The Impact of Childhood Family Adversity on Nighttime Change in Blood Pressure

by

Rika Tanaka

A Thesis in Partial Fulfillment
of the Requirements for the Degree
Master of Arts

Approved August 2012 by the
Graduate Supervisory Committee:

Linda Luecken, Chair
Mary Davis
Sharlene Wolchik

ARIZONA STATE UNIVERSITY

December 2012

ABSTRACT

Adverse childhood family environments have been found to have long-term effects on a child's well-being. Although no prior studies have examined the direct effects of childhood family adversities on nighttime blood pressure (BP) dip, parental death and divorce in childhood, have been associated with a variety of related psychological problems in adulthood. The current study examined the direct effects of parental death and divorce in childhood and quality of early family relationships on adult nighttime BP dip as well as the mediating role of three psychosocial factors (depression, hostility and social stress). One hundred and forty-three young adults were asked to complete self-reported measures of the three psychosocial factors and quality of family relationships. Study participants wore an ambulatory blood pressure (ABP) monitor over a 24-hr period in order to assess nocturnal BP dip. Although neither childhood family adversity nor quality of childhood family relationships directly predicted nighttime BP dipping, quality of early family relationships predicted all three psychosocial factors, and hostility was found to mediate the relationship between quality of childhood family relationships and nighttime systolic BP dip. Early family experiences play an important role in influencing nighttime cardiovascular functioning by influencing an individual's psychological functioning in young adulthood. Because nighttime non-dipping has been associated with increased risk for cardiovascular disease and other serious health conditions, the results of the present study have important

clinical implications and provide specific psychosocial pathways that may be targeted in future programs designed to prevent and treat cardiovascular disease.

ACKNOWLEDGEMENTS

I would like to thank my mentor and committee chair, Linda Luecken, for her invaluable expertise, enlightening feedback, and uplifting encouragement throughout every step of this project. I would also like to thank the other members of my committee, Mary Davis and Sharlene Wolchik, for their expert guidance and support. Working with this committee has taught me not only how to be a better researcher and writer, but also how to have more confidence in my abilities and insights. Without all three of my committee members, this project would truly not have been possible and I am sincerely grateful for their mentorship and advice.

TABLE OF CONTENTS

Page

Page

Page

LIST OF TABLES

LIST OF FIGURES

Figure Page

Introduction

Family environment, particularly the parent-child relationship, plays a critical role in the healthy development of a child. Within a secure parent-child relationship, children learn how to successfully regulate both their emotional and physical wellbeing (Bowlby, 1969). When the parent-child bond is broken through conflict, abuse, divorce, or parental death, children are at increased risk for a variety of psychological and physical disorders, potentially due to disruptions in the functioning of neurohormonal and cardiovascular stress response systems (Bowlby, 1969; Repetti, Taylor, & Seeman, 2002; Kranz & McCeney, 2002; Troxel & Matthews, 2004; Luecken & Lemery, 2004). Prolonged dysregulations in these systems may place individuals at risk for serious health conditions including hypertension, diabetes, cardiovascular disease, infectious illness and certain types of cancers (Kranz & McCeney, 2002; Troxel & Matthews, 2004). Therefore, understanding the causes and conditions under which adverse childhood family environments lead to poor physical health outcomes is crucial when considering ways in which children and families faced with challenges may be best supported.

In order to understand the specific conditions under which stressful family events affect a child, it is also important to recognize that there are wide individual differences in the physiological impact of parental divorce or bereavement on children. Most children adapt well after parental divorce or bereavement, while others are more vulnerable to long-term psychological or

physiological consequences. Moderating factors must therefore be considered when examining the association between childhood family adversity and acute and long-term wellbeing. As will be described below, the quality of relationships in the family environment consistently emerges as an important moderator of both psychosocial and physiological outcomes of parental death or divorce.

In addition to identifying moderating factors that influence the relationship between early adversity and negative outcomes, researchers have proposed specific causal pathways linking early loss of parental attachment to maladaptive neurohormonal and cardiovascular functioning. For example, Luecken and Lemery (2004) propose that childhood adversity leads to disruptions along a variety of pathways, by affecting genetic, psychosocial and cognitive-affective factors that over time may lead to chronic physiological dysfunction. Within this model, early family adversity may lead individuals to experience disruptions in psychosocial wellbeing marked by depression/anxiety, hostility and social isolation. Since depression/anxiety, hostility and social isolation are common predictors of physiological dysregulation, the current model identifies these psychosocial outcomes of early family experiences as potential mechanisms that link negative childhood events and long-term physiological dysfunction.

The present study focuses specifically on how the quality of family relationships moderates the association between parental death and divorce in childhood and young adult cardiovascular functioning in the form of nighttime blood pressure, which is hypothesized to be mediated by three psychosocial

factors: depression, hostility, and interpersonal stress (See Figure 1). First, the use of nighttime blood pressure as a unique measure of cardiovascular activity will be described. An overview of the impact of parental death or divorce on cardiovascular activity and the moderating role of family relationships will then be reviewed. An exploration of the literature supporting the relations between these adverse family experiences and depression, hostility and interpersonal stress will be discussed. Evidence will then be provided for the association between the proposed psychosocial factors and nighttime blood pressure. Finally, an outline will be provided of this study which was designed to identify a psychosocial pathway between adverse childhood family events and young adult nighttime blood pressure moderated by quality of family relationships.

Nighttime Blood Pressure: "Nocturnal Dip"

An important measure of nighttime physiological functioning is nocturnal dip. In normal, healthy individuals, blood pressure has a tendency to fluctuate throughout the day, spiking shortly after wake, peaking in mid-afternoon and dropping or "dipping" to a minimum during sleep (Sayk et al., 2007). Nighttime dip in blood pressure allows individuals to physiologically recover from elevations in daytime blood pressure and is an important indicator of healthy cardiovascular functioning (O'Brien et al., 2000; Sayk et al., 2007). Although there is some variation in the amount of "dipping" exhibited by healthy individuals, a decrease in nighttime blood pressure that is less than 10% compared to daytime values (non-dipping), has been linked to an increased risk for sleep

apnea, hypertension, heart failure, stroke, myocardial infarction, sudden death and has even been suggested as a better predictor of cardiovascular disease compared to daytime blood pressure (Hansen et al., 2011; Ohkubo et al., 2002). Although the effect sizes of non-dipping on long-term physical health tend to be small, they are important to consider as they may impact large numbers of individuals over a large population.

Non-dipping has also been associated with other elevated levels of cortisol throughout the day (Kostic & Secen, 1997), heightened daytime excretion of epinephrine (Wilson, Kliewer, Teasley, Plybon, & Sica, 2002), decreased heart rate variability (Ovdiienko, 2010) as well as other physiological factors, including sodium sensitivity, age-related hormonal changes, sleep apnea and sleep quality (Routledge & McFetridge-Durdle, 2007). Investigations of the association between non-dipping and daytime cardiovascular reactivity yields mixed results, indicating that non-dipping may lead to blunted daytime cardiovascular reactivity, only under certain conditions, moods or activities (Bishop, Pek, & Ngau, 2006). It is important to note that mixed results regarding the predictors and correlates of nocturnal blood pressure dipping may be due to some instability in ambulatory blood pressure (ABP) measurement and wide variability in the calculation of sleep hours and nocturnal dip across studies (Urbina et al., 2008; O'brien et al., 2003; Delaney, Pellizzari, Speiser, & Frank, 2008). However, ABPM is generally considered to be more stable over time compared to conventional measures of blood pressure and have been found to be reproducible over a 2- year period

(Urbina et al., 2008). And, while it has not been directly linked to divorce or bereavement, nocturnal dipping has been associated with related psychological outcomes.

Childhood Adversity & Cardiovascular Activity

Research has not yet examined the potential impact of childhood adversity on nocturnal dip. However, a growing literature has examined the impact of adversity on other forms of cardiovascular activity, including acute stress reactivity and daytime ambulatory blood pressure. Studies of direct effects of divorce or bereavement in childhood on cardiovascular functioning have yielded mixed results (Troxel & Matthews, 2004; Luecken, Kraft, Appelhans & Enders, 2009). For example, university students who had experienced the loss of a parent in childhood have been shown to have higher levels of blood pressure before, during and after stress-inducing laboratory tasks compared to non-bereaved counterparts (Luecken, 1998). Contrastingly, Luecken et al. (2009) found that participants who experienced parental loss in childhood had significantly lower blood pressure over a 24-hour period compared to non-bereaved counterparts.

The varying impact of childhood exposure to family disruption on daytime blood pressure highlights the need to identify moderating factors that may influence this association. The quality of family relationships has been identified a potential moderator in predicting health outcomes in individuals who have experienced adversity in childhood (Amato, 2000; Lutzke, Ayers, Sandler, & Barr, 1997). For example, Luecken, Rodriguez, and Appelhans (2005) found that

individuals who experienced parental loss within the context of high quality family relationships (high cohesion and expressiveness and low conflict) experienced stronger cardiovascular recovery from a minor stressor than those in the divorce or intact groups. On the other hand, higher quality of family relationships in the divorce group was associated with lower cardiovascular reactivity and recovery (Luecken et al., 2005). Therefore, the quality of childhood family relationships may play an important moderating role in individual cardiovascular functioning in adulthood.

It is important to note that most studies investigating cardiovascular activity related to psychosocial factors analyze how individuals react to acute stressors, both in vivo and in the laboratory setting. Even though data measuring cardiovascular reactivity provide useful information on the cardiovascular impact of adversity, the data do not allow researchers to see how exposure to stress may alter an individual's baseline physiological functioning (Wilson et al., 2002). Alternatively, measures of cardiovascular functioning during sleep allow researchers to understand the impact of psychosocial events on cardiovascular functioning outside the context of an acute stress response. Since individuals who are asleep are not consciously reacting to stimuli, researchers can measure how participants' bodies subconsciously rest or reset in order to compensate for daytime elevations in cardiovascular reactivity (Wilson et al., 2002). Even though daytime measures provide useful information about how individuals react to stress in the moment, nighttime assessment of physiological functioning, including

nocturnal blood pressure dipping, may reveal more about the chronic, underlying dysregulation caused by early adverse events.

Impact of Childhood Family Adversity on Psychosocial Factors

Adverse childhood events such as parental death or divorce put children at risk for losing important attachment relationships, impeding the development of adaptive emotion regulation (Bowlby, 1970). Over time, a child's inability to properly regulate their emotions may make him/her more susceptible to problems with depression/anxiety, hostility/anger and interpersonal stress (Kendler, Sheth, Gardner, & Prescott, 2002; Wainwright & Surtees, 2002; Huurre, Junkkari, & Aro, 2006). For example, Kendler et al. (2002) found that childhood parental loss increased risk for depression up to 12 years post-loss. Huurre et al. (2006) found that adult females whose parents divorced during adolescence had more depressive symptoms and increased interpersonal conflict relative to their non-divorced counterparts. Others have also found that young adults from divorced families may have higher interpersonal stress as evidenced by their less secure romantic attachments and higher likelihood of divorce compared to their intact family counterparts (Summers, Armistead, Forehand, & Tannenbaum 1998; Amato, 1996). However, the links between early family adversities and psychosocial outcomes are complex, requiring great consideration of the conditions under which adversities occur (Kelly & Emery, 2003).

For example, in a review of the literature, Amato and Keith (1991) found that parental divorce in childhood was associated with decreased psychological

well-being (depression/anxiety, life satisfaction) and physical health in adulthood. However, the authors of this review also found that, although effect sizes were relatively low in normative samples, in a clinical sample, parental divorce had a greater negative impact on the psychological and physical well-being of individuals (Amato & Keith, 1991). The larger effect sizes, however, were attributed to other family-of-origin variables including increased parental conflict and decreased quality of parent-child relationships which were observed more frequently in the clinical groups (Amato & Keith, 1991). This review therefore suggests that while divorce alone may not have a great impact on health, the combination of divorce with a series of other negative family factors places individuals at greater risk for poorer psychosocial and physical outcomes. Quality of family relationships is important to therefore consider as a moderating factor between early family experiences, psychosocial well-being, and health outcomes.

Evidence in support of the moderating role of the quality of family relationships in determining the impact of childhood family adversity on a child's psychosocial well-being is mounting. For example, researchers have found that the quality of family relationships before and after divorce played an important role in determining child psychosocial outcomes such that higher quality relationships were associated with decreased externalizing problems, better self-esteem, and better adjustment compared to families with low quality family relationships (Hines, 1997; Peterson & Zill, 1986; Wolchik, Wilcox, Tein, & Sandler, 2000). Luecken (2000a) found that the impact of parental loss on

depression, hostility and social support was dependent upon the quality of family relationships, such that higher quality of family relationships buffered parentally-bereaved young adults against negative psychosocial outcomes. Similarly, divorce stressors have been shown to have a greater impact on adjustment problems for children who reported low maternal acceptance and low consistency of discipline than for children who reported either a combination of high maternal acceptance and low consistency of discipline or low maternal acceptance and high consistency of discipline (Wolchik et al., 2000). The lowest levels of adjustment problems were seen in children who reported high scores on both maternal acceptance and consistency of discipline (Wolchik et al., 2000). Therefore, even though adverse family events may lead to disruptions in family structure or routines, the interpersonal contexts within which parental divorce and death occur play major roles in determining the health and wellbeing of a child.

Psychosocial Outcomes and Nocturnal "Dip"

Currently there is a lack of evidence directly linking childhood family adversity to nocturnal dipping. Some evidence, however, supports the relationship between the psychosocial factors described above (depression, hostility, and interpersonal stress) and high nighttime blood pressure. Higher hostility and anger expression have been shown to predict elevated nighttime blood pressure over and above race in a mixed-race sample (KaMala, Nelesen, & Dimsdale, 2004). Other studies have found that poor anger processing skills play an important role in predicting heightened nighttime blood pressure (Linden, Klassen & Phillips,

2008). Depression has also been identified as a predictor of non-dipping in hypertensive adults (Lederbogen et al., 2003; Pasqualini, Foroni, Salvioli, & Mussi, 2004). Moreover the links between nocturnal non-dipping and low socioeconomic status, ethnicity, exposure to violence, and PTSD has led some researchers to suggest that social stress may potentially play a causal role in predicting dipping status (Stepnowsky, Nelesen, Dejardin, & Dimsdale, 2004; Wilson et al., 2002; Bishop et al., 2006). In contrast, deep social relationships and increased social support have been associated with greater nocturnal dipping regardless of other relevant variables including sleep quality, age, hypertensive status, and marital status (Holt-Lunstad, Jones, & Birmingham, 2009; Ituarte, Kamarck, Thompson, & Bacanu, 1999). Therefore, contemporaneous psychosocial factors, including hostility, anger expression, depression, and the quality of social relationships are important in predicting variability in nocturnal blood pressure in adulthood.

The Current Study

Although the impact of childhood adversity on nocturnal dipping has not yet been examined, there is evidence linking childhood adversity to the development of psychosocial factors that are predictive of nighttime change in blood pressure. Combined, this evidence suggests that childhood adversity may influence nocturnal dipping in young adulthood through a psychosocial pathway. The literature would also suggest that the quality of family relationships plays an important role in moderating the relationship between early family experiences

and psychological and physiological outcomes in young adulthood. Understanding the conditions under which childhood experiences influence non-dipping can inform us about who is most at risk for experiencing negative psychosocial effects following divorce or bereavement. Further, understanding how these factors may lead to impaired physiological functioning may assist in the development of tailored and effective interventions for individuals most at risk for poorer mental and physical health outcomes post childhood family adversity.

It is important to note here that while divorce and parental loss in childhood are both forms of family adversity, the ways in which parent-child relationships are affected as a result of divorce may greatly differ from those of loss. Bowlby (1973) theorized that parental divorce may increase hostility in children because expressions of anger or despair could discourage the attachment figure from leaving in the future and motivate children to reunite with their parent. Bowlby (1980) also hypothesized that parental death may result in increased sadness and depression in response to the child's permanent inability to reunite with the parent. Empirically, however, the few studies that have directly compared the impact of divorce to the impact of parental death on the child have led to mixed results. Some studies find that there are no differences between the impact of divorce and bereavement on a child's health (Amato, 1988). Others have found significant differences between the effects of divorce and bereavement on psychological and physiological functioning. Mack (2001) found that adults who experienced parental divorce before the age of 19 had significantly

diminished quality of family relationships, but more self-confidence and decreased depression when compared to adults who had experienced parental death. And as noted above, Luecken et al. (2005) found differential effects between young adults who had experienced divorce and parental loss in childhood such that higher quality of family relationships in were associated with stronger cardiovascular reactivity and recovery from a stressful speech task in the loss group while higher quality of family relationships were associated with lower cardiovascular reactivity and recovery in the divorce group. The findings from past studies suggest that the processes by which divorce and bereavement affect both psychological and physiological well-being may not be equivalent, however, evidence in support of how family adversities differ is still fairly sparse, indicating a need for further investigation.

The present study investigated the impact of parental divorce and parental loss on nighttime change in blood pressure (BP) in young adulthood. The following hypotheses were examined:

1. Young adults from divorce and parentally-bereaved families will exhibit less change in nighttime BP than participants from intact/married families. This relation is predicted to be moderated by the quality of family relationships such that both divorce and loss groups will show more blunted nighttime change in blood pressure, especially when quality family relationships are low. Low quality family relationships are also expected to negatively impact nocturnal blood pressure dipping in the

intact group, however, this effect will be less pronounced in the intact group when compared to the divorce and loss groups.

   a. Exploratory analyses make comparisons between the effects of different pairs of groups on nighttime blood pressure dip. Comparisons of nighttime blood pressure dip are made between: 1) the intact group and the childhood adversity groups (divorce and bereaved groups combined), 2) divorce group and the bereaved group.

2. Young adults from divorced and bereaved families are predicted to report higher depression, hostility, and interpersonal stress. This relation is expected to be moderated by the quality of family relationships such that both divorce and loss groups will have elevated depression, hostility, and interpersonal stress especially when paired with low quality family relationships. Low quality family relationships are also expected to negatively impact depression, hostility, and interpersonal stress in the intact group, however, this effect will be less pronounced in the intact group when compared to the divorce and loss groups.

   a. Exploratory analyses make several comparisons between the effects of different pairs of groups on each psychosocial factor. Comparisons of psychosocial factors are made between: 1) the intact group and the childhood adversity groups (divorce and

bereaved groups combined), 2) divorce group and the bereaved group.

3. Depression, hostility and interpersonal stress are predicted to mediate the effects of family group (intact, divorce, loss) and the quality of family relationships on nighttime change in blood pressure.

Methods

Participants

One-hundred and forty-three undergraduates (ages 18-29 y; *M* = 19.8, *SD* = 2.16) from bereaved (*n* = 46), divorced (n= 49), or intact (*n* = 48) families participated in exchange for course credits in an introductory psychology class. Caucasians represented 75.5% of the sample while the rest was represented by African Americans (2.1%), Hispanics (11.2%), and individuals of other ethnic backgrounds (11.2%). A majority of the sample was female (60.8%) and most participants indicated they were non-smokers (79.7%). Over a third of the sample reported a yearly family income >$100,000, and on, average, participants were found to have a healthy body mass index (*M*=23.5, *SD*=3.69). The data presented were collected as a part of a large study evaluating physiological and cognitive effects of early family experiences.

Eligible respondents were selected from a pool of introductory psychology class students who completed a screening survey. Eligibility criteria included either parental loss or parental divorce prior to a student's 16th birthday and no

parental loss or divorce since this date. Students were also eligible to participate if they had two biological parents who were both alive and currently married to each other. Students were not made aware of the specific reasons for their eligibility to participate, but were told that the study was interested in recruiting people from a variety of family environments.

Measures

Family relationships. Family relationships prior to 16 years of age were retrospectively assessed using 27-items from the Family Environment Scale (FES; Moos & Moos, 1994; Cronbach's $\alpha = 0.85$). Cohesion, Expressiveness, and Conflict subscales of the FES were aggregated into a Family Relationships (FR) score, such that higher scores reflected higher quality family relationships. Items from the Cohesion subscale measured the extent to which members of the family were committed to and supported each other. The Expressiveness subscale measured the degree to which family members shared their feelings directly. The Conflict subscale were reverse coded and measured how much anger was expressed between family members prior to the age of 16. The quality of family relationship subscales have been empirically tested and have been found to be reliable and valid (Moos &Moos, 1994).

Depressive symptoms. The Beck Depression Inventory II (BDI-II; Beck, 1996; Cronbach's $\alpha = 0.89$), a 21 item scale, assessed the severity of depressive symptoms in the past two weeks, with symptoms rated on a 4-point scale ranging from 0-3. Scores from each item were summed. The BDI-II has high internal

consistency and good convergent validity with other measures of depression in adult and adolescent patients and normal adults (Krefetz, Steer, Gulab, & Beck, 2002).

Hostility. An abbreviated version of the Cook-Medley Hostility Scale (CMHO; Barefoot, Dodge, Peterson, & Dahlstrom, 1989; Cronbach's $\alpha = 0.73$) was used to measure three major components of hostility: cynicism, hostile affect, and aggressive responding. Although the measure of hostility was originally a 50-item measure derived from the Minnesota Multiphasic Personality Inventory (MMPI), the shortened version of the CMHO contains 27 items which have previously been found to be show better convergent and divergent validity when compared to scales on the NEO Personality Inventory (Barefoot et al., 1989). Moreover, the shortened scale has been found to be more predictive of health outcomes over time than the original scale developed by Cook & Medley (1957). The original full scale has been shown to have high internal consistency reliability (Smith & Frohm, 1985) and test-retest reliability has been found to be high (Shekelle, Gale, Ostfeld, & Paul, 1983). The original scale has also been used to assess the relationship between hostility and risk for various cardiovascular diseases including coronary heart disease and coronary artery disease (Barefoot, et al., 1989; Shekelle et al., 1983).

Interpersonal stress. The sum of endorsed social stressors on the Response to Stress Questionnaire (RSQ; Connor-Smith, Compas, Wadsworth, Thomsen, & Saltzman, 2000) was used to assess current interpersonal stress. In

addition to providing information about the ways in which individuals cope with stress, the RSQ can be used to measure the amount of current interpersonal stress experienced by individuals. The RSQ asked participants to identify the different ways in which they are currently experiencing problems in their relationships with family, friends and romantic partners; the total number of endorsed social difficulties were used as a measure of total interpersonal stress.

Nocturnal dipping. A Suntech Oscar II Ambulatory Blood Pressure (ABP) monitor (P. J. Hilton & Associates, Glendora, CA) assessed ABP, on average, every half –hour during waking hours and every hour during sleep. Participants were asked to wear the ABP monitor over a 24-hr period. In order to avoid anticipatory reactions, the measurement times were randomly varied within a 20-min interval. Each BP measure was marked by an unalterable timestamp and the monitors did not display readings to the participants. A handheld electronic dairy (Palm M100 or Palm IIIxe model, Palm Inc., Santa Clara, CA) was also given to each participant. Diary entries, which included information about minor stressful events, affect, posture, location, caffeine and energy drink consumption, exercise, food consumption, alcohol use and smoking, were completed every 30 minutes during daytime waking hours for a 24 hour period. Participants were cued to fill out the entries by the inflation of the ABP monitor. All diary entries were marked with an unalterable timestamp.

Sleep hours were determined by comparing the electronic diary entries to the ABP monitor readings such that ABP monitor readings with corresponding

electronic diary entries were considered to have occurred during waking hours. Consecutive series of ABP monitor readings that started during nighttime but did not have corresponding electronic diary entries were considered to have occurred during sleep.

Procedure

Each participant began their portion of the study between 1-3 p.m. on Monday-Thursday and concluded between 1-3 p.m. the following day. Participants completed self-report questionnaires on a laptop computer in the laboratory. Experimenters then trained participants on the procedure for completing diary entries on the electronic diary and fitted the ABP monitor. Before leaving the lab, participants were given written instructions and a phone number to call with any questions or concerns. Approximately 24hrs later, participants returned all materials to the laboratory.

Data Management

The first and last ABP readings in each group of nighttime readings were removed from to ensure that readings occurred during nocturnal sleep. Established procedures for the removal of artifacts and outliers from the ABP data were followed (Urbina et al., 2008; O'brien et al., 2003). Since sleep hours varied between subjects, the number of nighttime and daytime blood pressure readings recorded for each participant was calculated as potential covariates.

Data Analysis

Preliminary analyses. Descriptive statistics including frequency, mean, standard deviation, range, skewness and kurtosis were calculated for each variable. Zero-order correlations between study variables were also computed. A series of one-way ANOVA analyses compared groups across each study variable in order to determine possible covariates to be included in primary analyses. For each regression analysis conducted, regression diagnostics were examined in order to detect the influence of potential outliers on estimates of effects. More specifically, measures of distance and influence were evaluated by examining externally studentized residuals, DFFITS and DFBETAS statistics. Cases with externally studentized residuals that were greater than 3 and/or DFFITS and DFBETAS greater than 1 were considered to be potentially problematic. Further analyses were then conducted to determine whether the outliers had significant influence on the results of the analyses.

Calculating nighttime change in BP. The difference between mean BP during waking hours and the mean BP during sleep hours was calculated by using mean daytime BP as a covariate in analyses predicting nighttime BP. By including mean daytime BP as a covariate in analyses predicting mean nighttime BP, estimates reflected a prediction in nighttime BP, partialling out the effects of mean daytime BP and thus also represented a change in mean BP from day to night.

Primary analyses. Primary analyses were based on the three hypotheses: 1) the relation between family group (intact, divorce, or loss) and percentage dipping is moderated by quality of family relationships; 2) the relation between family group and three psychosocial factors (depressive symptoms, hostility and interpersonal stress) is moderated by quality of family relationships; and 3) psychosocial factors mediate the relationship between family group, quality of family relationships and nocturnal dipping. For the first hypothesis, the moderating role of quality of family relationships on the association between family group and mean nighttime blood pressure was analyzed by testing two linear regression models, one for both systolic and diastolic blood pressure. Age, gender, family income, and mean daytime blood pressure were identified as covariates in preliminary analyses and entered into the analysis first. Next the family group effect was entered in to both analyses using two contrast codes; Contrast 1 was coded to represent a contrast between the intact group and both adversity groups (bereaved and divorce) and Contrast 2 was coded to represent the contrast between the bereaved and divorce groups. Quality of family relationships was then entered into the analyses followed by two variables representing the interactions between the family group contrast variables and the quality of family relationships. All continuous variables, including age, mean daytime blood pressure and quality of family relationships, were centered prior to analyses.

For the 2nd hypothesis, linear regression models were used to estimate the effects of family group, quality of family relationships and the family group x family relationship interaction on the psychosocial outcomes (depressive symptoms, hostility, and interpersonal stress; coefficient *a* in the mediation model). In all 3 models, age, gender, and family income were identified as covariates in preliminary analyses and entered into the analyses first. Next the family group effect was entered in to both analyses using the same two contrast codes described above. Quality of family relationships was then entered into the analyses followed by two variables representing the interactions between the family group contrast variables and the quality of family relationships. All continuous variables, including age and quality of family relationships were centered prior to analyses.

The final analyses tested the mediating role of depression, hostility, and interpersonal stress in explaining the association between family group (intact, divorce, or loss) and/or quality of family relationships in predicting change in blood pressure from daytime to nighttime. In order to establish a mediated effect, the effects of the independent variables (IV; family group x family relationship interaction or main effects of family group and/or quality of family relationships) on proposed mediators (depression, hostility and interpersonal stress; coefficient *a*) were first examined. Linear regression models were then used to establish a relationship between the psychosocial factors and mean nighttime blood pressure, after adjusting for the IV and related covariates, including age, gender, and

daytime blood pressure (coefficient *b*). The mediated effect was tested only after establishing significance in both relations. The product of the *a* and *b* coefficients, *ab*, was calculated as the mediated effect, and represented the impact of family group and/or quality of family relationships on the change in mean blood pressure from daytime to nighttime, indirectly through psychosocial factors. The mediated effect was tested for significance by obtaining confidence limits for the indirect effect, *ab*, based on a comparison of this value to the asymmetrical distribution of the product of two normally distributed variables (Prodclin; MacKinnon, Fritz, Williams, & Lockwood, 2007).

Results

Preliminary Analyses

Descriptive statistics. Sample characteristics and descriptive statistics of study variables are reported in Table 1. Different sample sizes across variables were a result of occasional equipment problems. All continuous variables were in within the limits of acceptable skewness (<2) and kurtosis (<7), indicating that they meet assumptions of normality required for analyses (Cohen, Cohen, Aiken, & West, 2003). Mean day and nighttime systolic and diastolic blood pressure values found in the current sample are comparable to previously normative data taken from a sample of normotensive adolescents (Urbina et al., 2008).

Group comparisons. Table 2 shows sample characteristics and descriptive statistics by family group. One-way ANOVA analysis revealed significant differences in age ($F(2, 142)=3.39$, $p=0.04$), family income (F(2,

137)=12.5, p<.001), quality of family relationships (F(2, 142)=8.07, p<.001), total endorsed social stressors (F(2, 142)=3.41, p=.04), mean daytime systolic BP (F(2, 134)=3.18, p=.05), mean daytime diastolic BP (F(2, 134)=3.72, p=.03), mean nighttime systolic BP (F(2, 127)=3.06, p=.05) and mean nighttime diastolic BP(F(2, 127)=5.27, p=.01) across family groups. Post hoc pairwise Bonferroni comparisons revealed that individuals from divorced families were significantly older at the time of assessment when compared to individuals from bereaved families (p=.04). Individuals from intact families reported significantly higher family income compared to both bereaved (p<.001) and divorce groups (p=.001). Intact and divorce groups differed significantly in quality of family relationships, such that the intact group reported higher quality of family relationships when compared to the divorce group (p<.001). Individuals in the intact group also reported, on average, a greater number of social stressors compared to the bereaved group (p=.03). The loss group had lower mean daytime (p=.05) and nighttime (p=.05) systolic BP compared to the intact family group (p=.05) and lower mean daytime (p=.05) and nighttime (p=.02) diastolic BP compared to the divorce group. The loss group also had significantly lower nighttime diastolic BP compared to the intact group (p=.01). No significant differences were found among family groups for gender, ethnicity, body mass index, or smoking.

Selection of covariates. Gender, age, ethnicity (e.g. Caucasian, Hispanic, African American or other), family income, body mass index, posture, number of readings and smoking status were all considered as potential covariates as they

have been proposed to also play important roles in an individual's ambulatory blood pressure. After examining the results of the one-way ANOVA analyses (Table 2) and zero-order correlations (Table 3), age, gender, and family income were identified for inclusion in most of the primary analyses. Because significant differences between groups were identified for age and family income, and all three covariates were significantly correlated with various outcome measures of interest, these variables could potentially account for variation in the outcome measures that may otherwise be attributed to error, therefore, increasing the sensitivity and power of the regression analyses (Cohen et al., 2003). The inclusion of family income as a covariate was dropped, however, after initial analyses of path *a* revealed that family income had no significant effects in the prediction of psychosocial factors.

Evaluation of outliers. Examination of regression diagnostics for each regression analysis reported below found that, although some cases exceeded critical values for DFFITS (>1) and externally studentized residuals (>3), no cases exceeded critical values for DFBETAS (>1). Further investigation of outliers in each regression analysis revealed that identified cases did not reveal clear differences from other study participants on any study variable. Removal of the cases from the analyses did not affect the significance of results, thus all cases were retained for analyses.

Primary Analyses

Hypothesis 1: Predicting change in nighttime BP from family group and quality of family relationships. The hypothesis that the quality of family relationships would interact with family group to predict mean nighttime systolic BP was tested using linear regression, controlling for age, gender, family income and daytime mean systolic BP (See Table 4). The overall model was significant ($F(9, 124) = 14.1$, $p < .01$), however, neither main effects nor interactive effects of quality of family relationships and family group significantly predicted mean nighttime systolic BP (p's > .26). The analyses were repeated to predict mean nighttime diastolic BP. Although the overall model was significant ($F(9, 124) = 7.39$, $p < .01$), no interactive or main effects significantly predicted nocturnal diastolic BP (p's >.33).

Hypothesis 2: Predicting depressive symptoms, hostility, and interpersonal stress from family group and quality of family relationships. The hypothesis that quality of family relationships would interact with family group to predict depressive symptoms was tested using linear regression, controlling for age, gender, and family income (see Table 5). The overall model was significant ($F(8, 135) = 4.09$, $p<.01$). Although the interaction of family group and family relationships did not significantly contribute to the prediction of depressive symptoms, quality of family relationships significantly predicted depressive symptoms, $B = -.59$, $t(135) = -5.15$, $p < .01$. Neither of the contrast variables representing the family group main effects were significant predictors of

depressive symptoms. The analyses described above were repeated to predict hostility (See Table 5). The overall model was also significant ($F(8, 136) = 3.27$, $p=.002$). Neither of the interaction variables significantly contributed to the prediction of hostility, however, the main effects of quality of family relationships ($B =-.27$, $t(136) = -4.08$, $p < .01$) and Contrast 1 ($B =1.81$, $t(136) = 2.01$, $p =.05$) significantly predicted hostility. Contrast 2 approached significance in the prediction of hostility ($B =1.69$, $t(136) = 2.01$, $p =.08$). The same predictors were then used to predict interpersonal stress (See Table 5). This overall model was also significant ($F(8, 137) = 3.66$, $p=.001$). Similar to the results above, the interaction variables did not significantly contribute to the prediction of interpersonal stress. However, the both the main effects of quality of family relationships ($B =-.14$, $t(137) = -3.33$, $p = .001$) and Contrast 1 ($B =1.57$, $t(137) = 2.87$, $p =.005$) significantly predicted interpersonal stress. Although Contrast 1 significantly predicted hostility and interpersonal stress, the direction of these effects were in opposition to the hypothesized outcome: the intact family group reported higher hostility and interpersonal stress when compared to the family adversity groups. Moreover, the lack of significant interaction effects in both Hypothesis 1 and Hypothesis 2 indicated that the originally proposed moderated mediation model needed to be re-specified to exclude the moderated effects (see Figure 2).

Hypothesis 3: Psychosocial factors as mediators. The direct path between two variables does not have to reach statistical significance to test a

mediational effect (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002), therefore the present study continued to investigate the mediating role of three psychosocial factors on the relation between early childhood adversities and nighttime blood pressure dip.

Depressive symptoms as a mediator of the relation between quality of family relationships and nighttime change in systolic BP. The mediation of the relation between quality of family of relationships and mean nighttime systolic BP by depressive symptoms was investigated by reanalyzing the paths *a* and *c* after excluding the family group contrast codes, family group by quality of family relationship interactions, and family income, as they did not contribute significantly to the prediction of nocturnal systolic BP or depressive symptoms. The overall model was significant, $F(4, 127) = 32.91$, $p < .01$, however, quality of family relationships was not a significant predictor of mean nighttime systolic BP, $B = .13$, $t(127) = 1.32$, $p = .19$. Path *a* was significant, revealing that quality of family relationships significantly predicted depressive symptoms, $B = -.51$, $t(140) = -5.00$, $p < .01$. However, analysis of path *b* revealed that depressive symptoms did not predict mean nighttime systolic BP when controlling for the effects of quality of family relationships, $B = -.10$, $t(127) = -1.24$, $p = .22$. Because path *b* was not significant, depressive symptoms were not considered as a mediator and not further analyses were conducted. See Table 6.

Hostility as a mediator of the relation between quality of family relationships and nighttime change in systolic BP. The mediation of the relation

between quality of family of relationships and mean nighttime systolic BP by hostility was investigated by reanalyzing the paths *a* and *c* after excluding the family group contrast code 2, family group by quality of family relationship interactions, and family income, as they did not contribute significantly to the prediction of nocturnal systolic BP or hostility. The overall model was significant, $F(5, 127) = 26.16$, $p < .01$, however, neither quality of family relationships ($B = .12$, $t(127) = 1.11$, $p = .27$) nor family group Contrast 1($B = .44$, $t(127) = .32$, $p = .75$) were significant predictors of mean nighttime systolic BP. Path *a* was significant, revealing that quality of family relationships significantly predicted hostility, $B = -.23$, $t(141) = -3.62$, $p < .01$. The association between Contrast 1 and hostility, approached significance, $B = 1.56$, $t(141) = 1.92$, $p = .06$. Analysis of path *b* revealed that hostility significantly predicted mean nighttime systolic BP when controlling for the effects of quality of family relationships and Contrast 1, $B = .31$, $t(127) = 2.30$, $p = .02$. The PRODCLIN test of the mediated effect found that hostility was a significant mediator of the relation between quality of family relationships and mean nighttime systolic BP (Mediated effect (*ab*) = -.07, 95% CI=[-0.16, -0.006]). See Table 6.

Interpersonal stress as a mediator of the relation between quality of family relationships and nighttime change in systolic BP. The mediation of the relation between quality of family of relationships and mean nighttime systolic BP by interpersonal stress was investigated by reanalyzing the path *a* after excluding the family group contrast code 2, family group by quality of family

relationship interactions, and family income, as they did not contribute significantly to the prediction of nocturnal systolic BP or depressive symptoms. Path *a* was significant, revealing that both quality of family relationships (*B* =-.13, *t*(142) = -3.34, *p*=.001) and Contrast 1 (*B* =1.73, *t*(142) = 3.55, *p*=.001) significantly predicted interpersonal stress. Then, analysis of path *b* revealed that interpersonal stress did not significantly predicted mean nighttime systolic BP, *B* = .12, *t*(127) =.51, *p* =.62. Because path *b* was not significant, interpersonal stress was not considered as a mediator and not further analyses were conducted. See Table 6.

Depressive symptoms mediating the relation between quality of family relationships and nighttime change in diastolic BP. The mediation of the relation between quality of family of relationships and mean nighttime diastolic BP by depressive symptoms was investigated by reanalyzing the paths *a* and *c* after excluding the family group contrast codes, family group by quality of family relationship interactions, and family income, as they did not contribute significantly to the prediction of nocturnal diastolic BP or depressive symptoms. The overall model was significant, *F*(4, 127) =16.36, *p*<.01, however, quality of family relationships was not a significant predictor of mean nighttime diastolic BP, *B* = .0 3, *t*(127) = .79, *p*=.43. Because previous analysis found that quality of family relationships was a significant predictor of depressive symptoms, path *b* was then evaluated. Analysis of path *b* indicated that depressive symptoms did not predict mean nighttime diastolic BP when controlling for the effects of quality of

family relationships, B = -.06, t(127) =-1.09, p =.28. Because path *b* was not significant, depressive symptoms were not considered as a mediator and not further analyses were conducted. See Table 7.

Hostility mediating the relation between quality of family relationships and nighttime change in diastolic BP. The mediation of the relation between quality of family of relationships and mean nighttime diastolic BP by hostility was investigated by reanalyzing the paths *a* and *c* after excluding the family group contrast code 2, family group by quality of family relationship interactions, and family income, as they did not contribute significantly to the prediction of nocturnal diastolic BP or hostility. The overall model was significant, F(5, 127) =13.13, p<.01, however, neither quality of family relationships(B = .04, t(127) = .49, p=.62) nor family group Contrast 1(B = .65, t(127) =.69, p=.49) were significant predictors of mean nighttime diastolic BP. Because earlier analysis of indicated that the association between quality of family relationships and hostility was significant, path *b* was then evaluated. Analysis of path *b* revealed that hostility did not predict mean nighttime diastolic BP when controlling for the effects of quality of family relationships and Contrast 1, B = .10, t(127) =.96, p =.34. Because path *b* was not significant, hostility was not considered a mediator and no further analyses were conducted. See Table 7.

Interpersonal stress mediating the relation between quality of family relationships and nighttime change in diastolic BP. The mediation of the relation between quality of family of relationships and mean nighttime diastolic

BP by interpersonal stress was then investigated. Because earlier analysis of path *a* indicated a significant effects of both quality of family relationships and family group Contrast 1 on interpersonal stress, path *b* was evaluated. Analysis of path *b* revealed that interpersonal stress did not significantly predict mean nighttime diastolic BP, even when controlling for quality of family relationships and Contrast 1, $B = .14$, $t(127) = .84$, $p = .40$. Because path *b* was not significant, interpersonal stress was not considered a mediator and no further analyses were conducted. See Table 7.

Discussion

The current study examined the effects of parental death and divorce in childhood on adult nighttime blood pressure dip. Neither form of adversity directly predicted nighttime systolic or diastolic dip, alone or in interaction with the quality of childhood family relationships. However, poor quality of childhood family relationships was associated with higher levels of hostility, depressive symptoms, and social stress in young adulthood. Further, hostility was found to mediate the relationship between the quality of childhood family relationships and nighttime blood pressure dip.

Although the analyses failed to support the hypothesis that early childhood adversities would directly predict nighttime cardiovascular functioning in young adulthood, the results bring several practical and theoretical considerations to mind. First, given that the effect of early family experiences on later nighttime cardiovascular functioning may be relatively small, the analyses may have lacked

sufficient power to detect a direct effect. Second, childhood family adversities may impact nighttime blood pressure dipping through an indirect pathway. Therefore, analyses were conducted to investigate indirect effects of early childhood adversities on later nighttime blood pressure dip.

It was proposed that childhood family adversity in combination with poor quality of childhood family relationships would predict elevated depressive symptoms, hostility, and social stress, and that the psychosocial variables would act as mediators linking childhood adversity to nighttime blood pressure dip. Results indicated that the quality of family relationships alone was an important predictor of all three psychosocial factors in later adulthood, such that higher quality of family relationships, marked by low conflict and high cohesion, were associated with lower depressive symptoms, hostility and social stress. These findings indicate that the quality of the family environment may be more influential in predicting later psychosocial outcomes, over and above a specific family adversity such as parental death or divorce. Other studies investigating the role of the early family environment in predicting later mental health outcomes (Hines, 1997; Peterson & Zill, 1986; Wolchik et al., 2000) have found similar results to the current findings, and highlight the importance of considering the quality of the relationships between individuals within a family system when assessing long-term psychosocial risk and resilience in families. Although significant adverse family events undoubtedly place a great deal of stress on the entire family dynamic, the interpersonal contexts in which parental death and

divorce occur may play an even more important role in predicting long-term mental health.

Contrary to hypotheses, however, individuals in the intact family group endorsed higher levels of hostility and social stress compared to those in both the loss and divorce groups. Although the unexpected findings may have been a result of random error in measurement or response biases, they may also be an indication that adverse childhood family events do not necessarily lead to poor psychosocial outcomes later in life. From a differential susceptibility and stress inoculation perspective (Boyce & Ellis, 2005), although experiences of parental divorce or death in childhood may lead to more conflict and stress within the family, they may also pose as opportunities to learn adaptive conflict resolution and coping strategies that may promote the development of healthy relationships later in life. On the other hand, those who experience minimal adversity in childhood may have limited opportunities to develop appropriate coping mechanisms or may become overly sensitive to stressors that occur outside the family in adulthood. The association between early family adversities and lower levels of hostility and social stress may be a reflection of learned, adaptive coping, or may be a result unique to the sample of high functioning, healthy, undergraduates. The association between the intact family and higher levels of hostility and social stress may be due to the intact group's greater sensitivity to potential threats or social stressors. For example, post hoc analyses of specific social stressors endorsed by each group also found that the intact group endorsed

problems with not having a significant other more often than the divorced or bereaved groups, indicating that the intact group may have different expectations of social interactions and may have varying perceptions of social stress. Since most children who experience childhood parental bereavement or divorce do not develop psychosocial problems (Lin, Sadler, Ayers, Wolchik, & Luecken, 2004; Kelly & Emery, 2003) and individuals from intact families are still susceptible to developing later psychosocial deficits, both adaptive and maladaptive factors should be considered when looking to predict outcomes of early adverse family events and highly protective childhood environments. Therefore, in addition to the quality of family relationships in childhood, factors including personality/temperament, social competence, coping efficacy, perception of threat, and parenting warmth may be important to consider when predicting psychosocial adjustment post early family adversity.

Of the three psychosocial factors proposed to mediate the relation between quality of family relationships and nighttime blood pressure dip, a significant indirect effect was found only for hostility. Poor quality family relationships in childhood were associated with higher levels of hostility, which were then significantly associated with blunted nighttime systolic blood pressure dip. Evidence linking high levels of hostility and anger expression to blunted nighttime blood pressure dip has been documented in older, hypertensive adults (Linden et al., 2008; KaMala et al., 2004; Routledge & McFetridge-Durdle, 2007). The current study was unique in that it included a younger, relatively

healthy, and high functioning sample of college students. The association between hostility and nighttime blunted blood pressure dipping in the present analyses suggests that those who have a tendency to approach situations with cynicism, hostile affect and aggression may accumulate risk for developing cardiovascular disease over time. These results not only provide further support for the relation between hostility and nocturnal blood pressure dip, but also uniquely provide evidence for the indirect link between early family experiences and nighttime blood pressure dipping.

Although the mediating effect of hostility on the relation between quality of family relationships and nocturnal systolic blood pressure dip was significant, the analyses did not find support for the influence of hostility on nocturnal diastolic blood pressure dip. The results highlight the potential importance of investigating systolic and diastolic blood pressure dipping separately, as they index different aspects of cardiovascular functioning. Although both systolic and diastolic blood pressures are indicators of autonomic nervous system activity, they are measures of two different biological pathways within a larger system. Systolic blood pressure measures the force exerted on blood vessels and arteries when the heart is beating, providing a measure of sympathetic nervous system activity; and diastolic blood pressure measures the force when the heart is relaxed, providing a measure of parasympathetic nervous system activity. During healthy, restorative sleep the autonomic nervous system is dominated by the parasympathetic nervous system (Trinder, 2007). However, in dysregulated sleep,

the sympathetic nervous system is increasingly active, evidenced by the active role of the sympathetic nervous system in predicting blunted nighttime blood pressure dip (Sherwood, Steffen, Blumenthal, Kuhn, & Hinderliter, 2002). Moreover, psychological factors, such as anxiety and PTSD, have been found to influence autonomic nervous system during sleep by shifting towards elevated sympathetic nervous system activity (Mellman, Knorr, Pigeon, Leiter, & Akay, 2004; Mellman, Brown, Jenifer, Hipolito, & Randall, 2009). The significant outcomes associated with systolic blood pressure dip, but not diastolic blood pressure dip may, therefore, be a reflection of the specific link between hostility and its effects on sympathetic nervous system functioning during sleep. Although many studies of nighttime blood pressure dip use measures of blood pressure that create a weighted composite of the two measures to obtain a global measure of autonomic nervous system functioning, examination of both systolic and diastolic pathways individually may provide more important insight into how various psychosocial factors influence specific pathways within the autonomic nervous system during sleep.

Contrary to predictions, depressive symptoms and social stress did not predict nighttime blood pressure dip. Although previous studies have found that social stress, interpersonal support, and depression predict nighttime blood pressure dip (Routledge & McFetridge-Durdle, 2007), most of the past studies were conducted with hypertensive older adults who were hospitalized for a major depressive episode or had a history of depression. The effects of depressive

symptoms and social stress on nighttime blood pressure dip may not be as robust in a young healthy sample or may not be generalizable to other populations. The current sample reported minimal depressive symptoms on average; the lack of clinically significant depression may make the effects of depression on nighttime blood pressure dip too small to detect in the present study. Previous studies investigating the effects of social stress on nighttime blood pressure dip have also focused on lack of social support and low socioeconomic status. Although related to social support, measures of social stress may capture a unique aspect of social functioning that is different from the social support networks examined in previous studies. For example, the lack of social support at later stages in life may be an indicator of a more chronic or severe deficit in social functioning, loneliness, or social isolation. In contrast, the sum of perceived social stressors in young adulthood used in the current investigation requires individuals to desire to be in contact with others in order to report social stress. Future studies should investigate specific conditions under which early family adversities may contribute to the development of more severe psychosocial problems to better identify those who may be most at risk for long-term blunted nighttime blood pressure dip.

Sex Differences

Although not a primary focus of the current analyses, gender may play an important role in predicting nighttime diastolic blood pressure dip. In the present sample women had more blunted nighttime diastolic blood pressure dip compared

to men. The observed differences between sexes in nighttime diastolic blood pressure dip were unexpected, as other studies of children, young adults, and older hypertensive adults that have found no differences in nighttime blood pressure dip between sexes (Helmers, Baker, O'Kelly, & Tobe, 2000; Wang et al., 2006; Kario, Schwartz, Davidson, & Pickering, 2001). Although our finding may have been spurious, it may also be a reflection of real differences in both psychological and cardiovascular functioning between sexes. For example, Bishop et al., (2006) found that in a sample of Singaporean young adults, women showed more diastolic blood pressure dip than men and that high trait anger was associated with blunted dipping only in men. Moreover, Kario et al. (2001) also found that, although men and women did not differ in nighttime blood pressure dip, higher levels of depression were associated with blunted nighttime dipping in men but not women. Therefore, although men and women may not differ in nocturnal dipping status, they may differ in the psychosocial and physiological pathways in which they regulate nighttime blood pressure dipping. Post hoc analyses of the moderating effects of sex on the relations between the psychosocial factors and nighttime blood pressure dip were not found to be significant (results not reported). Future studies may consider sex differences in the pathways that link early childhood adversities to nighttime blood pressure dip.

Clinical Implications

The results from the present study have several clinical implications. Nighttime blood pressure dipping is an important indicator of healthy

cardiovascular functioning and chronic non-dipping has been associated with increased risk for several serious health conditions including sleep apnea, heart failure and myocardial infarction (Hansen et al., 2011). Understanding the developmental and psychosocial factors that contribute to dysregulated nocturnal blood pressure can inform future efforts to prevent the development of chronic cardiovascular dysfunction and may help to identify those at most risk for developing cardiovascular diseases. Although much of the previous literature has focused on the role of factors including socioeconomic status, race, and ethnicity on nighttime blood pressure dip (Stepnowsky et al., 2004; Wang et al., 2006), these demographic variables may not fully account for variability in nighttime blood pressure dipping. The current study suggests that psychosocial factors may play an important role in predicting nighttime blood pressure dip, over and above demographics, and should be considered when assessing for cardiovascular risk and planning treatment for related health conditions.

Two potential points of intervention aimed at mitigating the development of non-dipping are also indicated in the present findings. Interventions may consider psychotherapeutic strategies that help individuals reduce levels of cynicism, anger, and aggressive behaviors. One study found that a group intervention aimed at reducing hostility in male patients with coronary heart disease not only worked to reduce cynicism, anger, and aggression, but also decreased the amount of time spent in the hospital over a 6 month period (Davidson, Gidron, Mostofsky, & Trudeau, 2007). Interventions aimed at

lowering levels of hostility may be useful for preventing the development of blunted nocturnal dipping and, over time, subsequent cardiovascular conditions including coronary heart disease. Programs aimed at increasing the quality of relationships among family members, including strengthening bonds, reducing conflict, and increasing appropriate emotion expression have shown efficacy in decreasing risk for the development of externalizing problems, including aggression and hostility, in children who were at high risk for delinquent behaviors and experienced negative family events, including divorce and bereavement (Wolchik et al., 2002; Sandler et al., 2010). The current findings raise the intriguing possibility that interventions aimed at reducing hostility and conflict and increasing cohesion and expressiveness in families may also promote adaptive nighttime blood pressure dipping and related cardiovascular diseases.

Limitations

The present investigation bridges a gap in the literature between the long-term health effects of early family environments and psychosocial correlates of nighttime blood pressure dipping. However, there are important methodological limitations to consider. The data were collected over the course of 24-hrs. Although 24-hr blood pressure monitoring has been shown to be fairly stable over time (Urbina et al., 2008), many studies obtain measures over multiple days, which may provide a more reliable assessment of nighttime blood pressure dipping. Moreover, subjective (e.g. sleep diary) and objective (e.g. polysomnography) measures of sleep duration or quality were not included.

Future studies should consider longer assessment of ambulatory blood pressure and objective measures of sleep.

The sample of primarily Caucasian, healthy, young adult undergraduates in a university setting limits the generalizability of the findings. A more diverse sample of individuals with varying levels of psychosocial functioning and demographics may unveil additional pathways linking early family experiences to subsequent nighttime cardiovascular functioning. Nevertheless, even within a relatively young and healthy sample, poor quality of family relationships were associated with increased hostility, which was then associated with nighttime systolic non-dipping. These negative effects may accumulate over time and increase risk for cardiovascular disease as people age, highlighting an even greater need to understand the psychosocial pathways that lead to blunted nighttime blood pressure dip across the lifespan and in individuals with varying degrees of health. Still, future studies looking to better understand the pathways that link childhood adversity and psychosocial factors to nighttime physiological dysregulation may find more robust and influential effects in an older or less healthy sample.

The measure of childhood family relationships used in the current study was based on retrospective recall, raising the concern that individual level differences (e.g. hostility) or experiences that have since occurred (e.g. current psychopathology or current family relationships) may bias recall of past events. A review of the literature by Hardt & Rutter (2004) found that retrospective reports

of negative childhood events were most reliable when assessing well operationalized, serious events (e.g. neglect and abuse). Hardt & Rutter (2004) also found that retrospective reports of serious events most often led to underreporting or false negatives. Although the measure of quality of family relationships has been found to be reliable and valid (Moos & Moos, 1994), it is important to consider the potential biases and limitations presented by retrospective, self-reported data. Future studies may be able to limit biases in retrospective reporting through the use of longitudinal designs.

A related limitation is that the data were collected at one time point in young adulthood. Although the analyses reported above found a significant indirect effect, causation cannot be inferred in the current model as it is based on correlational data. The lack of a longitudinal design limits the assumption of temporal precedence in establishing a causal effect. Longitudinal data should therefore be considered in future investigations of causal pathways.

Summary and Conclusions

The present investigation found that perceived poor quality early family environments are associated with a variety of psychosocial symptoms in young adulthood, including elevated depressive symptoms, hostility, and social stress. Moreover, hostility mediated the relation between early family relationships and young adult nighttime systolic blood pressure dip, such that early family relationships marked with high conflict, low emotion expression, and low cohesion were associated with increased hostility, which predicted decreased

nighttime systolic blood pressure dipping. Therefore, early family experiences may play an important role in influencing nighttime cardiovascular functioning by influencing an individual's psychological functioning in young adulthood. Because nighttime non-dipping has been associated with increased risk for serious health conditions including cardiovascular disease and sleep apnea, the current study has important clinical implications. Understanding the psychosocial pathways that lead to reduced nighttime blood pressure dipping may provide useful information to help inform interventions aimed at promoting health and reducing cardiovascular disease and subsequent mortality risk by helping to identify individuals who are most at-risk and providing specific psychosocial pathways to target.

References

Amato, P. R. (1988). Long-term implications of parental divorce for adult self-concept. *Journal of Family Issues, 9,* 201-213.

Amato, P.R. (1996). Explaining the Intergenerational Transmission of Divorce. *Journal of Marriage and the Family, 58*:628-40.

Amato, P. R. (2000). The consequences of divorce for adults and children. *Journal of Marriage and Family, 62,* 1269-97.

Amato, P. R., & Keith, B. (1991). Parental divorce and adult well-being: A meta analysis. *Journal of Marriage and Family, 53* (1), 43-59.

Barefoot, J. C., Dodge, K. A., Peterson, B. L., & Dahlstrom, W. G. (1989). The Cook-Medley hostility scale: Item content and ability to predict survival. *Psychosomatic Medicine, 51*(1), 46-57.

Beck, A. T. (1996). *The Beck Depression Inventory II*. San Antonio, TX: Harcourt Brace & Co.

Bowlby, J. (1969). *Attachment and loss: Vol. 1. Attachment*. New York: Basic Books.

Bowlby, J. (1973). *Attachment and loss: Vol. 2. Separation*. New York: Basic Books.

Bowlby, J. (1980). *Attachment and loss: Vol. 3. Loss, sadness and depression*. New York: Basic Books.

Bishop, G., Pek, J., &Ngau, F. (2006). Blunted cardiovascular responses to daytime activities as related to reduced nocturnal blood pressure decline. *Annals of Behavioral Medicine, 31*(3), 248-253.

Boyce, W. T., & Ellis, B. J. (2005). Biological sensitivity to context: I. An evolutionary-developmental theory of the origins and function of stress reactivity. *Development and Psychopathology, 17,* 271-301.

Brown, F. (1961). Depression and childhood bereavement. *Journal of Mental Science, 107,* 754-777.

Cohen, J., Cohen, P., West, S. G., & Aiken, L. (2003). *Applied multiple regression/correlation analysis for the behavioral sciences Third Edition.*

Lawrence Erlbaum Associates, New Jersey.

Cook, W., & Medley, D. (1957). Proposed hostility and phariasaic-virtue scales for the MMPI. *Journal of Applied Psychology, 38,* 414-418.

Connor-Smith, J. K., Compas, B. E., Wadsworth, M. E., Harding-Thomsen, A., & Saltzman, H. (2000). Response to stress in adolescence: measurement of coping and involuntary stress responses. *Journal of Consulting Clinical Psychology, 68,* 976-992.

Davidson, K.W., Gidron, Y., Mostofsky, E., & Trudeau, K. (2007). Hospitalization cost offset of a hostility intervention for coronary heart disease. *Journal of Consulting and Clinical Psychology, 75,* 657-662.

Delaney, A., Pellizzari, M., Speiser, P. W., & Frank, G. R. (2008). Pitfalls in the measurement of the nocturnal blood pressure dip in adolescents with type 1 diabetes. *Diabetes Care, 32,* 165-168.

Forrest, A.D., Fraser, R. H., & Priest, R. G. (1965). Environmental factors in depressive illness. *British Journal of Psychiatry, 111,* 243-253.

Goyal, T. M., Shimbo, D., Mostofsky, E., & Gerin, W. (2008). Cardiovascular stress reactivity. In L.J. Luecken & L.C. Gallo (Eds.), *Handbook of Physiological Research Methods in Health Psychology.* Thousand Oaks, CA: Sage Publications.

Hansen, T. W., Li, Y., Boggia, J., Thijs, L., Richart, T., & Staessen, J. A. (2011). Predictive role of the nighttime blood pressure. *Hypertension, 57*(1), 3-10.

Helmers, K. F., Baker, B., O'Kelly, B., & Tobe, S. (2000). Anger expression, gender, and ambulatory blood pressure in mild, unmedicated adults with hyptertension. *Annals of Behavioral Medicine, 22*(1), 60-64.

Hines, A. M. (1997). Divorce-related transitions, adolescent development, and the role of the parent-child relationship: A review of the literature. *Journal of Marriage and Family, 59*(2), 375-388.

Holt-Lunstad, J., Jones, B. Q., & Birmingham, W. (2009). The influence of close relationships on nocturnal blood pressure dipping. *International Journal of Psyhophysiology, 71* (3), 211-217.

Huurre, T., Junkkari, H., & Aro, H. (2006). Long–term psychosocial effects of parental divorce. *European Archives of Psychiatry and Clinical Neuroscience,256* (4), 256-263.

Ituarte, P. H. G., Kamarck, T. W., Thompson, H. S., & Bacanu, S. (1999). Psychosocial mediators of racial differences in nighttime blood pressure dipping among normotensive adults. *Health Psychology, 18*(4), 393-402.

KaMala, T. S., Nelesen, R. A., & Dimsdale, J. E. (2004). Relationships between hostility, anger expression, and blood pressure dipping in an ethnically diverse sample. *Psychosomatic medicine, 66* (3), 298-304.

Kamarck, T. W., Peterman, A. H, & Raynor, D. A. (1998). The effects of the social environment on stress-related cardiovascular activation: current findings, prospects and implications. *Annals of Behavioral Medicine, 20* (4), 247-256.

Kario, K., Schwartz, J. E., Davidson, K. W., & Pickering, T. G. (2001). Gender differences in associations of diurnal blood pressure variation, awake physical activity, and sleep quality with negative affect: The Work Site Blood Pressure Study. *Hypertension, 38*(5), 997-1002.

Kelly, J. B., & Emery, R. E. (2003). Children's adjustment following divorce: Risk and resilience perspectives. *Family Relations, 52* (4), 352-362.

Kendler, K. S., Sheth, K., Gardner, C. O., & Prescott, C. A. (2002). Childhood parental loss and risk for first-onset of major depression and alcohol dependence: The time-decay of risk and sex differences. *Psychological Medicine, 32,* 1187-1194.

Kostic, N., & Secen, S. (1997). Circadian rhythm of blood pressure and daily hormone variations. *Med Pregl, 50,* 37-40.

Krefetz, D. G., Steer, R. A., Gulab, N. A., & Beck, A. (2002). Convergent validity of the Beck Depression Inventory-II with the Reynolds Adolescent Depression Scale in psychiatric inpatients. *Journal of Personality Assessment, 78* (3), 451-460.

Kranz, D. S., & McCeney, &M. K. (2002). Effects of psychological and social factors on organic disease: A review and methodological critique. *Psychological Bulletin, 96* (3), 435-464.

Lederbogen, F., Gernoth, C., Hamann, B., Kniest, A., Heuser, I., & Deuschle, M. (2003). Circadian blood pressure regulation in hospitalized depressed patients and non-depressed comparison subjects. *Blood Pressure Monitor,* 8 (2), 71-76.

Lin, K. K., Sandler, I. N., Ayers, T. S., Wolchik, S. A., & Luecken, L. J. (2004). Resilience in parentally bereaved children and adolescents seeking preventive services. *Journal of Clinical Child & Adolescent Psychology, 33*, 673-683.

Linden, W., Klassen, K., & Phillips, M. (2008). Can psychological factors account for a lack of nocturnal blood pressure dipping?. *Annals of behavioral medicine, 36*, 253-258.

Luecken, L. J. (1998). Childhood attachment loss experiences affect adult cardiovascular and cortisol function. *Psychosomatic Medicine, 60*, 765-772.

Luecken, L. J., (2000a). Attachment and loss experiences during childhood are associated with adult hostility, depression, and social support. *Journal of Psychosomatic Research, 49*(1), 85-91.

Luecken, L. J., (2000b). Parental caring and loss during childhood and adult cortisol responses to stress. *Psychology and Health, 15*, 841-851.

Luecken, L. J., & Appelhans, B. M. (2006). Early parental loss and salivary cortisol in young adulthood: The moderating role of family environment. *Development and Psychopathology, 18*, 295-308.

Luecken, L. J., Kraft, A., Appelhans, B. M., & Enders, C. (2009). Emotional and cardiovascular sensitization to daily stress following childhood parental loss. *Developmental Psychology, 45*(1), 296-302.

Luecken, L. J., & Lemery, K. (2004). Early caregiving and adult physiological stress responses. *Clinical Psychology Review, 24*, 171-191.

Luecken, L. J., Rodriguez, A. P., & Appelhans, B. M. (2005). Cardiovascular stress responses in young adulthood associated with family-of-origin relationship experiences. *Psychosomatic Medicine, 67*, 514-521.

Lutzke, J. R., Ayers, T. S., Sandler, I. N. , & Barr, A. (1997). Risks and interventions for the parentally bereaved child. In: Wolchik, S. A., Sandler, I. N., eds. *Handbook of Children's Coping: Linking Theory and Intervention*. New York: Plenum Press.

Mack, K. Y. (2001). Childhood family disruptions and adults well-being: the differential effects of divorce and parental death. *Death Studies, 25*, 419-443.

MacKinnon, D. P., Fritz, M. S., Williams, J., & Lockwood, C. M. (2007). Distribution of the product confidence limits for the indirect effect: Program PRODCLIN. *Behavior Research Methods, 39,* 384-389.

Mackinnon, D. P., Lockwood, C. M., Hoffman, J. M., West, S. G., & Sheets, V. (2002). A comparison of methods to test mediation and other intervening variable effects. *Psychological Methods,* 7(1), 83-104.

Marler, M.R., Jacob, R.G., Lehoczky, J.P., & Shapiro, A.P. (1988). The statistical analysis of treatment effects in 24-hour ambulatory blood pressure recordings. *Statistics in Medicine, 7,* 697-716.

Mellman, T., Knorr, B., Pigeaon, W., Leither, J., & Akay, M. (2004). Heart rate variability during sleep and the early development of PTSD. *Biological Psychiatry, 55,* 953-956.

Mellman, T. A., Brown, D. D., Jenifer, E., Hipolito, M. M. S., & Randall, O. S. (2009). Posttraumatic stress disorder and nocturnal blood pressure dipping in young adult African Americans. *Psychosomatic medicine, 71,* 627-630.

Moos, R. H., & Moos, B. S. (1994). *Family environment scale manual*. Palo Alto, CA: Consulting Psychologist Press.

Ohkubo, T., Hozawa, A., Yamaguchi, J., Kikuya, M., Ohmori, K., Michimata, M., … Imai, Y. (2002). Prognostic significance of the nocturnal decline in blood pressure in individuals with and without high 24-h blood pressure: The Ohasama study, *Journal of Hyptertension,20,* 2183-2189.

O'Brien, E., Asmar, R., Beilin, L., Imai, Y., Mallion, J-M., Mancia, G., …Verdecchia, P. (2003). European Society of Hypertension recommendations for conventional, ambulatory, and home blood pressure measurement. *Journal of Hypertension, 21,* 821-848.

O'Brien, E., Coats, A., Owens, P., Petrie, J., Padfield, P., Littler, W., …Mee, F. (2000). Use and interpretation of ambulatory blood pressure monitoring: Recommendations of the British Hypertension Society, *British Medical Journal, 320,* 1128-1134.

Ovdiienko, T. (2010). Relation between heart rate variability and nocturnal blood pressure pattern in hyptertensive patients. *Journal of Hypertension, 28,* 451.

Pasqualini, R., Foroni, M., Salvioli, G., & Mussi, G., (2004). The "nondipper" elderly: a clinical entity or a bias?. *Journal of American Geriatric Society, 52* (6), 967-971.

Pastor-Barriuso, R., Banegas, J., R., Damián, J., Appel, L., J., & Guallar, E. (2003). Systolic Blood Pressure, Diastolic Blood Pressure, and Pulse Pressure: An Evaluation of Their Joint Effect on Mortality. *Annals of Internal Medicine*, *139*(9),731-739.

Peterson, J. L., & Zill, N. (1986). Marital disruption, parent-child relationships, and behavior problems in children. *Journal of Marriage and Family, 48*(2). 295-307.

Repetti, R. L., Taylor, S. E., & Seeman, T. E. (2002). Risky families: Family social environments and the mental and physical health of offspring. *Psychological Bulletin, 128*, 330-336.

Routledge, F., & McFedtridge-Durdle, J. (2007). Nondipping blood pressure patterns among individuals with essential hyptertension: A review of the literature. *European Journal of Cardiovascular Nursing, 6*, 9-26.

Sandler, I., Ayers, T. S., Tein, J.-Y, Wolchik, S., Millsap, R., Khoo, S. T….Coxe, S. (2010). Six-Year Follow-up of a Preventive Intervention for Parentally Bereaved Youths: A Randomized Controlled. *Arcives of Pediatric and Adolescent Medicine, 164* (10), p. 907-914.

Sayk, F., Becker, C., Teckentrup, C., Fehm, H.-L., Struck, J., Wellhoener, J. P., & Dodt, C. (2007). To dip or no to dip: On the physiology of blood pressure decrease during nocturnal sleep in healthy humans. *Hypertension, 49*, 1070-1076.

Shekelle, R. B., Gale, M., Ostfeld, A. M., & Paul, O. (1983). Hostility, risk of coronary heart disease, and mortality. *Psychosomatic Medicine, 45* (2), 109-114.

Sherwood, A., Steffen, P., Blumenthal, J., Kuhn, C., & Hinderliter, A. (2002). Nighttime blood pressure dipping: the role of the sympathetic nervous system. *American Journal of Hyptertension, 15*, 111-118.

Smith, T. W., & Frohm, K. D. (1985). What's so unhealthy about hostility? Construct validity and psychosocial correlates of the Cook and Medley Ho Scale. *Health Psychology, 4*(6), 503-520.

Stepnowsky, C. J., Nelesen, R. A., DeJardin, D., & Dimsdale, J. E. (2004). Socioeconomic status is associated with nocturnal blood pressure dipping. *Psychosomatic Medicine, 66,* 651-655.

Summers, P., Forehand, R., Armistead, L., & Tannenbaum, L. (1998). Parental divorce during early adolescence in Caucasian families: The role of family process variables in predicting the long-term consequences for early adult psychosocial adjustment. *Journal of Consulting and Clinical Psychology, 66*(2), 327-336.

Tein, J., Sandler, I., Ayers, T., & Wolchik, S. (2006). Mediation of the effects of the Family Bereavement Program on mental health problems of bereaved children and adolescents. *Prevention Science, 7,* 179-195.

Trinder, J. (2007). Cardiac activity and sympathovagal balance during sleep. *Sleep Medicine Clinics, 2*(2), 199-208.

Troxel, W. M., & Matthews, K. A. (2004). What are the costs of marital conflict and dissolution to children's physical health?. *Clinical Child and Family Psychology review, 7* (1), 29-57.

Urbina, E., Alpert, B., Flynn, J., Hayman, L., Harshfield, G. A., Jacobson, M., … Daniels, S. (2008). Ambulatory blood pressure monitoring in children and adolescents: Recommendations for Standard Assessment: A scientific statement from the American Heart Association Atherosclerosis, Hypertension, and Obesity in Youth Committee of the Council on Cardiovascular disease in the Young and the Council for High Blood Pressure Research., *Hypertension,52,* 433-451.

Wainwright, N. W. J., & Surtees, P. G. (2002). Childhood adversity, gender, and depression over the life-course. *Journal of affective disorders, 72*(1), 33-44.

Wilson, D. K., Kliewer, W., Teasley, N., Plybon, L., & Sica, D. (2002). Violence exposure, catecholamine excretion, and blood pressure nondipping status in African American male versus female adolescents. *Psychosomatic medicine, 64,* 906-915.

Wang, X., Poole, J. C., Treiber, F. A., Harshfield, G.A., Hanevold, C. D., & Sneider, H. (2006). Ethnic and gender differences in ambulatory blood pressure trajectories: Results from a 15-year longitudinal study in youth and young adults. *Circulation, 114,* 2780-2787.

Wolchik, S. A., Sandler, I., Millsap, R., Plummer, B., Greene, S., & Anderson, E. (2002). Six-year follow-up of preventive interventions for children of divorce: A randomized control trial. *JAMA*, 288, 1874-1881.

Wolchik, S. A., Wilcox, K. L., Tein, J.-Y., & Sandler, I. N. (2000). Maternal acceptance and consistency of discipline as buffers of divorce stressors on children's psychological adjustment problems. *Journal of Abnormal Child Psychology, 28* (1), 87-102.

Woodall, K. L., & Matthews, K.A. (1993). Changes in and stability of hostile characteristics from a 4-year longitudinal study of children. *Journal of Personality and Social Psychology, 64*, 491-499.

Table 1

Sample Characteristics and Descriptive Statistics of Study Variables

	N (%)	Range Observed	*Mean*	*SD*	Skew	Kurtos.
Male	56 (39.2)					
Female	87 (60.8)					
Age		18-29	19.8	2.16	1.95	4.07
Caucasian	108 (75.5)					
Hispanic	16 (11.2)					
African-American	3 (2.1)					
Other	16 (11.2)					
Income						
Not reported	5 (3.5)					
0-$14,999	3 (2.1)					
$15,000-$29,999	15 (10.5)					
$30,000-$44,999	16 (11.2)					
$45,000-$59,999	17 (11.9)					
$60,000-$79,999	15 (10.5)					
$80,000-$99,999	23 (16.1)					
$100,000+	49 (34.3)					
Marital Status						
Single/Never Marr	133 (99.3)					
Marr/Lives w/Part	8 (6.3)					
Divorce/Separated	1 (.7)					
Body Mass Index		16.6-37.1	23.5	3.69	1.13	1.78
Smoke						
Yes	29 (20.3)					
No	114 (79.7)					
Posture						
Standing		.03-.55	.24	.12	.59	-.47
Sitting		.12-.93	.45	.13	.23	.66
Reclined		.00-.90	.12	.21	3.20	20.1
Family relations		3-26	15.3	5.97	-0.15	-0.96
Depressive sympt.		0-37	9.72	7.96	1.28	1.39
Hostility		3-23	13.1	4.55	-0.01	-0.71
Social Stress		0-11	4.52	2.79	0.72	-0.16
Day Systolic BP	135 (94.4)	96.0-141.6	118.4	9.54	.125	-.166
Day Diastolic BP	135 (94.4)	52.8-83.6	68.6	6.36	.247	-.327
Night Systolic BP	128 (89.5)	80.7-134.3	103.7	9.40	.401	.651
Night Diastolic BP	128 (89.5)	41.4-67.7	54.7	5.68	.205	-.344

Note: Posture=proportion of daytime readings spent in each posture.

Table 2

Sample Characteristics and Descriptive Statistics of Study Variables by Family Group

	Loss (n=45)	Divorce (n=49)	Intact (n=48)
Gender (*N*, %)			
Female	27 (58.7)	29 (59.2)	31 (64.6)
Male	19 (41.3)	20 (40.8)	17 (35.4)
Age (*M, SD*)*[a]	19.2 (1.43)	20.2 (2.41)	20.0 (2.35)
Ethnicity (*N*, %)			
Caucasian	34 (73.9)	38 (77.6)	36 (75.0)
Hispanic	3 (6.5)	5 (10.2)	8 (16.7)
African-American	1 (2.2)	1 (2.0)	1 (2.1)
Other	8 (19.6)	5 (10.2)	3 (6.2)
Family income**[bc] (*N*, %)			
Not reported	2 (4.3)	2 (4.1)	1 (2.1)
0-$14,999	1 (2.2)	2 (4.1)	0 (0.0)
$15,000-$29,999	10 (21.7)	5 (10.2)	0 (0.0)
$30,000-$44,999	6 (13.0)	8 (16.3)	2 (4.2)
$45,000-$59,999	7 (15.2)	6 (12.2)	4 (8.3)
$60,000-$79,999	4 (8.7)	4 (8.2)	7 (14.6)
$80,000-$99,999	7(15.2)	8 (16.3)	8 (16.7)
$100,000+	9 (19.6)	14 (28.6)	26 (54.2)
Marital Status (*N*, %)			
Single/Never Marr.	41 (91.1)	45 (91.8)	47 (97.9)
Marr./Lives w/Part.	4 (8.9)	3 (6.1)	1 (2.1
Divorced/Separated	0 (0)	1 (2.0)	0 (0)
Body Mass Index (*M, SD*)	23.3 (3.11)	23.8 (4.15)	23.5 (3.77)
Posture (*M, SD*)			
Standing	.25 (.10)	.23 (.13)	.25 (.11)
Sitting	.47 (.13)	.43 (.12)	.44 (.14)
Reclined	.10 (.06)	.13 (.09)	.13 (.14)
Smoke (*N*, %)			
Yes	11 (23.9)	9 (18.4)	9 (18.8)
No	35 (76.1)	40 (81.6)	39 (81.3)

[a] Loss v. Divorce, [b] Intact v. Divorce, [c] Intact v. Loss, *$p<0.05$, **$p<0.01$.,
Note: Posture=proportion of daytime readings spent in each posture.

Table 2 (cont'd)

Sample Characteristics and Descriptive Statistics of Study Variables by Family Group

	Loss (n=45)	Divorce (n=49)	Intact (n=48)
Family relations (*M, SD*)**[b]	15.0 (6.14)	13.1 (5.95)	17.8 (4.93)
Depressive symptom (*M, SD*)	10.2 (8.43)	9.87 (8.27)	9.17 (7.31)
Hostility (*M, SD*)	13.9 (4.42)	11.9 (4.49)	13.4 (4.59)
Social Stress (*M, SD*)*[c]	3.83 (2.74)	4.41 (2.64)	5.29 (2.85)
Day Sys. BP (*M, SD*)* [c]	115.5 (8.71)	119.0 (8.92)	120.4 (10.4)
Day Dia. BP (*M, SD*)* [a]	66.4 (5.26)	69.6 (6.64)	69.5 (6.63)
Night Sys. BP(*M, SD*)* [c]	100.9 (8.87)	104.0 (9.38)	105.9 (9.42)
Night Dia. BP (*M, SD*)** [ac]	52.3 (4.91)	55.6 (5.45)	55.9 (5.68)

[a] Loss v. Divorce, [b] Intact v. Divorce, [c] Intact v. Loss, *p<0.05, **p<0.01.,
Note: Posture=proportion of readings spent in each posture.

Table 3

Correlations between Study Variables

	1	2	3	4	5	6	7	8	9	10	11
1. Age	1										
2. Gender[a]	-0.09	1									
3. Family Income	0.03	-0.06	1								
4. Family Relations	-0.05	-0.04	.21*	1							
5. Depressive symptoms	-0.11	0.17	-0.03	-.41**	1						
6. Hostility	-0.13	-0.09	-0.01	-.27**	.37**	1					
7. Social stress	-0.17	0.01	0.17	-.19*	.43**	.45**	1				
8. Day Systolic BP	-0.09	-.22*	.22*	0.04	-0.1	-0.02	0.05	1			
9. Day Diastolic BP	0.03	0.08	.23*	-0.02	0.001	-.21*	0	.74**	1		
10. Night Systolic BP	-0.05	-0.07	.22*	0.11	0.16	0.08	0.06	.71**	.42**	1	
11. Night Diastolic BP	0.14	.21*	.24*	0.04	-0.07	-0.1	0.05	.40**	.55**	.67**	1

[a]0 = Male, 1 = Female. *p < .05, **p < .01.

Table 4

Regression Analyses: Predicting Nighttime Systolic BP from Quality of Family Relationships by Family Group Interactions

	B	*SE B*	*β*	*t-value*	*p-value*	Model R^2
Dependent variable: Nighttime Systolic BP						
(Constant)	101.2	2.14		47.2	<.01	.52**
Age	.15	.30	.03	.51	.61	
Gender[a]	1.79	1.27	.09	1.40	.16	
Family Income	.32	.36	.06	.87	.39	
Daytime Systolic BP	.69	.07	.70	9.9	<.01	
Contrast 1[b]	.36	1.48	.02	.24	.81	
Contrast 2[c]	-.41	1.61	-.02	-.26	.80	
Family Relationships	.12	.11	.07	1.01	.32	
Contrast 1 X Family Relationships	-.28	.25	-.08	-1.13	.26	
Contrast 2 X Family Relationships	-.07	.28	-.02	-.26	.80	
Dependent variable: Nighttime Diastolic BP						
(Constant)	51.7	1.53		33.82	<.01	.37**
Age	.31	.20	.12	1.54	.13	
Gender[a]	2.05	.87	.18	2.34	.02	
Family Income	.34	.26	.11	1.32	.20	
Daytime Diastolic BP	.42	.07	.48	6.08	<.01	
Contrast 1[b]	.24	1.03	.02	.23	.82	
Contrast 2[c]	-1.12	1.13	-.08	-1.0	.33	
Family Relationships	.04	.08	.04	-.53	.60	
Contrast 1 X Family Relationships	.003	.17	.001	.02	1.0	
Contrast 2 X Family Relationships	.08	.19	.03	.40	.69	

Note. All continuous variables centered prior to analysis. *B* = Unstandardized regression coefficient; β = Standardized regression coefficient. [b]Contrast 1=adversity vs. intact. [c]Contrast 2= Divorced vs. Loss. [a]0 = Male, 1 = Female. **p<0.01.

Table 5

Regression Analyses: Predicting Psychosocial Factors from Quality of Family Relationship by Family Group Interactions

Dependent variable: Depressive symptoms

	B	*SE B*	*β*	*t-value*	*p-value*	Model R^2
(Constant)	6.85	2.22		3.08	.003	.21**
Age	-.50	.30	-.14	-1.68	.10	
Gender[a]	2.19	1.31	.13	1.67	.10	
Family Income	.29	.37	.07	.77	.44	
Contrast 1[b]	1.17	1.54	.07	.76	.45	
Contrast 2[c]	.78	1.65	.04	.47	.64	
Family Relationships	-.59	.11	-.44	-5.15	<.001	
Contrast 1 X Fam. Rel.	-.09	.26	-.03	-.36	.72	
Contrast 2 X Fam. Rel.	.07	.26	.02	.26	.79	
Dependent variable: Hostility						
(Constant)	14.55	1.27		11.42	<.01	.17**
Age	-.32	.18	-.15	-1.82	.07	
Gender[a]	-1.07	.76	-.12	-1.41	.16	
Family Income	-.13	.22	-.05	-.61	.54	
Contrast 1[b]	1.81	.90	.19	2.01	.05	
Contrast 2[c]	1.69	.96	.15	1.76	.08	
Family Relationships	-.27	.07	-.35	-4.08	<.001	
Contrast 1 X Fam. Rel.	-.14	.15	-.08	-.93	.35	
Contrast 2 X Fam. Rel.	-.10	.15	-.06	-.68	.50	
Dependent variable: Social stress						
	B	*SE B*	*β*	*t-value*	*p-value*	Model R^2
(Constant)	3.56	.78		4.58	<.01	.04**
Age	-.33	.11	-.25	-3.05	.003	
Gender[a]	.05	.46	.01	.10	.92	
Family Income	.19	.13	.13	1.47	.14	
Contrast 1[b]	1.57	.55	.27	2.87	.005	
Contrast 2[c]	-.72	.58	-.10	-1.24	.22	
Family Relationships	-.14	.04	-.28	-3.33	.001	
Contrast 1 X Fam. Rel.	-.05	.09	-.04	-.53	.60	
Contrast 2 X Fam. Rel.	-.01	.09	-.01	-.06	.96	

Note. All continuous variables centered prior to analysis. *B* = Unstandardized regression coefficient; β = Standardized regression coefficient. [a] 0=Male, 1=Female. [b] Contrast 1=adversity vs. intact. [c]Contrast 2= Divorced vs. Bereaved. **p<0.01.

Table 6

Mediation Analyses: Psychosocial factors as Mediators of the Relation Between Quality of family relationships and Nighttime Systolic BP

Proposed mediator: Depressive symptoms (*N*=126)								
Path	DV	IV	*B*	*SE B*	*β*	*t*	*p*	R^2
c	Nighttime systolic BP	(Constant)	102.5	.94		108.9	<.01	.52**
		Age	.20	.28	.05	.72	.47	
		Gender[a]	1.81	1.23	.10	1.47	.14	
		Day sys BP	.72	.06	.73	11.32	<.01	
		Family relations	.13	.10	.08	1.32	.19	
a	Depressive symptoms	(Constant)	8.31	.99		8.38	<.01	.19**
		Age	-.56	.29	-.15	-1.94	.05	
		Gender[a]	2.29	1.27	.14	1.81	.07	
		Family relations	-.51	.10	-.39	-5.00	<.001	
b	Nighttime systolic BP	(Constant)	102.4	.97		105.4	<.01	.53**
		Age	.14	.29	.03	.50	.62	
		Gender[a]	2.03	1.27	.11	1.60	.11	
		Daytime sys BP	.71	.06	.72	11.09	<.01	
		Family relations	.08	.11	.05	.68	.50	
		Depressive sym	-.10	.08	-.09	-1.24	.22	
No further analyses were conducted because the *b* path was no statistically significant.								
Proposed mediator: Hostility (*N* = 128)								
c	Nighttime systolic BP	(Constant)	102.4	1.01		101.0	<.01	.52**
		Age	.19	.28	.04	.67	.51	
		Gender[a]	1.76	1.25	.09	1.41	.16	
		Day sys BP	.72	.07	.73	11.0	<.01	
		Contrast [b]	.44	1.36	-.02	.32	.75	
		Family relations	.12	.11	.08	1.11	.27	
a	Hostility	(Constant)	13.21	.63		23.00	<.01	.12**
		Age	-.39	.17	-.19	-2.27	.03	
		Gender[a]	-1.14	.75	-.12	-1.51	.13	
		Contrast [b]	1.56	.81	.16	1.92	.06	
		Family relations	-.23	.07	-.31	-3.62	<.01	
b	Nighttime systolic BP	(Constant)	102.3	1.00		102.7	<.01	.54**
		Age	.32	.29	.07	1.11	.27	
		Gender[a]	2.28	1.25	.12	1.83	.07	
		Daytime sys BP	.73	.06	.74	11.37	<.01	
		Contrast 1[b]	.28	1.37	.01	.20	.84	
		Family relations	.21	.11	.13	1.81	.07	
		Hostility	.31	.14	.15	2.30	.02	
Mediated effect (*ab*) = -.07, 95% CI=[-0.16, -0.006]								

Note. All continuous variables centered prior to analysis. *B* = Unstandardized regression coefficient; β = Standardized regression coefficient. [a]0=Male, 1=Female. [b] Contrast 1=adversity vs. intact. **p<0.01.

Table 6 (cont'd)

Mediation Analyses: Psychosocial factors as Mediators of the Relation Between Quality of family relationships and Nighttime Systolic BP

Proposed mediator: Social Stress (*N* = 128)								
Path	DV	IV	*B*	*SE B*	*β*	*t*	*p*	R^2
c	Nighttime systolic BP	(Constant)	102.4	1.01		101.0	<.01	.52**
		Age	.19	.28	.04	.67	.51	
		Gender[a]	1.76	1.25	.09	1.41	.16	
		Day sys BP	.72	.07	.73	11.0	<.01	
		Contrast [b]	.44	1.36	-.02	.32	.75	
		Family relations	.12	.11	.08	1.11	.27	
a	Social stress	(Constant)	3.95	.38		10.47	<.01	.15**
		Age	-.31	.10	-.24	-3.03	.003	
		Gender[a]	-.02	.45	.00	-.05	.96	
		Contrast 1[b]	1.73	.49	.29	3.55	.001	
		Family relations	-.13	.04	-.28	-3.34	.001	
b	Nighttime systolic BP	(Constant)	102.4	1.03		99.8	<.01	.52**
		Age	.22	.29	.05	.76	.45	
		Gender[a]	1.79	1.25	.09	1.43	.16	
		Day sys BP	.72	.07	.73	10.98	<.01	
		Contrast 1[b]	.20	1.44	.01	.14	.89	
		Family relations	.14	.11	.09	1.21	.23	
		Social stress	.12	.24	.04	.51	.62	
No further analyses were conducted because the *b* path was no statistically significant.								

Note. All continuous variables centered prior to analysis. *B* = Unstandardized regression coefficient; β = Standardized regression coefficient. [a]0=Male, 1=Female. [b] Contrast 1=adversity vs. intact. **p<0.01.

Table 7

Mediation Analyses: Psychosocial factors as Mediators of the Relation Between Quality of family relationships and Nighttime Diastolic BP

Path	DV	IV	*B*	*SE B*	*β*	*t*	*p*	R^2
Proposed mediator: Depressive symptoms (*N*=126)								
c	Nighttime diastolic BP	(Constant)	53.6	.65		82.3	<.01	.35**
		Age	.39	.20	.15	1.99	.05	
		Gender[a]	1.93	.85	.17	2.27	.03	
		Day dia BP	.47	.07	.53	7.23	<.01	
		Family relation	.03	.07	.06	.79	.43	
a	Depressive Symptoms	(Constant)	-1.41	.99		-1.42	.16	.19**
		Age	-.56	.29	-.15	-1.94	.05	
		Gender	2.29	1.27	.14	1.81	.07	
		Family relation	-.51	.10	-.39	-5.00	<.001	
b	Nighttime diastolic BP	(Constant)	53.34	.67		79.35	<.01	.37**
		Age	.37	.20	.14	1.85	.07	
		Gender[a]	2.19	.87	.19	2.51	.01	
		Day dia BP	.47	.07	.53	7.19	<.01	
		Family relation	.02	.08	.02	.28	.78	
		Depressive sym	-.06	.06	-.09	-1.09	.28	
No further analyses were conducted because the *b* path was no statistically significant.								
Proposed mediator: Hostility (*N* = 128)								
c	Nighttime diastolic BP	(Constant)	53.36	.71		74.91	<.01	.35**
		Age	.38	.20	.14	1.90	.06	
		Gender[a]	1.88	.85	.16	2.20	.03	
		Day dia BP	.46	.07	.52	7.06	<.01	
		Contrast 1[b]	.65	.94	.05	.69	.49	
		Family relation	.04	.08	.04	.49	.62	
a	Hostility	(Constant)	13.21	.63		23.00	<.01	.12**
		Age	-.39	.17	-.19	-2.27	.03	
		Gender[a]	-1.14	.75	-.12	-1.51	.13	
		Contrast 1[b]	1.56	.81	.16	1.92	.06	
		Family relation	-.23	.07	-.31	-3.62	<.01	
b	Nighttime diastolic BP	(Constant)	53.37	.71		74.89	<.01	.36**
		Age	.41	.20	.15	2.03	.04	
		Gender[a]	2.0	.86	.17	2.31	.02	
		Daytime dia. BP	.48	.07	.54	7.06	<.01	
		Contrast 1[b]	.42	.97	.04	.43	.67	
		Family relation	.06	.08	.07	.79	.43	
		Hostility	.10	.10	.08	.96	.34	
No further analyses were conducted because the *b* path was no statistically significant.								

Note. All continuous variables centered prior to analysis. *B* = Unstandardized regression coefficient; β = Standardized regression coefficient. [a]0=Male, 1=Female. [b] Contrast 1=adversity vs. intact. **p<0.01.

Table 7 (cont'd)

Mediation Analyses: Psychosocial factors as Mediators of the Relation Between Quality of family relationships and Nighttime Diastolic BP

Proposed mediator: Social stress (*N* = 128)								
Path	DV	IV	*B*	*SE B*	*β*	*t*	*p*	R^2
c	Nighttime diastolic BP	(Constant)	53.36	.71		74.91	<.01	.35**
		Age	.38	.20	.14	1.90	.06	
		Gender[a]	1.88	.85	.16	2.20	.03	
		Day dia BP	.46	.07	.52	7.06	<.01	
		Contrast 1[b]	.65	.94	.05	.69	.49	
		Family relation	.04	.08	.04	.49	.62	
a	Social stress	(Constant)	3.95	.38		10.47	<.01	.15**
		Age	-.31	.10	-.24	-3.03	.003	
		Gender[a]	-.02	.45	-.004	-.05	.96	
		Contrast [b]	1.73	.49	.29	3.55	.001	
		Family relation	-.13	.04	-.28	-3.34	.001	
b	Nighttime diastolic BP	(Constant)	53.4	.72		74.17	<.01	.35**
		Age	.42	.20	.16	2.04	.04	
		Gender[a]	1.91	.86	.17	2.24	.03	
		Day dia BP	.47	.07	.53	7.08	<.01	
		Contrast 1[b]	-37	1.0	.03	.37	.71	
		Family relation	.06	.08	.06	.72	.47	
		Social stress	.14	.17	.07	.84	.40	
No further analyses were conducted because the *b* path was not statistically significant.								

Note. All continuous variables centered prior to analysis. *B* = Unstandardized regression coefficient; β = Standardized regression coefficient. [a]0=Male, 1=Female. [b] Contrast 1=adversity vs. intact. **p<0.01.

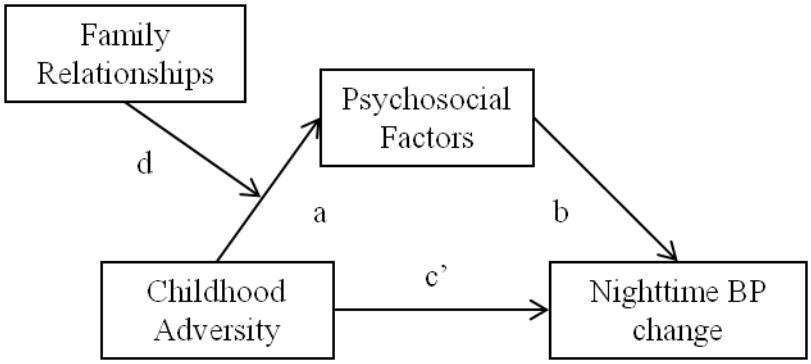

Figure 1. Originally hypothesized moderated mediational model: Effect of childhood adversity by quality of family relationships interaction on nighttime change in BP mediated by psychosocial outcomes.

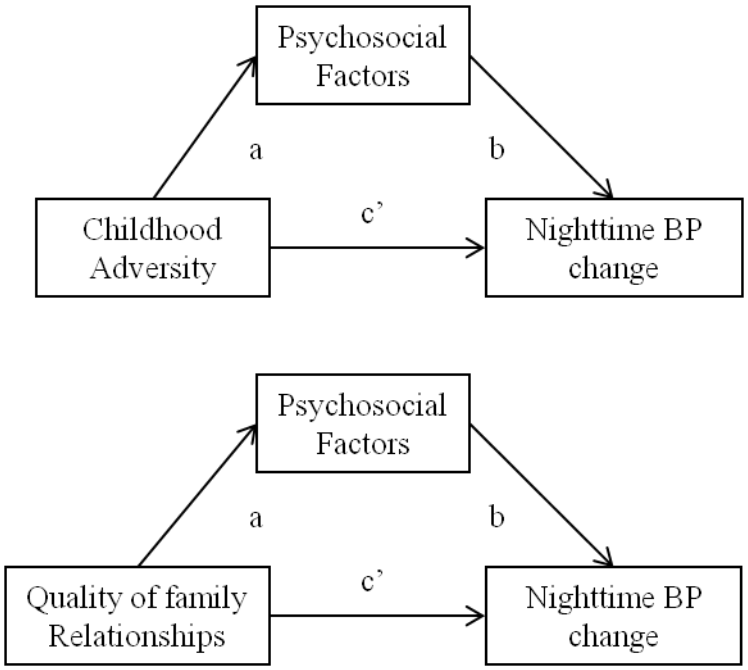

Figure 2. Revised mediational models: Effects of childhood adversity and quality of family relationships on nighttime change in BP mediated by psychosocial outcomes.

APPENDIX A

INSTITUATIONAL REVIEW BOARD APPROVAL LETTER

ASU ARIZONA STATE UNIVERSITY
Knowledge Enterprise Development

Office of Research Integrity and Assurance

To: Linda Luecken PSY

From: Mark Roosa, Chair Soc Beh IRB

Date: 12/01/2011

Committee Action: Renewal

Renewal Date: 12/01/2011

Review Type: Expedited F7

IRB Protocol #: 0005001031

Study Title: FAMILY LIFE STUDY: DEVELOPMENTAL EXPERIENCES AND ADULT RESPONSES TO CHALLENGE

Expiration Date: 01/13/2013

The above-referenced protocol was given renewed approval following Expedited Review by the Institutional Review Board.

It is the Principal Investigator's responsibility to obtain review and continued approval of ongoing research before the expiration noted above. Please allow sufficient time for reapproval. Research activity of any sort may not continue beyond the expiration date without committee approval. Failure to receive approval for continuation before the expiration date will result in the automatic suspension of the approval of this protocol on the expiration date. Information collected following suspension is unapproved research and cannot be reported or published as research data. If you do not wish continued approval, please notify the Committee of the study termination.

This approval by the Soc Beh IRB does not replace or supersede any departmental or oversight committee review that may be required by institutional policy.

Adverse Reactions: If any untoward incidents or severe reactions should develop as a result of this study, you are required to notify the Soc Beh IRB immediately. If necessary a member of the IRB will be assigned to look into the matter. If the problem is serious, approval may be withdrawn pending IRB review.

Amendments: If you wish to change any aspect of this study, such as the procedures, the consent forms, or the investigators, please communicate your requested changes to the Soc Beh IRB. The new procedure is not to be initiated until the IRB approval has been given.

Please retain a copy of this letter with your approved protocol.

PO Box 876111 Tempe, AZ 85287-6111 ♠ 660 S. Mill Avenue, Suite 315♠ P 480 965 6788 ♠ F 480 965 7772
http://researchintegrity.asu.edu