moderating and mediating variables that could be influencing this relationship. For example, asking participants if they have the intention to be physically active the next day, and examining if this mediates the relationships between daily stress and physical activity. Social support could be examined as a potential moderator to this relationship. Some research has shown that social support has moderated the relationship between stress and physical activity is differing populations (Brunet et al, 2014). There is evidence that a bidirectional relationship exists between physical activity and sleep (Kline et al., 2014). Sleep may also be an interesting moderating variable to examine within this relationship. Both the constructs that are being measured and the scales being used should be examined in future research to ensure that the variables under investigation are being appropriately measured.

Future research could also use a different design approach to studying the relationship between these variables. For example, implementing an experimental approach to studying the causal relationships between physical activity and stress in working parents. This would provide information on if there is causality in the relationships between physical activity and daily stressors. Randomly assigning participants to physical activity conditions, and a control group, and having them report daily stressors could determine the causality within daily physical activity and stress. Further, implementing an EMA design using smaller time scales would provide the opportunity to study the immediate effects of these variables. Schultchen et al. (2019) prompted participants every 2.5 hours to report their physical activity and stress levels, this may be needed in order to study the complex, dynamic nature of daily stressors and physical activity.

Overall, physical activity and daily stress do not appear to be related in working parents. Physical activity and daily stressors, along with physical activity and stressor severity, showed weak to nonexistent correlations that were not statistically significant. This was also seen in the non-significant results for the regression analyses when data was aggregated across days. The SEMs for fathers provided a poor fit, whereas the models for mothers provided an adequate fit. Due to poor fit for fathers' models, no conclusions can be made. It appears that for working mothers, encountering a stressor on one day may not be detrimental to the amount of physical activity that they perform the next day. Similarly, if physical activity engagement is low on one day, both the number of stressors and their severity appear not to increase. In conclusion, ensuring the correct measurement of the variables may be what is needed to capture the relationships between physical activity and daily stress.

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Table 1

Physical Activity Means, Standard Deviations, Skew and Kurtosis

Physical Activity	*N*	*M(SD)*	*Skewness(kurtosis)*
Day 1	664	44.23(91.33)	3.63(15.55)
Day 2	612	40.17(90.30)	4.21(21.55)
Day 3	600	38.70(82.37)	4.05(19.71)
Day 4	603	44.52(97.77)	4.36(25.82)
Day 5	592	41.57(90.99)	3.83(16.85)
Day 6	576	40.45(89.69)	4.10(20.52)
Day 7	577	46.14(107.15)	4.32(22.58)
Day 8	588	40.70(100.33)	4.62(25.33)

Note. This table displays the means, standard deviations, skewness and kurtosis for each day for physical activity.

Table 2

Stressor Frequency Means, Standard Deviations, Skew and Kurtosis

Stressor Frequency	***N***	***M(SD)***	***Skewness(kurtosis)***
Day 1	666	1.08(0.96)	0.81(0.74)
Day 2	612	0.72(0.86)	1.17(1.17)
Day 3	600	0.64(0.82)	1.24(1.28)
Day 4	603	0.55(0.75)	1.33(1.46)
Day 5	593	0.52(0.73)	1.34(1.72)
Day 6	576	0.44(0.65)	1.43(1.78)
Day 7	577	0.42(0.64)	1.35(0.98
Day 8	588	0.64(0.72)	1.91(5.60)

Note. This table displays the means, standard deviations, skewness and kurtosis for each day for number of stressors.

Table 3

Stressor Severity Means, Standard Deviations, Skew and Kurtosis

Stressor Severity	*N*	*M(SD)*	*Skewness(kurtosis)*
Day 1	666	2.07(2.30)	1.62(3.71)
Day 2	612	1.38(1.91)	1.30(1.76)
Day 3	600	1.20(1.75)	1.07(1.02)
Day 4	603	1.12(1.75)	1.82(1.49)
Day 5	593	1.06(1.69)	1.33(2.80)
Day 6	576	0.91(1.57)	1.21(2.04)
Day 7	577	0.92(1.62)	1.37(1.88)
Day 8	588	0.91(1.59)	1.91(7.01)

Note. This table displays the means, standard deviations, skewness and kurtosis for each day for stressor severity.

Table 4

Demographic Information

	n(%)	*M (SD)*
Sex		
Male	349(52.20)	
Female	318(47.70)	
Age		42.71(7.04)
Marital Status		
Married	540(81.00)	
Separated	21(3.10)	
Divorced	56(8.40)	
Widowed	3(0.40	
Never Married	45(6.70)	
Hispanic/Latino Descent		
Not Hispanic	642(93.30)	
Mexican	6(0.90)	
Mexican American	3(0.40)	
Chicano	1(0.10)	
Puerto Rican	4(0.60)	
Cuban	1(0.10)	
Other Spanish	7(1.00)	
Racial Origins		
White	566(84.90)	
Black and/or African American	62(9.30)	
Native American or Alaska Native	9(1.30)	
Asian	4(0.60)	
Other	23(3.40)	
Highest Level of Education Completed		
No school/ some grade school	2(0.30)	
Eighth grade/ junior high school	1(0.10)	
Some high school	16(2.40)	
GED	8(1.20)	
Graduated from high school	111(16.60)	
1 to 2 years of college, no degree	103(15.40)	
3 or more years of college, no degree	31(4.60)	
Associates degree	58(8.70)	
Bachelor's degree	181(27.10)	
Some Graduate school	10(1.50)	
Master's degree	109(16.30)	
Ph.D, MD, or other professional degree	35(5.20)	
Work Hours		43.86(12.53)
20-29 hours	55(8.20)	
30-39hours	100(15.00)	
40-49hours	319(47.90)	
50-59hours	117(17.50)	
60-69hours	45(6.80)	
70-79hours	15(2.20)	
80-89hours	11(1.70)	

90-99hours	3(0.40)	
100-109hours	1(0.10)	
110 + hours	1(0.10)	
Work Status		
Working now	575(86.20)	
Self-employed	82(12.30)	
Looking for work	5(0.70)	
Homemaker	2(0.30)	
Full-time student	1(0.10)	
Number of Children		2.58(1.52)
1	111(16.80)	
2	282(42.30)	
3	164(24.30)	
4	62(9.30)	
5	25(3.70)	
6	6(0.90)	
7	8(1.20)	
8	2(0.30)	
9	2(0.30)	
10	2(0.30)	
16	1(0.10)	
17	1(0.10)	

Note. This table displays the demographic information.

Table 5

Daily Minutes of Physical Activity

	n(%)	*M(SD)*
Physical Activity Day 1 Minutes		44.23(91.23)
0 minutes	362(54.30)	
1-14 minutes	12(0.70)	
15-29 minutes	26(3.80)	
30-44 minutes	68(10.10)	
45 - 59 minutes	20(3.00)	
60 – 74 minutes	64(9.50)	
75 – 89 minutes	5(0.50)	
90 – 104 minutes	27(4.00)	
105 – 119 minutes	2(0.30)	
120 + minutes	78(11.7)	
Physical Activity Day 2 Minutes		40.17(90.30)
0 minutes	342(51.30)	
1-14 minutes	8(1.10)	
15-29 minutes	24(3.50)	
30-44 minutes	74(11.10)	
45 - 59 minutes	23(3.30)	
60 – 74 minutes	62(9.20)	
75 – 89 minutes	5(0.70)	
90 – 104 minutes	11(1.60)	
105 – 119 minutes	2(0.30)	
120 + minutes	51(8.7)	
Physical Activity Day 3 Minutes		38.70(82.37)
0 minutes	333(54.90)	
1-14 minutes	2(0.30)	
15-29 minutes	32(4.80)	
30-44 minutes	64(9.50)	
45 - 59 minutes	22(3.30)	
60 – 74 minutes	66(9.90)	
75 – 89 minutes	6(0.80)	
90 – 104 minutes	18(2.70)	
105 – 119 minutes	1(0.10)	
120 + minutes	56(8.0)	
Physical Activity Day 4 Minutes		44.52(97.77)
0 minutes	324 (48.60)	
1-14 minutes	9(1.30)	
15-29 minutes	24(3.50)	
30-44 minutes	81(12.10)	
45 - 59 minutes	16(2.40)	
60 – 74 minutes	55(8.20)	
75 – 89 minutes	9(1.20)	
90 – 104 minutes	13(1.90)	
105 – 119 minutes	2(0.30)	
120 + minutes	70(11.60)	
Physical Activity Day 5 Minutes		41.57(90.99)

0 minutes	333(49.90)	
1-14 minutes	7(1.10)	
15-29 minutes	32(4.80)	
30-44 minutes	62(9.30)	
45 - 59 minutes	10(1.50)	
60 – 74 minutes	59(8.80)	
75 – 89 minutes	6(0.80)	
90 – 104 minutes	14(2.10)	
105 – 119 minutes	1(0.10)	
120 + minutes	67(11.30)	
Physical Activity Day 6 Minutes		40.45(89.69)
0 minutes	332(49.80)	
1-14 minutes	20(1.40)	
15-29 minutes	15(2.20)	
30-44 minutes	60(8.90)	
45 - 59 minutes	16(2.30)	
60 – 74 minutes	60(9.00)	
75 – 89 minutes	3(0.40)	
90 – 104 minutes	14(2.00)	
105 – 119 minutes	2(0.30)	
120 + minutes	63(10.90)	
Physical Activity Day 7 Minutes		46.14(107.15)
0 minutes	328(49.20)	
1-14 minutes	4(0.50)	
15-29 minutes	15(2.20)	
30-44 minutes	63(9.30)	
45 - 59 minutes	19(2.80)	
60 – 74 minutes	67(10.00)	
75 – 89 minutes	1(0.10)	
90 – 104 minutes	14(2.10)	
105 – 119 minutes	0(0.00)	
120 + minutes	66(11.40)	
Physical Activity Day 8 Minutes		40.70(100.33)
0 minutes	350(52.50)	
1-14 minutes	3(0.40)	
15-29 minutes	27(4.00)	
30-44 minutes	62(9.20)	
45 - 59 minutes	12(1.70)	
60 – 74 minutes	58(8.70)	
75 – 89 minutes	3(0.40)	
90 – 104 minutes	14(2.00)	
105 – 119 minutes	0(0.00)	
120 + minutes	59(10.00)	

Note. This table is a breakdown of the number of minutes of physical activity each day, in 15-minute intervals.

Table 6

Daily Number of Stressors Frequencies

number of stressors	Day 1 *n*(%)	Day 2 *n*(%)	Day 3 *n*(%)	Day 4 *n*(%)	Day 5 *n*(%)	Day 6 *n*(%)	Day 7 *n*(%)	Day 8 *n*(%)
0	200(30.30)	300(45.00)	322(48.30)	351(52.60)	356(53.60)	369(55.30)	383(57.40)	377(56.50)
1	267(40.00)	211(31.60)	192(28.80)	186(27.90)	178(27.90)	169(25.30)	150(22.50)	161(24.10)
2	148(22.20)	78(11.70)	68(10.20)	53(7.90)	48(7.20)	32(4.80)	42(6.30)	43(6.40)
3	40(6.00)	18(2.70)	15(2.20)	12(1.80)	10(1.50)	6(0.90)	2(0.30)	5(0.70)
4	6(0.90)	5(0.70)	3(0.40)	1(0.10)	1(0.10)	0(0.00)	0(0.00)	0(0.00)
5	3(0.40)	0(0.00)	0(0.00)	0(0.00)	0(0.00)	0(0.00)	0(0.00)	2(0.30)

Note. This table displays the frequencies for number of stressors for each day.

Table 7

Daily Stressor Severity Sum Frequencies

Summed severity	Day 1 *n*(%)	Day 2 *n*(%)	Day 3 *n*(%)	Day 4 *n*(%)	Day 5 *n*(%)	Day 6 *n*(%)	Day 7 *n*(%)	Day 8 *n*(%)
0	224(33.60)	317(47.50)	339(50.80)	364(54.60)	368(62.10)	380(57.00)	385(57.90)	390(58.50)
1	92(13.80)	59(8.20)	55(8.20)	45(6.70)	36(5.40)	41(6.10)	30(4.50)	30(4.50)
2	141(21.10)	113(16.90)	104(15.60)	90(13.50)	94(14.10)	71(10.60)	83(12.40)	96(14.40)
3	64(9.60)	44(6.60)	31(4.60)	44(6.60)	39(5.80)	41(6.10)	33(4.90)	28(4.20)
4	51(7.60)	31(4.80)	30(4.50)	21(3.10)	21(3.10)	19(2.80)	15(2.20)	21(3.10)
5	39(5.80)	14(2.10)	20(3.00)	17(2.50)	17(2.50)	9(1.30)	15(2.20)	9(1.30)
6	29(4.30)	17(2.50)	12(1.80)	12(1.80)	13(1.90)	11(1.60)	8(1.20)	9(1.30)
7	6(0.90)	7(1.00)	4(0.60)	5(0.70)	1(0.10)	1(0.10)	2(0.30)	3(0.40)
8	6(0.90)	5(0.70)	4(0.60)	2(0.30)	2(0.30)	1(0.10)	4(0.60)	0(0.00)
9	4(0.60)	2(0.30)	1(0.10)	3(0.40)	1(0.10)	2(0.30)	1(0.10)	0(0.00)
10	3(0.40)	2(0.30)	0(0.00)	0(0.00)	0(0.00)	0(0.00)	0(0.00)	0(0.00)
11	3(0.40)	0(0.00)	0(0.00)	0(0.00)	1(0.10)	0(0.00)	0(0.00)	0(0.00)
12	2(0.30)	0(0.00)	0(0.00)	0(0.00)	0(0.00)	0(0.00)	0(0.00)	0(0.00)
13	1(0.10)	0(0.00)	0(0.00)	0(0.00)	0(0.00)	0(0.00)	0(0.00)	1(0.10)
14	1(0.10)	0(0.00)	0(0.00)	0(0.00)	0(0.00)	0(0.00)	0(0.00)	0(0.00)

Note. This table displays the frequencies for each day for stressor severity. Percentages refer to the amount of the sample that had that value of summed severity.

Table 8

Correlations Between Physical Activity and Stressor Frequency For Mothers And Fathers

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
1. PA1	-	.40**	.45**	.44**	.46**	.39**	.53**	.49**	-.03	-.13	-.02	.07	-.01	-.02	-.06	-.01
2. PA2	.51**	-	.63**	.55**	.40**	.20**	.26**	.50**	-.07	-.05	-.01	.04	-.01	-.02	.01	.07
3. PA3	.49**	.45**	-	.62**	.54**	.24**	.33**	.52**	-.07	-.08	-.04	.16*	-.14*	-.01	-.07	.07
4. PA4	.47**	.58**	.44**	-	.58**	.22**	.49**	.46**	-.05	-.11	-.07	.13*	.02	.01	.00	.03
5. PA5	.44**	.51**	.40**	.53**	-	.44**	.38**	.50**	-.06	-.05	-.05	.10	-.02	-.01	-.06	-.01
6. PA6	.53**	.57**	.42**	.57**	.65**	-	.54**	.55**	.04	-.05	.08	.00	.04	.09	.04	-.02
7. PA7	.42**	.54**	.37**	.51**	.50**	.58**	-	.58**	.01	-.06	.10	.15**	-.02	-.03	.03	.00
8. PA8	.36**	.39**	.36**	.46**	.52**	.28**	.40**	-	-.03	-.08	.05	-.03	-.01	.02	-.01	-.01
9. SF1	-.03	-.08	-.01	-.01	.01	-.10	-.13*	.03	-	.29**	.26**	.25**	.25**	.14**	.19**	.22**
10. SF2	-.10	-.07	-.06	-.03	-.01	-.03	-.09	.04	.25**	-	.28**	.16**	.21**	.01	.11	.16**
11. SF3	-.04	-.03	.00	-.06	-.04	-.02	.00	.00	.25**	.31**	-	.21**	.13**	.20**	.14*	.26**
12. SF4	-.05	.10	-.04	.00	.06	-.08	-.04	.06	.17**	.25**	.20**	-	.14**	.07	.26**	.15**
13. SF5	-.04	.04	.07	.05	.05	.01	.04	.16*	.20**	.26**	.14*	.13*	-	.10	.23**	.18**
14. SF6	-.10	-.01	.02	.00	.02	-.04	-.08	.06	.30**	.24**	.32**	.09	.21**	-	.14*	.12*
15. SF7	-.01	.05	.16*	.04	.17*	.04	.03	.04	.29**	.24**	.27**	.12*	.27**	.34**	-	.27**
16. SF8	-.64	-.03	.05	-.02	.11	.05	-.06	-.01	.32**	.36**	.39**	.17*	.35**	.28**	.43**	-

Note. Physical activity is represented as "PA" and stressor frequency is represented as "SF".
Correlations for fathers are shown in the upper right-hand corner and correlations for mothers are shown in the lower left-hand corner.
*$p < .05$. **$p < .001$.

Table 9

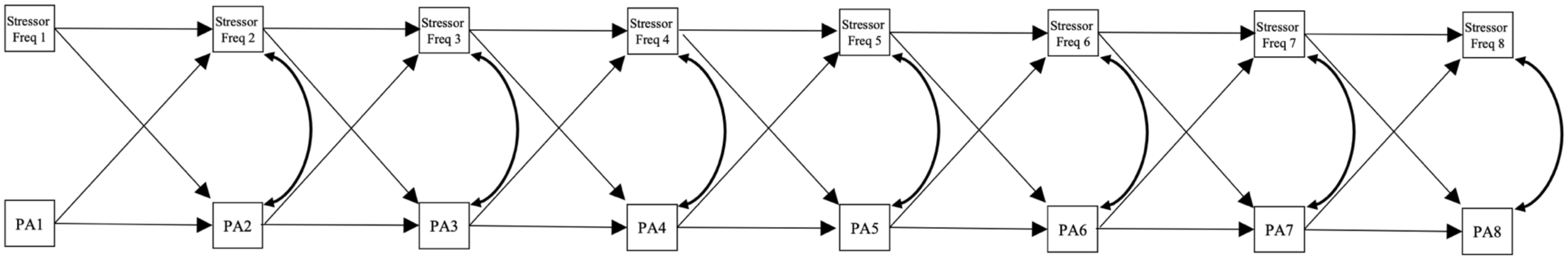
Correlations Between Physical Activity and Stressor Severity For Mothers And Fathers

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. PA1	-	.40**	.45**	.44**	.46**	.39**	.53**	.49**	-.02	-.11	-.01	.09	-.10	.03	-.11	.04
2. PA2	.51**	-	.63**	.55**	.40**	.20**	.26**	.50**	-.04	-.10	.00	.02	-.03	.01	-.03	.11
3. PA3	.49**	.45**	-	.62**	.54**	.24**	.33**	.52**	-.02	-.07	-.02	.11	-.10	.03	-.10	.10
4. PA4	.47**	.58**	.44**	-	.58**	.22**	.49**	.46**	-.03	-.06	-.03	-.14*	.02	.04	.02	.05
5. PA5	.44**	.51**	.40**	.53**	-	.44**	.38**	.50**	-.02	.02	-.03	.13*	-.04	.02	-.03	.04
6. PA6	.53**	.57**	.42**	.57**	.65**	-	.54**	.55**	.05	-.04	.10	.06	.08	.14	.01	.03
7. PA7	.42**	.54**	.37**	.51**	.50**	.58**	-	.58**	.01	-.03	.09	.18**	-.01	.04	.00	.04
8. PA8	.36**	.39**	.36**	.46**	.52**	.28**	.40**	-	.01	-.06	.08	-.04	-.01	.04	.00	.04
9. SS1	-.02	-.08	-.04	.02	.00	-.13	-.11	.03	-	.28**	.33**	.26**	.21**	.24**	.22**	.22**
10. SS2	-.09	-.06	-.08	-.06	-.04	-.06	-.10	-.03	.23**	-	.14**	.13**	.19**	-.01	.12*	.18**
11. SS3	-.04	-.05	-.02	-.05	-.07	-.03	-.04	.01	.27**	.36**	-	.32**	.17**	.15**	.17**	.26**
12. SS4	-.01	.05	.00	-.01	.60	-.05	-.06	.04	.13**	.25**	.27**	-	.16**	.08	.23**	.14**
13. SS5	-.07	.02	.03	.02	.01	-.04	.04	.09	.19**	.26**	.16**	.11	-	.05	.18**	.60**
14. SS6	-.08	.00	.00	.03	.02	-.05	-.05	.70	.31**	.26**	.25**	.06	.27**	-	.14*	.08
15. SS7	-.03	.05	.13*	.02	.12	.02	.01	.20	.31**	.26**	.28**	.13*	.26**	.35**	-	.20**
16. SS8	-.60	-.03	.05	-.05	.13*	.04	-.05	-.02	.30**	.29**	.28**	.11	.29**	.27**	.44**	-

Note. Physical activity is represented as “PA” and stressor severity is represented as “SS”.
Correlations for fathers are shown in the upper right-hand corner and correlations for mothers are shown in the lower left-hand corner.
$^{*}p < .05$. $^{**}p < .001$.

Figure 1

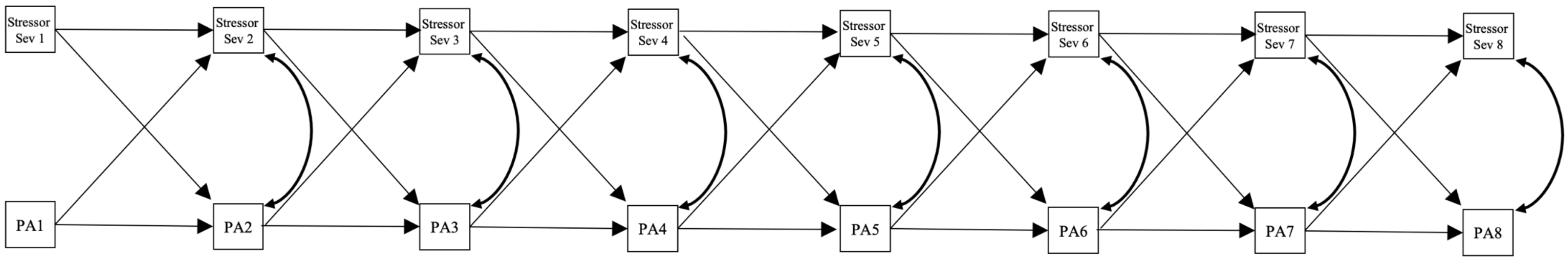
Depiction of the Proposed Structural Equation Model Evaluating the Prospective Associations Between Physical Activity and Stressor Frequency.



Note. Daily frequencies of stressors is represented as Stressor Frq and physical activity is abbreviated to PA.

Figure 2

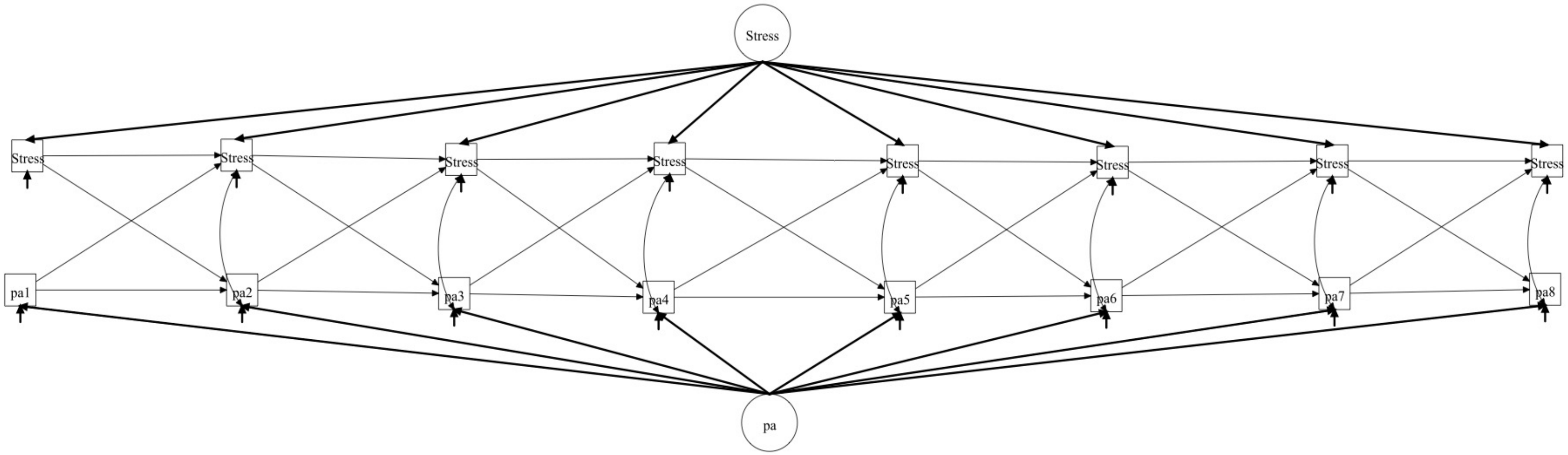
Depiction of the Structural Equation Model Evaluating the Prospective Associations Between



Note. Daily frequencies of stressors is represented as Stressor Sev and physical activity is abbreviated to PA.

Figure 3

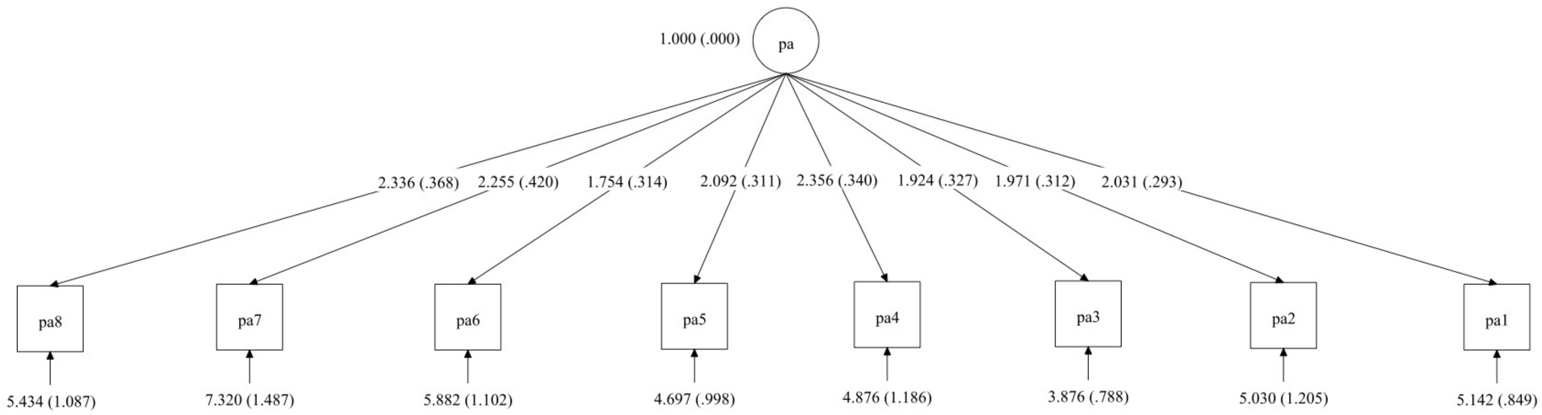
Depiction of the Structural Equation Model that Was Used in Analysis Evaluating the Associations Between Physical Activity And Daily Stressors.



Note. Daily stressors are represented as Stress and physical activity is abbreviated to PA.

Figure 4

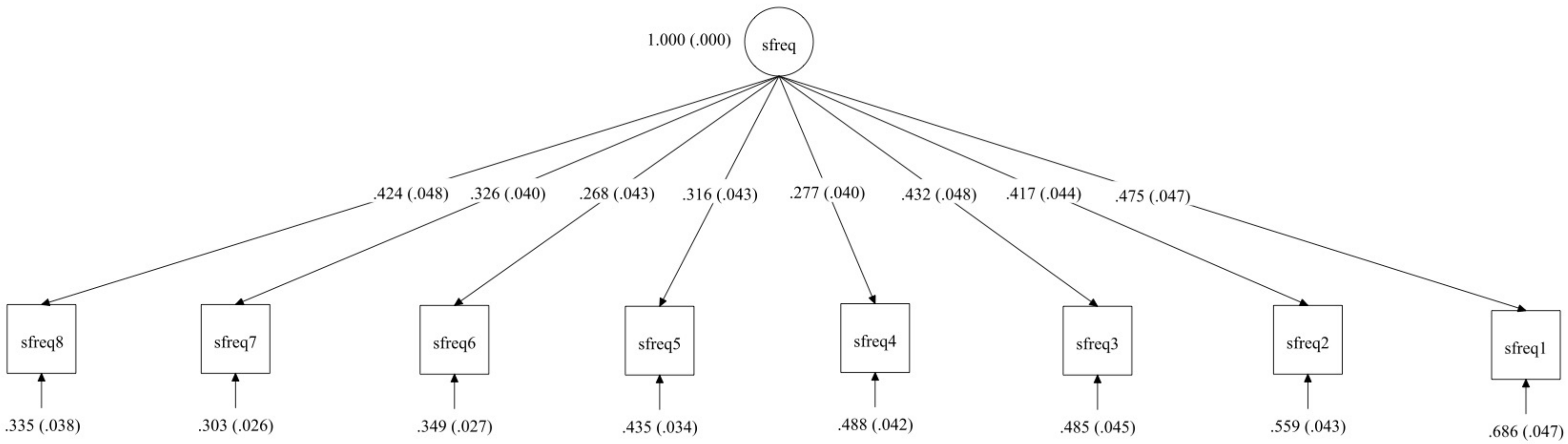
Figure Depicting the Standardized Factor Loadings For Physical Activity CFA.



Note. Physical activity is abbreviated to PA.

Figure 5

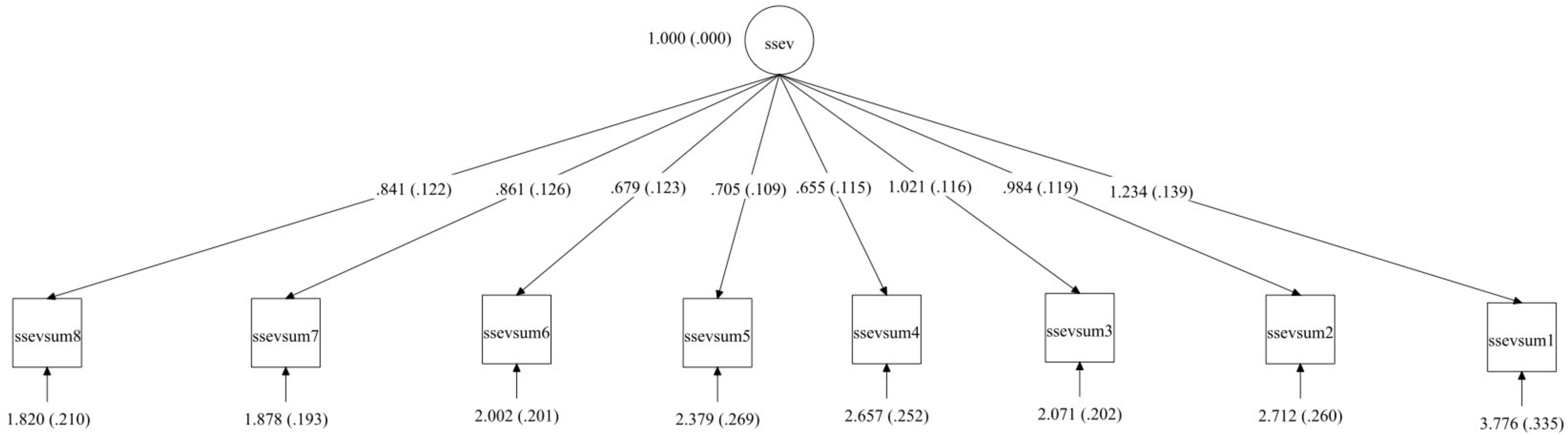
Figure Depicting the Standardized Factor Loadings For Stressor Frequency CFA.



Note. Stressor frequency is represented as sfreq.

Figure 6

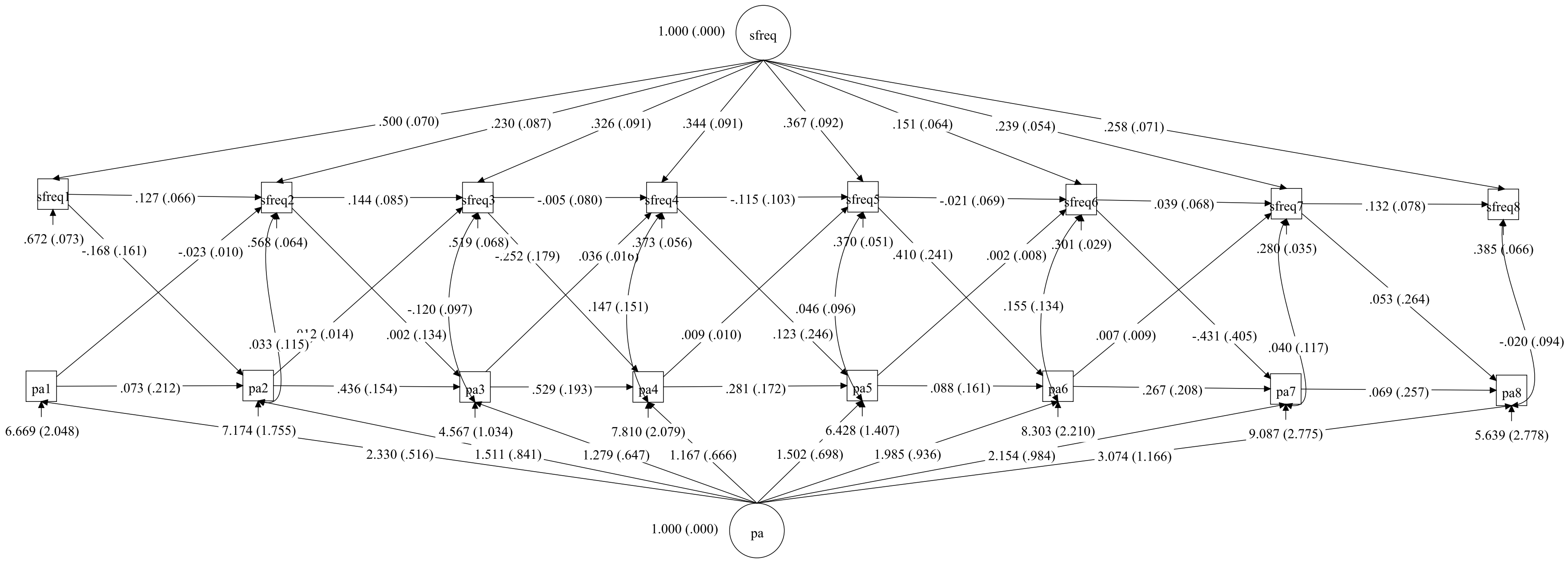
Figure Depicting the Standardized Factor Loadings For Stressor Severity CFA.



Note. Stressor severity is represented as sevsum.

Figure 7

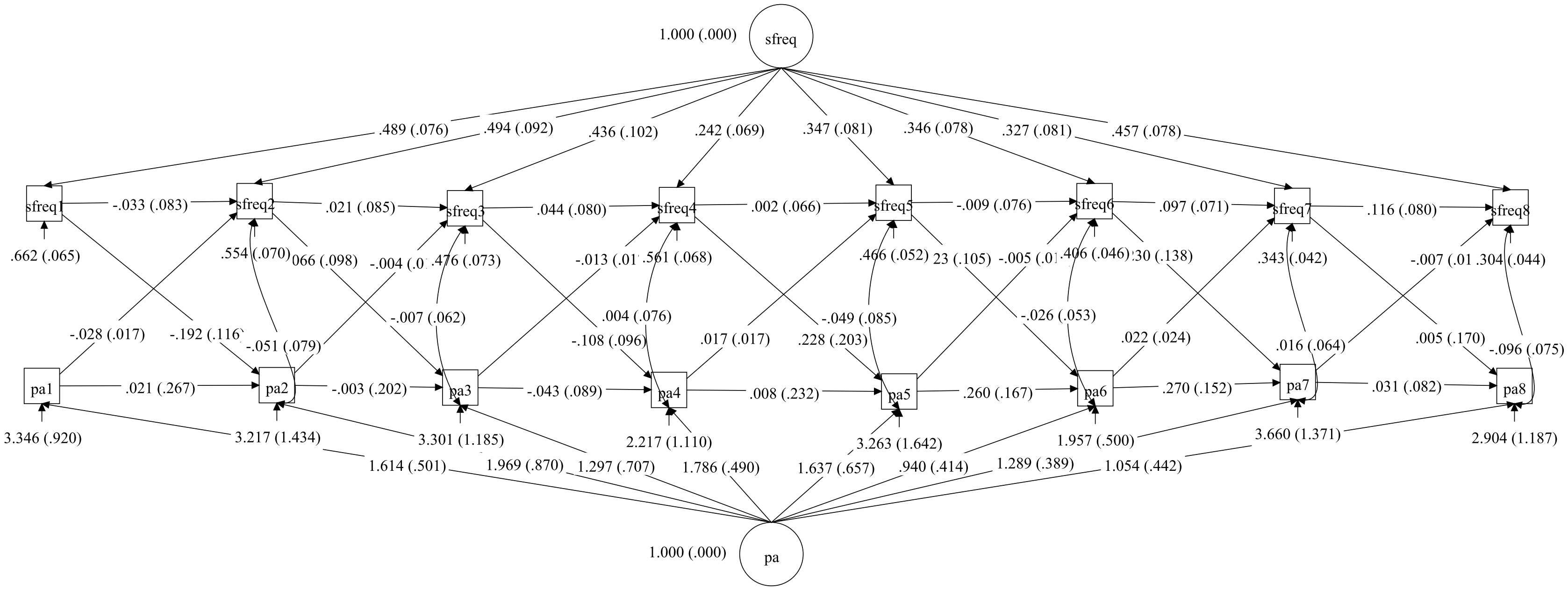
Figure Depicting the Beta Coefficients For The Full Model For Stressor Frequency For Fathers.



Note. Stressor frequency is represented as sfreq.

Figure 8

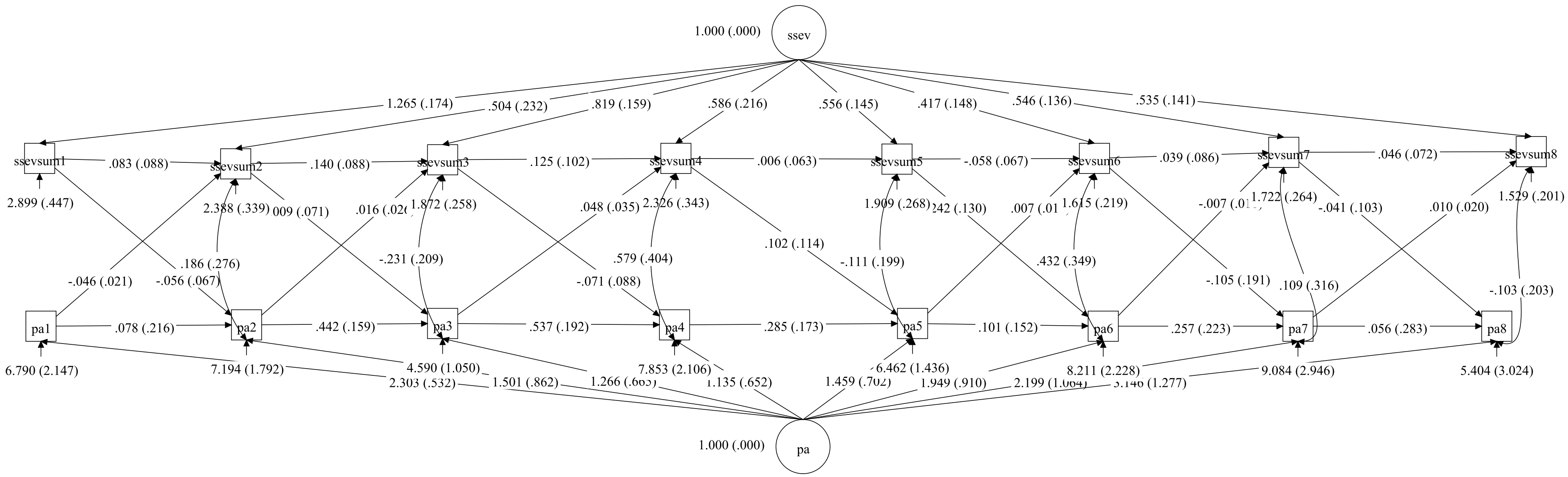
Figure depicting the Beta coefficients for the full model for stressor frequency for mothers.



Note. Stressor frequency is represented as sfreq.

Figure 9

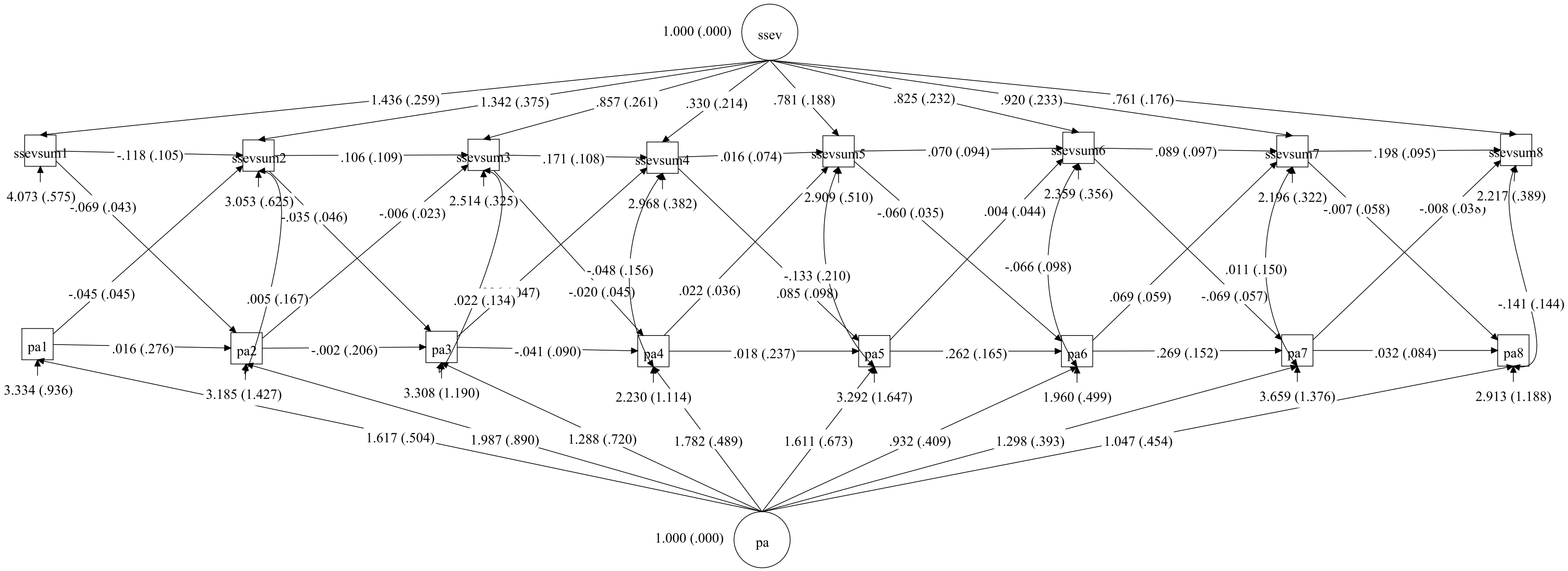
Figure Depicting the Beta Coefficients For the Full Model For Stressor Severity For Fathers.



Note. Stressor severity is represented as sevsum.

Figure 10

Figure Depicting the Beta Coefficients For The Full Model For Stressor Severity For



Note. Stressor severity is represented as sevsum.