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Quality of Relationships with Parents and Friends in Adolescence Predicts Metabolic Risk in Young Adulthood

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Abstract

Objective—The present study was designed to examine whether family and peer relationships in adolescence predict the emergence of metabolic risk factors in young adulthood.

Methods—Participants from a large, nationally representative cohort study (N = 11,617 for these analyses) reported on their relationship experiences with parents and close friends during adolescence. Fourteen years later, interviewers collected blood samples, as well as anthropometric and blood pressure measurements. Blood samples were analyzed for HbA1c.

Results—Ordered logistic regressions revealed that for females, supportive parent-child relationships and close male friendships in adolescence were associated with reduced odds of having elevated metabolic risk markers in young adulthood. These effects remained significant even after controlling for baseline measures of body mass index (BMI) and health and demographic covariates. The protective effects of close relationships were not significant for males, however. Exploratory analyses with two-parent families revealed that supportive father-child relationships were especially protective for females.

Conclusions—These findings suggest that, for females, close and supportive relationships with parents and male friends in adolescence may reduce the risk of metabolic dysregulation in adulthood.

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Keywords

Parent-adolescent relationships; friendships; metabolic risk

Adolescence is a time of increased importance of close relationships, particularly those with friends and peers at school (Rubin, Bukowski, & Parker, 2006; Smetana, Campione-Barr, & Metzger, 2006). Adolescents spend the majority of their waking hours in the presence of peers, and they are highly influenced by daily experiences with friends (Steinberg, 2008). At the same time, despite spending less than 15% of their waking hours with their families, adolescents report that parents remain a critical source of emotional support (Collins & Laursen, 2004). These experiences across relationship domains are widely viewed as central to the maintenance and ongoing development of social and emotional competencies in adolescence (e.g., identity development, individuation). Consistent with this notion, poor quality parent-adolescent and peer relationships during adolescence have been associated with increased risk for a range of adjustment problems, including internalizing and externalizing disorders (e.g., Allen, Porter, & McFarland, 2006; Cole & McPherson, 1993; El-Sheikh & Elmore-Staton, 2004; Hops et al., 1990; La Greca & Harrison, 2005; for reviews, see Laursen & Collins, 2009; Parker, Rubin, Erath, Wojslawowicz, & Buskirk, 2006). Thus, establishing and maintaining high quality relationships with family and peers has important implications for adolescents' mental health.

Emerging evidence suggests that close relationship experiences in childhood and adolescence are also important for physical health (e.g., Almquist, 2009; Caspi, Harrington, Moffitt, Milne, & Poulton, 2006; Gustafsson, Janlert, Theorell, Westerlund, & Hammarström, 2012; House, Landis, & Umberson, 1988). For example, in a study of adolescent females, negative social interactions in everyday life were associated with increasing metabolic risk over a 2-year follow-up period (Ross, Martin, Chen, & Miller, 2011). Relationships in childhood and adolescence appear to be predictive of physical health even decades later in life. Using prospective data from the Dunedin Multidisciplinary Health and Development Study, Caspi and colleagues (2006) found that childhood peer isolation was associated with a 37% increased odds of having three or more cardiovascular risk problems (e.g., heightened blood pressure, HbA1c, total cholesterol) 20 years later. Notably, childhood peer isolation remained a significant predictor of cardiovascular risk even when accounting for adult health behaviors and stressors, suggesting that the effect was not explained by poor health choices that adults made as a result of negative peer experiences in childhood. Additionally, Gustafsson et al. (2012) found that negative peer experiences in adolescence, such as isolation and unpopularity, predicted higher odds of having metabolic syndrome (a cluster of metabolic abnormalities that puts individuals at increased risk for cardiovascular disease and diabetes; e.g., Cornier et al., 2008) at age 43. Interestingly, in analyses stratified by gender, these predictive relations were only significant for women.

Indeed, there has been growing interest in exploring whether social experiences predict health outcomes for men and women equally (e.g., Kiecolt-Glaser & Newton, 2001; Sneed & Cohen, 2014). Compared to males, females (a) are more negatively affected by stressful relationship experiences (e.g., Shih, Eberhart, Hammen, & Brennan, 2006), and (b) spend

more time thinking about their peers (Richards, Crowe, Larson, & Swarr, 1998). Further, some evidence suggests that women have stronger physiological responses to negative social experiences (e.g., Kiecolt-Glaser & Newton, 2001; Stroud, Salovey, & Epel, 2002). Recently, in a sample of older adults, Sneed and Cohen (2014) found that negative social interactions were associated with increased odds of developing hypertension across a four-year period for women but not for men. It may be that social experiences with parents and friends in adolescence are more likely to predict metabolic outcomes for women than men.

Most of the previous research on the physical health outcomes associated with relationship experiences has focused on deleterious outcomes associated with *poor* relationships or negative social experiences (e.g., social isolation, bullying) rather than on positive relationship characteristics. Yet it is possible that positive, high quality relationship experiences also play a role in long-term health outcomes, independent of the adverse effects of negative relationship characteristics (e.g., Uchino, Cacioppo, & Kiecolt-Glaser, 1996). Most of the evidence for the beneficial effects of positive relationship experiences on physical health comes from studies of older adults. For example, in a recent meta-analysis of studies examining all-cause mortality risk, Holt-Lunstad, Smith, and Layton (2010) found that social support was associated with a 50% reduced mortality risk. However, the average age of participants in this meta-analysis was 63, and only a handful of studies sampled children or young adults. The relative lack of information on how positive relationship experiences influence health outcomes in younger individuals is perhaps not surprising, given that the effects of relationship experiences on physical health may be harder to detect in younger populations who are likely to be relatively healthy. Yet at the same time, early symptoms of chronic health problems are increasingly emerging in adolescence and early adulthood (Cornier et al., 2008; Duncan, Li, & Zhou, 2004; Gordon-Larsen, The, & Adair, 2010; Lule, Rosen, Singh, Knowles, & Behrman, 2006). Thus, it is important to examine the time course by which psychosocial factors in adolescence—a period when interpersonal relationships are particularly influential (e.g., Rubin et al., 2006)—may foreshadow later physical health problems.

The Present Study

The present study adds to the small but growing body of longitudinal research on interpersonal relationships and later physical health by using data from a nationally representative longitudinal study of the transition from adolescence to young adulthood to address some of the limitations of previous research. In particular, the present study was designed to consider both adolescents' negative and positive relationship experiences with their mothers, fathers, and male and female friends and how these experiences may be associated with metabolic functioning in young adulthood. We tested these factors within a single regression model in order to examine unique effects of each predictor on later metabolic risk. We hypothesized that close relationships with parents and friends in adolescence would independently predict metabolic risk in young adulthood. We further hypothesized that positive aspects of adolescents' relationships would predict metabolic risk above and beyond the effects of negative relationship characteristics. Consistent with emerging research on gender differences in links between social experiences and health outcomes (e.g., Gustafsson et al., 2012; Sneed & Cohen, 2014), we hypothesized that the

strengths of these connections may differ for males and females. Specifically, we hypothesized that females would be more sensitive to positive and negative aspects of relationships, such that the benefits of high quality relationships and the risks of poor quality relationships with parents and friends would be especially strong for females.

Method

The data were drawn from Waves 1 and 4 of the National Longitudinal Study of Adolescent Health (Add Health), a nationally representative sample of adolescents in grades 7 through 12 in the United States in 1995. The study used a school-based design to select a stratified sample of 80 high schools (and feeder middle schools) with selection probability proportional to the size of the school. The survey design has been described extensively elsewhere (e.g., Harris et al., 2009). Wave 1 (1994-1995) included 20,745 adolescents (aged 11-20). The most recent wave of data collection (Wave 4) took place from 2007-2008; all respondents from the Wave 1 sample were eligible. Wave 4 participants ($n = 14,800$) consisted of 71% of the original Wave 1 sample, at which time respondents were between the ages of 24 and 32.

Participants

The final analytic sample included respondents who participated in Waves 1 and 4 and provided at least three¹ of the four health measurements used to create the metabolic risk index. The final analytic sample included 11,617 respondents, 54.0% female, with a mean age of 16.0 (SD = 1.8) years at baseline. About 70.1% of the sample is White; 14.4% Black; 3.0% Asian; 10.9% Hispanic; and 1.6% reported another race. A full list of descriptive statistics for the sample can be found in Table 1.

Measures

All questions in Add Health were constructed for the goals of the Add Health study and were not drawn from any existing measures. For the scales that follow, we provide indices of internal reliability where possible.

Parent-child relationship quality—A measure of positive parent-child relationship quality was created using adolescent responses to the following five questions about their relationships with their parents at Wave 1 using a 5-point Likert-type scale: “how close do you feel to your mom/dad; how much does your mom/dad care about you; is your mom/dad warm and loving towards you; are you satisfied with your communication with mom/dad; are you satisfied with your relationship with mom/dad”. Higher scores indicate higher quality parent-child relationships. Scales were first created separately for mothers ($\alpha = 0.85$) and fathers ($\alpha = 0.89$). However, given that (a) mother-child and father-child relationship quality were significantly correlated ($r = .46, p < .001$) and (b) approximately a quarter of the sample ($n = 3,296$) had a relationship with only one parent, for our primary analyses, a composite score reflecting the average of mother-child and father-child relationship quality

¹In follow-up analyses, we created a metabolic risk composite using all available data from participants; the pattern of findings obtained from these analyses was identical to the findings that emerged when requiring three or more metabolic indices to create a composite score.

was used ($\alpha = 0.89$). (For adolescents who had a relationship with only one parent [see Table 1], their composite score was identical to the rating for that parent.)

Adolescents also reported about whether they had a serious argument with their mothers or fathers in the past four weeks using a yes/no scale. As was the case with responses about positive parent-child relationships, adolescent reports of serious arguments with mothers and fathers were significantly correlated ($r = .48, p < .001$). Thus, we averaged scores for reports about conflict with mothers and fathers to create an overall parent-child conflict score.

For both the positive parent-child relationship quality variable and the parent-child conflict scores, follow-up analyses examining each parent separately were conducted with the subsample ($n = 8,037$) of youth with two parents.

Peer relationship quality—At Wave 1, adolescents were first asked to list the name of their best male friend and their best female friend, and then they were asked a series of questions about their activities with each of these friends over the past 7 days (responses were made separately for male and female friends). Adolescents indicated whether they engaged in the following five activities with (a) their best male friend and (b) their best female friend: “did you go to his/her house; did you meet him/her after school to hang out or go somewhere; did you spend time with him/her during the past weekend; did you talk to him/her about a problem; did you talk to him/her on the telephone”. Two friendship closeness scales were created by averaging responses separately for closest male friendship ($\alpha=0.67$) and closest female friendship ($\alpha=0.73$). Higher scores indicate greater friendship closeness.

Loneliness was measured by asking adolescents to report how frequently they felt lonely on a 4-point Likert-type scale, ranging from 0 (*never or rarely*) to 3 (*most of the time*).

Metabolic risk index—The dependent variable of metabolic risk included four key components: waist circumference, systolic and diastolic blood pressure, and hemoglobin A1c (HbA1c; an integrated measure of blood glucose over the preceding two to three months; Saaddine et al., 2002). Trained field interviewers collected biological measures in participants’ homes during the Wave 4 interview. Waist circumference was measured to the nearest 0.5 cm at the superior border of the iliac crest. Field interviewers asked respondents to remove bulky clothing and stand relaxed, breathing normally, with their weight evenly distributed. The measurement was taken using a circumference tape measure at the end of the respondent’s normal exhalation. Blood pressure was recorded using a self-inflating, digital monitor (Omron HEM-705). Three readings were taken over 30-second intervals while the participant was in a seated, resting state. The mean of the second and third readings were used to calculate final measures of systolic and diastolic blood pressure. If either the second or third measure was missing, the other single measure was used; if the second and third measures were both missing, the first measure was used. Finally, field interviewers obtained capillary whole blood spots from a finger prick onto filter paper that were dried and shipped to FlexSite Diagnostics (Palm City, Florida) for laboratory analysis of HbA1c (Whitsel et al., 2013).

Each metabolic risk marker was standardized within the sample, with the exception of waist circumference, which was standardized within gender due to gender differences in body composition. Similar to other studies of metabolic risk (e.g., Carroll et al., 2013; Gruenewald et al., 2012; Rääkkönen, Matthews, & Salomon, 2003), participants were categorized into quartiles for each marker, and participants in the top 25% were considered to be at high risk. Then, we summed across markers to create a metabolic risk composite. Scores ranged from 0 (*not high risk on any marker*) to 4 (*high risk on all four markers*). Scores in the top quartiles correspond with diagnostic criteria for metabolic disruption (e.g., Grundy et al., 2005; see Table 2).

Sociodemographic covariates—Basic demographic data were collected at Wave 1, including age, gender, race/ethnicity, and years of parents' education. Self-reported race indicator variables were created for White, Black/African American, American Indian/Native American, Asian/Pacific Islander, or Other. Additionally, an indicator variable was created for Hispanic ethnicity. In light of evidence that socioeconomic status (SES) is associated with physical health (e.g., Adler & Ostrove, 1999), parents' education level was included as a measure of SES to control for possible alternative explanations for any observed links between adolescent relationship experiences and later metabolic risk. Specifically, parents' education level was reported by the parent at Wave 1 based on the question, "How far did you go in school?" Responses were coded as: less than high school, high school graduate/GED, some college, college graduate, and post graduate. A mean parental education variable was created using the higher level of mother or father's education; if either mother or father's educational status was missing, the other parent's educational status was used. Finally, family structure was controlled for by categorizing adolescents into one of four categories, including: living with two parents, both biological; living with two parents, one biological parent; living with a single parent; and other family structure.

Health controls—Although biological measures of health were not available in Wave 1, baseline self-reports of general health and body mass index (BMI) were included in all models to account for preexisting health conditions. Self-reported general health was measured by a single question, "In general, how is your health?" ranging from 0 (*poor*) to 4 (*excellent*). Self-reported height and weight were used to calculate participant body mass index (BMI, kg/m^2) at Wave 1.

Analytic Strategy

Participants with missing data on two or more of the metabolic risk index variables were dropped from the analyses ($n = 238$). Listwise deletion was used for all other variables.

Analyses were designed to examine the longitudinal associations between both parent and friendship closeness during adolescence (Wave 1) and metabolic risk in young adulthood (Wave 4). We used an ordered logistic regression to examine the effects of male and female friendships and parent-child relationships, as well as their interactions with gender (entered simultaneously into a single model), on the categorical metabolic risk variable while also statistically controlling for demographic covariates and baseline measures of health and

BMI. Follow-up analyses examined (a) age as a moderator of the proposed effects, (b) the prediction of each metabolic risk factor separately, and (c) the relative predictive roles of mother- and father-child relationships for a subsample of adolescents with relationships with two parents. Analyses were conducted in Stata Version 13. Continuous covariates were standardized, and all coefficients are presented in odds ratios. All analyses used sampling weights that were created by Add Health for use with data from Wave 1 and Wave 4 to compensate for the complex cluster sample design, unequal probability of selection, and non-response; these sampling weights ensure that the results are nationally representative (Brownstein et al., 2010; Tourangeau & Shin, 1998). Further, the Survey Research Unit at the University of North Carolina reports that bias due to non-response at Wave 4 is negligible and the resulting sample adequately reflects the nationally representative sample that was selected at Wave 1 (Brownstein et al., 2010).

Results

Descriptive Statistics and Preliminary Analyses

Participants varied in their metabolic risk. Specifically, 45.3% were not at elevated risk on any markers of risk, 25.2% were at risk on one measure, 16.0% were at risk on two measures, 8.2% were at risk on three measures, and 3.7% were at elevated risk on all four measures of metabolic functioning. Descriptive statistics for study variables can be found in Table 1.

Correlations among the principal variables of interest can be found in Table 2.

Unexpectedly, positive parent-child relationship quality was negatively correlated with male ($r = -.05, p < .001$) and female friendship closeness ($r = -.08, p < .001$). Participants' scores for male and female friend closeness were positively correlated ($r = .20, p < .001$).

Principal Analyses

Baseline BMI was a significant predictor of metabolic risk 14 years later, whereas baseline self-reports of general health were unrelated to Wave 4 metabolic risk. As shown in Table 4, a significant main effect of parent-child relationship quality emerged that was qualified by a significant Gender \times Positive Parent-Child Relationship Quality interaction (see Figure 1). Similarly, a significant effect of male friendship relationship quality was qualified by a significant Gender \times Male Friendship Closeness interaction (see Figure 2).

To probe the significant interactions, we conducted ordered logistic regressions stratified by gender. Examination of these analyses indicated that for females, a 1 SD increase in parent-child relationship quality was associated with a 7.7% reduced odds of having the highest metabolic risk (4) versus the combined middle and lower categories of metabolic risk (0-3) in adulthood. Similarly, for females, a 1 SD increase in male friendship closeness was associated with a 7.8% reduced odds of having the highest metabolic risk (4) versus the combined middle and lower categories of metabolic risk in adulthood. Friendships and parent-child relationships in adolescence were not associated with later metabolic risk for males. Further, loneliness and parent-child conflict were not associated with metabolic risk.

Supplementary Analyses

Interactions with age—We next examined whether any of the adolescent relationship factors were moderated by age. No significant interactions emerged, however, suggesting that these effects do not differ as a function of adolescent age at entry into the study.

Prediction of individual metabolic risk factors—In a series of follow-up models, we tested how well our original model predicted individual metabolic risk outcomes. These analyses revealed similar, although not identical, patterns to findings for the overall metabolic risk composite. Specifically, we found that male friendship closeness, but not female friendships or parent-child relationships, predicted smaller adult waist circumference (OR = .89, $p = .015$, CI = .81 – .98). In addition, we identified a main effect of male friendship closeness that was moderated by gender in the prediction of HbA1c (OR: 1.16, $p = .029$, CI: 1.02 – 1.33). For females, but not males, male friendships were associated with a 16% reduced odds of being in the high risk group for HbA1c. In contrast, we found a significant positive parent-child relationship main effect that was qualified by a significant interaction with gender in the prediction of diastolic blood pressure (OR = 1.23, $p = .003$, CI: 1.08 – 1.41). Positive parent-child relationships in adolescence were associated with a 23% reduced odds of being at risk for high diastolic blood pressure for females but not for males. Adolescent relationships were not predictive of subsequent systolic blood pressure risk.

Separate effects for mothers and fathers—In a final set of models, we selected a reduced sample of adolescents ($n = 8,037$) who had relationships with both a mother and father to explore whether mother-adolescent and father-adolescent relationships differentially predicted metabolic risk. We found a significant main effect for positive father-child relationships that was qualified by a significant Gender \times Positive Father-Child Relationship Quality interaction (OR = 1.16, $p = .018$, CI = 1.03 – 1.31). Analyses stratified by gender revealed that the protective effect of supportive father-child relationships emerged for females (OR = .89, $p = .013$, CI = .81 – .97) but not for males (OR = 1.01, $p = .75$, CI = .93 – 1.11). Further, a significant Gender \times Male Friendship interaction emerged; stratified analyses indicated that the protective effect of male friends was marginally significant for females (OR = .91, $p = .06$, CI = .83 – 1.01) but was not significant for males (OR = 1.06, $p = .14$, CI = .98 – 1.15). Lastly, we found a marginally significant Gender \times Mother-Child Conflict interaction (OR = 1.33, $p = .06$, CI = .99 – 1.79). Analyses stratified by gender indicated that mother-adolescent conflict was associated with a 29% greater odds of being in the high metabolic risk category for males (OR = 1.29, $p = .014$, CI = 1.06 – 1.59) but not for females (OR = 1.01, $p = .94$, CI = .82 – 1.24).

Discussion

Using a nationally representative sample of adolescents across the U.S., we demonstrated that positive qualities of adolescents' relationships with parents and friends predicted lower metabolic risk in early adulthood. Furthermore, these protective effects of positive relationships were specific to female, and not male, participants. These findings represent a novel addition to the growing body of longitudinal research on the importance of

relationships for physical health (e.g., Caspi et al., 2006; Gustafsson et al., 2012; House et al., 1988) by examining the relative roles that positive and negative relationship experiences play for physical health at an age when the precursors to chronic disease are beginning to emerge. This study is also novel in that we examined relationships across family and peer domains, thus capturing a more comprehensive assessment of adolescents' social experiences. Our findings suggest that, for women, both parent-adolescent relationships *and* close friendships are predictive of later metabolic risk.

In our analyses with the total sample, we found that positive, but not negative, qualities of adolescents' social relationships uniquely predicted later metabolic risk. This pattern is in contrast with other studies that have identified poor quality relationship characteristics, such as social isolation, as risk factors for later health problems (e.g., Adam et al., 2011; Caspi et al., 2006). Although relatively few studies have explicitly contrasted positive and negative qualities of social interactions when examining the link between interpersonal relationships and physical health, one exception is the investigation by Ross et al. (2011). In their study of adolescent females, only negative—and not positive—everyday social encounters were significantly related to trajectories of metabolic risk over a 2-year follow-up period. One difference between the present study and that of Ross et al. (2011) is that our measures of positive qualities of relationships with parents and friends captured more global features of relationships (e.g., relationship closeness), whereas Ross et al. (2011) assessed acute events, such as positive daily social encounters, using daily diary reports. Additional research is needed to better understand how positive and negative aspects of adolescents' social relationships—both in the short term and over longer periods of time—relate to physical health.

This study adds to the growing evidence that the effects of close relationship experiences on later mental and physical health may differ for men and women (e.g., Gustafsson et al., 2012; Shih et al., 2006; Sneed & Cohen, 2014; Vaughan, Foshee, & Ennett, 2010). We found evidence that both parent-adolescent relationships and friendship closeness with boys were predictors of metabolic risk for female but not male participants. This finding is consistent with Gustafsson et al. (2012), who conducted analyses stratified by gender and found that peer problems in adolescence were predictive of metabolic syndrome in midlife for women but not men. Similarly, findings from the present study are consistent with evidence from observations of spouses' physiological responses to marital conflict, which suggests that women may be more sensitive than men to the deleterious effects of hostility in the marriage (e.g., Kiecolt-Glaser, Malarkey, Cacioppo, & Glaser, 1994). Interestingly, the protective effects of women's close relationships on later metabolic risk were limited to their relationships with parents and close male friends – their closeness with female friends was not predictive of later metabolic risk. It may be that females' same-sex friendships are not relevant for their physical health. Equally likely, however, is the possibility that the aspects of female friendship that are most predictive for later health were not captured in the present study. Our measure of friendship closeness centered on behavioral indicators, such as whether the dyad talked on the phone or spent time together outside of school in the past week. Although these items assess closeness and companionship in the relationship, the items do not necessarily measure *quality* of the friendship. It is possible that forms of

emotional support from female friends (e.g., intimacy, the ability to depend on the friend in times of distress) are better predictors of later metabolic risk than whether female friends spend time together during the week.

Supplementary analyses yielded additional insight into the ways in which adolescents' close relationships may be predictive of future metabolic problems. For example, our analyses with a subsample of adolescents with two parents revealed that supportive father-child relationships are particularly protective against metabolic disruption for females. One effect that emerged in the two-parent sample was the role of mother-son conflict, which was associated with greater odds of metabolic risk in adulthood. Mother-son conflict was less frequent than mother-daughter conflict in adolescence (see Table 1), so it may be that when this conflict arises, it is more stressful for boys than for girls, which may promote lifestyle behaviors (e.g., unhealthy diets, sedentary behavior) that foster metabolic disruption. Overall, the pattern of findings in our study suggests that greater attention to the ways in which gender moderates the links between relationship characteristics and physical health is warranted.

Additional supplementary analyses suggested that relationship characteristics were not able to predict each metabolic risk marker equally well—a pattern that is frequently observed in studies of allostatic load and metabolic disruption (e.g., Räikkönen et al., 2003). The protective effects of having a close male friend were observed in the prediction of HbA1c and waist circumference, while the protective effects of supportive parent-child relationships emerged for subsequent diastolic blood pressure risk. It may be that these relationship factors influence physical health through different metabolic pathways.

Limitations and Future Directions

Despite providing evidence for the roles of supportive parent-adolescent relationships and close friendships in predicting metabolic risk in young adulthood, the current findings should be considered in light of several study limitations. First, this study relied on adolescent self-report measures of relationship quality. Although self-reports of relationship experiences provide some insight into the quality of one's relationships, self-report measures can be biased and may not be reflective of actual experiences in these relationships (e.g., De Los Reyes & Prinstein, 2004; Ehrlich, Cassidy, Lejuez, & Daughters, 2013). Further, the self-report items were designed specifically for the Add Health study. As a result, we lack extensive reliability and validity data about these measures. Additional measures of relationship qualities, such as behavioral observations or informant reports, should be used in future studies of predictors of physical health. A second limitation of the present study is that we were unable to fully control for baseline metabolic risk in the analyses. Measures of blood pressure, HbA1c, and waist circumference were not added to the research design until Wave 4. We included Wave 1 measures of BMI and self-reported general health in an effort to control for any baseline differences in metabolic functioning. Future studies with multiple assessments of metabolic risk will be important for documenting changes in metabolic risk associated with relationship experiences. Moreover, the Add Health sample began data collection when participants were in adolescence, but it is likely that these processes begin to unfold earlier in development. Future studies that can assess relationship experiences at

earlier points in childhood will provide insight into questions concerning developmental timing, and whether there are sensitive periods in development during which social relationships are especially likely to contribute to physical health outcomes in adulthood.

Conclusions

In summary, the findings from the present study provide solid evidence that positive relationship qualities with parents and friends in adolescence are predictive of metabolic risk in adulthood. These effects were independent of negative relationship qualities, including conflict and loneliness, and remained significant even when controlling for baseline measures of health. These findings provide support for the notion that relationship experiences play an important role in physical health across the lifespan. Future research should investigate potential mechanisms that might help explain why supportive relationships with parents and friends serve to protect adolescents—particularly female adolescents—from later metabolic risk.

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References

- Adam EK, Chyu L, Hoyt L, Doane L, Boisjoly J, Duncan G, Chase-Lansdale L, McDade T. Adverse adolescent relationship histories and young adult health: Cumulative effects of loneliness, low parental support, relationship instability, intimate partner violence and loss. *Journal of Adolescent Health*. 2011; 49:278–286. [PubMed: 21856520]
- Adler NE, Ostrove JM. Socioeconomic status and health: What we know and what we don't. *Annals of the New York Academy of Sciences*. 1999; 896:3–15. doi:10.1111/j.1749-6632.1999.tb08101.x. [PubMed: 10681884]
- Allen JP, Porter MR, McFarland FC. Leaders and followers in adolescent close friendships: Susceptibility to peer influence as a predictor of risky behavior, friendship instability, and depression. *Development and Psychopathology*. 2006; 18:155–172. [PubMed: 16478557]
- Almqvist Y. Peer status in school and adult disease risk: A 30-year follow-up study of disease-specific morbidity in a Stockholm cohort. *Journal of Epidemiology and Community Health*. 2009; 63:1028–1034. doi:10.1136/jech.2009.088377. [PubMed: 19789170]
- Brownstein, N.; Kalsbeek, WD.; Tabor, J.; Entzel, P.; Daza, E.; Harris, KM. Non-response in Wave IV of the National Longitudinal Study of Adolescent Health. 2010. Retrieved from the Add Health website: http://www.cpc.unc.edu/projects/addhealth/data/guides/W4_nonresponse.pdf
- Carroll JE, Gruenewald TL, Taylor SE, Janicki-Deverts D, Matthews KA, Seeman TE. Childhood abuse, parental warmth, and adult multisystem biological risk in the Coronary Artery Risk Development in Young Adults study. *Proceedings of the National Academy of Sciences*. 2013; 110:17149–17153. doi:10.1073/pnas.1315458110.

- Caspi A, Harrington H, Moffitt TE, Milne BJ, Poulton R. Socially isolated children 20 years later: Risk of cardiovascular disease. *Archives of Pediatrics and Adolescent Medicine*. 2006; 160:805–811. [PubMed: 16894079]
- Cole DA, McPherson AE. Relation of family subsystems to adolescent depression: Implementing a new family assessment strategy. *Journal of Family Psychology*. 1993; 7:119–133. doi: 10.1037/0893-3200.7.1.119.
- Collins, WA.; Laursen, B. Parent-adolescent relationships and influences. In: Lerner, RM.; Steinberg, L., editors. *Handbook of adolescent psychology*. 2nd ed. Wiley; New York, NY: 2004. p. 331-361.
- Cornier M, Dabelea D, Hernandez TL, Lindstrom RC, Steig AJ, Stob NR, Eckel RH. The metabolic syndrome. *Endocrine Reviews*. 2008; 29:777–822. doi:10.1210/er.2008-0024. [PubMed: 18971485]
- De Los Reyes A, Prinstein MJ. Applying depression-distortion hypotheses to the assessment of peer victimization in adolescents. *Journal of Clinical Child and Adolescent Psychology*. 2004; 33:325–335. doi:10.1207/s15374424jccp3302_14. [PubMed: 15136197]
- Duncan GE, Li SM, Zhou X. Prevalence and trends of a metabolic syndrome phenotype among U.S. adolescents, 1999-2000. *Diabetes Care*. 2004; 27:2438–2443. doi:10.2337/diacare.27.10.2438. [PubMed: 15451913]
- Ehrlich KB, Cassidy J, Lejuez CW, Daughters SB. Discrepancies about adolescent relationships as a function of informant attachment and depressive symptoms. *Journal of Research on Adolescence*. 2013 Advance online publication. doi:10.1111/jora.12057.
- El-Sheikh M, Elmore-Staton L. The link between marital conflict and child adjustment: Parent-child conflict and perceived attachments as mediators, potentiators, and mitigators of risk. *Development and Psychopathology*. 2004; 16:631–648. doi:10.1017/S0954579404004705. [PubMed: 15605629]
- Gordon-Larsen P, The NS, Adair LS. Longitudinal trends in obesity in the United States from adolescence to the third decade of life. *Obesity*. 2010; 18:1801–1804. doi:10.1038/oby.2009.451. [PubMed: 20035278]
- Gruenewald TL, Karlamangla AS, Hu P, Stein-Merkin S, Crandall C, Koretz B, Seeman T. History of socioeconomic disadvantage and allostatic load in later life. *Social Science & Medicine*. 2012; 74:75–83. doi:10.1016/j.socscimed.2011.09.037. [PubMed: 22115943]
- Grundy SM, Cleeman JI, Daniels SR, Donato KA, Eckel RH, Franklin BA, Costa F. Diagnosis and management of the metabolic syndrome: An American Heart Association/National Heart, Lung, and Blood Institute scientific statement. *Circulation*. 2005; 112:2735–2752. doi:10.1161/CIRCULATIONAHA.105.169404. [PubMed: 16157765]
- Gustafsson PE, Janlert U, Theorell T, Westerlund H, Hammarström A. Do peer relations in adolescence influence health in adulthood? Peer problems in the school setting and the metabolic syndrome in middle-age. *Plos One*. 2012; 7:e39385. doi:10.1371/journal.pone.0039385. [PubMed: 22761778]
- Harris, KM.; Halpern, CT.; Whitsel, E.; Hussey, J.; Tabor, J.; Entzel, P.; Udry, JR. *The National Longitudinal Study of Adolescent Health: Research design*. 2009. URL: <<http://www.cpc.unc.edu/projects/addhealth/design>>
- Holt-Lunstad J, Smith TB, Layton JB. Social relationships and mortality risk: A meta-analytic review. *Plos Medicine*. 2010; 7:e1000316. doi:10.1371/journal.pmed.1000316. [PubMed: 20668659]
- Hops H, Tildesley E, Lichtenstein E, Ary D, Sherman L. Parent-adolescent problem-solving interactions and drug use. *The American Journal of Drug and Alcohol Abuse*. 1990; 16:239–258. doi:10.3109/00952999009001586. [PubMed: 2288323]
- House JS, Landis KR, Umberson D. Social relationships and health. *Science*. 1988; 241:540–545. doi: 10.1126/science.3399889. [PubMed: 3399889]
- Kiecolt-Glaser, JK.; Malarkey, WB.; Cacioppo, JT.; Glaser, R. Stressful personal relationships: Immune and endocrine function. In: Glaser, R.; Kiecolt-Glaser, JK., editors. *Handbook of human stress and immunity*. Academic Press; San Diego, CA: 1994. p. 321-339.
- Kiecolt-Glaser JK, Newton TL. Marriage and health: His and hers. *Psychological Bulletin*. 2001; 127:472–503. doi:10.1037/0033-2909.127.4.472. [PubMed: 11439708]

- La Greca AM, Harrison HW. Adolescent peer relations, friendships and romantic relationships: Do they predict social anxiety and depression? *Journal of Clinical Child and Adolescent Psychology*. 2005; 34:49–61. doi:10.1207/s15374424jccp3401_5. [PubMed: 15677280]
- Laursen, B.; Collins, WA. Parent-child relationships during adolescence. In: Lerner, RM.; Steinberg, L., editors. *Handbook of adolescent psychology*. 3rd ed. Vol. Vol. 2: Contextual influences on adolescent development. Wiley; New York, NY: 2009. p. 3-42.
- Lule, E.; Rosen, JE.; Singh, S.; Knowles, JC.; Behrman, JR. Adolescent health programs. In: Jamison, DT.; Breman, JG.; Measham, AR., et al., editors. *Disease control priorities in developing countries*. 2nd ed. World Bank; Washington, DC: 2006. p. 217-234.
- Parker, JG.; Rubin, KH.; Erath, SA.; Wojslawowicz, JC.; Buskirk, AA. Peer relationships, child development, and adjustment: A developmental psychopathology perspective. In: Cicchetti, D.; Cohen, DJ., editors. *Developmental psychopathology*. 2nd ed. Vol. Vol. 1: Theory and method. Wiley; Hoboken, NJ: 2006. p. 419-493.
- Räikkönen K, Matthews KA, Salomon K. Hostility predicts metabolic syndrome risk factors in children and adolescents. *Health Psychology*. 2003; 22:279–286. doi:10.1037/0278-6133.22.3.279. [PubMed: 12790255]
- Richards MH, Crowe PA, Larson R, Swarr A. Developmental patterns and gender differences in the experience of peer companionship during adolescence. *Child Development*. 1998; 69:154–163. doi:10.1111/j.1467-8624.1998.tb06140.x. [PubMed: 9499564]
- Ross K, Martin T, Chen E, Miller GE. Social encounters in daily life and 2-year changes in metabolic risk factors in young women. *Development and Psychopathology*. 2011; 23:897–906. doi:10.1017/S0954579411000381. [PubMed: 21756440]
- Rubin, KH.; Bukowski, W.; Parker, JG. Peer interactions, relationships, and groups. In: Eisenberg, N.; Damon, W.; Lerner, RM., editors. *Handbook of child psychology*. 6th ed. Vol. Vol. 3. Social, emotional, and personality development. Wiley; Hoboken, NJ: 2006. p. 571-645.
- Saaddine JB, Fagot-Campagna A, Rolka D, Narayan KM, Geiss L, Eberhardt M, Flegal KM. Distribution of HbA1c levels for children and young adults in the U.S. *Diabetes Care*. 2002; 25:1326–1330. doi:10.2337/diacare.25.8.1326. [PubMed: 12145229]
- Shih JH, Eberhart NK, Hammen CL, Brennan PA. Differential exposure and reactivity to interpersonal stress predict sex differences in adolescent depression. *Journal of Clinical Child and Adolescent Psychology*. 2006; 35:103–115. [PubMed: 16390306]
- Smetana JG, Campione-Barr N, Metzger A. Adolescent development in interpersonal and societal contexts. *Annual Reviews of Psychology*. 2006; 57:255–284. doi:10.1146/annurev.psych.57.102904.190124.
- Sneed RS, Cohen S. Negative social interactions and incident hypertension among older adults. *Health Psychology*. 2014; 33:554–565. doi:10.1037/hea0000057. [PubMed: 24884909]
- Steinberg, L. *Adolescence*. 8th ed. McGraw-Hill; New York, NY: 2008.
- Stroud LR, Salovey P, Epel ES. Sex differences in stress responses: Social rejection versus achievement stress. *Biological Psychiatry*. 2002; 52:318–327. doi:10.1016/S0006-3223(02)01333-1. [PubMed: 12208639]
- Tourangeau, R.; Shin, H. *National Longitudinal Study of Adolescent Health: Grant Sample Weight*. Carolina Population Center, University of North Carolina; Chapel hill, NC: 1998.
- Uchino BN, Cacioppo JT, Kiecolt-Glaser JK. The relationship between social support and physiological processes: A review with emphasis on underlying mechanisms and implications for health. *Psychological Bulletin*. 1996; 119:488–531. doi:10.1037/0033-2909.119.3.488. [PubMed: 8668748]
- Vaughan CA, Foshee VA, Ennett ST. Protective effects of maternal and peer support on depressive symptoms during adolescence. *Journal of Abnormal Child Psychology*. 2010; 38:261–272. doi: 10.1007/s10802-009-9362-9. [PubMed: 19908140]
- Whitsel, EA.; Tabor, JW.; Nguyen, QC.; Cuthbertson, CC.; Wener, MH.; Potter, AJ.; Harris, KM. Center, CP., editor. *Add Health Wave IV: Documentation report measures of glucose homeostasis*. 2012. Available at: <http://www.cpc.unc.edu/projects/addhealth/data/guides/Glucose_HbA1c.pdf/view>

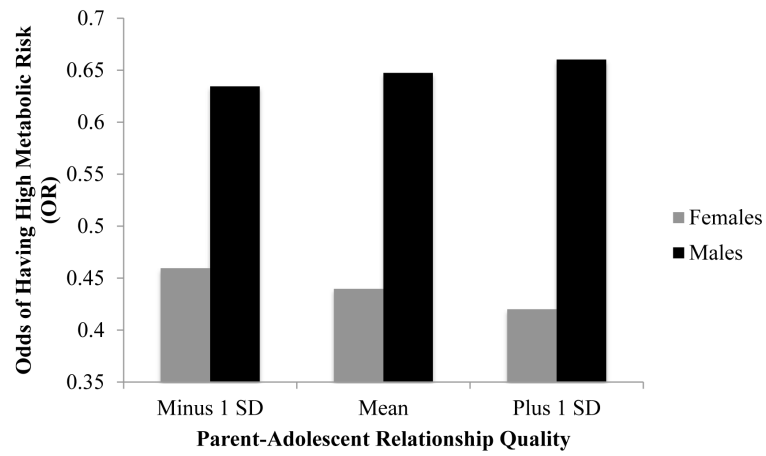


Figure 1. Odds of having metabolic risk in adulthood as a function of parent-adolescent relationship quality. For females, high quality parent-child relationships was predictive of lower odds of metabolic risk 14 years later. For males, parent-adolescent relationship quality was unrelated to subsequent metabolic risk.

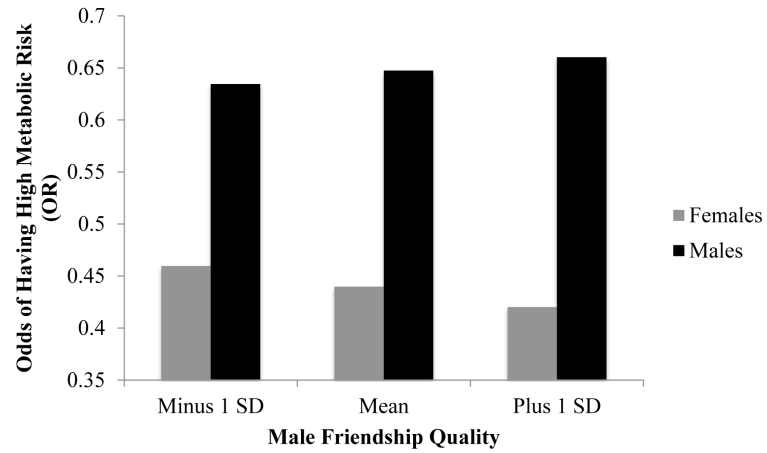


Figure 2. Odds of having metabolic risk in adulthood as a function of male friendship relationship quality. For females, high quality male friendships were predictive of lower odds of metabolic risk 14 years later. For males, male friendship quality was unrelated to subsequent metabolic risk.

Table 1

Weighted Descriptive Statistics for Principal Variables in the Present Study

Variable	Males (<i>n</i> = 6930)			Females (<i>n</i> = 7870)		
	Percent (<i>n</i>)	Mean	SD	Percent (<i>n</i>)	Mean	SD
White	67.3% (4,664)			67.4% (5,304)		
Two Biological Parent Families	65.7% (4,553)			64.4% (5,068)		
Single-Parent Families	27.8% (1,926)			28.9% (2,274)		
W1 Age		16.1	1.77		15.9	1.87
Parents' Education (years)		13.0	2.5		12.9	2.7
W1 Controls						
BMI		22.7	4.48		22.3	4.62
General Health		2.05	.86		2.20	.95
W1 Relationship measures						
Positive Mother-Child Relationship		4.49	.54		4.36	.72
Positive Father-Child Relationship		4.30	.69		4.18	.83
Mother-Child Conflict		.30	.44		.37	.50
Father-Child Conflict		.24	.41		.28	.46
Male Friendship Closeness		.60	.30		.51	.34
Female Friendship Closeness		.49	.32		.65	.32
Loneliness		.38	.62		.53	.77
W4 Metabolic Risk Index						
Indices						
Waist Circumference		99.6	15.1		97.2	19.2
Systolic Blood Pressure		129.8	12.0		119.9	13.2
Diastolic Blood Pressure		81.8	9.5		76.9	10.1
HbA1c		5.64	.78		5.53	.76

Table 2

Range of Values Included in the Top Quartile for Each Metabolic Risk Factor

Metabolic Risk Factor	Males			Females		
	Range of Values	M	SD	Range of Values	M	SD
Waist Circumference	107.5 – 197	121.5	14.5	107.5 – 195	122.1	13.1
Systolic Blood Pressure	133 – 215	142.3	9.2	133 – 222.5	142.3	10.3
Diastolic Blood Pressure	86 – 147	92.7	6.6	86 – 133.5	92.6	7.0
HbA1c	5.8 – 22.4	6.32	1.31	5.8 – 23.1	6.38	1.37

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Table 3

Intercorrelations Among Primary Study Variables

Variable	1	2	3	4	5	6	7	8
1. Age	-	-.07***	-.15***	.02 [†]	.31***	.10***	.12***	.07***
2. Race	-.05***	-	.06***	.04**	.09***	.10***	-.05***	-.14***
3. W1 Positive Parent-Child Relationship Quality	-.19***	-.01	-	-.23***	-.09***	-.03*	-.27***	-.02
4. W1 Parent-Child Conflict	.00	.03**	-.17***	-	.10***	.10***	.13***	.00
5. W1 Male Friendship Closeness	.16***	.06***	-.05***	.08***	-	.21***	.05***	-.05***
6. W1 Female Friendship Closeness	.30***	.02	-.11***	.07***	.31***	-	.01	-.04**
7. W1 Loneliness	.13***	-.08***	-.19***	.10***	.03*	.08***	-	.03**
8. Metabolic Risk Composite	.06***	-.08***	.02	.00	.00	.00	.02	-

Note. Race coded as 0 = Minority, 1 = White. Gender coded as 0 = Female, 1 = Male. Values for females appear above the diagonal; values for males appear below the diagonal.

[†] $p < .10$.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

Table 4

Prediction of Adult Metabolic Risk from Adolescent Relationship Quality Measures

Predictor	Whole Sample (<i>n</i> = 11,617)	Males (<i>n</i> = 5,347)	Females (<i>n</i> = 6,270)
Gender (1 = male)	2.56*** (2.27, 2.88)		
W1 Age	.99 (.94, 1.05)	.97 (.91, 1.05)	1.01 (.94, 1.10)
Race/ethnicity (White)			
Black	1.69*** (1.49, 1.92)	1.45*** (1.23, 1.73)	1.94*** (1.64, 2.29)
Native American	1.76 (.88, 3.50)	1.58 (.62, 4.03)	2.04* (1.11, 3.75)
Asian	1.08 (.79, 1.48)	1.17 (.73, 1.86)	.97 (.65, 1.46)
Hispanic	1.01 (.87, 1.17)	1.06 (.83, 1.34)	.94 (.75, 1.18)
Other	.71 (.38, 1.33)	.65 (.30, 1.38)	.80 (.26, 2.41)
Parents' mean education (high school)			
Less than high school	1.01 (.86, 1.20)	.99 (.78, 1.25)	1.04 (.83, 1.30)
Some college	.89 [†] (.78, 1.02)	.91 (.72, 1.13)	.88 (.73, 1.06)
College	.84* (.72, .98)	.90 (.74, 1.10)	.78* (.63, .97)
More than college	.77* (.62, .94)	.99 (.79, 1.24)	.54*** (.39, .74)
Parental Structure (two biological parents)			
Two parents, one biological	1.02 (.90, 1.17)	1.03 (.85, 1.25)	1.02 (.84, 1.24)
Single parent	1.01 (.90, 1.14)	1.12 (.96, 1.31)	.91 (.75, 1.10)
Other parental structure	.83 (.62, 1.09)	.86 (.63, 1.17)	.83 (.57, 1.21)
W1 BMI	2.11*** (1.98, 2.24)	1.97*** (1.81, 2.14)	2.28*** (2.10, 2.47)
W1 General health	1.04 (.98, 1.09)	1.04 (.97, 1.11)	1.04 (.96, 1.12)
W1 Relationship measures			
Positive parent-child relationship quality	.93* (.86, .99)	1.06 (.98, 1.15)	.92* (.86, .99)
Parent-child conflict	1.02 (.96, 1.08)	1.03 (.97, 1.10)	1.02 (.96, 1.09)
Male friendship closeness	.93* (.87, .99)	1.05 (.98, 1.13)	.92* (.86, .99)
Female friendship closeness	1.01 (.93, 1.09)	1.06 (.98, 1.16)	1.01 (.94, 1.10)
Loneliness	.97 (.90, 1.04)	1.03 (.95, 1.11)	.96 (.89, 1.03)
Gender × Positive parent-child relationship quality	1.14* (1.02, 1.28)		
Gender × Parent-child conflict	1.02 (.94, 1.10)		
Gender × Male friendship	1.14** (1.04, 1.26)		
Gender × Female friendship	1.05 (.96, 1.16)		
Gender × Loneliness	1.06 (.95, 1.18)		

Note. Reference groups are in parentheses. Findings are reported in odds ratios. 95% confidence intervals are presented in parentheses.

[†]*p* < .10.

*
 $p < .05$.

**
 $p < .01$.

 $p < .001$.

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