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Peer Interactions and Health Among Youth With Diabetes: An Ecological Momentary Assessment

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Objective: We examined the links of supportive and conflictual peer interactions to mood and self-care via ecological momentary assessment. ***Method:*** Adolescents with Type 1 diabetes ($n = 167$, 49% female) recruited between 2018 and 2021 were prompted 8 times a day for 8 days to complete brief surveys that measured perceived social interactions, affect, and self-care. ***Results:*** Cross-sectional analyses revealed between- and within-person (WP) links of peer support to positive mood and conflict to negative mood. Between-person peer support was linked to healthy self-care, but WP support was not. Lagged analyses showed conflictual interactions were associated with self-care decline. There was some evidence that females did not benefit as much from support and were more bothered by conflict than others. ***Conclusions:*** Results underscore differences in between- and WP links of social interactions to health. Individual differences in support were more influential than conflict, but conflictual interactions had more momentary effects than supportive interactions.

Public Significance Statement
Substantive contributions to research on Type 1 diabetes are made by focusing on peer relationships, examining both support and conflict, testing gender moderation, and employing a design that examines proximal links of social interactions to health. Between-person and within-person support and conflict were related to mood, but only between-person support was related to self-care. A key longitudinal finding showed within-person peer conflict was linked to declines in self-care over time.

Keywords: diabetes, adolescents, friendship, social support

The vast majority of research on youth with Type 1 diabetes (T1D) focuses on the implications of the family for adolescents' psychological and physical health (Helgeson et al., 2019). However, the social environment of adolescents, including adolescents with T1D, extends beyond the family to include peers and friends. Indeed, over the course of adolescence, youth spend an increasing amount of time with friends, and friends become a major source of social influence (Spitz et al., 2020). Despite these facts, the literature on the implications of friends for the health of adolescents with T1D is small.

This is a particularly important oversight because adolescence is a high-risk period for both psychological health and diabetes health. Depressive symptoms increase during adolescence as does risk behavior (e.g., alcohol) and disturbed eating behavior (Arnett, 2000). For those with Type 1 diabetes, self-care behavior decreases and glycemic instability increases over the course of adolescence (Helgeson et al., 2010; King et al., 2014).

A risk and resistance framework has been applied to the study of psychosocial factors involved in diabetes outcomes over the course of adolescence (Palladino & Helgeson, 2012). Social/environmental variables are thought to constitute both a resistance factor (i.e., support) and a risk factor (i.e., conflict). These factors can also apply to peer relationships. Support refers to interactions that provide one

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Vicki S. Helgeson served as lead for conceptualization, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, resources, supervision, writing–original draft, and writing–review and editing. Fiona S. Horner served in a supporting role for data curation, formal analysis, writing–original draft, and writing–review and editing. Harry T. Reis served in a supporting role for conceptualization, funding acquisition, and writing–review and editing. Nynke M. D. Niezink served in a supporting role for conceptualization, formal analysis, funding acquisition, and writing–review and editing. Ingrid Libman served in a supporting role for funding acquisition and writing–review and editing.

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with a sense of self-worth and validation, information and advice, and concrete assistance (Cohen, 1988). By contrast, conflictual interactions include miscarried helping (i.e., support efforts that fail; Coyne et al., 1988), social conflict (Rook et al., 2004), and social constraints (Lepore & Helgeson, 1998).

A review of the literature on peer relationships and health among youth with T1D revealed more evidence that conflictual friendships are related to poor health than that supportive friendships are related to good health (Van Vleet & Helgeson, 2020). For example, in an ecological momentary assessment (EMA) study (Helgeson et al., 2009), adolescents between the ages of 13 and 16 first completed baseline measures of friend support and friend conflict and then reported every 2 hr over the course of 4 days whether they interacted with a friend and the extent to which the interaction was enjoyable or upsetting. Baseline measures of friend support were unrelated to depressive symptoms or self-care, but baseline measures of friend conflict were related to poorer self-care. Momentary interaction enjoyment was related to fewer depressive symptoms, and momentary interaction upset was related to more depressive symptoms. A longitudinal study of adolescents average age 12 found that friend support did not predict depressive symptoms or glycemic control, but friend conflict predicted more depressive symptoms and a deterioration in glycemic control 1 year later (Helgeson et al., 2007). This same sample was reassessed as high school seniors (average age 18), and longitudinal analyses found that friend conflict was a more robust predictor of psychological outcomes and risk behaviors than friend support (Helgeson et al., 2014). Specifically, support predicted decreases in perceived stress but not depressive symptoms 1 year later, whereas friend conflict was related to increases in perceived stress, depressive symptoms, alcohol use, binge drinking, drive for thinness, and bulimic symptoms 1 year later. When glycemic control was examined in this sample via annual assessments over a 4-year period, multilevel modeling (MLM) revealed that friend conflict was linked to poor glycemic control but friend support was not (Helgeson et al., 2008). These findings are interesting given that the majority of research in this area focuses on peer support and neglects to measure peer conflict.

Moderator variables—gender, in particular—may explain some of the inconsistencies in this work. A number of studies in the review showed that links of peer relationship variables to health were stronger for females than males (Van Vleet & Helgeson, 2020). For example, the study described above of adolescents ages 13–16 (Helgeson et al., 2009) showed that survey measures of peer conflict were more strongly related to higher depression and to higher hemoglobin A1c (HbA1c) (indicator of blood glucose instability) for females than males and that an aggregate measure of enjoyable interactions was more strongly linked to fewer depressive symptoms and better self-care for females than males. Friends may play a larger role in the lives of females than males, as female friendships during adolescence have been found to be more intimate than those of males (Linden-Andersen et al., 2009; Swenson & Rose, 2009). The review concluded that more studies should include proximal assessments of positive and negative social interactions so that links to health can be examined in real time rather than through cross-sectional retrospective methods.

Some work has started to address this need by employing daily diary methods among youth with T1D. These daily diary studies have examined social interactions, but those interactions have involved parents rather than peers. One study showed that late adolescents (average age 18) were more likely to discuss diabetes with parents on days when they perceived parents as more knowledgeable about what was going on with their diabetes (Berg et al., 2016). Disclosure to mothers, but not fathers, was related to better daily diabetes management. Another daily dairy study of adolescents ages 11–16 conducted by this lab showed that daily conflict with parents was related to a greater likelihood of having a low blood glucose value or an episode of hypoglycemia (Campbell et al., 2023).

Although these daily diary studies are a methodological improvement from cross-sectional surveys, end-of-day reports are likely to collapse across a number of social interactions over the course of the day, making it difficult to discern the link of a specific social interaction to psychological health and diabetes self-care. To the best of our knowledge, there has only been one previous study of adolescents with T1D that has attempted to examine more momentary links of psychosocial factors to health—and it focused on friends. This is the previously described study in which teens ages 13–16 completed a survey every 2 hr over the course of the day for 4 days (two weekdays, two weekends) and checked their blood glucose every 4 hr (Helgeson et al., 2009). Results showed that more enjoyable interactions and less upsetting interactions with friends were associated with better mood, but neither was associated with blood glucose. Gender was not found to moderate any of these relations, but power was limited to detect interactions. Unfortunately, self-care behavior was not measured on a momentary basis in this study.

A primary goal of the present study was to apply the risk and resilience framework to the study of how peer relationships connect with psychological and diabetes outcomes. The resilience factor we examine is peer support, and the risk factor that we examine is peer conflict. Not only is research on the risk and resilience framework limited by its reliance on cross-sectional methods, but the research on peer relationships also generally relies on cross-sectional survey methods and is thus vulnerable to recall biases and precludes causal inferences. To address these limitations, we present an EMA study of youth with T1D that focuses on the links of supportive and conflictual interactions with peers during the course of a day to mood (positive and negative) and diabetes self-care in real time. We also examine whether these findings were stronger for females than others, consistent with previous research. The present study examined this question in the context of high school youth with T1D. In a previous report on this sample, survey measures of friend support and conflict were measured once in the Fall and once in the Spring (Helgeson et al., 2023). Consistent with the previous literature review (Van Vleet & Helgeson, 2020), that report showed relations of friend conflict were more consistently linked to psychological and diabetes health than friend support in both cross-sectional and longitudinal analyses. Relations of friend support to outcomes were inconsistent. In addition, gender moderated a number of findings, such that the relations of friend conflict to poor health were stronger for females than nonfemales. However, there was also suggestive evidence that females were less likely than nonfemales to reap the benefits of support. In the present report, we examine this same sample, but we use EMA rather than survey data. This work thus expands on prior research—and extends the entire body of friendship research in the area of diabetes—by examining proximal assessments of positive and negative social interactions and linking them to health on a more momentary basis.

In sum, the present study extends prior research in four ways. First, the study contributes to the literature on adolescent friendship

in the context of diabetes, which remains a sparse area of research despite its salience in the lives of all youth. Second, the study focuses not only on supportive interactions with peers but also on conflictual interactions with peers. Third, the research expands on what is known at the between-person (BP) level (i.e., comparing people who have more and less support) to the within-person (WP) level (i.e., comparing interactions that are more and less supportive for a given person). Fourth, and relatedly, these WP assessments are more proximal to the social interactions occurring over the course of the day instead of being averaged at the end of a given day. Daily diary studies rely on retrospective reports of social interactions throughout the day, which may represent the average of the interactions, the most recent interaction, or the most potent interaction. With EMA we can examine people's experiences in the moment and link them directly to outcomes in that moment. To our knowledge, only one other study has used this approach (described above; Helgeson et al., 2009) but with a much smaller sample ($n = 76$), a shorter timeframe (4 days), and a scheduled (i.e., 2 hr) protocol rather than random sampling throughout the day.

Method

Participants

Participants were 167 youth aged 14–17 with T1D. They were recruited between 2018 and 2021. Eligibility requirements included having T1D for at least 1 year, having no other chronic illness that affected everyday life more than diabetes, and being a freshman/sophomore/junior in high school. There was no other screening for study eligibility. We asked people to report their gender; nearly half identified as female (49%), 49% as male, and 2% as nonbinary. Using the National Institutes of Health categories for ethnicity and race, nearly all participants were non-Hispanic (99%), and the majority were White race only (89%). Note that T1D disproportionately affects White persons. Detailed demographic information is shown in Table 1.

Table 1
Demographics ($n = 167$)

Variable	Value
Age	$M = 15.83$, $SD = 0.78$
Age at diagnosis	$M = 8.87$, $SD = 3.71$
HbA1c (%)	$M = 8.49$, $SD = 1.61$
Grade	22.8% ninth grade
	48.5% 10th grade
	28.7% 11th grade
Gender	48.5% female
	49.7% male
	1.8% nonbinary
Ethnicity	98.8% non-Hispanic
	1.2% Hispanic
Race	92.8% White
	9.6% Black
	1.2% Asian
	3.6% more than one race
Household structure	67.1% live with biological mother and father
Parent education	0.6% less than high school
	12% high school graduate or equivalent
	13.8% some college
	6% technical/vocational school graduate
	18.0% 2-year college graduate
	27.4% 4-year college graduate
	22.2% postgraduate training
Insulin delivery system	59.9% insulin pump
	40.1% injections
CGM	79% CGM
	21% glucometer

Note. HbA1c = hemoglobin A1c; CGM = continuous glucose monitor.

Procedure

All procedures were approved by the Institutional Review Boards of Carnegie Mellon University and the University of Pittsburgh. The study was preregistered, and all the data are available at https://osf.io/fh9r3/ (Helgeson & Vaughn, 2023).

Participants were recruited from the pediatric diabetes clinic at UPMC Children's Hospital of Pittsburgh. A nurse recruiter approached potentially eligible participants when they came to the clinic or contacted them by phone. She briefly described the study and obtained permission to release contact information to the project director. Only 18 families refused. The project director then called families, screened for eligibility, described the study, and obtained verbal consent from one parent and the child to participate. Of the 334 families referred to the study, the project director reached 253 families after multiple attempts (e.g., some did not answer the phone, some had incorrect phone number). Of the 253 reached, 18 were ineligible, 22 declined, and 213 agreed to participate. Of the 213, 167 were scheduled for the initial interview; 46 were not scheduled for various reasons (i.e., unable to reach for scheduling; phone disconnected; changed mind; study ended before participant could be scheduled). Thus, our effective response rate was 71% (167/235 [213 + 22]).

We conducted an initial session (in person prior to COVID-19 [March 16, 2020, $n = 59$] and virtually after COVID-19 [$n = 108$]) in the Fall. During this session, we obtained informed consent from one parent and assent from the youth. Following interviews of both parent and child (data not discussed in the present article), we described the EMA procedure in detail to the child. They were told that they would be texted a link to an online survey 8 times a day (randomly) for four consecutive days on two separate occasions: once in the Fall and once in the Spring, approximately 4 months later. Each survey would take about 5 min to complete. Once they received the text, they would have 30 min to complete the survey before it would expire. If they had not completed the survey, they were sent a reminder text after 15 min. To encourage compliance, each survey was associated with an increased monetary incentive. Participants earned $1 for the first survey and $8 for the last survey, with increasing increments between the first and last. If participants completed all eight surveys, they earned $28 that day.

Participants were asked to select a 4-day window that included a weekend (Thurs–Sun OR Sat–Tues) in which they would be relatively available and not traveling out of town overnight. For each of the 4 days, participants provided us with an awake time and a sleep time, with the goal of having at least a 12-hr window. (We programmed the surveys to be delivered randomly 8 times over the course of the awake time window with the restriction that two consecutive surveys would be separated by at least 30 min.) Once the time period was selected, participants registered with SurveySignal, a software service that facilitates EMA data collection, to indicate that they agreed to receive the EMA signals/surveys.

Participants were asked if they would be willing to complete the surveys during the school day. The vast majority of participants

(98%) agreed; only four people declined. Those four completed the surveys for the part of the day they were not in school. For those who agreed, the study investigator contacted the school principal to obtain permission for the participant to carry their cell phone with them throughout the school day. We offered that participants could go to the main office to complete the survey, step into the hall to complete the survey, or complete the survey in class if the teacher permitted. All principals agreed to this procedure. Afterward, either the principal or the study investigator (depending on the principal's advice) emailed each of the youth's teachers to let them know about the procedure.

In the Fall (Time 1), 162 of the 167 participated in the EMA. Two people were unable to complete the EMAs due to intellectual disabilities, one person had problems with SurveySignal, and two persons declined to participate in this aspect of the study. Participants repeated the entire procedure in the Spring (Time 2); 91% of the Fall EMA sample completed the EMA in the Spring ($n = 148/162$). The 14 people lost to EMA follow-up consisted of three persons who dropped out of the study, six passive refusals, three persons declined to participate in this aspect of the study, one person had difficulties with SurveySignal, and one person agreed to participate but did not complete any of the surveys.

Our overall response rate in terms of the number of EMAs completed was 80% ($SD = 20\%$) in the Fall and 77% ($SD = 21\%$) in the Spring. We reviewed the number of EMAs completed on each of the 8 days (four Falls, four Springs) for each respondent and made the decision to retain participants in the analyses based on the number of lags available for our lagged data analysis. A lag consists of two surveys on the same day that had to have been completed within 6 hr of each other. Thus, lags cannot occur overnight or across days. Thus, a person who completed all eight surveys in a day has seven lags, and a person who completed two surveys in a day has only one lag. Participants had to have at least 10 lags in the Fall or at least 10 lags in the Spring to be retained in analyses. This resulted in the removal of seven of the 162 participants for a final $n = 155$. Of the possible 32 surveys, the average number of EMAs completed in the Fall was 25.97 ($SD = 5.24$), and the average number of EMAs completed in the Spring was 25.36 ($SD = 6.36$).

We examined differential attrition by comparing participants we retained in the analyses to those who did not meet our threshold of 10 lags ($n = 155$ vs. $n = 12$). There were no group differences on any variables shown in Table 1 with the exception of race/ethnicity. We lost 14 of 155 (18%) non-Hispanic White persons compared to five of 12 (47%) of all other groups, $\chi^2(1) = 11.76$, $p < .001$. There were no group differences in baseline depressive symptoms or HbA1c.

Instruments

Before responding to questions about support and conflict, participants were first asked whether they had had an interaction since the last prompt. An interaction was defined following the original procedures put forth by Wheeler et al. (1983): An interaction consists of you and at least one other person; you must be attending to one another and adjusting your behavior in response to the other person. We then provided participants with several examples. For instance, sitting next to someone in lecture is not an interaction, but talking to the person for 10 min is an interaction. For an exchange to qualify as an interaction, we suggested that it had to last at least 3 min if in person and had to go back and forth at least 3 times if via text, online, or social media. Participants were then asked who was included in the interaction. Analyses in this article were limited to interactions that included at least one peer.

Independent Variables

Unless otherwise specified, the response scales (described below) were sliding scales that ranged from 0 = *not at all* to 10 = *very much* and included 0.1 increments.

Support

The support index was composed of four items that reflected intimacy and emotional support (i.e., acceptance, authenticity, understanding; Reis & Shaver, 1996): (a) How much did you feel like this person accepted you? OR (if more than one person) How much did you feel like you fit in with these people? (b) How much did you feel like your true self during the interaction? (c) Did you feel understood during the interaction? and (d) How enjoyable did you find the interaction? Variance components analysis revealed a within-person reliability of .79 in the Fall and of .79 in the Spring.

Conflict

Friend conflict was the average of: (a) How stressful was the interaction? and (b) How annoying was the interaction? From our past experience in piloting conflict items via EMA, reports of arguments with friends/parents are extremely low. We wanted to use items that would more broadly capture interactions that were difficult or unpleasant. This was the basis for our selection of the first item. We drew the second item from the survey measure of conflict that we used in this study (Helgeson et al., 2023) and from informal conversations with youth with T1D about the terminology they use to capture unpleasant interactions.

Dependent Variables

Mood

Four subscales from the Profile of Mood States (McNair et al., 1971) were used to measure mood: anxiety (nervous, tension, anxious; Fall estimate = 0.78, Spring estimate = 0.74), happiness (happy, pleased, cheerful; Fall estimate = 0.74, Spring estimate = 0.77), depressed (sad, unhappy, depressed; Fall estimate = 0.78, Spring estimate = 0.77), and calm (relaxed, calm, at ease; Fall estimate = 0.77, Spring estimate = 0.79). Because the positive affect (PA) items were strongly correlated with each other, and the negative affect (NA) items were strongly correlated with each other, we averaged calm and happiness to create the PA scale and averaged depressed and anxiety to create the NA scale.

Overall Diabetes Self-Care

Respondents rated how well they took care of their diabetes since the last survey on a 4-point scale: 1 = *poorly*, 2 = *fair*, 3 = *good*, 4 = *nearly perfect*.

Diet

If respondents had eaten since the last survey, they rated how much their physician would change about their meal/snack on a

4-point scale: 1 = *not at all*; 2 = *a little bit*, 3 = *some*, 4 = *a lot*. We refer to this variable as dietary difficulties. Participants who had eaten were asked if they checked their blood glucose before eating (no, yes) and if they took insulin before eating (no, yes)—behaviors indicative of healthy self-care.

Exercise

If participants had exercised since the last survey, they were asked if they had checked their blood glucose before exercising, a behavior indicative of healthy self-care.

We note that the four individual self-care items (dietary difficulties, check blood glucose before eating, took insulin before eating, and check blood glucose before exercise) were each significantly ($p < .001$) but modestly related to the overall diabetes self-care assessment (rs ranged from .20 to .39).

Overview of the Analysis

First, we examined the data for duplicate entries. If a second entry occurred within 15 min of the first entry (0.5% of the time), we retained the first entry and deleted the second.

Covariates

We controlled for time point (Fall vs. Spring), weekend/weekday, and day (1–4) in all analyses. With these three control variables, we examined whether the demographic and disease variables listed in Table 1 were related to one or more outcomes. This was the case for gender (female vs. nonfemale), household structure (lives with two parents vs. not), and COVID-19 (pre vs. post). Thus, we controlled for these six variables in all analyses (which are reported in Table 2). The other demographic and disease variables (age, race, age at diagnosis, pump, continuous glucose monitoring [CGM] system) were not related to outcomes.

Cross-Sectional MLM

We used MLM to examine concurrent (i.e., within the same survey) links of peer support and conflict to each of the five self-care outcomes (overall self-care assessment, dietary difficulties, check blood glucose before eating, took insulin before eating, check blood glucose before exercise), controlling for the covariates. We parsed the BP and WP variance for support and conflict so as to differentiate momentary links from dispositional differences. The BP variables were grand-mean centered, and WP variables were person-mean centered. We allowed the intercepts to vary randomly across participants; because of convergence problems stemming from random slopes, all slopes were fixed. Due to the repeated nature of the EMA surveys, we allowed for autocorrelation of residuals across the surveys.

For dichotomous outcomes (checking glucose prior to eating, taking insulin prior to eating, checking glucose prior to exercise), we used logistic MLM. Degrees of freedom were estimated using the Satterthwaite method. This method allowed us to select robust estimation to handle violations of model assumptions.

Next, we examined whether gender moderated the effects of peer support and conflict by computing interactions between gender and each of the four predictors: BP support, WP support, BP conflict, and WP conflict. Because our hypotheses focused on relations being stronger for females, we compared females to nonfemales (i.e., males and nonbinary).

Lagged MLM

Lagged analyses were then conducted to assess if peer support and conflict at time$_n$ predicted outcomes at time$_{n+1}$ controlling for the outcome at time$_n$. For lagged analyses, we did not examine overnight lags. We also made the decision that two EMA surveys had to be within 6 hr of each other for there to be a legitimate lag (87.1% of entries). Lagged analyses for outcomes that did not necessarily occur at every prompt were more challenging to conduct. For example, lagged analyses for whether the participant adjusted insulin before eating would require the participant to eat at two successive survey prompts, which would be very unlikely. Thus, for the three diet variables and the one exercise variable, we conducted longitudinal rather than lagged analyses because we did not control for the outcome at time$_n$.

Power

We conducted an a priori power analysis. With 144 participants, a 75% response rate to entries, and a .5 intra-class correlation coefficient, we had 80% power to detect an effect size of .5. The final study sample for this article was 148 participants, response rates in the Fall and the Spring exceeded 75% (Fall 80%, Spring 77%), and the intra-class correlation coefficients for the dependent variables ranged from .34 to .60, with an average of .50. Thus, we met the anticipated conditions to detect a 0.5 effect size.

Results

We organized the results by first presenting all of the BP findings and then presenting all of the WP findings.

BP Findings

Cross-Sectional

As shown in Table 2, BP support was positively associated with greater PA and marginally related to lower NA. By contrast, BP conflict was related to higher NA. Considering the self-care outcomes, BP support was related to better overall diabetes self-care, fewer dietary difficulties, being more likely to check your blood glucose before eating, and being more likely to take insulin before eating. BP conflict was marginally related to being less likely to take insulin before eating.

Cross-Sectional Moderated by Gender

For PA, gender moderated the relation of BP support ($B = -0.48$, $SE = 0.18$, $p < .01$), such that BP support was related to higher PA especially for nonfemales (nonfemale slope = 1.08, $SE = 0.13$, $p < .001$; female slope = 0.60, $SE = 0.12$, $p < .001$; Figure 1). For NA, there was a significant gender by BP support interaction ($B = 0.20$, $SE = 0.09$, $p < .05$) and a significant gender by BP conflict interaction ($B = 0.45$, $SE = 0.12$, $p < .001$). As shown in Figure 2, BP support was related to lower NA for nonfemales ($B = -0.20$, $SE = 0.07$, $p < .01$) and was unrelated to NA for females ($B = 0.00$, $SE = 0.06$, not significant). By contrast, as shown in Figure 3, BP conflict was related to higher NA, especially for females (nonfemale $B = 0.50$, $SE = 0.09$, $p < .001$; female $B = 0.95$, $SE = 0.08$, $p < .001$).

Table 2
Cross-Sectional Relations of Support and Conflict to Outcomes

Variable	PA β (*SE*)	NA β (*SE*)	Diabetes self-care β (*SE*)	Diet difficulties β (*SE*)	Check BG before eating β (*SE*)	Check BG before eating *OR*	Insulin before eating β (*SE*)	Insulin before eating *OR*	Check BG before exercise β (*SE*)	Check BG before exercise *OR*
Spring	.16* (0.07)	−.11* (0.04)	.07** (0.02)	.01 (0.04)	−.05 (0.43)	.948	.05 (0.22)	1.06	−.71† (0.38)	.49
Weekend	.34*** (0.06)	−.22*** (0.04)	−.03 (0.02)	.03 (0.04)	−.59† (0.30)	.557	−.14 (0.22)	.87	.40 (0.34)	1.49
Day	−.06* (0.03)	.04* (0.02)	−.00 (0.01)	.03† (0.02)						
Day 2					−.16 (0.49)	.855	.04 (0.25)	1.04	.67 (0.49)	1.97
Day 3					−.19 (0.43)	.831	.04 (0.30)	1.04	.72 (0.54)	2.05
Day 4					.11 (0.46)	1.119	.10 (0.30)	1.10	.68 (0.60)	1.95
Female	−.93*** (0.24)	.27* (0.11)	−.20** (0.07)	.11 (0.09)	−.39 (0.55)	.676	−.63† (0.35)	.53	−.25 (0.59)	.78
Household	.09 (0.25)	−.08 (0.12)	.15† (0.08)	.03 (0.09)	−.33 (0.55)	.721	−.76* (0.37)	.47	1.04 (0.63)	2.82
COVID	.14 (0.19)	.24* (0.10)	.01 (0.06)	−.15† (0.08)	−.67 (0.43)	.510	.23 (0.58)	1.32	1.40* (0.63)	4.04
BP support	.80*** (0.09)	−.08† (0.04)	.16*** (0.03)	−.08* (0.03)	.48** (0.16)	1.615	.25* (0.13)	1.29	.30 (0.20)	1.35
WP support	.29*** (0.03)	−.06** (0.02)	.01 (0.01)	.03† (0.01)	.19 (0.14)	1.203	.10 (0.08)	1.11	.11 (0.11)	1.111
BP conflict	.06 (0.13)	.73*** (0.06)	−.02 (0.04)	.07 (0.05)	−.31 (0.23)	.731	−.28† (0.16)	.76	−.29 (0.28)	.75
WP conflict	−.17*** (0.03)	.23*** (0.02)	−.00 (0.01)	.01 (0.02)	.12 (0.14)	1.125	.16† (0.08)	1.17	−.05 (0.17)	.95

Note. Spring: 1 = *spring*, 0 = *fall*; weekend: 1 = *weekday*, 0 = *weekend*; female: 1 = *female*, 0 = *nonfemale*; household: 1 = *live with mother and father*, 0 = *all other living arrangements*; COVID: 0 = *pre-COVID*, 1 = *post-COVID* (after March 15, 2020, the date widespread closures began in Western Pennsylvania); all dichotomous outcomes scored 0 = *no* and 1 = *yes*. BG = blood glucose; BP = between-person; WP = within-person; PA = positive affect; NA = negative affect.
$^{\dagger}p < .10$. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

BP effects cannot be lagged as they involve aggregated measures across the EMA period.

WP Findings

Cross-Sectional

WP support was positively associated with PA and negatively associated with NA. WP conflict was negatively related to PA and positively related to NA. WP support was marginally related to higher dietary difficulties, and WP conflict was marginally related to being more likely to take insulin.

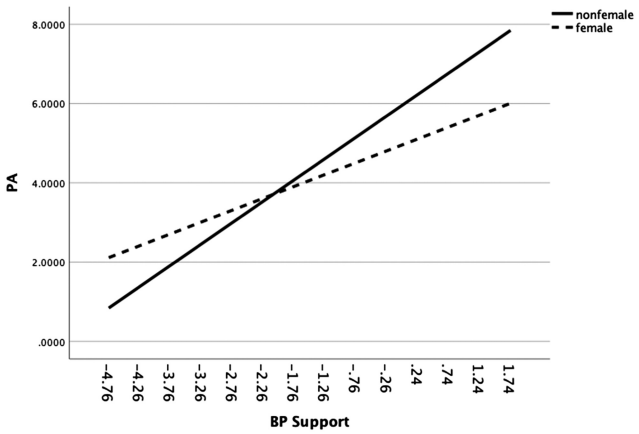
Cross-Sectional Moderated by Gender

There were no significant gender by WP support or gender by WP conflict interactions. There was a marginally significant gender by WP support interaction on taking insulin before eating ($B = -0.29$, $SE = 0.15$, $p < .10$, $OR = 0.75$).

Lagged

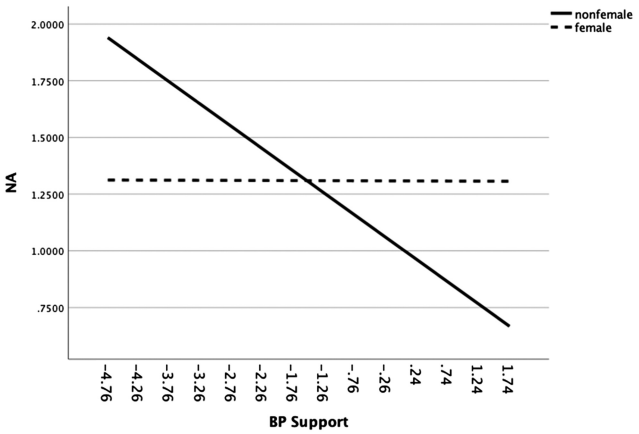
WP support was related to an increase in PA from one survey to the next ($B = 0.08$, $SE = 0.03$, $p < .01$), and unexpectedly, WP conflict also was related to an increase in PA from one survey to the next ($B = 0.09$, $SE = 0.03$, $p < .01$). Because this latter finding was counterintuitive and counter to predictions, we reran the analyses without controls for time$_n$ to determine if this finding was consistent with regression toward the mean. With this longitudinal (but not lagged) analysis, the link of within person conflict to PA disappeared. Thus, WP conflict was concurrently linked to lower PA, but PA generally recovered by the next time point. There were no WP lagged effects of support or conflict on NA.

Figure 1
Relation of BP Peer Support to PA for Females and Nonfemales



Note. BP = between-person; PA = positive affect.

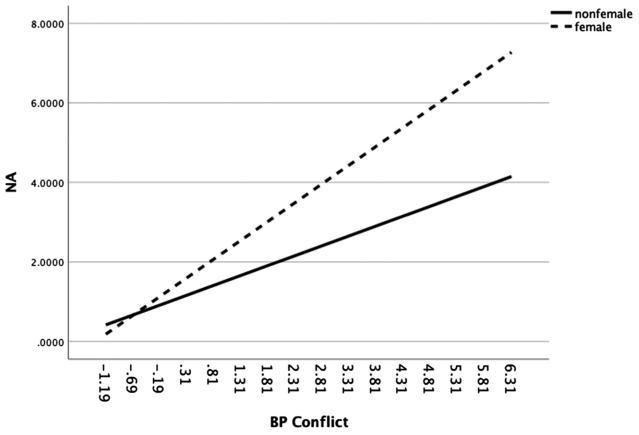
Figure 2
Relation of BP Peer Support to NA for Females and Nonfemales



Note. BP = between-person; NA = negative affect.

Figure 3

Relation of BP Peer Conflict to NA for Females and Nonfemales



Note. BP = between-person; NA = negative affect.

WP conflict was related to a decline in overall diabetes self-care from one survey to the next ($B = -0.02$, $SE = 0.01$, $p < .05$). Neither support nor conflict was related to changes in dietary difficulties. There were no WP effects for checking blood glucose before eating, taking insulin before eating, or checking blood glucose before exercise.

Lagged Moderated by Gender

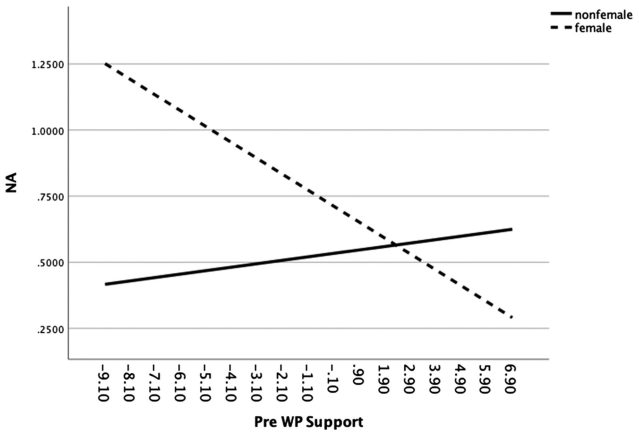
There was a single gender by WP support interaction in predicting lagged NA ($B = -0.07$, $SE = 0.03$, $p < .05$). As shown in Figure 4, more support was related to a decrease in NA from one survey to the next for females ($B = -0.06$, $SE = 0.02$, $p = .01$) but there was no relation for nonfemales ($B = 0.01$, $SE = 0.03$, $p = .61$).

Ancillary Analysis

Although not a planned analysis, we also examine whether the mere presence of a social interaction—as opposed to the supportive or conflictual nature of the interaction—was related to the outcomes examined here. We found a number of BP effects, such that people who have more interactions have higher PA ($B = 2.08$, $SE = 0.77$, $p < .01$), lower NA ($B = -1.73$, $SE = 0.46$, $p < .001$), better overall self-care ($B = 0.61$, $SE = 0.20$, $p < .01$), and are more likely to check their blood glucose before eating ($B = 2.60$, $SE = 1.17$, $p < .05$). There was only a single WP effect ($B = 0.10$, $SE = 0.05$, $p < .05$), suggesting that having an interaction compared to not having an interaction is associated with higher PA. There were no WP effects on diabetes outcomes. Thus, there is only one finding that shows the presence of an interaction was linked to a psychological or diabetes outcome following the interaction.

Figure 4

Relation of WS Peer Support to Changes in NA for Females and Nonfemales



Note. WP = within-person; NA = negative affect.

Discussion

The primary goal of this study was to examine momentary links of supportive and conflictual peer interactions to affect and self-care. Cross-sectional findings revealed largely consistent links of support to better mood and links of conflict to worse mood. These findings appeared at both the BP and WP levels. That is, people who generally had more supportive interactions and fewer conflictual interactions with peers reported more PA and less NA compared to people who had fewer supportive and more conflictual interactions with peers. In addition, within individuals, when youth had a supportive interaction with a peer, they reported a better mood than their own average, and when youth had a conflictual interaction with a peer, they reported a worse mood than their own average.

Longitudinal or lagged analyses, however, revealed only a few links of peer support or conflict to mood. When youth reported a supportive interaction, they later reported an increase in PA, suggesting that support has a sustained effect on positive mood. However, when youth reported a conflictual interaction, they also later reported an increase in PA, which makes less sense. Because there was a cross-sectional link of conflictual interactions to lower PA, it may be that the increase in PA is due to the dissipation of the conflict. That is, youth may be troubled by a negative interaction with their peers in the moment; get over it rather quickly so that mood bounces back by the next survey. The fact that the effect for conflict disappeared when controls for the previous level of PA were omitted is supportive of such an explanation. However, this reasoning is post hoc and requires replication.

The links of supportive and conflictual peer interactions to self-care were more mixed. Cross-sectional analyses revealed consistent links of BP support to nearly all of the self-care outcomes. Youth who generally report interactions with peers that are more supportive seem to practice healthier self-care in the moment compared to youth who report interactions with peers that are less supportive. Youth who have peers who are understanding may find it easier to enact self-care behaviors that can be disruptive to daily activities, such as checking blood glucose or administering insulin before eating. However within person, there were no significant cross-sectional associations of interactions to momentary self-care outcomes. Thus, this study did not provide any evidence that supportive interactions were helpful in the moment in regard to self-care. The fact that BP effects emerged but within-person effects did not suggests that it may take time for supportive interactions to accrue and provide youth with the confidence that they can rely on their friends when needing to take care of diabetes.

Longitudinal analyses revealed only a single finding for self-care, but it was an important one. When youth experienced a conflictual interaction with peers, their later overall diabetes-self-care was lower. This finding is extremely important as it provides the first evidence that on a momentary basis, and over and above individual differences that may create conflict or self-care neglect, difficulties with peers could have negative consequences for how youth take care of themselves. It is important to point out that the lagged finding in light of the lack of a cross-sectional association gives some support to the causal direction of conflictual interactions leading to declines in self-care. The specific ways in which youths' self-care falters are not clear. We did not find links of conflictual interactions to the specific domains of self-care that we tapped, such as checking blood glucose before eating or exercise.

One outcome that the length of the EMA survey did not permit us to assess that may have been linked to self-care is diabetes distress. It would be interesting to know whether interactions with friends were helpful or harmful in connection with an aspect of diabetes that is distinct from disease management—the emotional difficulties in having to deal with the disease. Diabetes distress is an important outcome in its own right but also has implications for disease management (Schmitt et al., 2021).

A second study goal was to examine gender as a moderating variable. We hypothesized that links of social interactions with peers to mood and self-care would be stronger for females than others. We found some evidence of moderation, but not all findings were consistent with this prediction. In terms of mood, gender moderated between-person effects such that conflict was more strongly related to NA for females than nonfemales. By contrast, support was more strongly linked to higher PA and lower NA for nonfemales than females. These findings are consistent with the survey results from this sample, which indicated that females may be more bothered by conflictual interactions than nonfemales and less able to reap the benefits of supportive interactions than nonfemales. Because these findings are cross-sectional, they preclude causal interpretation. Longitudinal analyses revealed a single gender moderation finding, which did not fit the pattern described above: Supportive interactions were related to a subsequent decrease in NA for females but not nonfemales.

Taken collectively, one of the take-home messages from this study is the divergence between the BP and WP results. Researchers who employ daily diary and EMA designs parse effects into BP and WP and often predict corresponding effects across levels of analysis (Hamaker, 2012 refers to this as homology across levels). But these are two fundamentally different questions, the answers to which may or may not mirror each other in terms of direction or magnitude. BP analyses reflect tests of individual differences and map more clearly onto survey research. In fact, the BP findings in this article were consistent with predictions and more robust across outcomes than the WP findings: People who had overall more supportive interactions with peers had better affective and self-care outcomes, whereas people who had more conflictual interactions with peers had worse affective outcomes. With respect to self-care, the findings for support were stronger than the findings for conflict.

However, the WP analyses test a different question and revealed a different story. WP analyses test whether the quality of an interaction at a given moment for a given individual is related to changes in an individual's mood and behavior in comparison to their personal average, at the same moment (cross-sectional) or at the next moment (lagged). These intraindividual findings are then aggregated across the sample to assess if a pattern can be broadly identified. There is increasing recognition that these effects—and their heterogeneity across persons—more accurately reflect researchers' underlying theoretical assumptions (Bolger et al., 2019; Hamaker, 2012). That is, researchers typically make predictions about what generally occurs for most people rather than about the distributions of variables across a population—the goal of BP work. In the present research, and consistent with the BP findings, WP supportive and conflictual interactions with peers were linked to better affective outcomes. However, the results for self-care diverged. There were no cross-sectional connections of supportive or conflictual interactions with peers to self-care, but lagged analyses showed that conflictual interactions were related to a subsequent decline in self-care. Thus, the WP findings reveal more evidence for conflict being problematic than support being helpful and highlight the independence of within- from BP results.

Future research should continue to investigate these discrepant self-care findings to better understand why links were more evident at the BP than the WP level. The fact that there was a WP link to overall diabetes self-care but not the specific self-care behaviors indicates that the general variable captures information missed by other items. Overall glucose monitoring—a near-continuous task—was not explicitly measured and may be an important driver of this observed effect. In the future, glucose monitoring could be tapped in a more objective way by capitalizing on data from diabetes technology. For example, phone applications for CGMs record the timing and frequency of glucose checking. Technology could be used to predict fine-grained blood glucose data from individuals' CGM. In general, leveraging diabetes technology could reduce participant burden while circumnavigating the limitations—shared by the present research—of self-report measures. Finally, future work should investigate the heterogeneity of these effects across persons to identify if there are certain individuals or contexts in which peer support and conflict matter most for diabetes. While some of these findings depended on participant gender, other factors like relationship satisfaction or overall stress level may impact the way one interprets or reacts to peer interactions.

These findings have implications for the treatment of youth with Type 1 diabetes. Health care practitioners tend to focus on the family context as it relates to disease management and disease outcomes. As mentioned earlier, youth with Type 1 diabetes are spending an increasing amount of time with friends, and these findings suggest that the peer context matters. Health care practitioners might inquire about relationships with friends and suggest ways to navigate difficult relationships or interactions.

Before concluding, we note several study limitations. First, we limited analyses to interactions that involved at least one peer. However, some of these interactions involved multiple people—not all of whom may have been peers. To the extent that the effects of supportive and conflictual interactions depend on the specific interaction partner, multiple-person interactions could have obscured some of the findings. We partially addressed this concern by comparing single-person interactions to multiple-person interactions and did not find any differences with respect to their links to outcome variables. Second, we did not find evidence that support or conflict predicted checking blood glucose before exercise. This is likely due to the infrequency with which participants exercised. The average number of responses to this question (10%) reflected relatively low levels of exercise.

Exercise may be a self-care behavior that is more amenable to being assessed on a daily basis than a momentary basis.

Third, we developed the conflict items for this study. We aimed for wording that would be broad enough to capture any kind of unpleasant or difficult interaction. We presented a variety of wordings to six youth with diabetes prior to conducting this study and chose these items based on their feedback. However, future endeavors in this area should consider more systematic forms of community-based participatory research in item development as well as study methodology feasibility. Relatedly, although both the support and conflict items reflect the emotional impact of social interactions, we acknowledge that the support and conflict items may not have been parallel in terms of their intensity, which makes it difficult to compare their effects.

Fourth, the sample is relatively homogenous with respect to demographic variables such as race and ethnicity, which limits the generalizability of the findings. Although Type 1 diabetes is a disease that is overrepresented among White persons, the lack of diversity in this sample precludes our ability to generalize these findings beyond non-Hispanic White persons. The meaning of friendship, especially in relation to family, differs across race, ethnicity, and culture (Rose et al., 2022). In addition, people with different demographic backgrounds are likely to view illnesses such as diabetes differently, which includes the role that others play in their illness management (Campos & Kim, 2017). Relatedly, we had more non-White people drop out of the study at the spring assessment. This study limitation reminds us to bring more effort not only into recruiting diverse groups but also to retaining those groups in our studies. This was a labor-intensive study in that we asked participants to complete eight surveys each day for four consecutive days. Despite our relatively overall high compliance, the design may have been too burdensome and disruptive for some groups of people. To that end, we also note that we did not specifically screen participants for other psychological, cognitive, behavioral, or physical health problems. We relied on parental report that the youth did not have any other health problem that affected their daily life more than diabetes, and parent reports are subjective.

In conclusion, the present study investigated within- and between-person effects of peer interactions on well-being and self-care behaviors among adolescents with Type 1 diabetes. At both levels, support and conflict were linked to better and worse mood outcomes, respectively. BP support was a robust predictor of self-care but did not predict these behaviors in real time. By contrast, conflict predicted self-care only within persons, indicating that peer conflict may lead to subsequent difficulties performing diabetes self-care tasks. Moderation by gender showed that females tended to experience greater harm and less benefit from peer interactions compared to nonfemales. Overall, these findings underscore the importance of peer interactions for self-care and well-being outcomes among adolescents with Type 1 diabetes and highlight the value of separately considering within- versus between-person findings in the complex interplay of social interactions and health.

Resumen

Objetivo: Examinamos los vínculos entre las interacciones de apoyo y conflictivas entre pares con el estado de ánimo y el autocuidado a través de una evaluación ecológica momentánea. ***Métodos:*** A los adolescentes con diabetes tipo 1 ($n = 167$, 49% mujeres) reclutados entre 2018 y 2021 se les pidió 8 veces al día durante ocho días que completaran breves encuestas que medían las interacciones sociales percibidas, el afecto y el autocuidado. ***Resultados:*** Los análisis transversales revelaron vínculos entre y dentro de las personas entre el apoyo de los pares y el estado de ánimo positivo y el conflicto con el estado de ánimo negativo. El apoyo entre pares se vinculó con un autocuidado saludable, pero el apoyo intrapersonal no. Los análisis rezagados mostraron que las interacciones conflictivas estaban asociadas con una disminución del autocuidado. Hubo cierta evidencia de que las mujeres no se beneficiaban tanto del apoyo y les molestaban más los conflictos que otras. ***Conclusiones:*** Los resultados subrayan las diferencias en los vínculos entre las interacciones sociales y la salud entre personas y dentro de ellas. Las diferencias individuales en el apoyo fueron más influyentes que el conflicto, pero las interacciones conflictivas tuvieron efectos más momentáneos que las interacciones de apoyo.

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