

Longitudinal Associations of Childhood Parenting and Adolescent Health: The Mediating Influence of Social Competence

Brittany P. Boyer and Jackie A. Nelson
The University of Texas at Dallas

The current study examined a process through which parenting during the primary school transition contributes to cardiovascular health in adolescence, a foundational period for adult health trajectories. Using path analyses, social competence was tested as a mediator between parental sensitivity and adolescent health among 884 families. Results indicated that mothers' and fathers' sensitivity was associated with increasing social competence from first grade (age 7) to sixth grade (age 12), which was associated with higher awakening cortisol in ninth grade (age 15) and decreasing blood pressure from sixth to ninth grade. Results suggest that social competence mediates associations between childhood parenting and adolescent cardiovascular risk, and may be protective to children's health over time.

During adolescence, individuals physically mature, take increasing responsibility for managing their own health, and begin to develop behavioral health habits (Mulye et al., 2009). Thus, adolescence represents a developmental transition during which adult health tendencies and trajectories are beginning to be established, making it an important focal point for examining risk factors that lay the foundation for chronic illness in adulthood (Mulye et al., 2009). Due to the prevalence and cost to society associated with cardiovascular disease in particular, understanding developmental antecedents to cardiovascular risk factors in adolescence is of particular interest in focusing preventive efforts.

The family context forms an important proximal environment for children's physiological and psychological development, and parent-child relationships have been linked to long-term health in a number of studies (e.g., Brody et al., 2014; Tarullo & Gunnar, 2006). Specifically, deficits in parent-child relationships have been associated with obesity (Fuemmeler et al., 2012), higher resting blood pressure (Luecken, 1998), and maladaptive biological responses to stressful situations (Gunnar & Vaz-

quez, 2001) in adulthood. Repetti, Taylor, and Seeman (2002) posit that parental involvement in children's social development is an important contributor to these associations. Sensitive parenting, the extent to which parents are warm, involved, and responsive to children's needs, is associated with the development of social competence, the set of skills and knowledge needed to engage in appropriate and effective interactions with others (National Institute of Child Health and Human Development Early Child Care Research Network [NICHD ECCRN], 1999). Thus, the early family context may impact the degree to which children experience social stress, rejection, and social failures that maintain self-perceptions of social inadequacy (Dodge & Price, 1994; Luecken, Roubinov, & Tanaka, 2013). These social self-perceptions are especially important during preadolescence (McDougall & Hymel, 1998), when encountering daily social stressors is more likely to result in chronic activation of physiological stress response systems (Gunnar, Wewerka, Frenn, Long, & Griggs, 2009), particularly in children low in social competence (Schmidt et al., 1999). Because chronic stress is associated with damage to biological regulatory systems responsible for maintaining health (McEwen & Stellar, 1993), social competence represents a pathway through which parenting exerts its influence on children's physical health (Luecken et al., 2013; Repetti et al., 2002).

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Correspondence concerning this article should be addressed to Brittany P. Boyer, School of Behavioral and Brain Sciences, The University of Texas at Dallas, 800 W. Campbell Road GR41, Richardson, TX 75080. Electronic mail may be sent to brittany.boyer@utdallas.edu.

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The present study responds to a call for research investigating social mechanisms to explain associations between parenting and adolescent health (Hostinar & Gunnar, 2013). Specifically, the present investigation evaluates social competence in middle childhood as a mediator between sensitive parenting during children's transition to primary school and cardiovascular health indicators in early adolescence. Longitudinal examination of these relations is an important contribution to literature that has yet to identify mediators of these associations in the same children over time.

Parenting and Physical Health

The risky families paradigm posits that childhood parenting is the foundation for children's developmental trajectories across the life course (Repetti et al., 2002). The extent to which children experience parenting that instills feelings of safety and security can limit or attenuate children's subjective experience of stress. If parents are generally cold and unresponsive to children's needs, children are more likely to remain emotionally and physiologically aroused for longer periods of time and are less likely to develop the capacity to regulate emotional reactions than children whose parents provide relief from these unpleasant states (Gunnar, Tout, de Haan, Pierce, & Stansbury, 1997; Tarullo & Gunnar, 2006). Insensitive parenting is proposed to catalyze a "cascade of risk" that can result in suboptimal development of children's biological stress systems and undermine the social and emotional skills necessary to effectively manage stress (Repetti et al., 2002).

Sensitive and supportive parents who provide a warm interpersonal context and consistently respond to their children's needs, on the other hand, promote the integrity of children's developing physiological systems responsible for building immunity, maintaining health, and adaptively responding to stressors (Repetti et al., 2002). Suboptimal development of these systems is related to dysregulations in biological stress responses and compromised ability to fight disease, risks that can accumulate over time and lead to chronic illness (McEwen & Stellar, 1993). Cross-sectional studies have demonstrated links from insensitive parenting to higher rates of child illness (Gottman, Katz, & Hooven, 1996), poorer metabolic control of diabetes (Martin, Miller-Johnson, Kitzmann, & Emery, 1998), and internalizing problems (Chorpita & Barlow, 1998). These short-term risks have the potential to develop into more serious health problems. In ado-

lescence, individuals who have experienced insensitive parenting are more likely to display disrupted diurnal cortisol patterns (Roisman et al., 2009), have more physical health complaints (Wickrama, Lorenz, & Conger, 1997), and use drugs, alcohol, or promiscuous sexual behaviors as coping mechanisms (Miles et al., 2001).

Due to the cumulative nature of these risk factors, research focused on identifying factors in childhood related to later health consequences is warranted. Because adolescent health risk factors tend to track into adulthood, examining adolescent health can give researchers insight into how childhood experiences shape lifelong health (Mulye et al., 2009). For example, high blood pressure and obesity are indicators of cardiovascular health problems that are likely to persist from adolescence to adulthood (Gustafsson, Janlert, Theorell, Westerlund, & Hammarström, 2012; Schmidt et al., 2009). Additionally, because lower awakening cortisol response during adolescence is indicative of damage to the biological systems responsible for adaptively responding to stress, adolescents with dampened stress responses enter adulthood with more cumulative wear and tear that is likely to become accelerated with increasing damage over time (McEwen & Stellar, 1993; Saxbe, 2008).

Parenting and Social Competence

Parental sensitivity during early childhood facilitates children's ability to effectively manage social challenges and cultivate meaningful relationships, critical precursors for the coping skills children will use across the life span to manage stress (Repetti et al., 2002). These competencies are first put into practice as children enter primary school, an important transition that requires children to apply social skills learned in the home to the more rigid and peer-oriented academic setting (Berndt, 2004). Although later school transitions are also stressful for children, and are impacted by social support (McDougall & Hymel, 1998), the primary school transition represents a period during which children are first learning to navigate relationships with nonparental adults, the institution of formal school, and larger peer networks, which has implications for trajectories of school engagement and social involvement (Huffman, Mehlinger, & Kerivan, 2000). Thus, examining the influence of parenting during the transition to primary school is particularly relevant to children's ongoing social development as parent-child relationships lay the

foundation for long-term social success (NICHD ECCRN, 2004).

Sensitive parenting is an important predictor of children's developing social and emotional skills, including emotional regulation (Cabrera, Shannon, & Tamis-LeMonda, 2007) and social competence (Martin, Ryan, & Brooks-Gunn, 2010; NICHD ECCRN, 2004). Much of the parenting literature focuses on mother-child relationships, but increasing rates of father involvement and responsibility in two-parent families have led to more emphasis on exploring how fathers influence their children (Cabrera, Tamis-LeMonda, Bradley, Hofferth, & Lamb, 2000). Sensitive fathering has been shown to predict children's social competence and emotional well-being beyond the influence of mothers (Cabrera et al., 2007; Stolz, Barber, & Olsen, 2005), and these associations are long lasting (Grossman et al., 2002). Thus, early experiences with fathers affect children's ability to form high-quality social relationships throughout middle childhood and adolescence. Despite our knowledge that fathers exert a long-term influence on child outcomes, few studies include both mothers and fathers in longitudinal investigations examining the impact of childhood parenting on children's developmental trajectories. Understanding contributions of both parents is vital; although the number of children raised by single parents is climbing, the majority of children are still reared in two-parent households (Federal Interagency Forum on Child and Family Statistics, 2013). Thus, the current study aims to address common, yet understudied, family processes.

Social Competence and Health

Developing the ability to effectively navigate social situations and build a supportive social network are skills that individuals will use throughout life to manage stress. Children's social competence is associated with the degree to which children experience physiological and psychological stress responses in everyday social situations (Schmidt et al., 1999). According to Lazarus and Folkman (1984), three factors are associated with the expression of a stress response in humans: (a) the perception of a situation as threatening, (b) the importance of the outcome to the individual, and (c) the degree to which the individual believes he or she has the resources necessary to cope with the situation. Children who are low in social competence are likely to have deficits in social information processing, making them more susceptible to inac-

curate perception of peers' intentions and attribution of hostile motives (Dodge & Price, 1994).

As children progress from early to middle childhood, social interactions become increasingly important to them as they transition from parent to peer socialization. During this time, children are particularly sensitive to peer acceptance and rejection (McDougall & Hymel, 1998), and experience greater stress system activation in response to social stressors (Gunnar et al., 2009; Stroud et al., 2009). Children who are less socially skilled are less likely to be confident in their abilities to successfully handle these stressful social situations. Due to the daily social demands children must meet in the school environment, perceiving social situations as threatening, assigning high importance to the outcomes of these situations, and having low self-efficacy in managing social stress coalesce in children with low social competence to contribute to a stress response that is stronger and more frequently activated than that of their more competent peers (Gunnar et al., 1997; Schmidt et al., 1999). Subsequent social experiences likely reinforce these beliefs for these children; physiological arousal accompanied by frequent social failures, embarrassment, and avoidance are mechanisms that may maintain or strengthen stress responses in social situations (Dodge & Price, 1994; Gunnar et al., 1997).

The cumulative effects of deficiencies in social competence also contribute to a diminished ability to attract and maintain social support (Repetti et al., 2002). Socially competent children are more well liked and popular and tend to have more high-quality, intimate friendships than children who have difficulty navigating social situations and controlling negative emotions (Buhrmester, 1990; Denham, Mitchell-Copeland, Strandberg, Auerbach, & Blair, 1997; Kerns, Klepac, & Cole, 1996). Social relationships represent a powerful health-promoting resource that is associated with lower stress, improved immune functioning, and lower all-cause mortality across the life span (Taylor, 2007). In sum, lower social competence contributes to a lower likelihood of developing social and emotional coping mechanisms and meaningful, stress-relieving friendships, making children more likely to experience frequent social stress and less likely to successfully manage these situations in the future. In turn, experiencing more unmanageable social situations makes it more difficult for them to practice social-emotional skills, contributing to a cycle of social and emotional distress that is both difficult to overcome and additive across the life span (Repetti et al., 2002).

The Current Study

Because chronic stress has deleterious health effects that are cumulative across the life span, social competence represents an important mechanism that may explain well-established associations between the childhood parenting environment and adolescent health. Although there is strong evidence supporting each link in the proposed model, longitudinal investigations examining these mechanisms in the same children over time that include contributions by both mothers and fathers are needed. We hypothesized that higher levels of maternal and paternal sensitivity at the transition to school would independently predict increases in children's social competence from first to sixth grade. Higher social competence at sixth grade would, in turn, be related to better health in ninth grade, specifically higher awakening cortisol levels, lower systolic blood pressure, and lower body mass index (BMI) percentile. Because cortisol is regulated by its own feedback mechanism, when it is detected in the bloodstream, the hypothalamic-pituitary-adrenal (HPA) axis halts processes that are the precursors to further cortisol production. Thus, over time, cortisol release as a result of repeated stressors may blunt normative diurnal rhythms, the adaptive pattern of cortisol release consisting of peak concentrations 30 min after awakening followed by gradual declines throughout the day. Cortisol awakening response is an indicator of the extent to which these normative rhythms are adaptively regulated; low morning cortisol is an indicator of dysregulation associated with stressors that are chronic, unmanageable, and associated with shame or embarrassment (Miller, Chen, & Zhou, 2007). For children low in social competence, social stress is likely to embody these features (Dodge & Price, 1994; Gunnar et al., 1997; McDougall & Hymel, 1998; Schmidt et al., 1999). Lower systolic blood pressure and BMI percentile are indicators of more favorable cardiovascular health (Lobelo, Pate, Dowda, Liese, & Daniels, 2010). We expected direct relations between each parent's sensitivity during the school transition and adolescent health, such that more sensitive parenting would also be related to higher awakening cortisol, lower blood pressure, and lower BMI percentile.

Method

Participants

Participants were enrolled in the NICHD Study of Early Child Care and Youth Development (SECCYD), a prospective longitudinal study conducted

at 10 research sites across the United States starting in 1991. During selected 24-hr intervals, all women giving birth were screened for eligibility and willingness to be contacted. Families were excluded if the mother was younger than 18 years of age, the family planned to move, there was a multiple birth, the infant had a known disability or remained in the hospital more than 7 days, or the mother acknowledged substance abuse, did not speak English, or lived more than an hour from the laboratory site. A conditionally random sample of 3,015 was then selected (56%) for a 2-week phone call. The conditioning assured adequate representation ($\geq 10\%$) of single mothers, mothers without a high school degree, and ethnic minority mothers (not mutually exclusive). A total of 1,525 families were selected for the call as eligible and agreed to an interview. From that group, 1,364 families became study participants upon completing a home interview when their infants were 1 month old. The recruited sample consisted of 52% boys, 24% children of color, 45% first-born children, 11% mothers not completing high school, and 14% single-parent families. Additional details about recruitment and selection procedures are available from the study website (<https://www.nichd.nih.gov/research/supported/Pages/seccyd.aspx>).

The current study utilized data from the 54-month (hereafter referred to as preschool), first grade, sixth grade, and age 15 (hereafter referred to as ninth grade) waves of the SECCYD. Only families in which mothers' partners lived in the home and mothers or partners were observed interacting with the child at the preschool or first grade assessments were included in the current study sample. There was no requirement that mothers and partners were married or that the partner was biologically related to the child. These selection criteria resulted in a subsample of 884 families, evenly split by child gender (50.5% female). Eighty-five percent of the children were Caucasian, 5.2% were Hispanic, and 6.3% were African American. Based upon preschool demographic information, the majority of fathers were biological (80.5%) and most of the parents were married and living together (92.2%). Mothers were 29.25 years old on average ($SD = 5.29$) and had a mean education of 14.70 years ($SD = 2.41$), and partners had a mean education of 14.86 years ($SD = 2.67$). The sample was economically diverse; 18.4% were low-income families (income-to-needs ratios < 2 ; $n = 163$), 55.6% were middle income (income-to-needs ratios 2–5; $n = 491$), and 26% were high income (income-to-needs ratios > 5 ; $n = 230$).

Compared to families who participated in some part of the preschool assessment, but did not participate in the preschool parent-child interaction, families in the current subsample had higher incomes, $t(506.73) = 12.37$, $p < .01$. Mothers tended to be older, $t(289.13) = 9.12$, $p < .01$, and have more years of education, $t(1,083) = 8.52$, $p < .01$. Partners also had more years of education, $t(220.40) = 6.96$, $p < .01$, and children in the current sample were more likely to be Caucasian and less likely to be African American, $\chi^2(5) = 131.24$, $p < .01$.

Procedure

Participating families reported demographic information during a home visit when the child was approximately 1 month old. At preschool ($M_{\text{age}} = 4.82$, $SD = 0.18$) and first grade ($M_{\text{age}} = 6.84$, $SD = 0.32$), parents were observed in interaction with the study child. At first grade, parents provided updated demographic information and teachers rated children's social competence in the classroom during the spring semester. At sixth grade ($M_{\text{age}} = 11.90$, $SD = 0.58$), children's height and weight were measured in the laboratory, and they completed a health and physical development assessment (HPDA) with a physician or nurse practitioner where blood pressure measurements were taken. During the spring of sixth grade, teachers also filled out measures of children's social competence. During ninth grade, adolescents ($M_{\text{age}} = 15.07$, $SD = 0.15$) completed another laboratory visit and HPDA with the same health measurements taken at sixth grade. Adolescents were also asked to collect saliva samples for 3 consecutive days upon awakening to be analyzed for cortisol concentration and were observed interacting with both parents. See Table 1 for a summary of measures collected at each wave of data, children's grade level at each wave, and reliability information, if applicable.

Measures

Parental Sensitivity

The Mother-Child and Father-Child Interaction Tasks took place when the children were in preschool and at first grade, and involved observations of the mother and child interacting in the laboratory setting and the father and child interacting in the home setting for approximately 15 min. The semistructured teaching and play tasks included drawing a sailboat on an Etch-a-Sketch, building

colored cubes based on instructional task cards, and a card game with the potential to be exciting and frustrating to the child. These tasks were designed to be entertaining but challenging, requiring the adult and child to collaborate and form plans, demonstrate adequate teaching and learning abilities, and display appropriate affect and emotional regulation (NICHD ECCRN, 2004, 2008). Sessions were videotaped and later coded based on scales modified from Egeland and Heister (1993); parental behavior was rated from 1 (*very low*) to 7 (*very high*) on six scales: supportive presence, respect for autonomy, hostility, cognitive stimulation, quality of assistance, and confidence. Two trained raters coded tapes independently on these six scales. Parental sensitivity was defined as the average of each parent's score on the supportive presence, respect for autonomy, and hostility (reverse-coded) scales. The sensitivity composite, created by the principal investigators of the SEC-CYD, is reliable at preschool and first grade for mothers, $\alpha_s = .84$, $.82$, and fathers $\alpha_s = .75$, $.79$. It is a widely used and well-validated measure of the degree to which parents provide an emotionally supportive environment for their children (see NICHD ECCRN, 2008). Interrater reliability was assessed from approximately 28% ($n = 242$) of mother-child interaction tapes and 21% ($n = 156$) of father-child interaction tapes at preschool that were coded by both raters. Pearson correlations indicate that interrater reliability was high for mother sensitivity, $r = .78$, $p < .01$, as well as father sensitivity, $r = .77$, $p < .01$. To capture parental sensitivity during children's transition to primary school, sensitivity scores from preschool and first grade were averaged for each parent when data were available at both time points (68.7% of the cases). When data from only one time point were available, sensitivity scores from the available wave were used. Sensitivity scores were moderately stable across the two time points for both mothers, $r = .47$, $p < .01$, and fathers, $r = .44$, $p < .01$.

The Mother-Adolescent and Father-Adolescent Interaction Tasks took place during a home visit when adolescents were in ninth grade and were designed to assess parent and adolescent behavior qualities during an 8-min discussion of at least one topic of disagreement (e.g., homework, chores) chosen by the adolescent from a list of topics. Each parent was rated on a scale of 1 (*very low*) to 7 (*very high*) on the extent to which parents respected or inhibited adolescents' autonomy, perspectives and opinions, and promoted or inhibited relatedness (e.g., showing appreciation and warmth vs. ignor-

Table 1
Summary of Study Variables

	Measure	Wave	Reporter	α
Maternal sensitivity	Structured interactions	Pre-K, first grade, ninth grade	Observational	.84, .82, .81
Paternal sensitivity	Structured interactions	Pre-K, first grade, ninth grade	Observational	.75, .79, .79
Social competence	Social Skills Rating System	First grade, sixth grade	Teacher	.93, .94
Awakening cortisol	Salivary cortisol assay	Ninth grade	Study child	—
Body mass index	Height, weight	Sixth grade, ninth grade	Researcher	—
Systolic blood pressure	Blood pressure cuff	Sixth grade, ninth grade	Nurse practitioner	—

ing or expressing hostility) with the adolescent. Mother and father sensitivity were defined as a sum of each parent's scores on validation or agreement with the adolescent, engagement in the interaction, inhibiting relatedness with the adolescent (reverse-coded), hostility or devaluing behavior (reverse-coded), respect for the adolescent's autonomy, and valuing and warm behavior during the interaction. This composite score was reliable for mothers, $\alpha = .81$, and fathers, $\alpha = .79$. Parental sensitivity at the school transition was moderately related to sensitivity in ninth grade for mothers, $r = .38$, $p < .01$, and for fathers, $r = .28$, $p < .01$.

Social Competence

The Social Skills Rating System (Gresham & Elliott, 1990)–Teacher Form is a questionnaire that asks teachers to rate frequency of classroom behaviors (0 = *never* to 3 = *very often*). The Total Social Skills scale captures three facets of social competence: cooperation (listening to instructions, cleaning up materials used in the classroom), assertion (introducing self, offering help to peers), and self-control (responding to teasing or peer pressure, receiving criticism). The subscales are internally reliable, α s = .84–.91, and have consistently demonstrated content, criterion, and construct validity in first grade samples (U.S. Department of Health and Human Services, National Institutes of Health, Eunice Kennedy Shriver National Institute of Child Health and Human Development, 1999). Social competence is defined as the Total Social Skills score, calculated by adding the cooperation, assertion, and self-control subscales. First grade and sixth grade social competence were moderately correlated, $r = .44$, $p < .01$.

Awakening Cortisol

At the ninth grade home visit, researchers provided adolescents with salivettes, verbal instructions,

and detailed booklets with steps to collect saliva samples to be analyzed for cortisol concentration. For three consecutive mornings upon awakening and before eating or drinking anything, adolescents were instructed to rinse their mouths out with water prior to placing the cotton roll from the salivettes under the tongue for 3 min. Then, adolescents were instructed to place the saturated cotton roll into the plastic tube provided before storing it in a freezer to be taken to the local lab site. Samples were shipped in dry ice to be analyzed at Salimetrics Inc. in State College, PA, and awakening cortisol was defined as the average cortisol concentration ($\mu\text{g} \cdot \text{dL}^{-1}$) of the three measurements. Of adolescents who participated in saliva collection, 94% provided collections on all 3 days, and cortisol means were moderately to highly correlated from one day to the next, r s = .42–.53, p s < .01. On average, these measurements were taken 9.26 min after awakening, indicating that adolescents who provided saliva samples were compliant with collection instructions.

BMI Percentile

In sixth and ninth grades, children's weight and height (with shoes removed) were measured at a lab visit using a scale and a yardstick taped flat against a wall. Body mass index ($\text{kg} \cdot \text{m}^{-2}$) was calculated using these measurements with a program provided by the Centers for Disease Control, and BMI percentile represents the percentage of children of the same age and gender who have a BMI lower than the study child.

Systolic Blood Pressure

During the sixth and ninth grade HPDA, children's blood pressure was taken while seated from the nondominant arm using a cuff and stethoscope. Systolic blood pressure (mmHg) was used as an indicator of cardiovascular health.

Covariates

Mothers reported on the child's gender and ethnicity during the first home visit when the child was 1 month old. At first grade, they reported on family income and family size, and researchers calculated family income-to-needs ratio based on this information. At the ninth grade time point, adolescents completed questionnaires about awakening time, sleep quality the night previous to each saliva collection day, general sleep problems, morning or evening preference, date of last menstrual period (females only), and the use of 26 different classes of medications that may be associated with cortisol activity.

Analysis Plan

Mediation describes a situation in which a mediator variable explains relations between an independent variable and a dependent variable (Baron & Kenny, 1986). This relation may be described as full mediation, in which relations between the independent and dependent variables become nonsignificant after accounting for the mediating variable, or partial mediation, when relations between independent and dependent variables undergo a reduction in magnitude after accounting for the mediator (Baron & Kenny, 1986). Path analysis with manifest variables was used to test mediation study hypotheses with three models constructed using Mplus version 6.11 (Muthén & Muthén, 1998–2012), each of these models testing one of the adolescent health outcomes under consideration. Rather than using a causal steps regression approach (Baron & Kenny, 1986), we chose to use path analysis because it takes all relations between variables in a model into account when testing mediational processes (Kaplan, 2000). Because study variables were skewed, models used a maximum likelihood robust estimator and were evaluated for model fit using the root mean square error of approximation (RMSEA), the comparative fit index (CFI), and the Tucker–Lewis index (TLI), as well as the significance of paths corresponding to study hypotheses. Acceptable model fit indices include RMSEA values smaller than 0.10, and CFI and TLI values within the range of 0.90–1.0 (Bentler, 1990; Browne & Cudeck, 1993; Hu & Bentler, 1999). Because the chi-square statistic is dependent on sample size (Kline, 2005), we did not rely on this criterion when determining adequate model fit.

All models included main effects of mother and father sensitivity during the school transition predicting children's social competence in sixth

grade. In turn, we evaluated whether the sixth grade social competence mediator predicted adolescent health. In addition to the indirect effect of parenting on adolescent health through social competence, we also tested direct effects from each parent's sensitivity during the school transition to adolescent health. The magnitudes of indirect effects are the products of the standardized path coefficients that comprise these effects and represent the change in each health outcome in standard deviation units as a result of each standard deviation change in parental sensitivity via the social competence pathway (Kline, 2005). A significant indirect effect indicates that the mediating variable, social competence, is explaining the association between the independent variable, parental sensitivity, and the dependent variable, adolescent health (Baron & Kenny, 1986).

To examine change over time, models controlled for first grade social competence, and, whenever possible, health outcome variables at sixth grade. It was possible to control for sixth grade BMI percentile and blood pressure in the models testing these outcomes at ninth grade, but because children's awakening cortisol levels were not measured at sixth grade, this model does not include a sixth grade health control. In order to account for mothers' and fathers' interdependence as a result of their close relationship within the family system, mother and father sensitivity were correlated in all models. Maternal and paternal sensitivity when children were in ninth grade was included in each model in order to control for the effects of concurrent parenting on adolescent health outcomes, thus testing the importance of parenting during the transition to primary school on children's long-term health while accounting for the stability of parental sensitivity over time.

Missing Value Analysis

Approximately 17% of data were missing overall. Twelve children (1.4%) attrited from the study after the preschool data collection point, 53 (6.0%) attrited after the first grade wave, and 11 (1.2%) attrited after the sixth grade wave. Of children who remained in the study, 59 (6.7%) were missing teacher reports of social competence at sixth grade, and 126 (14.3%) did not participate in father-child interaction tasks in ninth grade. Little's missing completely at random (MCAR) test indicated that data were MCAR, $\chi^2(1,385) = 1,307.99, p = .93$, suggesting that participants with missing data could be excluded from analyses without creating biases in the results. Nonetheless, in order to retain power,

we used full information maximum likelihood estimation to handle missing data. Full information maximum likelihood uses available and implied values to estimate parameters for missing values.

Results

Preliminary Analyses

Descriptive information for study variables is included in Table 2, and correlations among study variables are included in Table 3. Higher maternal and paternal sensitivity were each related to lower BMI percentile and systolic blood pressure in adolescence, and sixth grade social competence was positively associated with awakening cortisol and inversely associated with blood pressure at ninth grade. Adolescent health outcomes were related to each other such that higher BMI percentile was

related to lower awakening cortisol and higher blood pressure. Awakening cortisol levels and blood pressure were not significantly correlated.

Covariate Analysis

In addition to social competence, health, and adolescent parenting controls, demographic characteristics of the child were evaluated as covariates. Child gender and ethnicity and family income-to-needs ratios were included in all models due to relations with study variables. Because sleep patterns, menstrual cycles, and certain medications can alter cortisol activity (Saxbe, 2008), we examined adolescents' sleep quality on nights prior to saliva collection, general sleep problems, morning or evening preference, time of awakening each morning, days since last menstrual period (for females only), and each of 26 medication classes adolescents

Table 2
Descriptive Statistics for Study Variables

	M	SD	Range
Pre-K/first maternal sensitivity	17.22	2.38	5.5–21
Pre-K/first paternal sensitivity	17.34	2.13	7–21
First grade social competence	44.98	9.23	14–60
Sixth grade social competence	45.04	9.54	9–60
Sixth grade BMI percentile	62.04	29.73	0.00–99.68
Sixth grade systolic blood pressure	104.76	11.72	80–140
Ninth grade maternal sensitivity	31.45	4.86	15–42
Ninth grade paternal sensitivity	31.75	4.40	10–42
Ninth grade BMI percentile	63.62	27.13	0.10–99.78
Ninth grade awakening cortisol ($\mu\text{g} \cdot \text{dl}^{-1}$)	0.36	0.18	0.03–1.11
Ninth grade systolic blood pressure (mmHg)	113.66	11.72	83.33–173

Note. BMI = body mass index.

Table 3
Correlations Between Study Variables

	1	2	3	4	5	6	7	8	9	10
1. Pre-K/first maternal sensitivity	—									
2. Pre-K/first paternal sensitivity	.35**	—								
3. First grade social competence	.23**	.18**	—							
4. Sixth grade social competence	.27**	.17**	.44**	—						
5. Sixth grade BMI percentile	-.10**	-.11**	-.02	-.11**	—					
6. Sixth grade systolic blood pressure	-.03	-.06	.06	.03	.30**	—				
7. Sixth grade maternal sensitivity	.38**	.22**	.15**	.14**	-.01	.05	—			
8. Ninth grade paternal sensitivity	.21**	.28**	.08	.10*	.01	.02	.32**	—		
9. Ninth grade BMI percentile	-.15*	-.14**	-.06	-.11*	.80**	.28**	-.08*	-.05	—	
10. Ninth grade awakening cortisol	.04	.05	.09*	.16**	-.04	-.04	.00	-.06	-.08*	—
11. Ninth grade systolic blood pressure	-.07*	-.09*	-.07	-.11**	.31**	.33**	-.07*	.02	.36**	-.06

Note. BMI = body mass index.

* $p < .05$. ** $p < .01$.

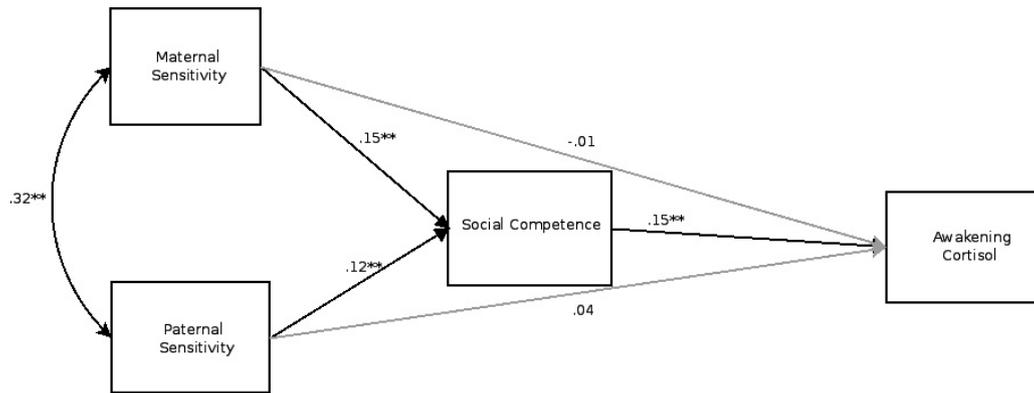


Figure 1. Awakening cortisol model including standardized path estimates. First grade social competence, child gender and ethnicity, family income-to-needs ratio, and ninth grade maternal and paternal sensitivity were included as control variables. ** $p < .01$.

reported taking as covariates for the cortisol outcome model. None of these variables was related to awakening cortisol levels, consistent with previous covariate analyses conducted by Roisman et al. (2009) using the NICHD SECCYD data set.

Parenting and Adolescent Awakening Cortisol

The first path model tested mediation of the effects of mother and father sensitivity during the school transition on adolescent awakening cortisol via sixth grade social competence. This model demonstrated adequate fit to the data, RMSEA = 0.03, 90% CI [0.02, 0.05], CFI = 0.97, TLI = 0.89, $\chi^2(16, N = 884) = 31.80, p < .01$. Figure 1 shows the awakening cortisol model with standardized path estimates. There were significant main effects for both maternal and paternal sensitivity; higher levels of sensitivity predicted increasing social competence from first to sixth grade. In turn, children with more advanced social skills in sixth grade had higher awakening cortisol levels in ninth grade. There were no significant direct effects from parenting during the school transition to adolescent awakening cortisol.

Magnitudes of the significant indirect effects from maternal and paternal sensitivity to adolescent awakening cortisol via social competence are shown in Table 4. These values show that for every standard deviation increase in maternal sensitivity, there was a 0.023 *SD* increase ($0.004 \mu\text{g} \cdot \text{dl}^{-1}$) in awakening cortisol via the pathway of social competence in middle childhood. For every standard deviation increase in paternal sensitivity, there was a 0.017 *SD* increase ($0.003 \mu\text{g} \cdot \text{dl}^{-1}$) in adolescent awakening cortisol via social competence in middle childhood.

Table 4
Standardized Estimates for Indirect Effects by Health Outcome

	β		
	Awakening cortisol	BMI percentile	Systolic blood pressure
Total indirect effects			
Maternal sensitivity	.023*	-.010	-.10*
Paternal sensitivity	.017*	-.008	-.08*

Note. BMI = body mass index.
* $p < .05$.

Parenting and Adolescent BMI Percentile

The second path model tested mediation with mother and father sensitivity during the school transition, social competence at sixth grade, and BMI percentile in ninth grade. This model demonstrated adequate fit, RMSEA = 0.04, 90% CI [0.02, 0.06], CFI = 0.99, TLI = 0.94, $\chi^2(13, N = 884) = 28.89, p < .01$. Again, there were main effects of maternal and paternal sensitivity on sixth grade social competence; children with more sensitive mothers and fathers during the transition to primary school demonstrated increases in social competence from first to sixth grade (see Figure 2). There was no significant effect of sixth grade social competence on children's ninth grade BMI percentile, and direct effects of parental sensitivity on children's BMI percentile in ninth grade were nonsignificant for fathers and marginally significant for mothers, controlling for sixth grade BMI percentile. Despite differences in statistical significance, Fisher's *r*-to-*z* tests revealed that path estimates for mothers' and fathers' direct effects were not statistically different from one another, $z = -0.42$,

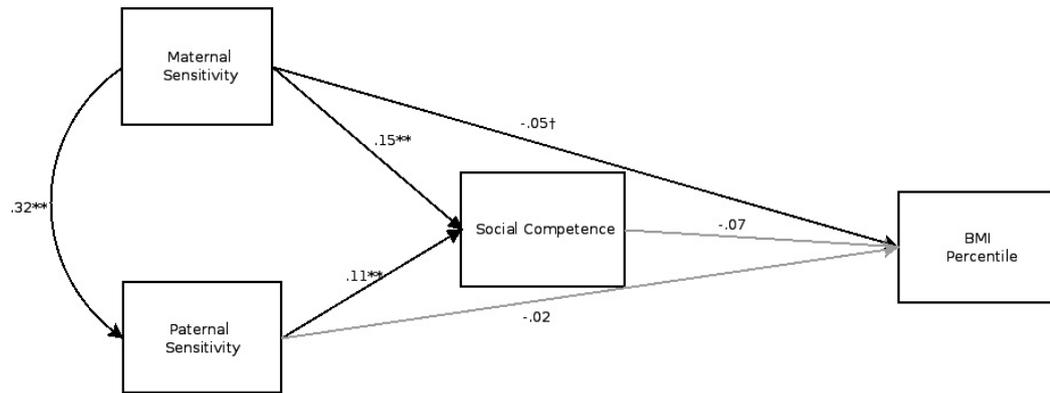


Figure 2. Body mass index (BMI) percentile model including standardized path estimates. Sixth grade BMI percentile, first grade social competence, child gender and ethnicity, family income-to-needs ratio, and ninth grade maternal and paternal sensitivity were included as control variables.
[†] $p < .07$. ** $p < .01$.

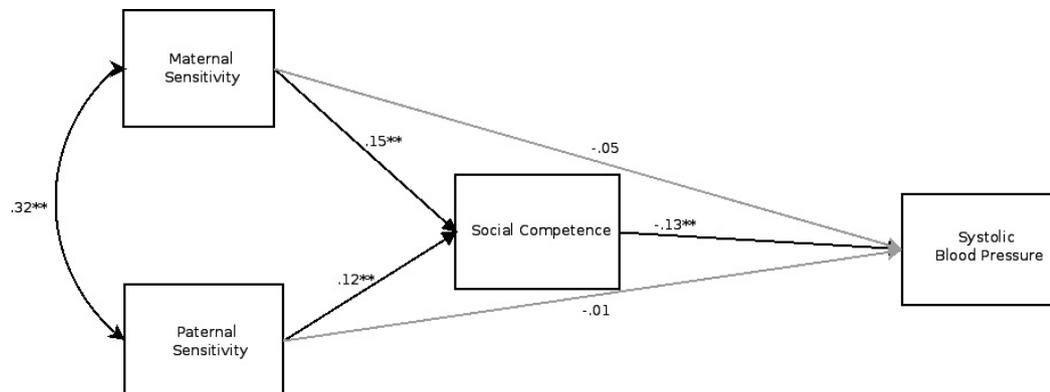


Figure 3. Systolic blood pressure model including standardized path estimates. Sixth grade systolic blood pressure, first grade social competence, child gender and ethnicity, family income-to-need ratios, and ninth grade maternal and paternal sensitivity were included as control variables.
 ** $p < .01$.

$p = .674$. For mothers, more sensitive parenting marginally predicted a 1.36 percentile decrease in BMI in their children over and above the influence of father sensitivity.

Parenting and Adolescent Blood Pressure

The final path model tested mediation effects of mother and father sensitivity during the school transition, social competence at sixth grade, and systolic blood pressure in ninth grade. This model demonstrated excellent fit, RMSEA = 0.02, 90% CI [0.00, 0.04], CFI = 0.99, TLI = 0.97, $\chi^2(11, N = 884) = 15.18, p = .174$. Significant main effects were found between maternal and paternal sensitivity and social competence such that more sensitive parenting during the school transition was

associated with increases in social competence from first to sixth grade (see Figure 3). In turn, higher levels of social competence at sixth grade were associated with decreasing systolic blood pressure from sixth to ninth grade. These indirect effects were statistically significant for mothers and fathers. There were no significant direct effects of either parent’s sensitivity on children’s systolic blood pressure in adolescence.

Magnitudes of indirect effects from each parent’s sensitivity to adolescent systolic blood pressure via the sixth grade social competence pathway are presented in Table 3. For mothers, every increase of 1 SD in sensitivity resulted in a decrease in adolescent systolic blood pressure by 1.17 mmHg via the social competence pathway. For fathers, each increase of 1 SD in paternal sensitivity resulted in a

decrease in adolescent systolic blood pressure of 0.94 mmHg via children's sixth grade social competence.

Discussion

The current study responds to recent review articles (e.g., Hostinar & Gunnar, 2013; Repetti et al., 2002) that have called for longitudinal investigations of processes by which children's early parenting experiences influence their long-term health, with specific emphasis on social and emotional development. From a public health perspective, understanding the developmental processes associated with cardiovascular disease risk during adolescence, a time during which trajectories of adult health are being established, is important for focusing preventive efforts in practical and cost-effective ways. Findings support the idea that social competence in middle childhood is a pathway through which parenting during children's transition to primary school exerts its effects on the integrity of adolescents' biological stress response systems indicated by blood pressure and awakening cortisol response. More sensitive parenting during the primary school transition is associated with healthier cardiovascular indicators, such as lower blood pressure and higher awakening cortisol levels, via middle childhood social competence.

Increases in each parent's sensitivity uniquely predicted increases in social competence for all three models, which is consistent with parenting literature suggesting that mothers and fathers contribute to their children's social development in distinct ways. For example, sensitive mothers tend to offer emotional security and provide a nurturing environment for their children, whereas sensitive fathers provide social challenges that teach children to manage difficult emotions and mild frustration (Paquette, 2004). Each of these may benefit children differently; the emotional comfort that mothers provide may promote feelings of safety in their children that encourages them to participate in social interactions, and the emotional arousal that fathers provide may require children to develop the regulatory skills that are common in children who are well liked by their peers.

Bivariate correlations indicated that maternal and paternal sensitivity were each directly related to two of the three adolescent health outcomes; higher levels of sensitivity for each parent were related to lower systolic blood pressure and lower BMI percentile in adolescents. These results are consistent with a

multitude of studies that have identified parent-child relationships as important contributors to adolescent health (e.g., Brody et al., 2014; Roisman et al., 2009). Of the models used to test whether social competence in middle childhood mediated these associations between parental sensitivity and adolescent health, the indirect effect through middle childhood social competence was found to be significant in the awakening cortisol and systolic blood pressure models, but was not significant in the BMI model.

In the awakening cortisol model, more sensitive mothers and fathers each offered benefits to children's social development from early primary school to middle childhood after accounting for the other parent's sensitivity level. In turn, children with more advanced social skills in sixth grade had higher awakening cortisol levels in adolescence. These indirect effects were significant for both mothers and fathers, providing evidence to support middle childhood social competence as a mediator of relations between mother and father sensitivity during the school transition and adolescent awakening cortisol response.

Normative diurnal cortisol patterns show a peak approximately 30 min after awakening to prepare the body and mind for the day's activities, followed by steady declines throughout the course of the day. Because cortisol is a self-regulating hormone, its release activates mechanisms within the HPA axis that halt its own production (Gunnar & Vazquez, 2001). Thus, if the HPA axis is chronically activated and cortisol repeatedly released, this system will downregulate the production of cortisol by making adjustments to reduce overall output throughout the day. A flattening of the normative peak upon awakening over time is an indication of this phenomenon, a condition marked by low awakening cortisol and termed *hypocortisolism* (Gunnar & Vazquez, 2001). In sum, these results suggest that contributions from both parents as children make the transition to primary school lay the foundation for social competence during middle childhood. More advanced social skills provide a protective buffer for children in terms of the integrity of their developing cardiovascular stress response systems in adolescence (Hostinar & Gunnar, 2013). Children who begin preadolescence with poor social skills are more likely to experience social problems as they approach adolescence, putting them at risk for the repeated social stressors that result in chronic HPA activation (McEwen & Stellar, 1993). Additionally, they are less likely to build and maintain a supportive social network to help them manage life stress (Taylor, 2007), resulting in more prolonged and

unmanageable stress reactions that ultimately result in HPA dysregulation marked by hypocortisolism in adolescence. The magnitude of indirect effects from parenting during the primary school transition to awakening cortisol in adolescence via middle childhood social competence should be considered in light of the fact that the current sample of children of two-parent families is much lower risk than typical samples of children exposed to extreme trauma or adverse childhood environments (e.g., maltreatment; Tarullo & Gunnar, 2006). That significant effects were observed using this low-risk sample indicates that the development of long-term health risk does not require extreme circumstances of adversity. Exploring developmental antecedents to health risk may clarify how long-term dysregulation and disease processes unfold in populations that do not possess the overt characteristics of risk traditionally emphasized in the literature.

In predicting adolescents' BMI percentile, higher levels of sensitivity from each parent were independently associated with increases in social competence when children were in sixth grade, and direct effects of sensitivity on decreases in BMI percentile were nonsignificant for fathers and marginally significant for mothers. Sixth grade social competence was not significantly related to adolescent BMI percentile. Thus, social competence was not found to be a significant mediator between parenting during the school transition and adolescent BMI percentile ranking, but rather mother sensitivity during the school transition marginally predicted youths' BMI percentiles 10 years later.

Findings failed to support either a social mechanism to explain associations between early parenting and adolescent BMI percentile or direct effects from sensitive parenting to BMI percentile in adolescence. Perhaps more discrete parental behaviors, like providing consistent family meals and limiting sedentary behavior, are better predictors of overweight or obesity risk than global sensitivity (Anderson & Whitaker, 2010). The marginal direct effects that were found from maternal, but not paternal, sensitivity to adolescents' BMI percentile may be due to the fact that mothers tend to be charged with organizing family meals, and more sensitive mothers tend to be more involved in meal planning (O'Brien et al., 2007). Future work is needed to clarify relations between sensitive parenting, discrete parenting practices, and the development of overweight or obesity risk in adolescence.

In the systolic blood pressure model, higher levels of maternal and paternal sensitivity during the school transition each uniquely predicted increases

in social competence in their children from primary school to sixth grade, which in turn predicted decreasing systolic blood pressure in ninth grade. Direct effects from each parent's sensitivity to adolescent blood pressure were nonsignificant, indicating that when taking the indirect effect of social competence into account, parental sensitivity did not explain variation in adolescent blood pressure. Indirect effects were significant for mothers and fathers, providing evidence for social competence as a mediator between parental sensitivity and adolescent blood pressure.

Blood pressure, like cortisol response, is an indicator of cardiovascular dysregulation that is directly related to an individual's experience of and ability to cope with chronic stressors, such as those encountered in the social environments of middle childhood through adolescence (Repetti et al., 2002). Many studies have established the importance of social skills in daily stress reduction, in terms of both minimizing stress reactivity in response to social interactions and building stress-buffering friendships that provide a network of coping resources (see Taylor, 2007). Results support the idea that better social competence in middle childhood is a protective factor for the stress-related cardiovascular marker of elevated blood pressure in adolescence, a time that adult tendencies toward hypertension and other markers of cardiovascular risk are being established (Bao, Srinivasan, Wattigney, & Berenson, 1994). Although the magnitude of the indirect effect of parenting on blood pressure is relatively small, the relation between blood pressure and cardiovascular risk is graded such that even small increases in blood pressure represent risks for maladaptive health outcomes that may become compounded as adolescents reach early adulthood and beyond (Chioloro, Bovet, Paradis, & Paccaud, 2007). Furthermore, in light of normative increases in blood pressure from preadolescence to adolescence (National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents, 2004), small decreases during this developmental period indicate that these normative increases are being attenuated and reversed for children higher in social competence.

The present study adds to the literature in a number of ways. It is among the first to examine social competence as a mechanism to elucidate relations between sensitive parenting, including contributions from both mothers and fathers, and cardiovascular health markers that are indicators of chronic illness risk as children transition into adolescence and begin to embark upon their

adult health trajectories. The longitudinal design measured change over time by controlling for levels of the mediator and health outcomes at the previous time points when possible, and isolated contributions of parenting during the transition to primary school by accounting for concurrent effects of parental sensitivity during adolescence on health. The study focused on developmentally relevant time periods for children as they first begin to apply skills socialized by parents in the home to the school environment, as these social skills become vitally important during middle childhood, and as children physically develop into adolescents that will likely carry similar cardiovascular health profiles with them into adulthood. Multiple methods and informants were utilized, including observations of parental behavior, teacher reports, and physiological measurements, reducing the likelihood of shared method variance. Additionally, multiple aspects of adolescent health were examined to assess a more complete profile of physical well-being.

Despite these strengths, the current study is not without limitations. Inclusion criteria limited the sample to children who lived with two parents. Previous literature that examines the long-term effects of parenting on children's health has tended to emphasize a childhood environment that is relatively high risk, with exposure to high levels of stress due to low socioeconomic status and hostile or abusive parenting. Although our sample was relatively low risk and analyses focused on sensitive parenting rather than hostility, effects were nonetheless found for both mothers and fathers on adolescent cortisol and blood pressure through the proposed social pathway. Unfortunately, we were not able to examine how these processes differ in single-parent families due to the fact that there was not a large enough sample of single parents in the SECCYD. Because single-parent households are at higher risk for poverty, instability, and heightened stress that can affect parental sensitivity, child socialization, and health (Huffman et al., 2000), these environmental stressors likely have a stronger impact on long-term associations of childhood parenting and health. Second, this study focused on parenting at an important developmental transition, but it is likely that parenting continued to exert unique effects across time among parents who increased or decreased their sensitivity in response to life events or children's behavior. Third, because awakening cortisol was not measured at any time point in the study other than at ninth grade, sixth grade awakening cortisol was unable to be included as a control variable in the cortisol model. This

limits our ability to draw conclusions about changes in stress responses over time. Although the current study relied on a single-morning measurement of salivary cortisol as an indicator of awakening response, which is consistent with procedures used in other studies (see Miller et al., 2007, for a review), more recent evidence suggests that multiple-morning saliva collections are ideal for measuring the awakening cortisol response (Saxbe, 2008). Future work would benefit by measuring the slope of the awakening response with multiple collections at multiple developmental periods of interest (e.g., the transition to primary school and the transition to secondary school) using indicators of compliance other than self-report (e.g., electronic time-stamped collection tubes). And finally, although these findings are consistent with the notion that social competence contributes to children's experience of social stress throughout middle childhood and adolescence, future investigations should specifically address this question using measures of children's perceived social stress and physiological reactivity to social stressors during these developmental periods as indicators of later physical and psychological health.

This study suggests that social competence is an important contributor to children's stress-related health outcomes as they transition from middle childhood to adolescence, and that both mothers and fathers offer unique contributions to this social resource that appears to protect adolescents from cardiovascular dysregulations that provide the foundation for their adult health trajectories. Findings point to social competence as another potential domain that can be improved upon with intervention, in addition to well-established and effective parenting interventions (e.g., Family Check-Up, Stormshak, Fosco, & Dishion, 2010; Incredible Years Parenting Program, Webster-Stratton, 1998), to promote the social skills that are associated with adaptive coping and social functioning throughout the life span. Children's social focus during middle childhood may make them particularly malleable to change. For example, an evaluation of the Second Step program, an intervention including empathy training, impulse control and problem solving, and anger management, found that participation in the program was associated with more teacher-rated prosocial behaviors and fewer antisocial behaviors in 7- to 11-year-olds (Frey, Nolen, Edstrom, & Hirschstein, 2005). Although child gender was not a focus of the current study, intervention efforts may benefit from future research on how social mechanisms may differentially impact health for

adolescent girls versus boys. Because females generally have larger social networks and tend to give and receive social support more than males (Taylor, 2007), perhaps deficits in social competence are more damaging to health for girls compared to boys. Due to the extraordinary costs associated with chronic illness management, it is important to improve children's chances of developing effective social skills that are likely to have a significant and cumulative impact on long-term health.

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