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Peer relationships and Diabetes: Retrospective and Ecological Momentary Assessment Approaches

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Abstract

Objective—To examine the association of positive and negative aspects of friendship to psychological well-being, self-care behavior, and blood glucose control, and determine whether these relations were moderated by gender.

Design—Adolescents with type 1 diabetes (*n* = 76) completed baseline measures of friendship quality, depressive symptoms, and self-care. A measure of metabolic control was obtained from medical records. Adolescents also tested blood glucose periodically over the course of 4 days and completed ecological momentary assessments of interpersonal interactions and mood using PDAs.

Main Outcome Measures—For between-groups analyses, primary outcomes were depressive symptoms, self-care behavior, and metabolic control. For within-groups analyses, primary outcomes were mood and blood glucose.

Results—Results showed baseline reports of peer conflict but not support was associated with outcomes, particularly among girls. Conflict was more strongly related to poor metabolic control for girls than boys. Momentary interaction enjoyment and interaction upset were associated with mood, but were unrelated to blood glucose. Aggregate indices of enjoyable interactions were associated with fewer depressive symptoms and better self-care—especially among girls.

Conclusions—These results suggest that the positive and negative aspects of peer relationships are related to the psychological well-being and physical health of adolescents with diabetes.

Keywords

diabetes; adolescence; friendship; social support

Type 1 diabetes mellitus is a chronic disease in which the pancreas no longer produces insulin to metabolize glucose. To address this deficiency, individuals with type 1 diabetes need to administer insulin exogenously. Thus, the treatment is primarily behavioral, involving daily insulin injections, frequent blood glucose testing, monitoring food consumption, and engaging in regular exercise (Glasgow et al., 1999). Failure to adhere to the treatment regimen may result in irregular blood glucose levels which can have short-term consequences such as faintness,

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shortness of breath, and susceptibility to illness or long term consequences such as retinopathy, renal disease, and circulatory problems (Centers for Disease Control and Prevention, 2005).

Managing a chronic illness like diabetes can be burdensome--especially in the case of adolescents who are trying to assert their independence from families and establish peer relationships (Holmbeck et al., 2000). Compared to younger children and adults, adolescents exhibit poorer self-care behavior (Anderson, Auslander, Jung, Miller, & Santiago, 1990) and poorer metabolic control (Kovacs, Kass, Schnell, Goldston & Marsh, 1989). Compared to healthy peers, adolescents with diabetes may have elevated levels of depression and anxiety; however, the data are inconsistent on these issues (see Dantzer, Swendsen, Maurice-Tison, & Salamon, 2003; Hauser, Jacobson, Benes, & Anderson, 1997 for reviews).

The majority of research on adolescents with diabetes has focused on the implications of family relationships for adolescents' psychological and physical health. That research clearly shows that support from family is associated with child and adolescent adaptation to disease (see Wysocki & Greco, 2006, for a review). As children transition into adolescence, another important source of support is peers (Wysocki & Greco, 2006). During adolescence teens spend an increasing amount of time with peers (Larson & Verma, 1999), and parent support declines while friend support increases (Scholte, van Lieshout, & van Aken, 2001). Less research has focused on the implications of peer relationships for adaptation to diabetes. Among youth with diabetes, perceptions of diabetes support from friends increases from childhood to adolescence (Shroff Pendley et al., 2002). Although parents seem to be the primary source of support for diabetes care, friends are an important source of emotional support for adolescents with diabetes (La Greca, Auslander, et al., 1995).

The overall goal of the current study was to examine the implications of friendship for psychological well-being, self-care behavior, and blood glucose control among adolescents with diabetes. We also examined whether these relations were the same for boys and girls. Below we briefly review studies that have examined the implications of peer relationships for psychological well-being and diabetes-related outcomes among adolescents. We also consider the literature on gender to determine whether we expect similar relations for boys and girls.

Friendship and Diabetes

There is some evidence that peers play a role in the self-care behavior of adolescents with diabetes (Wysocki & Greco, 2006). Although two studies of adolescents ages 11 to 18 showed that friend support was not related to overall adherence (Bearman & La Greca, 2002; La Greca, Auslander, et al., 1995), one of those studies showed that friend support was related to one dimension of adherence—adherence to blood glucose testing (Bearman & La Greca, 2002). An interview study with adolescents ages 13 to 17 showed that friends who offered support by accommodating to the lifestyle of the teen with diabetes or reminding the teen with diabetes about self-care had better self-care behavior (Kyngäs, Hentinen, & Barlow, 1998). One longitudinal study showed no relation of friend support to an overall index of self-care (Helgeson, Reynolds, Escobar, Siminerio, & Becker, 2007), but another longitudinal study showed that support from both friends and family predicted one dimension of adherence—good dietary behavior 6 months later (Skinner, John, & Hampson, 2000). Finally, one study showed that friend support moderated the relation of stress to metabolic control in a counterintuitive fashion—stress was unrelated to metabolic control at low levels of friend support but related to poor metabolic control at medium and high levels of friend support (Hains et al., 2007)

Regardless of whether support from friends is associated with diabetes self-care and metabolic control, support from friends may help adolescents adjust better psychologically to diabetes (La Greca, Auslander, et al., 1995). One study of adolescents ages 12 to 19 found no relation

of friend support to psychological well-being (de Dios, Avedillo, Palao, Ortiz, & Agud, 2003), but another study showed that an index of friend and family support was related to better psychological well-being (Skinner et al., 2000). A longitudinal study of adolescents found a weak (marginal) relation of friend support to psychological well-being at baseline, but did not find that friend support predicted changes in psychological well-being over the course of the year (Helgeson et al., 2007). Thus, the evidence for the relation of friend support to psychological health among adolescents with diabetes is limited.

Much of the literature on adolescents' relationships with friends has focused on the supportive aspects of those relationships, despite the fact that researchers have raised concerns about the negative impact peers could have on diabetes self-care. When faced with the choice of appropriate self-care behavior and peer desires, Thomas, Peterson, and Goldstein (1997) found that older adolescents have better problem solving skills but are more vulnerable to nonadherence in the face of peer pressure. Another study showed that adolescents who perceive that their friends would react negatively to their self-care behavior report more diabetes stress which in turn is associated with poor metabolic control (Hains et al., 2007). A cross-sectional study found that adolescents who reported negative, dominating interactions with friends reported poorer self-care behavior (Kyngäs et al., 1998), and a longitudinal study showed that friend conflict predicted a decline in psychological well-being and a deterioration in metabolic control over one year (Helgeson et al., 2007). Thus, problematic relations with friends may be associated with psychological distress and may distract adolescents from engaging in good self care.

Taken collectively, the research examining the positive and negative aspects of friend relations to diabetes outcomes and psychological well-being is not clear. There seems to be more evidence that conflictual relations are harmful than that supportive relations are beneficial, which is consistent with the literature on healthy adults (see Lincoln, 2000, for a review). Past research has suffered from three limitations that will be remedied by the present study. First, previous studies frequently examined heterogeneous age groups of children and adolescents, without examining whether the associations of friendship to outcomes differs by age. Second, the majority of studies are cross-sectional or longitudinal with a single follow-up. Studies are needed that examine the relation of friendship to psychological well-being and self-care that employ more momentary methodologies to try to obtain more proximal relations. Previous research has relied on the retrospective recall of relationships. Third, investigators have failed to examine whether the association of friend relationships to outcomes is the same for males and females.

A relatively recent review article on children and chronic illness concluded that researchers have failed to incorporate gender into their models (Miller & La Greca, 2005). There are a number of reasons why one might expect the relations of friendship to health to differ for boys and girls. First, research on children and adolescents in general shows that females' peer relations are more supportive than those of boys'. In the diabetes area, two studies showed that girls received more support for self-care than boys (Bearman & La Greca, 2002; La Greca, Swales, et al., 1995). Second, girls with diabetes seem to have a harder time adjusting to the disease and more difficulty controlling blood glucose than boys (La Greca, Swales, et al., 1995; Pound, Sturrock, & Jeffcoate, 1996) which may suggest that girls have greater needs for support and would be more sensitive to the effects of supportive or conflictual peer relations. Research outside the area of diabetes suggests that friend support and interpersonal conflict is more strongly related to psychological health among girls than boys (Demir & Urberg, 2004; Rigby, 2000; Shih, Eberhart, Hammen, & Brennan, 2006). Thus, it is possible that peer relationships are more strongly related to the psychological and physical health of girls than boys with diabetes.

Current Study

In the present study, we examined the implications of the positive and negative aspects of friend relationships for psychological well-being and diabetes-related outcomes among adolescents with diabetes. We had a more homogenous age range of adolescents, ages 13 to 16, than that previously studied. We also had a roughly even distribution of males and females so that we were able to examine whether findings generalize across the two genders. We hypothesized that the positive aspects of friendship would be related to better psychological well-being, better self-care behavior, and good blood glucose control, whereas the negative aspects of friendship would be inversely related to these outcomes. We also hypothesized that the negative aspects of peer relationships would be more strongly related to outcomes than the positive aspects, as shown by previous literature. Finally, we hypothesized that the association of peer relations to health outcomes will be stronger for females than males.

We used two different methodologies to test these hypotheses. First, we used a between-subjects procedure by having adolescents complete a questionnaire assessing friend support, friend conflict, psychological well-being, and self-care behavior at study start. Overall metabolic control was obtained from medical records. With this methodology, we can determine whether adolescents who have more and less friend support and conflict have different health outcomes. Second, we used a within-subjects procedure by having adolescents complete ecological momentary assessments (EMA) of enjoyable and upsetting interactions with friends, mood, and blood glucose levels over the course of four days. With this methodology, we can determine whether an individual's mood or blood glucose fluctuates in accordance with having enjoyable or upsetting interactions with friends over the course of four days.

This study expanded on previous research in the area of adolescents with diabetes in several ways. First, we focused on friends rather than family. Second, we measured the negative as well as the positive aspects of relationships. Third, we utilized two different methodologies to examine the implications of friendship for health. Fourth, this is the first study to our knowledge that examined blood glucose on a momentary basis over the course of four days and attempted to link psychosocial data to blood glucose. Previous research typically relied on an overall measure of metabolic control, which reflects an average over the course of 3 months, although a few studies have examined end-of-day blood glucose levels over a series of days (e.g., Aikens, Wallander, Bell, & McNorton, 1994). By including both a retrospective survey measure of friend relationships and EMA analysis of interactions with friends, we were able to compare our findings across the two methodologies to better understand the role that friendship plays in the psychological well-being and blood glucose control of adolescents with diabetes.

Method

Participants

Participants were 76 adolescents with diabetes (38 boys, 38 girls), ranging in age from 13 to 16 (M = 14.54; SD = .95). Adolescents had been diagnosed with diabetes an average of 6.34 (SD = 3.22) years earlier. Approximately half administered insulin via injections (n = 37), and half used an insulin pump (n = 39). The majority of the adolescents were Caucasian; the final sample included 1 Hispanic adolescent (1.3%) and 7 African American adolescents (9.2%).

Recruitment

To be eligible, participants had to be ages 13 to 16, had to have had type 1 diabetes for at least one year, could not have another major chronic illness, and had to live within a one-hour drive from Children's Hospital. The majority of participants were recruited from the diabetes clinic at Children's Hospital of Pittsburgh. Two physicians mailed a total of 355 letters to their

adolescent patients with type 1 diabetes. Letters provided information about the study and requested that families return a stamped postcard indicating whether they would like to be contacted about the study. Because of HIPAA regulations, we were not allowed to contact families unless they returned a postcard. Of the 355 letters mailed, 11 letters were returned as undeliverable and 212 postcards were not returned, leaving it unclear as to whether they would have participated in the study or not. Of the 132 postcards that were returned, 86 indicated an interest in contact and 46 declined to be contacted. Thus, of the 344 delivered letters, 25% expressed an interest in the study; of the 132 returned postcards, 65% expressed an interest in the study. When the 86 families were contacted by phone, 10 changed their mind and indicated they were no longer interested in the study, 9 were determined to be ineligible, 1 was not able to be reached, and 66 adolescents agreed to participate in the study. After the initial session, 1 adolescent was dropped from the study due to noncompliance with the protocol. In the end, 65 adolescents participated in the study.

To increase our sample size, we visited and obtained an additional 11 participants from a local diabetes summer camp (n = 7) and from a local information session for families of teens with diabetes (n = 4). These 11 participants attended the same diabetes clinic as the other 65 participants, but for some reason did not respond to the mailed invitation. They did not differ from the other 65 participants on any demographic or disease-related variable. Thus, the final data set consisted of 76 adolescents.

Procedure

Each participant completed the study over 4 days which were divided into two 2-day sessions. The first session took place over a weekend. Researchers met participants in their homes on the Friday evening or Saturday morning that preceded this session. Informed consent was obtained from one parent and the adolescent, the baseline interview was conducted, and adolescents and parents were provided with detailed information about the procedure. Adolescents were shown how to complete the brief palm pilot questionnaire. They also were given a blood glucose meter to use over the course of the study.

Over the 2-day weekend, participants completed a 3-5 minute questionnaire on the palm pilot every 2 hours throughout the day, beginning when the adolescent woke up in the morning and ending when the adolescent went to bed. Participants were prompted to complete the questionnaire by a watch that beeped every 2 hours. We chose a 2-hour interval to maximize the number of entries per day (between 6 and 8), without increasing participant burden to the point of noncompliance. As there is very little research on adolescents using this methodology, the interval chosen was exploratory. At the end of every other questionnaire (every 4 hours), the palm pilot prompted participants to test their blood glucose level and record the number in the palm pilot. This interval was chosen for similar reasons—to maximize the number of readings without increasing burden to the point of noncompliance. To reduce the intrusiveness of the methodology and enhance compliance, we told participants that it was better to complete an entry a few minutes early or late than to not complete an entry at all.

At the end of the second day, the interviewer returned to the family's home to collect the equipment and conduct a process evaluation interview with the adolescent. Palm pilot and blood glucose meter data were downloaded and reviewed with the adolescent. Adolescents were asked to explain any discrepancies between blood glucose readings recorded in the meter and palm pilot as well as any delays in testing or completing a questionnaire.

The second session was conducted within a month of the first session and over two weekdays during the school year. Prior to the second session, school principals were contacted to ensure that participants could bring the palm pilot to school. All principals agreed, and school nurses were often contacted. This second session was similar to the first, except there was no baseline

questionnaire and a vibrating watch was used to minimize the disruption to school. At the conclusion of the second session, adolescents were thanked for their participation and paid $100 for participating in both sessions.

On average, participants completed 7 entries (range 2 to 9) per day, which was close to the stated expectation of 8 entries. All participants completed a minimum of 2 entries per day, and only 6% of participants completed less than 5 entries per day. Thus, our compliance with number of entries was high. Among entries completed, 78% were completed within 15 minutes of the designated time. Only 8% of entries were completed more than 30 minutes past the designated time.

Baseline Measures

Support and conflict—General support from friends was assessed using the Berndt and Keefe (1995) friendship questionnaire. This instrument contains 6 scales: companionship, intimacy, instrumental support, self-esteem enhancement, conflict, and dominance. In addition to high internal consistencies, the scales have been found to differentiate the degree of closeness of friends. Five of the six scales consist of 4 items; companionship contains 6 items. All 26 items are rated on 5-point scales ranging from 0 (never) to 4 (very). In accordance with the authors' recommendations, we had participants list their three closest friends with whom they see or talk to on a regular basis prior to administering the instrument and asked them to think about those friends while they answered the questions.

Because the four positive scales were highly intercorrelated (*r's* ranged from .46 to .72, all *p*'s < .001), we standardized the four scales and averaged them to form an overall support index. The two negative aspects of friendship (conflict and dominance) were correlated ($r = .65$, $p < .001$), but were unrelated to the four positive friendship scales. Thus, we averaged across these two scales to form an overall conflict index. The internal consistency of the support index was .92, and the internal consistency of the conflict index was .79. The support and conflict indices were not correlated, $r = .15$, $p > .10$. The average friend support score was 3.81 ($SD = .70$), which suggests high levels of support. The average conflict score was 1.86 ($SD = .55$), which suggests low levels of conflict.

Depressive symptoms—We measured depressive symptoms using the 20-item Center for Epidemiological Studies Depression Scale (CES-D; Radloff, 1977). Adolescents are asked to indicate how often they experienced each symptom in the past two weeks. Each item is rated on a 0 (none) to 3 (most) scale; items are summed to form a total score. Higher numbers indicate greater depressive symptoms. The average score was 9.75 ($SD = 6.17$), which is slightly lower than the level of depressive symptoms reported by the general population (Radloff, 1977). Internal consistency was good ($\alpha = .80$).

Self-care—We used the 14-item Self-Care Inventory (La Greca, Swales, Klemp, & Madigan, 1988), which assesses how well respondents follow their physician's recommendations for glucose testing, insulin administration, diet, exercise, and other diabetes-related behaviors. Each item is rated on a 1 (never do it) to 5 (always do this as recommended) scale. This scale reflects domains of self-care that have been regarded as important by the American Diabetes Association, and it has been associated with metabolic control among adolescents in a number of studies (e.g., Delamater, Applegate, Eidson, & Nemery, 1998; La Greca, Follensbee, & Skyler, 1990). We omitted three items from the scale. The item “adjusted insulin based on blood glucose levels” was inadvertently omitted when creating the questionnaire. The item “coming in for regular appointments” was omitted because it is dependent upon the parents. Finally, the item “eating regular snacks” was omitted because the internal consistency analysis revealed that it detracted from the overall reliability of the scale. We updated this scale by

adding six more contemporary items, 3 adopted from another study (Weissberg-Benchell, Wirtz, & Glasgow, 1995; took extra insulin because ate inappropriate food, skipping injections or boluses, eating foods that should be avoided) and 3 of our own (skipping meals, rotating injection sites, measuring food). Responses for these 6 items were made on a five-point scale (1 = never do it; 5 = always do this). Negative items were reverse-coded before summing and averaging to form the self-care index. The average score in this study was 3.66 (*SD* = .50) which indicates good self-care. The final scale consisted of 17 self-care behaviors and had good internal consistency (α = .74). This modified index was used in a previous study of adolescents with diabetes (Helgeson et al., 2007) and found to have good reliability.

Metabolic control—The participant's most recent hemoglobin A1c was obtained from medical records. This is a test of the plasma glucose concentration over the past 2-3 months. The average hemoglobin A1c was 8.65 (*SD* = 1.78), which exceeds the 7.5% that the American Diabetes Association (2008) has defined as good control among adolescents with diabetes.

Palm Pilot Measures

Our computer diary was modeled after the Diary of Ambulatory and Behavioral States (DABS; Kamarck, Shiffman, Smithline, Goodie, & Thompson, 1998) which is a self-report questionnaire designed for repeated administration in the natural environment. The majority of scales that are used are visual analogue scales which make it easy for respondents to answer the questions quickly. Subscales from this diary (including mood and social interactions) have been shown to be reliable within- and between-persons (Kamarck et al., 1998), to be sensitive to fluctuations in psychosocial demands throughout the day (e.g., ratings differ between home and work in adult samples; Kamarck et al., 1998) and, when averaged across observations, to be associated with global questionnaire measures of comparable constructs in the expected direction (Kamarck et al., 1998; Kamarck et al., 2004). DABS subscales have been shown to be associated with biological markers of stress (ambulatory blood pressure and heart rate) within and between persons (Kamarck et al., 2002), and some of these measures are associated with biological markers of subclinical disease as well (Kamarck et al., 2004). Minor wording changes were made to make the items more easily understood by adolescents, recognizing that this particular diary has not been validated in adolescent populations although similar items have been used in EMA studies of adolescents (Whalen, Jamner, Henker, Delfino & Lozano, 2002). Diary entries are time-stamped so they can be directly linked to blood glucose readings on the time-stamped blood glucose meter.

Interpersonal interactions—Participants were asked if a social interaction occurred within the past two hours. If so, the following two items were used to measure the positive and negative valance of the most recent interaction: (1) how enjoyable was the interaction, and (2) how upsetting was the interaction. Scale endpoints were “not at all” (0) and “very” (100). We asked about the most recent interaction to capitalize on the strength of EMA methods to capture “real time” assessment rather than retrospective reports. After rating the valence of the interaction, participants indicated with whom the interaction occurred: parent, other family member, same-sex friend, other-sex friend, or other. Participants checked all that applied. For the purpose of these analyses, only interactions that included same-sex or other-sex friends were examined (regardless of whether other people also were involved in the interaction). Of the interactions that included friends, 31% of them included relatives as well.

Mood—The questionnaire contains a 6-item measure of mood: 2 anxiety (nervous, relaxed), 2 depression (sad, happy [reverse scored]), and 2 anger (mad, annoyed). Participants rated their current mood on a scale from “not at all” (0) to “very” (100). Scores on the individual items were averaged to create three mood scores.

Blood glucose—We examined blood glucose levels on a momentary basis over the four days. At the end of every second palm pilot entry (four hours) participants were asked to test their blood glucose and record it. (This was in addition to any blood glucose readings that they took as a part of their normal regimen or in response to symptoms.) Data were downloaded from participants' blood glucose meters to verify the accuracy of the number recorded on the palm pilot and the time tested. For the vast majority of entries (93%), the number recorded on the palm pilot matched the number in the blood glucose meter. In 4% of the cases, the discrepancy between the two numbers was 10 or less. In 1% of the cases, participants recorded a higher number on the palm pilot than was found on the meter (ranging from 11 to 53). In 2% of the cases, participants recorded a lower number on the palm pilot than was found on the meter (ranging from 11 to 456). There were an additional 5% of cases where participants entered numbers in the palm pilot that could not be located in the meter, suggesting that participants did not test their blood sugar and possibly made up numbers. We used the value entered in the blood glucose meter for all analyses.

Statistical Analyses

Three levels of analysis were conducted. The first analysis was a between-subjects survey analysis. We used regression analysis to predict psychological well-being, self-care behavior, and metabolic control. Measures of support, conflict, and gender were entered on the first step, and the interactions between gender and support and gender and conflict were entered on the second step of the equation. In this way, we could observe the unique relations of support and conflict to each outcome. Predictors were centered before computing interaction terms.

The second level of analysis was a within-persons analysis that was conducted using multi-level modeling with HLM 6 software (Raudenbush, Bryk, Cheong, Congdon, & du Toit, 2004). Because palm pilot data (level 1) are nested within days (level 2) which are nested within participants (level 3), we used a three-level multilevel model. Multilevel models account for the lack of independence among palm pilot entries and among days. Multilevel modeling allowed us to calculate the relation between the level 1 variables (interpersonal interactions and outcomes [i.e. mood, activity, blood glucose]) for each individual and then determine if gender (a level 3 variable) moderated the relations. We were interested in measuring how changes in ratings of interpersonal interactions within-persons affect various outcomes, so data were person-centered. Person-centering measures an individual's deviation from his or her average ratings of interactions. We examined the relations of both interaction enjoyment and interaction upset to mood and blood glucose at the end of the interval. We also examined whether gender predicted the slopes of the relations of enjoyable and upsetting interactions to outcomes.

A third way to examine the implications of peer relationships for psychological well-being and physical health that utilizes aspects of both the between-persons and the within-persons measures is to aggregate over the within-persons independent variables and correlate these aggregate variables with the between-persons dependent variables. In this way, we could determine if the accumulation of interaction enjoyment and interaction upset was related to outcomes between individuals. This would tell us if the accumulation of interaction enjoyment functioned as the survey measure of social support and if the accumulation of interaction upset functioned as the survey measure of conflict. This would be the case to the extent that the results from the aggregate analyses replicate the results from the between-groups analyses. Regression analysis was conducted in which interaction enjoyment aggregated across four days, interaction upset aggregated across four days, and gender were entered on the first step followed by the interactions between gender and aggregate enjoyment and gender and aggregate upset.

Results

Between-Persons Survey Analyses

Background variables—To determine whether we needed to control for any demographic variables in our analyses, we examined whether any demographic variable was related to both baseline independent variables (support, conflict) and dependent variables (depressive symptoms, self-care behavior, metabolic control). Gender was related to only one variable, support, $t = -4.01$, $p < .001$, such that girls reported more support from friends ($M = 4.11$) than boys ($M = 3.51$). There were no gender differences on any dependent measure. Income was unrelated to independent variables but was related to better self-care, $r = .31$, $p = .01$, and better metabolic control, $r = -.38$, $p < .01$. Race, time since diagnosis, and age were unrelated to all independent and dependent variables. Because none of the demographic variables were related to both independent and dependent variables, we did not control for any of them in our analyses.

Intercorrelations among dependent variables—Depression was associated with poor self-care behavior, $r = -.32$, $p < .01$, and poor metabolic control, $r = .25$, $p < .05$. Self-care behavior revealed a marginally significant relation with good metabolic control, $r = -.21$, $p = .07$.

Support vs. conflict—We hypothesized that support from friends would be associated with psychological well-being, better self-care behavior, and good metabolic control, while conflict with friends would be inversely associated with these outcomes. We also predicted that relations with conflict would be stronger than relations with support. The results from the regression analyses are shown in Table 1. Neither support nor the interaction between support and gender were significant predictors of any outcome. Conflict was associated with worse self-care behavior. Conflict interacted with gender to predict depressive symptoms and metabolic control. We used the procedures outlined by Aiken and West (1991) to interpret and plot the interactions. As shown in Figure 1, conflict was more strongly associated with more depressive symptoms among girls compared to boys. As shown in Figure 2, conflict was more strongly associated with poor metabolic control for girls than boys.

Within-Persons Ecological Momentary Assessment Analyses

Descriptives—On average, adolescents rated their most recent interaction with friends as fairly enjoyable ($M = 68.21$, $SD = 22.94$) and not very upsetting ($M = 18.22$, $SD = 24.34$). There were no gender differences in ratings of interaction enjoyment or interaction upset. Average ratings of depressed, anxious, and angry mood were all low (depressed $M = 26.28$, $SD = 20.21$; anxious $M = 31.98$, $SD = 22.24$; angry $M = 24.47$, $SD = 25.44$). Average blood glucose levels were 188.71 ($SD = 107.39$). There was no gender difference. We examined all momentary variables for outliers. Using an outlier criterion of 2 standard deviations from the mean, we found between 0% and 3.7% of values were outliers. With the exception of 2 participants, outliers appeared to be random. Removing those two participants from the analyses did not alter the results we report below.

Interpersonal interactions—We used multi-level modeling to examine the relations of interaction enjoyment and interaction upset with friends to ratings of mood and blood glucose at the end of each interval. We hypothesized that interaction enjoyment would be associated with better mood and lower blood glucose, that interaction upset would be associated with worse mood and higher blood glucose, that the relations of the latter would be stronger than the relations of the former, and that these relations would be stronger for girls compared to boys. Depressed mood was predicted by both less interaction enjoyment (B = -.15, SE = .03, $p < .001$) and more interaction upset (B = .23, SE = .04, $p < .001$). Anger was predicted by both less interaction enjoyment (B = -.21, SE = .03, $p < .001$) and more interaction upset (B

= .24, SE = .04, $p < .001$). Finally, anxiety was predicted by less interaction enjoyment (B = -.10, SE = .04, $p < .05$) and more interaction upset (B = .18, SE = .04, $p < .001$). Neither interaction enjoyment nor interaction upset predicted blood glucose. Gender did not moderate any of these relations.

Aggregating Across Interactions

To determine if the accumulation of interaction enjoyment and interaction upset were related to between-groups outcomes (psychological well-being, self-care behavior, metabolic control) in the same way that friend support and friend conflict were, interaction enjoyment with friends and interaction upset with friends were aggregated across the four days and entered in a regression analysis to predict between-persons outcomes. Regression analyses (shown in bottom of Table 1) revealed no main effects of aggregate interaction enjoyment or aggregate interaction upset on outcomes, but interactions between gender and aggregate interaction enjoyment for depressive symptoms and self-care behavior. As shown in Figure 3, aggregate interaction enjoyment was associated more strongly with less depressive symptoms for girls than boys. As shown in Figure 4, aggregate interaction enjoyment was associated more strongly with better self-care for girls than for boys.

Discussion

We hypothesized that both the positive and negative aspects of friend relationships would be associated with psychological well-being, self-care behavior, and blood glucose control, that the latter relations would be stronger than the former, and that relations would be stronger for girls than boys. Our between-groups analysis—which is the traditional analysis employed by other research—largely supported these hypotheses. Although there were no relations of friend support to outcomes, conflict with friends was associated with more depressive symptoms, worse self-care behavior, and poor metabolic control. This finding is consistent with other between-groups designs among adults (Lincoln, 2000) and a recent study of adolescents with diabetes (Helgeson et al., 2007). Like these other studies, the results suggest that conflict may be a more salient and impactful aspect of friendships than support. However, the cross-sectional nature of these data precludes our ability to draw causal inferences. It may be that people who are more distressed and in poorer physical health elicit conflictual interactions with friends.

Also as hypothesized, several of these findings were stronger among girls than boys or limited to girls. Although boys and girls reported the same level of conflict, conflict appeared to be more troublesome for girls. Friend conflict was more strongly associated with poor psychological well-being and poor metabolic control for girls than boys. Conflict in relationships may be more bothersome for girls than boys because conflict is a more normative aspect of boys' friendships. Boys tend to experience more conflict in their peer relationships than girls (Black, 2000; Furman, 1998), especially in the context of competition (Schneider, Woodburn, del Pilar Soteras del Toro, & Udvari, 2005). Girls' relationships also tend to be more supportive than boys (Kuttler, La Greca, & Prinstein, 1999; Lempers & Clark-Lempers, 1993), suggesting that conflict may be a greater deviation from expectations among girls. Our data suggested that conflict in friendships was associated with poor metabolic control for girls but not boys. One possibility is that conflict distracts girls from taking care of themselves, which results in poor metabolic control. Alternatively, the distress associated with conflict, in and of itself, may lead to greater blood glucose fluctuation and, hence, poor metabolic control for girls. Again, the cross-sectional nature of these findings makes it unclear whether conflict is causing poor metabolic control for girls or whether girls' poor metabolic control becomes disruptive to their relationships.

The findings from the within-group analyses did not replicate those from the between-groups analyses. Here, both interaction enjoyment and interaction upset predicted the three mood

indices. In all cases, the beta coefficient was larger for interaction upset than interaction enjoyment, consistent with the idea that the negative aspects of relationships are more potent predictors of health than the positive aspects. Here, however, there were no interactions with gender, a point we will return to in a moment.

Aggregating across these interactions and examining their association with between-groups outcomes revealed a third set of findings that did little to reconcile the findings from the two different methodologies. It was the aggregate of interaction enjoyment rather than interaction upset that predicted the between-person outcomes. And, these effects were moderated by sex, such that they held only for females, consistent with the previous between-group findings.

Why was friend conflict more strongly related to health outcomes for girls than boys, interaction upset equally associated with health for boys and girls, and aggregage interaction enjoyment more strongly related to health outcomes for girls than boys? One explanation for the discrepancy in the findings might have to do with the different ways that boys and girls cope with conflict. The literature on gender and coping shows that girls are more likely than boys to ruminate about aversive experiences (Tamres, Janicki, & Helgeson, 2002). This could explain why conflict was more strongly related to psychological well-being and physical health in the between-group survey analysis but not the within-group or aggregate analysis. In the moment, boys and girls seem to respond to upsetting interactions similarly. The between-group retrospective conflict measure, however, is likely to reflect difficulties with friends that linger —as the momentary upsets will have faded from memory. Girls may be more likely than boys to ruminate about an upsetting interaction over time, causing it to have longer lasting effects. Thus, the effects of upsetting or conflictual interactions may dissipate over time for boys but become amplified over time for girls who tend to ruminate about the problem.

There are other reasons for the inconsistency in the findings across the different methods of analyses. First, recall that the between-groups and within-groups analyses are asking different questions. The between-groups analysis shows that people who have more conflict with their friends have poorer self-care behavior. The analysis focuses on differences among people. The within-groups analysis shows that when a given person has an upsetting interaction that involves a friend they have a poorer mood, and when they have an enjoyable interaction with a friend they have a better mood. The analysis focuses on differences within individuals in terms of when they feel good and feel bad.

Second, the between-group survey and within-group EMA employed different measures of the independent variables. When we examined the relation between friend support and an aggregate measure of enjoyable interactions, we found a modest positive relation ($r = .29$, $p < .05$), but no relation between friend conflict and an aggregate measure of upsetting interactions ($r = .04$, n.s.). Third, the independent variables used in the two analyses reflected different timeframes. The between-group survey analysis assessed friendship quality with retrospective measures of support and conflict. The within-group analysis assessed friendship quality with ratings of interaction enjoyment and upset over the past two hours. The retrospective reports are subject to greater recall bias than the on-line ratings of interactions. With retrospective reports, conflictual interactions may be more salient and easily recalled than supportive interactions. With on-line reports, interaction enjoyment and upset are equally accessible. Thus, in the moment, both positive and negative aspects of an interaction or relationship may be important. But, when some time has passed, it is the negative aspects of relationships that are recalled and impactful.

One of the most novel aspects of this study was our ability to examine momentary changes in blood glucose level. Although friend conflict was associated with poor metabolic control (only for females), we did not detect any relations between enjoyable or upsetting interactions with

friends and blood glucose levels. In our attempt to understand this null finding, we came across 3 participants who had several extremely high blood glucose readings (range 575 to 600). When these six readings were removed from the data, we found that interaction upset was a marginally significant predictor ($p < .10$) of higher blood glucose (B = .48; SE = .28). This is somewhat encouraging as blood glucose readings are highly variable and respond to a number of factors including hormonal fluctuations, diet, activity levels, stress, and the type and timing of insulin administration (American Diabetes Association, 2008). To the extent that future research can better control for these extraneous variables, stronger relations may be extracted between psychosocial variables and changes in blood glucose.

Conclusions and Future Directions

The results of this study suggest that the positive and negative aspects of peer relationships are related to the psychological well-being and physical health of adolescents with diabetes. Of the two, the negative aspects of peer relationships revealed more robust relations. Conflict was associated with poor psychological well-being and poor diabetes health when assessed retrospectively, upsetting interactions were associated with negative mood states in the moment, and the aggregate of those upsetting interactions was associated with poor psychological well-being. The positive aspects of relationships were only linked to outcomes on a momentary basis. Finally, the findings suggest that girls are especially responsive to both the positive and negative aspects of peer relationships. We hypothesized that the positive and negative aspects of friendship would be more strongly associated with outcomes for girls than boys. Gender did not moderate all of the associations between relationship variables and outcomes, but when moderation did occur, it was consistently in the predicted direction.

This study makes a significant contribution to the literature on adolescent health by providing a novel methodology to explore the effects of psychosocial factors on psychological and physical health. Few studies have employed EMA methods among adolescents, let alone adolescents with a chronic illness such as diabetes. As a first attempt in this area, we asked adolescents to complete a brief questionnaire every 2 hours for four days and test their blood glucose every 4 hours over those same four days. We were uncertain about whether adolescents would be willing and able to do this over four days, with two of those days taking place during school. We found an extremely high rate of compliance. The average number of intervals completed over the course of a day was 7. We emphasized the importance of completing an entry, even if a few minutes early or late, rather than the omission of an entry. We allowed the timing to be more flexible as we did not want the protocol to disrupt school or leisure activities. If we had held to the strict 2-hour window, we believe that we would have had a lower rate of compliance with entries completed and greater concerns raised by school officials. The vast majority of entries were completed on time. The average entry was completed 5 minutes after the designated time. Only 8% of entries were completed more than 30 minutes later. The findings from this study demonstrate to researchers in the field that this is a feasible method to collect data on what is going on in youth's lives and how daily events might impact mood, self-care, and blood glucose. Future research can expand this methodology to incorporate continuous blood glucose monitoring, within which much more data on momentary blood glucose can be collected without having to ask adolescents to test their blood sugar.

There are several limitations to the conclusions that can be drawn from the results of this study. First, it may be inappropriate to compare the findings from the between-group survey and within-group EMA analyses because the relationship measures were not the same and may reflect different constructs. Second, the between-group survey analyses are cross-sectional and may reflect the reverse causal sequence. That is, adolescents who have poor health may experience more conflict in their relationships. Even the within-groups analyses could imply that adolescents who are in a negative mood are more likely to interpret an interaction as

upsetting. Third, it is important to keep in mind that the different methods of analysis are asking different questions. The between-group survey analyses show that individuals who report more (compared to individuals who report less) conflict in their relationships also report poorer psychological well-being. The within-groups analyses show that when a given individual experiences a more upsetting interaction (compared to a less upsetting interaction), that individual reports more negative mood. The between-group survey analyses reflect individual differences in the sample of adolescents, whereas the within-group EMA analyses reflect differences within each individual. Other limitations include our use of a daily diary questionnaire that has been validated on adults but not adolescents and our reliance on a brief self-report measure of self-care behavior. Better measures of self care exist, but they are labor intensive. Among the self-report instruments, the one we chose is one of the most widely used. Finally, the sample size of 76 may appear small at first glance but hierarchical linear modeling is able to take advantage of the repeated measures format of the data. Thus, the degrees of freedom in the analyses are not based on 76 but on the total number of observations (76 subjects × 4 days × 7 per day, or 2128). Nonetheless, the sample size coupled with the large number of analyses conducted is a study limitation.

We believe these limitations are offset by the following strengths. First, this study focused on relations with friends rather than family, an understudied topic in diabetes. Second, we examined both the positive and negative aspects of peer relationships. Third, we tested our hypotheses with two different methods, a retrospective survey and an EMA method. Fourth, we examined gender as a moderator of the relations of friendship to health, a research avenue that has been neglected by past research.

Our findings suggest that more research in the area of adolescents with diabetes ought to focus on peer relationships. Clinicians should consider incorporating peers into their intervention research as a possible source of support. To date, only one intervention has focused on friends--with some success (Greco, Pendley, McDonell, & Reeves, 2001). Researchers also should distinguish among different levels of peer relationships. Because adolescents are trying to establish a peer group and trying to fit in with their peers, it may be that difficulties with classmates rather than friends have more of an impact on adherence. In that case, intervention research should help provide adolescents with the skills to respond to situations involving peers that could detract from good self-care. Adolescents who feel that they are different from their peers or not well-liked by classmates may be unlikely to engage in behaviors (e.g. testing, insulin administration) that further distinguish them from the general student population.

Acknowledgments

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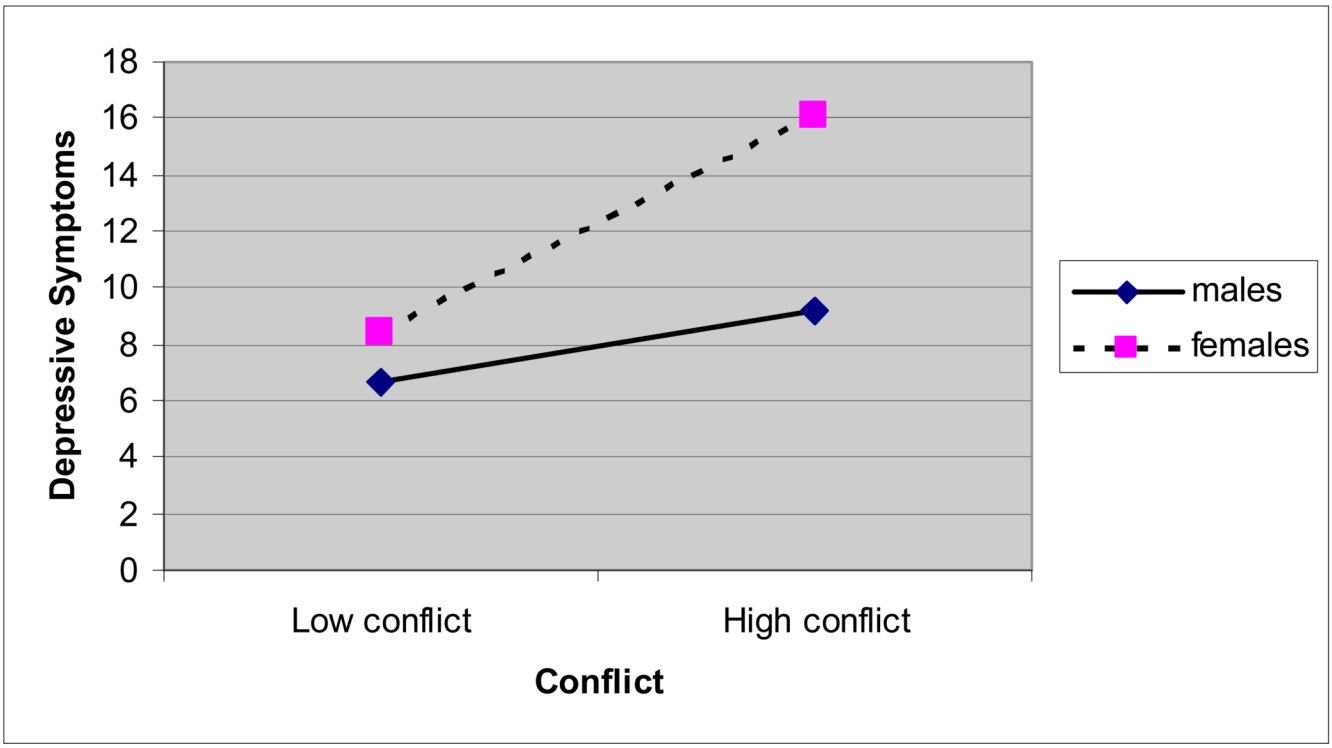

Figure 1.
Conflict is more strongly related to depressive symptoms among females than males.

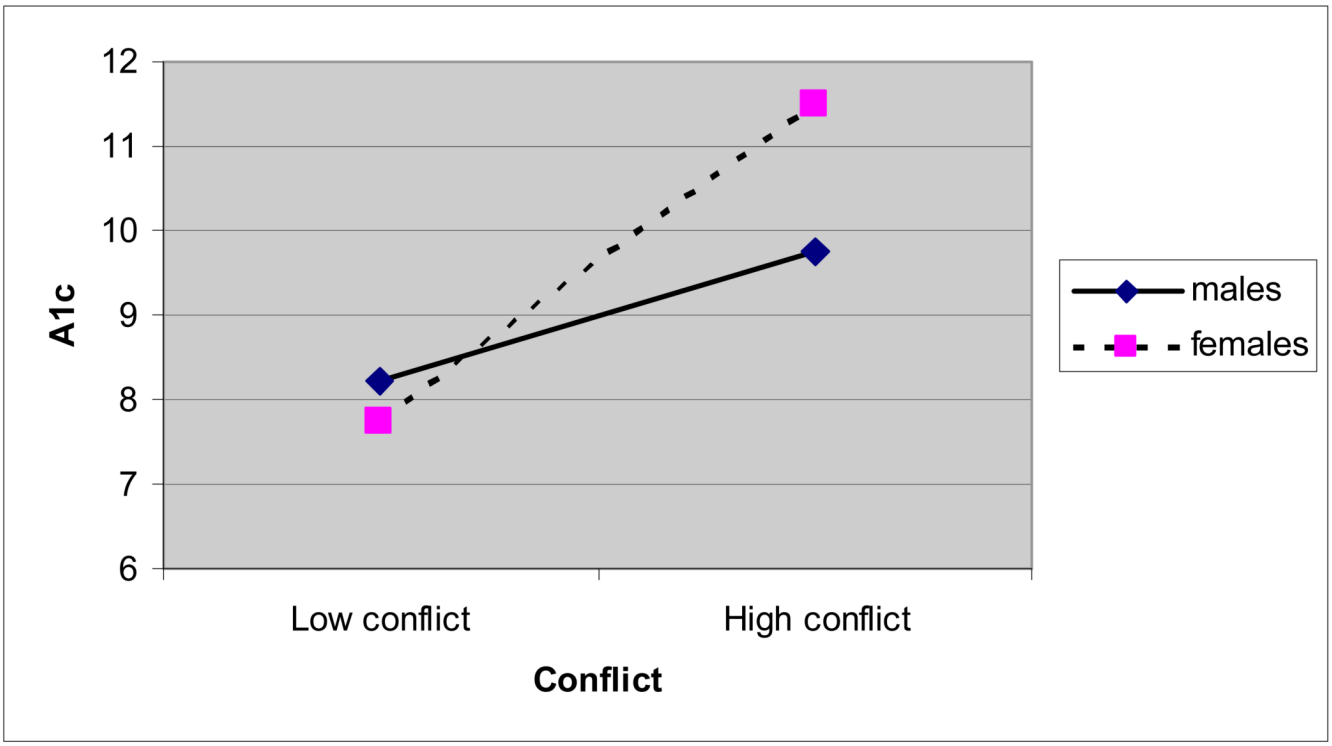

Figure 2.
Conflict is more strongly related to poor metabolic control (higher A1c) among females than males.

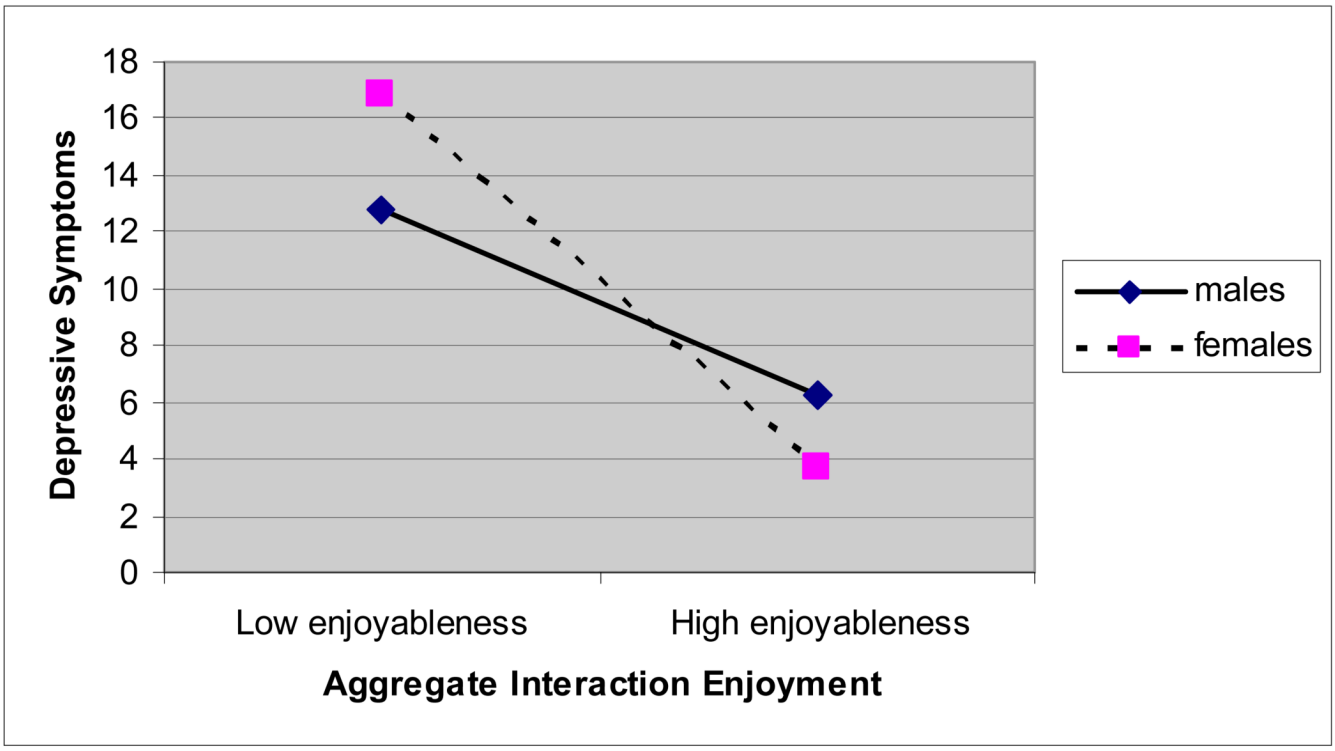

Figure 3.
The aggregate of interaction enjoyment is more strongly related to fewer depressive symptoms among females than males.

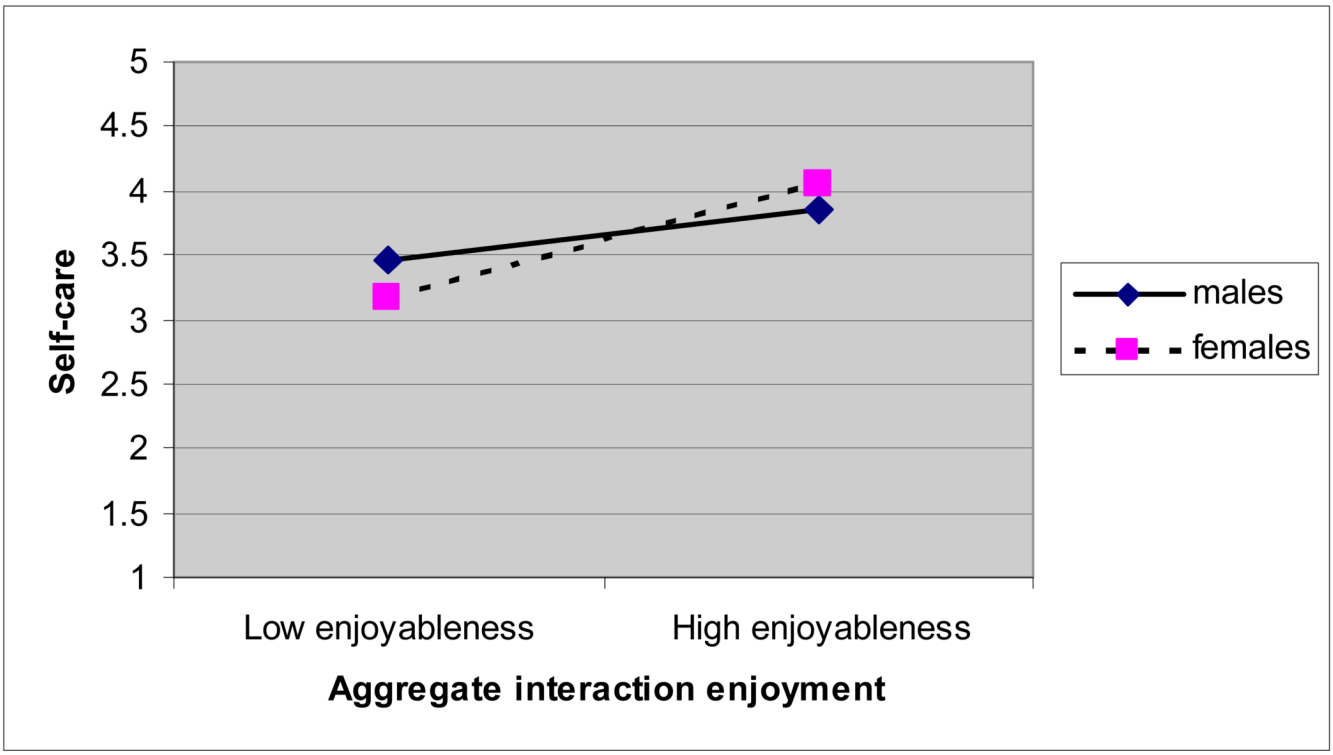

Figure 4.
The aggregate of interaction enjoyment is more strongly related to better self-care behavior among females than males.

Table 1

Multiple Regression Analysis to Predict Survey Outcomes: Beta Coefficients for Support, Conflict, Gender, and Interactions with Gender

	Depression	Self-Care	A1c
Friend support	.01	.08	.22
Friend conflict	-.22	-.35**	-.97**
Gender	.36**	---	.22
Gender * support	-.36	---	-.29
Gender * conflict	.68*	---	1.20***
Aggregate Enjoyable Interactions	.64	-.59	.10
Aggregate Upsetting Interactions	-.26	-.30	.00
Gender	.08	.04	---
Gender * Aggregate Enjoyable Interactions	-1.06**	.83*	---
Gender * Aggregate Upsetting Interactions	.58	.20	---

* $p < .05$,

** $p < .01$,

*** $p < .001$