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Daily Sleep Quality and Daily Stressors in Couples Coping With Type 1 Diabetes

Eunjin Lee Tracy, Cynthia A. Berg, Katherine J. W. Baucom, Sara L. Turner, and Caitlin S. Kelly
University of Utah

Meredith Van Vleet
Carnegie Mellon University

Jonathan Butner
University of Utah

Vicki S. Helgeson
Carnegie Mellon University

Objective: To examine the influence of daily sleep quality in patients with Type 1 diabetes (T1D) on that of their spouses and to investigate the influence of couples' sleep quality on patients' diabetes-specific stressors and couples' general stressors the following day. ***Methods:*** 199 patients with Type 1 diabetes (M_{age} = 46.82) and their spouses (M_{age} = 46.41) completed a 14-day diary where they reported on their own sleep quality, and the presence of general stressors. Patients reported the presence of diabetes-specific stressors. Multilevel modeling examined the effects of daily variability in (within-person effects) and average levels of (between-person effects) sleep quality on the number of next-day diabetes-specific stressors (controlling for prior day stressors). Furthermore, the actor-partner interdependence model was used to examine the effect of sleep quality on general stressors. ***Results:*** Greater patients' daily sleep quality was related to their spouses' greater sleep quality. Increases in the patients' own daily- and average sleep quality were uniquely associated with fewer next day diabetes-specific stressors. Better own daily- and average sleep quality were associated with fewer general stressors for both partners. Spouses' increased daily sleep quality was associated with fewer general stressors of patients. ***Conclusions:*** The results support that sleep quality is a dyadic phenomenon among couples and suggest that better sleep quality may buffer diabetes specific and general stress in couples coping with T1D.

Keywords: couple relationships, sleep quality, stressors, Type 1 diabetes, daily diary methods

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Individuals diagnosed with Type 1 diabetes (T1D) encounter sleep disruptions as a result of symptoms of T1D (e.g., hyperglycemia, hypoglycemia, and glucose variability) and its management (Farabi, 2016). Adults with T1D report more sleep problems compared to individuals without T1D (van Dijk et al., 2011). Sleep problems are especially problematic among patients with T1D, as they may negatively affect insulin sensitivity, disease progression, and development of complications (Donga et al., 2010; Farabi, 2016). Patients' sleep problems and the daily management of T1D likely affect their partners' sleep as well (Brod, Pohlman, Wolden, & Christensen, 2013). Despite this hypothesized association, research has not yet examined daily sleep processes among couples coping with TID.

Because of the interdependent nature of couple relationships, it is important to examine sleep quality from a dyadic perspective as couples often share a nightly sleeping environment (Troxel, 2010). In this study, sleep quality is operationalized as an individual's overall perceived satisfaction with sleep quality (Hall, 2010). For those with T1D, the sleep context frequently involves diabetes-related events that may compromise sleep quality. For instance, the presence of nocturnal hypoglycemia is associated with poorer self-reported sleep quality in adults with T1D (van Dijk et al., 2011), which may in turn influence the sleep quality of their partners. In extreme cases of hypo- or hyperglycemia, patients may be unable to treat their out-of-range blood glucose independently and may need their partners' assistance (e.g., having their partners bring them a snack or insulin if they are unable to get up) before returning to sleep. More frequently, very high or low blood glucose levels may trigger events such as blood glucose alarms (i.e.,

Eunjin Lee Tracy, Cynthia A. Berg, Katherine J. W. Baucom, Sara L. Turner, and Caitlin S. Kelly, Department of Psychology, University of Utah; Meredith Van Vleet, Department of Psychology, Carnegie Mellon University; Jonathan Butner, Department of Psychology, University of Utah; Vicki S. Helgeson, Department of Psychology, Carnegie Mellon University.

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Correspondence concerning this article should be addressed to Eunjin Lee Tracy, Department of Psychology, University of Utah, 380 South 1530 E Beh S 518, Salt Lake City, UT 84112. E-mail: eunjin.lee@psych.utah.edu

from blood glucose monitoring technology such as continuous glucose monitoring [CGM]), waking the patient and partner. All in all, the sleep quality of patients and partners is likely especially intertwined for couples coping with T1D. However, no known study has examined daily sleep quality among couples coping with T1D. Thus, this study investigates the interdependence of each partner's sleep quality to determine if spouses' daily sleep quality is influenced by patients' daily sleep quality.

Sleep quality is likely to influence the experience of daily stressors. Poor sleep quality can negatively affect daily functioning such as emotion regulation, cognitive performance, and behavioral alertness, creating vulnerability to daily stressors (Banks & Dinges, 2007; Palmer, Oosterhoff, Bower, Kaplow, & Alfano, 2018). In the context of T1D, poor sleep quality may affect patients' and partners' abilities to manage daily stressors related to T1D (e.g., managing highs and lows in blood glucose, forgetting to check blood glucose, and problems in managing diet and exercise; Fortenberry et al., 2009). Further, poor sleep quality may affect couples' abilities to manage more general daily stressors that occur at work, home, and in their relations to others (Krizan & Herlache, 2016; Uehli et al., 2014; Yang et al., 2013). Furthermore, poor sleep quality of one partner may have negative associations with the health and well-being of the other in the context of couple relationships (Hasler & Troxel, 2010; Gilbert, Pond, Haak, DeWall, & Keller, 2015; Strawbridge, Shema, & Roberts, 2004). However, less is known about the impact of daily poor sleep quality on daily stressors among couples coping with T1D. In one qualitative study, patients with T1D or Type 2 diabetes described how sleep disruptions resulted in increased irritability and fatigue, which are emotional and physical manifestations of stress, the next day for both themselves and their partners (Brod et al., 2013). Thus, this study builds on this work by empirically investigating the effects of daily sleep quality on daily stressors among couples coping with T1D. In particular, this study includes both diabetes-specific stressors and general stressors to allow for a more complete understanding of the role of daily sleep quality on daily stressors in the context of T1D.

The Current Study

We examined how the daily sleep quality of patients with T1D affects that of partners (hereafter referred to as *spouses*, as 92% of couples were married), and how patients' and spouses' daily sleep quality is associated with experiences of daily diabetes-specific and general stressors. Patients and spouses completed a 14-day diary that assessed their own daily sleep quality and presence of general stressors. Patients also reported on presence of diabetes-specific stressors. We examined whether sleep quality of patients affected that of spouses both in terms of daily variability (within-person effects, or deviation from one's average across the 14 days) and average effects (between-person effects, averaged across the 14-days; Bolger & Laurenceau, 2013). We hypothesized that when patients reported better sleep quality, spouses also would report better sleep quality both at the daily level (within-person) and on average (between-person; Hypothesis 1).

To examine the association between sleep quality and stressors, we analyzed whether one night's sleep quality predicted the number of next-day stressors (controlling for the number of prior day's stressors), examining both daily variability (within-person) and average (between-person) effects of sleep quality on stressors. To examine the relation between daily sleep quality and the number of diabetes-specific stressors, we first examined the relation of patients' sleep quality and spouses' sleep quality to patients' diabetes-specific stressors separately. Then we examined the relation of patients' and spouses' sleep quality to patients' diabetes-specific stressors simultaneously to test whether the role of sleep quality of one partner of a couple matters more than that of the other partner on patients' diabetes-specific stressors. We hypothesized that patients' and spouses' better sleep quality, respectively, at both the daily and average levels would be associated with fewer patient diabetes-specific stressors. Second, to examine sleep quality and general stressors, we included an actor-partner interdependence model (APIM; Campbell & Kashy, 2002; Cook & Kenny, 2005; Kenny, Kashy, & Cook, 2006) to examine patients' and spouses' general stressors and sleep quality from a dyadic perspective. We hypothesized that both patients' and spouses' better sleep quality at both the daily and average levels would be associated with fewer general stressors for themselves and their partner (Hypothesis 2).

Method

Participants

All study procedures for this National Institutes of Health funded project were approved by each of the two university's institutional review boards. Patients with T1D and their spouses provided written informed consent. Patients were recruited from participating endocrinology clinics at the University of Utah Diabetes and Endocrinology Center and St. Mark's Hospital in Salt Lake City and University of Pittsburgh Medical Center and the University of Pittsburgh Pitt + Me research registry in Pittsburgh. Patients were eligible if they had a diagnosis of T1D for at least one year, were taking insulin for T1D within 1 year of diagnosis, spoke English as their primary language, and were married or in a cohabiting relationship for at least 1 year. At the Utah sites, of the 319 patients approached, 66 were ineligible, and 118 declined to participate. Of the remaining 135 couples, 107 were scheduled and included in the study. At the Pittsburgh sites, of the 202 contacted by the project director, 47 were ineligible (including two found ineligible after they started study procedures), 57 declined participation, and six could not be reached, resulting in 92 couples included in the study. The final sample included 199 couples (398 individuals) who were eligible, enrolled, and completed study measures across both sites. Couples were primarily heterosexual (n = 193), with three female same-sex and three male same-sex couples. Demographic data for patients and spouses are shown in Table 1.

Procedure

At the University of Utah, trained recruiters approached patients who were diagnosed with T1D and were at least 25 years of age in clinic. Interested participants were provided information about the study (verbally and with a brochure) and were asked to provide their preferred contact information to discuss eligibility and enrollment. At the University of Pittsburgh, patients with T1D were approached by their regular diabetes care provider and were asked for permission to release their name and contact information to the

Table 1
Demographic Information for Patients and Spouses

Variable	Patients		Spouses	
	M (*SD*)	Range	*M* (*SD*)	Range
Age	46.82 (13.95)	25.85–74.89	46.40 (14.17)	23.92–76.70
Gender (% women)	52.3%	—	47.2%	—
Race (% White)	92.5%	—	94%	—
Ethnicity (% Hispanic)	6%	—	3%	—
Daily sleep quality	3.17 (.60)	1.75–4.93	3.09 (4.85)	1–4.85
Pittsburgh Sleep Quality Index	3.60 (2.55)	0–12	3.76 (2.10)	0–9
Length of diagnosis	26.97 (13.88)	3.10–60.63	—	—
Pump use (%)	68.7%	—	—	—
CGM use (%)	43.4%	—	—	—
HbA1c	7.57 (1.06)	4.9–11.20	—	—

Note. CGM = continuous glucose monitoring.

project coordinator. The project coordinator then contacted patients who agreed to be contacted and provided them with more information about the study, assessed interest in the study, and discussed eligibility and enrollment. If patients were eligible and interested in the study, the study team then obtained permission to independently contact their romantic partner for eligibility screening. If both members of a couple met study criteria and agreed to participate, the couple was enrolled in the study and scheduled for a laboratory visit.

Prior to attending the in-person laboratory session, patients and romantic partners provided their informed consent for completing a brief at-home questionnaire online and provided their informed consent for completing all other study procedures in oral and written form at their laboratory visit. During the laboratory visit, participants completed cognitive assessments, an interview, and a couples' interaction task that were part of the larger study on couples coping with T1D. Following the laboratory visit, participants completed a short online questionnaire every evening before going to bed for 14 days. The present study primarily uses measures from the daily diary portion of the study. On average, patients completed 13.82 days of the diary, and spouses completed an average 13.71 days of the diary.

Participants were compensated individually for their participation and for mileage for traveling to the laboratory. Patients were compensated up to $225 for completing all of the parts of the study ($100 for the initial survey and lab-assessment, $7.14 per diary day completed up to $100, and $25 for returning a study-owned glucometer in a prepaid/preaddressed envelope), with spouses compensated similarly with the exception of the glucometer data.

Measures

Daily sleep quality. To capture daily sleep quality, participants rated the prior night's sleep using the following item: "How satisfied/dissatisfied were you with your sleep last night?" on a 1 (*not at all satisfied*) to 5 (*completely satisfied*) scale (Williams, Cribbet, Rau, Gunn, & Czajkowski, 2013). This item was modeled after a similar item on the Pittsburgh Sleep Quality Index (a longer, validated global self-report of sleep quality; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989), with the wording changed to reflect the daily level. In the present study, our daily sleep quality item from the diary correlated with global scores on the Pittsburgh Sleep Quality Index, where lower scores denote better sleep quality ($r = -.54$ for patients, $p < .001$; $r = -.57$ for spouses, $p < .001$; Buysse et al., 1989). On average across the days of the diary, patients and spouses reported they were somewhat satisfied with their sleep (*M* patients = 3.17, *SD* = .98 and *M* spouses = 3.09, *SD* = .98).

Daily diabetes-specific stressors. Patients completed a brief checklist (1 = *yes*, 0 = *no*) where they indicated the presence of six common daily diabetes-specific stressors: problems with high blood sugar, problems with low blood sugar, taking the wrong amount of insulin, problems with food management, feeling bad (upset, angry, sad) because of diabetes, and forgetting or skipping a blood glucose test. This measure has been used previously in adolescents and emerging adult samples with T1D (Berg, Butner, Butler, King, Hughes, & Wiebe, 2013) and is based on empirically derived coding of patients' descriptions of diabetes-specific stressors (Beveridge, Berg, Wiebe, & Palmer, 2006). The daily measure of diabetes-specific stressors reflected the mean number of stressors endorsed. Patients on average reported .25 diabetes-specific stressors each day (*SD* = .22).

Daily general stressors. Both patients and spouses indicated the presence of four general daily stressors (1 = *yes*, 0 = *no*; argument or disagreement with someone, stressful events at work, home, related to a relative or close friend) from the Daily Inventory of Stressful Events (Almeida, Wethington, & Kessler, 2002). This daily measure of general stressors reflected the mean number of stressors endorsed. An average of .15 (*SD* = .21) and .15 (*SD* = .20) general stressors were reported each day by patients and spouses, respectively.

Analytic Strategy

The present study used multilevel models (Raudenbush & Bryk, 2001) in IBM SPSS Mixed (Version 25; 2017) to account for the data structure, wherein diary days were nested within individuals and individuals were nested within couples. We used a two-level multilevel model to address the study's central questions. Level 1 represented variability due to within-person repeated measures for patients and spouses, and Level 2 represented between-person variability across patients and spouses (Bolger & Laurenceau, 2013).

We separated the within- and between-person variability by group (person) mean centering at Level 1 and grand mean centering at Level 2 (Hoffman, 2015). Modeling within- and between-person variability decomposes the effect of individuals' and their partners' day-to-day fluctuations in the constructs of interest while accounting for between-person (individual) differences in these constructs. For instance, the models that examined the effect of daily sleep quality on daily stressors allowed for the separation of the effect of individuals' and partners' day-to-day fluctuations in sleep quality while accounting for between-person differences in sleep quality (i.e., average levels of a patient's or spouse's sleep quality across the 14 days) on daily stressors.

This study used multilevel modeling to examine if spouses' sleep quality was influenced by patients' sleep quality and also to investigate relations between daily sleep quality and daily diabetes-specific stressors. When examining the relation of patients' and spouses' sleep quality to general stressors, we used APIMs for distinguishable dyads framework (Campbell & Kashy, 2002; Cook & Kenny, 2005; Kenny et al., 2006). In this study, distinguishability occurs because one member of the couple was an individual with diabetes (i.e., patient) and the other was a spouse. APIMs are conceptual and statistical data analytic approaches that measure and account for the interdependence found in dyadic social relationships. As shown in Figure 1, APIMs simultaneously estimate effects of patients' and spouses' independent variables on their own dependent variables, namely actor effects (a_P, a_S) and effects of the partner's independent variables on the person's dependent variables, namely partner effects (p_P, p_S). In this study, the two-intercept approach was used to examine simple slopes for each level of patients and spouses. We report effects separately for patients and spouses to examine the relations between daily sleep quality and daily general stressors.

In this study, participants were asked to report previous day's sleep quality and daily stressors that day each evening. To examine the effect of daily sleep quality on next-day stressors, we analyzed prior day's sleep quality predicting stressors during that day, controlling for prior day's stressors. This allowed us to examine whether sleep quality predicts changes in fluctuations in daily stressors across days.

Results

First, we ran unconditional models to calculate intraclass correlation coefficients and examine within- and between-person variability in daily sleep quality and daily stressors across the 14 diary days. There was both within-person (81.83%) and between-person variability (18.17%) in daily sleep quality. There was also both within- and between-person variability in measures of daily diabetes-specific stressors (64.27% within; 35.73% between), and daily general stressors (90.25% within; 9.75% between).

Is Patients' Daily Sleep Quality Related to Spouses' Daily Sleep Quality? (Hypothesis 1)

Analyses revealed both within- and between-person effects of patients' sleep quality on spouses' sleep quality. Spouses' daily sleep quality was related to patients' sleep quality, such that on days when patients reported better than their average sleep quality, spouses did as well (within-person effect; $p < .001$). In addition, on average, patients who reported better sleep quality compared to others in the sample, had spouses who also reported better sleep quality (between-person effect; $p = .048$). These results indicated that patients' and spouses' daily sleep quality were interrelated. See Table 2 for full model results.

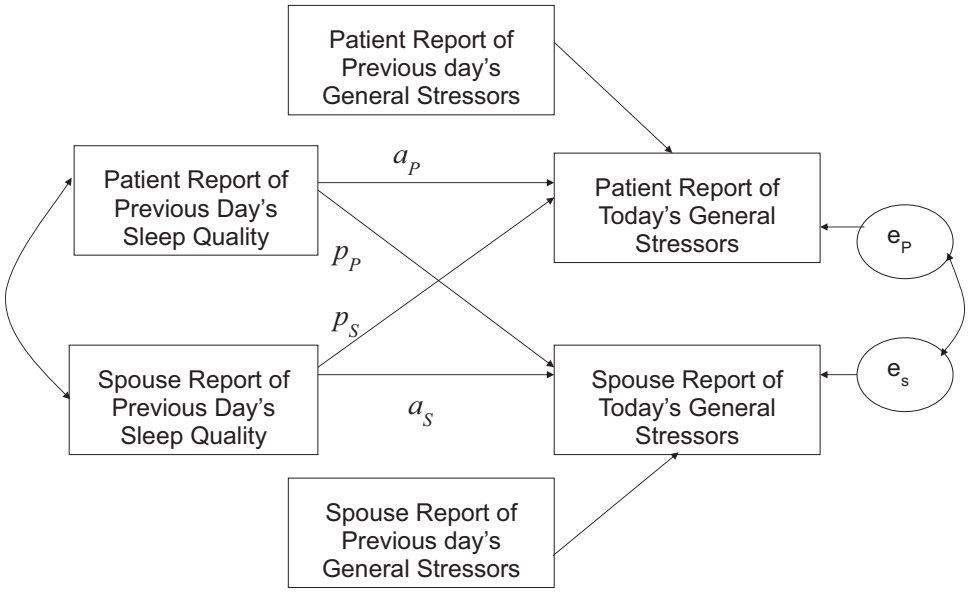

Figure 1. Actor-partner interdependence model with distinguishable dyads to test associations between previous day's sleep quality and today's general stressors after controlling for previous day's general stressors. a_P and a_S = actor effects for patients and spouses, respectively; p_P and p_S = partner effects for patients and spouses, respectively.

Table 2
Effect of Patients' Sleep Quality on Spouses' Sleep Quality

Dependent variable: Spouses' daily sleep quality	*b* (*SE*)	*t*
Level 1 (within)		
Intercept	3.09 (.04)	73.62***
Patients' daily sleep quality$_{wp}$	.15 (.02)	7.42***
Level 2 (between)		
Patients' daily sleep quality$_{bp}$	.14 (.07)	1.99*

Note. wp = within-person; bp = between-person. Table reports unstandardized coefficients (*b*) with standard errors (*SE*) in parentheses.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Is Daily Sleep Quality Associated With Daily Stressors? (Hypothesis 2)

Effect of daily sleep quality on patients' next-day diabetes-specific stressors. We first examined the effects of patients' daily sleep quality on their reports of next-day diabetes-specific stressors. A significant within-person effect was found, such that on days when patients reported having better sleep quality than their average, they reported fewer diabetes-specific stressors on the next day (within-person effects; $p = .007$). In addition, a significant between-person effect was found, such that patients who had better average sleep quality across the 2 weeks experienced fewer daily diabetes-specific stressors (between-person effects; $p < .001$). Second, we examined the relation between spouses' sleep quality and patients' diabetes-specific stressors. A significant within-person effect was found, such that on days when spouses reported having better sleep quality than their average level, patients reported fewer diabetes-specific stressors on the next day (within-person effects; $p = .04$). See top half of Table 3 for full model results.

We then simultaneously examined the effects of both patients' and spouses' sleep quality on patients' diabetes-specific stressors. With both members' sleep quality included in the model, only patients' sleep quality was statistically significant (within-person effect; $p < .001$; between-person effect; $p = .013$); spouses' sleep quality was no longer a significant predictor (within-person effect; $p = .24$). Thus, patients' sleep quality was a unique predictor above and beyond spouses' sleep quality of patients' diabetes-specific stressors.

Effect of daily sleep quality on couples' next-day general stressors. There were a number of significant within-person effects in our APIMs examining associations between daily sleep quality and next-day general stressors. Both patients and spouses endorsed fewer next-day general stressors following days when their own sleep quality was above average (i.e., actor effects; within-person effects; $p < .001$ and $p < .001$, respectively). Further, patients endorsed fewer next-day general stressors following days on which spouses reported above-average sleep quality (i.e., partner effect; within-person effects; $p = .049$). Between-person effects were also found, such that both patients and spouses who reported better average sleep quality relative to others in the sample reported fewer general stressors (between-person effects; $p = .018$ and $p = .002$, respectively). Altogether, these findings indicated that daily sleep quality and average sleep quality were related to fewer general stressors for patients and their spouses. The spouses' increased daily sleep quality was associated with fewer general stressors in patients, implying that patients' experience of general stressors are influenced by their spouses' sleep quality as well as their own. See top half of Table 4 for full model results.[1]

Are Daily Stressors Associated With Subsequent Poorer Sleep Quality?

To rule out the reverse direction of effects that daily stressors affect next day sleep quality, we analyzed daily stressors predicting sleep quality that evening, controlling for the previous day's sleep quality.

Effects of daily diabetes-specific stressors on daily sleep quality. To examine these effects for diabetes-specific stressors, we used two separate models to examine (a) the relation between patients' daily diabetes-specific stressors and their own sleep quality and (b) the relation between patients' daily diabetes-specific stressors and spouses' sleep quality. For the effect of patients' daily diabetes-specific stressors on their own sleep quality, no within-person effect was found. However, there was a significant between-person effect, such that patients who reported more diabetes-specific stressors on average compared to other patients reported poorer sleep quality (between-person effect; $p = .014$). There were no significant within- or between-person effects of patients' daily diabetes-specific stressors on their spouses' sleep quality ($ps > .05$). These findings indicated that overall levels of patients' diabetes-specific stressors are associated with their own sleep quality. See bottom half of Table 3 for full model results.

Effects of daily general stressors on daily sleep quality. In contrast to the results examining sleep quality on general stressors, no within-person actor effects were found for either patients' or spouses' reports of general stressors on sleep quality. However, between-person actor effects revealed that patients who reported more daily general stressors on average reported poorer sleep quality on average (between-person effect; $p = .027$). In addition, spouses who reported more daily general stressors on average reported poorer sleep quality on average. Despite the significant actor effects found, no statistically significant partner effects emerged (between-person effect; $p = .002$). All in all, these findings indicated that patients' and their spouses' overall levels of general stressors are associated with their own sleep quality. See bottom half of Table 4 for full model results

Discussion

This study is the first to examine the extent to which the sleep quality of patients with T1D affects that of their spouses, and how both couple-members' sleep quality affects the experience of next-day diabetes-specific and general stressors. To rule out other

[1] Additional analyses were conducted to understand how another metric of sleep (i.e., sleep duration) were affecting diabetes-specific and general stressors. We examined the effects of daily sleep duration (participants' reports of "about how long did you sleep altogether" in hours and minutes) on couples' next-day general stressors and diabetes-specific stressors as well as the effects of daily general stressors and diabetes-specific stressors on daily sleep duration. We found similar findings to those examined between sleep quality and diabetes-specific and general stressors. See the appendix for full model results.

Table 3
Bidirectional Relationship Between Patient and Spouse Sleep Quality and Patient Daily Diabetes Stressors

Variable	Sleep quality of patients → Diabetes stressors of patients		Diabetes stressors of patients → Sleep quality of patients		Sleep quality of spouses → Diabetes stressors of patients		Diabetes stressors of patients → Sleep quality of spouses	
	b (*SE*)	*t*	*b* (*SE*)	*t*	*b* (*SE*)	*t*	*b* (*SE*)	*t*
Level 1 (within)								
Intercept	.21 (.01)	21.90***			.21 (.01)	21.47***		
Previous day's stressors	.15 (.02)	7.77***			.15 (.02)	7.59***		
Daily sleep quality$_{wp}$	−.03 (.005)	−6.09***			−.01 (.005)	−2.06*		
Level 2 (between)								
Daily sleep quality$_{bp}$	−.04 (.01)	−2.72**			−.01 (.01)	−.96		
Level 1 (within)								
Intercept			2.90 (.07)	39.34***			2.85 (.07)	38.48***
Previous day's sleep quality			.08 (.02)	4.19***			.07 (.02)	3.71***
Daily stressors$_{wp}$			.15 (.10)	1.61			.10 (.10)	.68
Level 2 (between)								
Daily stressors$_{bp}$			−.70 (.28)	−2.48*			−.34 (.29)	−1.19

Note. wp = within-person; bp = between-person. Table reports unstandardized coefficients (*b*) with standard errors (*SE*) in parentheses.
* $p < .05$. ** $p < .01$. *** $p < .001$.

directions of effects, we also examined the effects of daily stressors on subsequent daily sleep quality as well. Consistent with recent work examining the dyadic nature of sleep among couples without T1D (e.g., Kane, Slatcher, Reynolds, Repetti, & Robles, 2014), this study demonstrated positive associations between daily sleep quality of patients with T1D and their spouses. With respect to the association between daily sleep quality and daily diabetes-specific stressors, patients' sleep quality and spouses' sleep quality, respectively, were associated with patients' diabetes-specific stressors. However, when both the effects of patient and spouse sleep quality were examined simultaneously, only patients' sleep quality uniquely predicted patients' diabetes-specific stressors. This finding suggests that patients' sleep quality is most predictive of their own daily diabetes-specific stressors in the context of couple relationships. However, our findings indicate that there is overlap in patient and spouse sleep quality, suggesting that patients' sleep quality reflects, in part, spouses' sleep quality as well. In addition, this study found that daily general stressors of patients with T1D are affected not only by their own daily sleep quality, but also by their spouses' sleep quality. These findings point to the interdependence of sleep quality for couples in everyday life (Bradbury & Karney, 2014). Furthermore, these findings suggest that dyadic data approaches can provide a more complete picture of the daily sleep quality of coupled individuals than approaches in which data is collected from only one partner. The dyadic nature of daily sleep quality may be especially salient and critical for couples coping with T1D, as sleep disturbance is highly prevalent due to diabetes-related issues (e.g., responding to a CGM alarms during sleep time; Barnard et al., 2016).

This study helps to understand the complex interplay between sleep quality and stressors among couples coping with T1D in everyday life. Using statistical models for capturing intensive longitudinal data that allowed for separating effects into within- and between-person effects, this study captured the daily fluctuations in individuals' sleep quality and stressors and the average estimates of sleep quality and stressors across the 2-week period. In addition, the use of intensive longitudinal data allowed for an examination of the degree to which daily sleep quality and daily stressors were bidirectionally associated and a determination of the relative strength of each direction in everyday life (Troxel, 2010). This study found that better average sleep quality was associated with both fewer diabetes-specific and general stressors and having more diabetes-specific and general stressors on average was associated with poorer sleep quality (between-person effects). However, within-person effects were found only for the effects of daily sleep quality on daily diabetes-specific and general stressors.

The results linking daily sleep quality and daily general stressors were similar to the link between daily sleep quality and daily diabetes-specific stressors, in particular for patients. That is, with respect to the effects of daily sleep quality on daily stressors, we found similar patterns of both within-person and between-person effects. For example, on days when patients and spouses, respectively, had better daily sleep quality than their average level, patients rated fewer daily stressors (both general and diabetes-specific stressors) the next day. These results suggest that sleep quality affects the experience of diabetes-specific stressors and general stressors similarly in everyday life. This study lays a foundation for future research to examine how daily general stressors and daily diabetes-specific stressors are associated with one another—in particular, how this process takes place at the intra-individual level. Daily diabetes-specific stressors may create the context for more daily general stressors as well as arise from these more daily general stressors for patients. In addition, future research should examine how this process takes place at the inter-personal level in the context of couple relationships. For example, a patient's daily diabetes-specific stressors may create a context for their spouse's daily general stressors or may arise from their spouse's general stressors (Bakker, Demerouti, & Dollard, 2008).

We found both within-person and between-person effects for sleep quality on diabetes-specific and general stressors, but we only found between-person effects for diabetes-specific and general stressors on sleep quality. Several potential explanations exist for why fluctuations of daily stressors did not affect daily sleep quality (i.e., the reverse direction of effects). As stressful events in this study were measured as present or absent, the intensity of the daily stressful events was not captured. That is, the intensity of

Table 4
Relationship Between Patient and Spouse Sleep Quality and Daily General Stressors

Variable	*b* (*SE*)	*t*
Actor and partner effects of daily sleep quality on daily general stressors		
Level 1 (within)		
Patients		
Intercept	.13 (.01)	18.96***
Previous day's stressors	.11 (.02)	5.54***
Actor effect (patients → patients)		
Daily sleep quality$_{wp}$	−.02 (.005)	−4.32***
Partner effect (spouses → patients)		
Daily sleep quality$_{wp}$	−.01 (.005)	−1.97*
Spouses		
Intercept	.14 (.01)	19.87***
Previous day's stressors	.03 (.02)	1.73
Actor effect (spouses → spouses)		
Daily sleep quality$_{wp}$	−.02 (.005)	−4.66***
Partner effect (patients → spouses)		
Daily sleep quality$_{wp}$	−.01 (.005)	−1.48
Level 2 (between)		
Patients		
Actor effects (patients → patients)		
Daily sleep quality$_{bp}$	−.03 (.01)	−2.40*
Partner effects (spouses → patients)		
Daily sleep quality$_{bp}$	−.01 (.01)	−.81
Spouses		
Actor effects (spouses → spouses)		
Daily sleep quality$_{bp}$	−.03 (.01)	−3.10**
Partner effects (patients → spouses)		
Daily sleep quality$_{bp}$	−.01 (.01)	−.51
Actor and partner effects of daily general stressors on daily sleep quality		
Level 1 (within)		
Patients		
Intercept	2.92 (.07)	39.75***
Previous day's sleep quality	.08 (.02)	4.06***
Actor effect (patients → patients)		
Daily stressors$_{wp}$	.15 (.09)	1.59
Partner effect (spouses → patients)		
Daily stressors$_{wp}$	.07 (.09)	.80
Spouses		
Intercept	2.82 (.07)	38.78***
Previous day's sleep quality	.08 (.02)	4.02***
Actor effect (spouses → spouses)		
Daily stressors$_{wp}$	.14 (.09)	1.50
Partner effect (patients → spouses)		
Daily stressors$_{wp}$	.09 (.09)	.93
Level 2 (between)		
Patients		
Actor effect (patients → patients)		
Daily stressors$_{bp}$	−.87 (.39)	−2.24*
Partner effect (spouses → patients)		
Daily stressors$_{bp}$	−.29 (.42)	−.69
Spouses		
Actor effect (spouses → spouses)		
Daily stressors$_{bp}$	−1.33 (.42)	−3.21**
Partner effect (patients → spouses)		
Daily stressors$_{bp}$	−.38 (.39)	−.99

Note. wp = within-person; bp = between-person. Table reports unstandardized coefficients (*b*) with standard errors (*SE*) in parentheses.
* $p < .05$. ** $p < .01$. *** $p < .001$.

daily stressful events can be low so that they may not have been sufficiently stressful to affect sleep quality. In addition, the effects of stressful events may have been diffuse across the day or were not maintained until bedtime, and therefore did not affect sleep quality on a daily basis. All in all, fluctuations of daily sleep quality affected daily stress experience in everyday life; in contrast, fluctuation of daily stressors did not affect daily sleep quality in everyday life, implying that couples coping with T1D are sensitive to poor sleep quality in daily life.

The results of the current study must be interpreted in the context of some limitations. First, data were solely self-report. Future research would benefit from objective measures of sleep such as actigraphy and polysomnography to give additional insights into how sleep duration and sleep disturbances relate to diabetes-specific and general stressors in real time (Troxel, 2010). The fact that similar results were found for another metric of sleep, that is sleep duration, are encouraging. These greater details regarding sleep should also include whether couples occupied the same bed, whether patients and spouses had other sleep disruptions, including sleep apnea (treated or not), as well as whether sleep was disrupted by diabetes-related events such as severe hypoglycemia. In addition, participants completed the daily diary in the evening about the previous night's sleep quality and that day's daily stressors. Thus, the measurement of daily sleep quality may be more affected by retrospective bias than that of daily stressors. In future studies, participants should rate their previous night's sleep quality upon waking in the morning and rate their daily stressors in the evening to more accurately capture these constructs.

These findings hold some useful clinical implications. First, the interdependence of daily sleep quality of patients with TID and spouses and the effect of daily sleep quality on daily general stressors emphasize the importance of addressing sleep quality issues within the context of couple relationships. A couple-based approach to intervention may be a useful adjunct to individual interventions. Second, process-oriented investigations between daily sleep quality and daily stressors hold the potential to identify targets for prevention and intervention efforts to optimize daily sleep quality among couples coping with T1D. In particular, because within-person sleep quality was associated with next-day stressors, interventions could target sleep quality via improvements in sleep hygiene and addressing possible factors contributing to insomnia. In addition, patients could work with their endocrinologists to improve daily sleep quality by attempting to better manage diabetes prior to sleep, thus precluding the disruption of diabetes management behaviors during sleep. It is possible that targeting sleep quality could improve daily life among couples coping with T1D, possibly by reducing the number or perceived severity of subsequent stressors experienced (Barnard et al., 2016).

In conclusion, this study provides a window into the interdependence of daily sleep quality of patients with T1D and their spouses, as well as an illustration of the dynamic interplay between daily sleep quality and daily stressors among couples coping with T1D. In addition, by using a daily diary design, the implications of the study contribute to the field of T1D research demonstrating the importance of considering within-person variability of sleep quality on experiences of stressors among couples coping with T1D. This study provides a foundation for future longitudinal research on couples in which one member has T1D to examine the underlying physiological, psychological, and behavioral mechanisms of these associations. This study also encourages future longitudinal research to examine how associations between daily sleep quality and daily stressors impact the daily relationship and diabetes management outcomes.

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