Abstract

Youth with type 1 diabetes (T1D) must adhere to a complex treatment regimen to prevent health complications. Friends may provide diabetes-specific support to help youth manage diabetes, but evidence on whether youth benefit from diabetes-specific friend support is inconclusive. The present study first investigated whether satisfaction with friend support was linked to psychological distress and diabetes management. Second, it was investigated whether self-esteem mediated these relations. To this end, 324 Dutch-speaking emerging adults (17-28 years) with T1D completed questionnaires on diabetes-specific friend support, self-esteem, diabetes-specific distress, depressive symptoms, and self-care. HbA1c values were obtained from patients' physicians. Receiving diabetes-specific support from friends was associated with more diabetes-specific distress, but not for youth who were satisfied with the received support. Diabetes-specific friend support was not associated with other outcomes. Self-esteem did not mediate these relations. These results suggest that associations between diabetes-specific friend support and diabetes management are limited and that support satisfaction should be taken into consideration when examining the role of friend support for youth with T1D.

Keywords. Diabetes Mellitus, Type 1; Peers; Friend Support; Appraisals; Emerging Adulthood; Chronic Illness

Type 1 diabetes (T1D) is the most common chronic metabolic condition in youth. Youth with T1D need to adhere to a complex and intensive daily treatment regimen to avoid short- and long-term health complications (Daneman, 2006). Managing T1D can become especially challenging when youth reach the developmental stage of emerging adulthood—a period defined as between the ages of 18 and 29 in industrialized nations. This life phase comes with unique challenges such as continued identity exploration, establishing job security, and maintaining healthy social relationships while growing increasingly independent from parents (Arnett, 2004). The combined challenges of T1D and emerging adulthood render emerging adults with T1D vulnerable for poor diabetes management (Markowitz et al., 2016) and high diabetes-specific distress (Vallis et al., 2018). The gradual decline of parental involvement in diabetes care across adolescence and emerging adulthood contributes to increases in HbA1c (a measure of how well an individual is meeting recommended targets of blood glucose across a 3-4 month period with lower values being better) (Berg et al., 2019; King et al., 2014; Young et al., 2014). Also, emerging adults spend increasingly more time with peers, and bonds with peers become stronger and more intimate (Barry et al., 2016), which may affect diabetes management. Yet, research on peer relationships in connection with diabetes is lagging behind, especially in the emerging adult population.

A substantial portion of the T1D literature on peers is about diabetes-specific friend support, which is support from friends revolving around diabetes self-care (Mattacola, 2020; Van Vleet & Helgeson, 2020). However, findings are inconsistent as to whether self-care actually benefits from such diabetes-specific friend support. Some studies have found diabetes-specific friend support to be associated with better self-care in adolescence (Bearman & La Greca, 2002; J. A. Malik & Koot, 2012) and late adolescence/early emerging adulthood (Pihlaskari et al., 2018). Other studies have found diabetes-specific friend support to be unrelated to self-care in adolescence (Idalski Carcone et al., 2011; Naar-King et al., 2006), or

even to be associated with worse self-care in adolescence (Hains et al., 2007) and late adolescence (Doe, 2016).

One factor that may help to explain these inconsistent findings is how individuals with T1D appraise the support they receive from friends. An appraisal is a cognitive evaluation (Lazarus & Folkman, 1984)—in this case, the evaluation of how satisfied one is with the support received (Newsom et al., 2005). The degree to which someone positively appraises received support can be referred to as support satisfaction (Luszczynska et al., 2007). Whereas associations between received support and outcomes are ambivalent (Bolger & Amarel, 2007), positive associations between support satisfaction and well-being are consistent across a wide variety of populations and types of well-being. For example, satisfaction with emotional support was found to be positively associated with emerging adults' overall well-being (i.e., satisfaction with life, positive and negative affect, and self-acceptance) (Lane & Fink, 2015). Satisfaction with informational, instrumental, emotional support, and companionship was positively associated with life satisfaction and negatively with depressive symptoms in older adults (65-90 years) (Newsom et al., 2005). Finally, satisfaction with emotional and instrumental support was found to be negatively associated with post-traumatic stress symptoms in adult victims of violent crime (Andrews et al., 2003).

The issue that youth with T1D may not always be satisfied with the support they receive has been overlooked in literature. When youth receive diabetes-specific support from their friends, their identity as 'a person with diabetes' and being different from their peers without diabetes becomes salient. This feeling of being different may be associated with distress in some youth (Commissariat et al., 2016; Lambert & Keogh, 2015; Wilson, 2010). Further, friends often have limited expertise surrounding diabetes and may not be the most adequate providers of support targeting diabetes self-care, another reason why youth with T1D may not always be satisfied with received support from peers. Inadequate or unhelpful

support may hinder good diabetes management (Van Vleet & Helgeson, 2020). Finally, a recent qualitative study suggested that some youth with T1D dislike diabetes-specific friend support because they perceive it as intrusive (Mattacola, 2020). In sum, for youth who are not satisfied with the diabetes-specific support they receive from friends, this support may discourage, rather than encourage, self-care and can be associated with higher HbA1c levels and higher levels of depressive symptoms and diabetes-specific distress.

As a secondary research objective, we aim for a more in-depth understanding of how receiving diabetes-specific friend support could be associated with poor physical and psychological health. Studies investigating harmful correlates of social support receipt have indicated that receiving support can establish a hierarchical relationship between the recipient and support provider, which may threaten the recipient's self-esteem (J. D. Fisher et al., 1982; Lau et al., 2018; Lepore et al., 2008; Nadler et al., 1983; Symister & Friend, 2003). Diabetes-specific friend support that is not appraised positively may be associated with lower self-esteem. For example, when an emerging adult with T1D suffers from hypoglycemia after drinking too much alcohol at a party, a friend may be inclined to provide support. In this situation, the support may not be appraised positively and may evoke a sense of shame and indebtedness toward that friend. One study indeed found that a majority of adolescents and emerging adults with type 1 diabetes experience stigma associated with diabetes self-care and hypoglycemia (Brazeau et al., 2018). As a consequence, self-esteem and well-being may suffer (Bolger & Amarel, 2007; Gleason et al., 2003; Kowitt et al., 2017). Diminished self-esteem may not only lead to worse well-being, but also may reduce confidence in one's capabilities for adhering to the diabetes treatment regimen (van der Ven et al., 2003). Thus, self-esteem may partly explain why unsatisfying support is not always related to better outcomes in emerging adults with diabetes.

The primary goal of the present study is to examine whether the association of friend support to depressive symptoms, diabetes-specific distress, self-care, and HbA1c depends on support satisfaction in a large sample of emerging adults with type 1 diabetes. We hypothesize that received support is beneficial for these diabetes outcomes in the context of high satisfaction but harmful in the context of low satisfaction. Second, we investigate whether self-esteem partly explains the hypothesized moderated effect of support satisfaction on the relation of received support to diabetes outcomes.

Method

Participants and Procedure

The data were drawn from the fourth measurement wave (T4) of a longitudinal study in which individuals with type 1 diabetes were contacted through the Belgian Diabetes Registry. The fourth wave took place between November 2017 and January 2018. At baseline, patients were selected according to the following criteria: (1) diagnosed with type 1 diabetes, (2) between 14 and 25 years, and (3) Dutch speaking. A total of 1450 eligible participants were mailed a package including a questionnaire bundle and informed consent forms with detailed information about the study's purpose and content. Parents provided consent for youth below 18 years. After four and eight weeks, non-responders were sent reminders. All participants received a cinema ticket each time they participated. Participants with impaired cognitive abilities, as declared by their parents, were excluded from analyses. At baseline, 571 bundles were returned of which 559 cases were eligible for analyses (response rate = 41%).

Youth who participated at least once in the previous waves were invited for T4, three years after baseline. At T4, participants were between 17 and 28 years of age. A total of 507 youth were contacted for participation at T4, and 324 youth participated (participation rate = 64%). Table 1 presents participants' characteristics at baseline (T1) for T4 responders versus non-responders. Non-responders had higher HbA1c levels ($t(216.6) = 2.083$, $p=.038$) and

were more likely to be male ($\chi 2(1) = 4.765$, $p = .029$). The Medical Ethics Committee and Social and Societal Ethics Committee of KU Leuven provided ethical approval (file number: S57299). Data on diabetes-specific friend support were only gathered at the fourth and final wave of the longitudinal study, hence the cross-sectional nature of the present findings.

Measures

Diabetes-specific friend support, frequency & satisfaction. Diabetes-specific friend support was measured using the 28-item Diabetes-Specific Support Questionnaire–Friends (DSSQ-Friends; Bearman & La Greca, 2002). The items were translated to Dutch using the back-translation procedure. Each item was rated in terms of frequency of receipt ('how often do your friends…?') and support satisfaction ('how does it feel or how would it feel?'). No recall period was specified. The items can be grouped according to four diabetes care domains: insulin and blood glucose checking, diet, exercise, and emotional support. Unlike previous studies using the DSSQ-Friends, frequency and satisfaction scores were not combined into a single score but were treated as two distinct variables. Confirmatory factor analysis was conducted to investigate whether support frequency and support satisfaction can be used as separate constructs in subsequent analyses. Based on the best fitting factor model (as described in the results-section), weighted frequency and satisfaction scores were computed for each individual.

Self-esteem. Self-esteem was measured using the 10-item Rosenberg Self-Esteem Scale (RSES; Rosenberg, 1965), translated to Dutch by Van der Linden et al. (1983). No recall period was specified. Cronbach's alpha was .90.

***Diabetes-specific distress*.** Diabetes-specific distress was measured using the Problem Areas in Diabetes Scale (PAID; Polonsky et al., 1995), translated to Dutch by Snoek et al. (2000). Participants were asked how they perceived diabetes-related items as problematic at the moment of questionnaire completion. For the present analyses, the 2-item 'lack of social

support' subscale was omitted to avoid inflated estimates for the association between diabetes-specific distress and peer variables. A total of 18 items were used to compute an overall diabetes-specific distress score. Cronbach's alpha was .94.

***Depressive symptoms*.** The 20-item Center for Epidemiologic Studies Depression scale (CES-D) was used to measure depressive symptoms experienced during the past week (Radloff, 1977), translated to Dutch by Bouma et al. (1995). Cronbach's alpha was .93.

***Self-care*.** Self-care was measured using the Self-Care Inventory (SCI; Weinger et al., 2005) and translated to Dutch using the back-translation procedure (Oris et al., 2016). The item 'wearing a medic alert ID' was removed from the scale as this is not standard in Belgium. A total of 13 items were rated on a scale from 1 (never do it) to 5 (always do this as recommended without fail). Responding 'not applicable' was also possible. Patients reported on their own self-care during the past month. Cronbach's alpha was .73.

HbA1c. HbA1c values obtained via patients' endocrinologists within three months before or after questionnaire completion were used as an indicator of blood glucose control.

Statistical Analyses

A detailed outline of the study's hypotheses and analysis plan (including R-code) can be found at Open Science Framework (OSF) where they were registered prior to testing hypotheses (https://tinyurl.com/osfdiab). A non-registered sensitivity analysis was conducted as well, excluding all 17 year old participants (n=32) to better align our sample with ages 18 to 29 years—the age range generally theorized to reflect emerging adulthood (Arnett, 2004). All results reported in this manuscript are based on the entire sample (n = 324). It is mentioned in footnotes when results from the sensitivity analysis (n=292) differ in statistical significance (with $\alpha = .05$) from the results obtained in the full sample. All analyses were conducted using R version 3.5.0 and the R-package 'lavaan' 0.6-5 for structural equation modelling (Rosseel, 2012). All structural equation models were estimated using full

information maximum likelihood estimation (FIML) to use all available data. Robust standard errors (MLR) were used to take non-normal variable distributions into account.

Preliminary analyses. Prior to hypothesis testing, we examined whether gender, age, illness duration, and insulin administration (pump/injection) were related to the main study variables using MANOVAs (Wilks' λ was calculated to assess statistical significance) and Pearson correlations. Variables that were significantly related to one or more of the main study variables were statistically controlled in all analyses. For these preliminary analyses, multiple imputation was used to deal with missing data[1]. Five datasets were imputed with predictive mean matching and results were pooled using the r-packages 'mice' and 'miceadds'.

Identifying the factor structure of the DSSQ-Friends, frequency & satisfaction. To determine whether a total score for support frequency and a total score for support satisfaction could be extracted from the DSSQ-Friends, three competing confirmatory factor analysis (CFA) models were compared [Figure 1 in Electronic Supplementary Materials (ESM)]. This was done twice, once for the support frequency scores and once for the support satisfaction scores. First, a single factor model was fitted. Second, a second-order factor model including four first-order domain-specific factors (i.e., insulin & blood checking, diet, exercise, emotional support) and one higher-order general factor was fitted. Third, a bi-factor model was fitted with a general first-order factor on which all items loaded directly, and four first-order domain-factors that were independent from both the general factor and from each other.

One important difference between the bifactor model and the second-order factor model is the so-called proportionality constraint imposed by the second-order factor model on its factor loadings (Gignac, 2016). In the second-order factor model, an item cannot be

[1] In the registered analysis plan we opted for listwise deletion to handle missing data in the preliminary analyses, but changed this to multiple imputation for the actual paper. This did not affect the inclusion of control variables in the structural equation models.

strongly associated with the second-order factor if it does not have a high loading on the first-order factor. This constraint is not present in the bifactor model but comes at the cost of model degrees of freedom. Model fit was evaluated based on the following criteria: RMSEA should be below 0.08, SRMR should be below 0.09, CFI should exceed 0.90, and the χ^2-value divided by its degrees of freedom was also computed, for which values below 2 indicate good model fit (Kline, 2015). The reader is referred to the registered analysis plan at OSF for more detailed information on the CFA procedure.

Assessing moderation by satisfaction and mediation by self-esteem of the relation of received support to diabetes management and psychological distress. Prior to conducting path analysis, all variables except gender were standardized. Paths were estimated from support frequency and support satisfaction to diabetes-specific distress, depressive symptoms, self-care, and HbA1c. Two path models were estimated using structural equation modeling. In the first model, moderation was tested by including an interaction term between support satisfaction and support frequency (Figure 1, model 1). In the second model, a moderated mediation was tested with self-esteem as a mediator of the moderated relation between support frequency and outcome variables (Figure 1, model 2). Direct and indirect effects via self-esteem from support frequency to outcomes were estimated, conditional on levels of support satisfaction (1 SD above and below its mean). Control variables, which significantly related to the main study variables, were added as predictors in both path models[2].

Results

Preliminary analyses

[2] A small addendum was made to the registered analysis plan in that the variances and covariances of exogenous variables were estimated freely, rather than the 'lavaan' default to fix them at their sample values. This appeared necessary for estimating mediation and moderation effects within the SEM framework and did not alter the path coefficients.

As shown in Table 2, illness duration was not significantly associated with any of the main study variables, but older age was associated with less support frequency and less treatment self-care. In addition, a MANOVA indicated that gender was significantly related to the main study variables (Wilk's λ range across imputed datasets = [.918, .927]; $F_{(7,312)}$ range = [3.508, 3.995]; *p* range = [.0003, .001]; η^2 range = [.0729, .0822]). Women had significantly higher HbA1c, more depressive symptoms and diabetes-specific distress, and lower self-esteem than men (Table 3). A second MANOVA with type of insulin administration as a fixed factor revealed no significant associations with the main study variables (Wilk's λ range across imputed datasets = [.960, .975]; $F(7,312)$ range = [1.135, 1.843,]; *p* range = [.079,.341]; η^2 range = [.025,.040]). Thus, age and gender were controlled in all path analyses.

Identifying the factor structure of the DSSQ-Friends, frequency & satisfaction

The fit indices for the estimated factor models are summarized in ESM Table 1. After allowing three covariances among the item residuals to be estimated freely in each model, neither the single factor models nor the second-order factor models fitted the data adequately. The bi-factor models fitted the data adequately. This provides some support that the DSSQ-Friends can be used to measure diabetes-specific friend support frequency on the one hand and support satisfaction on the other. ESM Table 2 presents the item means and standardized factor loadings of the bi-factor models for frequency of and satisfaction with diabetes-specific friend support. Thus, instead of summing item scores to compute aggregated scale scores, weighted support frequency and support satisfaction scores were computed for each individual, based on the bi-factor models' implied factor structure.

Assessing moderation by satisfaction and mediation by self-esteem of the relation of received support to diabetes management and psychological distress.

First, a SEM model was evaluated with gender, age, support frequency, support satisfaction, and the interaction between frequency and satisfaction as predictors of self-care,

HbA1c, depressive symptoms, and diabetes-specific distress. Non-significant interaction terms were excluded from the model. The final model had excellent fit [$\chi^2(3)=1.847$, $p=.605$; RMSEA=0, 90% CI[0,0.085]; CFI=1; SRMR=.011]. The β-coefficients and corresponding *p*-values are displayed in Table 4. In line with expectations, the interaction between support frequency and support satisfaction was a significant predictor of diabetes-specific distress. As shown in Figure 2, for those low in support satisfaction, greater support frequency was related to more diabetes distress (β = .245, $p = .001$), but this relation was not significant for those who were high in support satisfaction (β = -.027, $p = .999$). There were no significant main or interaction effects of support satisfaction and support receipt for depressive symptoms, self-care, and HbA1c on top of age and gender[3].

Second, a moderated mediation model with self-esteem was investigated to test the hypothesis that self-esteem mediates the moderated relation between support frequency and outcome variables. The model had adequate fit [$\chi^2(3)=6.816$, $p=.078$; RMSEA=0.060, 90% CI[0,0.121]; CFI=994; SRMR=.021]. Self-esteem negatively predicted depressive symptoms (β = -.742, $p < .001$), diabetes-specific distress (β = -.468, $p < .001$), and positively predicted self-care (β = .263, $p < .001$). However, none of the indirect effects were significant, regardless of the levels of support satisfaction, indicating that there was no (moderated) mediation of self-esteem.

Discussion

The aim of the present study was to increase our understanding of the role of diabetes-specific friend support in psychological and behavioral health for youth with T1D. Previous findings linking this type of support to patient functioning are contradictory (Van Vleet &

[3] In the reduced sample (excluding 17 year olds), there also was a significant interaction effect between support satisfaction and frequency in predicting diabetes-specific distress (β = -.102, $p = .003$). In addition, support satisfaction negatively predicted HbA1c (β = -.187, $p = .040$) and depressive symptoms (β = -.142, $p = .048$).

Helgeson, 2020). We hypothesized that taking the degree of support satisfaction into account would partly explain these inconsistencies.

We found no evidence that the frequency of diabetes-specific friend support has a simple relation to psychological distress, self-care, or HbA1c, which is in line with several other studies that did not find such associations (Van Vleet & Helgeson, 2020). Some studies have found diabetes-specific support to be positively related to self-care and well-being, but only for specific subtypes of diabetes-specific friend support (Bearman & La Greca, 2002; Pihlaskari et al., 2018). We did find evidence, however, that receiving diabetes-specific friend support was associated with higher diabetes-specific distress, especially for youth who were not satisfied with friend support. A recent qualitative study suggested that some youth view diabetes-specific friend support as intrusive and annoying rather than helpful (Mattacola, 2020). Our results extend these qualitative findings by suggesting that the receipt of unsatisfying diabetes-specific support is possibly harmful for diabetes-specific well-being.

One possible explanation of these findings has to do with the visibility of the support that friends provide. Friends can provide diabetes-specific support that is visible and direct to the recipient but also support that is more subtle or less visible. Examples of visible diabetes-specific support are when friends remind someone to check their blood sugar or help out in cases of hypoglycemia. Less visible kinds of support include friends being available to listen to worries concerning diabetes or watching for signs of low blood sugar (Bearman & La Greca, 2002). Some research from community populations shows that less visible support is positively associated with physical and mental health, whereas more visible support is linked to worse outcomes (Bolger & Amarel, 2007; Bolger et al., 2000). In the same vein, it is possible that less visible types of diabetes-specific friend support are appraised more positively than more visible types, especially for youth who do not accept diabetes as part of

their identity (Oris et al., 2016) or have a serious fear of being judged by their peers because of diabetes (Wilson, 2010).

In contrast to our expectations, we did not find that self-esteem mediated the moderated relation between support frequency and outcomes. Lower self-esteem was related to more depressive symptoms, diabetes-specific distress, and lower self-care, irrespective of satisfaction levels. These findings are in line with prior studies that identified self-esteem as an important predictor of patient functioning (van der Ven et al., 2003). It is possible that our measure of self-esteem was too general and not sensitive to the ways in which diabetes impacts one's view of the self. Concepts related to self-esteem but specific to diabetes may be more promising as mediators of the association between support and outcomes. One such example would be diabetes self-efficacy, being the perception of one's ability to manage diabetes (Beckerle & Lavin, 2013). Our measure of self-esteem also may not have functioned as a mediator because it is typically viewed as a trait measure. Future studies would benefit from a longitudinal design that uses more proximal measures of support and state or diabetes-specific measures of self-esteem.

Notwithstanding the inconclusive evidence on whether diabetes-specific support from friends is beneficial for youth, diabetes-specific support may be more beneficial when coming from other sources than regular friends. For example, a multitude of studies have demonstrated the value of diabetes-specific support for youth's self-care when parents are the source of support (Berg et al., 2017). Further, the type of friend or peer that provides support may also play an important role in the effectiveness of diabetes-specific support. Intervention studies in different international settings show that diabetes-specific support from fellow patients (i.e., peers who also have T1D) can improve patients' well-being and self-care (E. B. Fisher et al., 2012). Fellow patients have first-hand experience with T1D and may therefore be excellent providers of diabetes-specific support. Moreover, in contrast to the present study,

diabetes-specific support from fellow patients is less likely to contribute to patients' diabetes-specific distress, as fellow patients instill a sense of normalcy (Lambert & Keogh, 2015). The growth of social media platforms over the last two decades may play a prominent role in connecting fellow patients with each other, increasing opportunities to exchange diabetes-specific support (F. S. Malik et al., 2019; Sparud-Lundin et al., 2010). Finally, romantic partners may also be promising as a source of diabetes-specific support, given that they likely are more emotionally engaged when providing support and are better educated concerning diabetes self-care than friends (Morelli et al., 2015). However, research on this topic is scarce and more research is needed to further clarify the (potentially intertwined) role of peers, romantic partners, fellow patients, and parents, in the context of T1D (Van Vleet & Helgeson, 2020).

Future Directions

First, given the present findings, we deem it important for both researchers and clinicians to focus on whether youth are satisfied with the support they receive from friends in addition to noting how frequently they receive it (Newsom et al., 2005). Second, evidence that diabetes-specific support from friends is beneficial for youth remains inconclusive. Some evidence suggest that non-directive and emotional diabetes-specific friend support may be helpful, whereas diabetes-specific support that is instrumental, directive, or less subtle may be less helpful and even harmful to some extent when coming from friends without T1D (Doe, 2016; Kowitt et al., 2017; Mattacola, 2020; Pihlaskari et al., 2018). More studies investigating different subtypes of diabetes-specific friend support are needed, as well as more studies on romantic partners and fellow patients. Third, most studies have used the 28-item DSSQ-Friends questionnaire or an adaptation to assess diabetes-specific friend support (Bearman & La Greca, 2002), but research investigating the validity of this measure is lacking. This study demonstrates the importance of distinguishing the receipt and satisfaction subscales. Also,

several technological advancements and changes in diabetes care have taken place since its original publication (Zimmerman et al., 2019). In addition, youth communicate more frequently through social media channels. An updated measure of diabetes-specific friend support would have the potential to further advance this research field. Future studies should continue to investigate how diabetes-specific friend support and its domains can best be conceptualized and measured.

Study Strengths and Limitations

The following limitations should be taken into account when interpreting the results. First, our sample consisted of emerging adults between ages 17 and 28. Thus, our findings are limited to this particular age group. Previous research has shown that developmental age group can be an important moderating variable for associations between peers and patient outcomes (Raymaekers et al., 2017; Van Vleet & Helgeson, 2020). Hence, one should be cautious to generalize the present findings to adolescents. Relatedly, our sample consisted of Belgian youth who all spoke Dutch and were homogenous with respect to race. Further, the data of the present study comprise the fourth wave from a longitudinal study, and there was some drop-out with respect to the first wave. Participants who participated in the fourth wave were more likely to have lower HbA1c and were more likely to be female compared to wave 4 non-responders. Our sample may thus at best be representative of the Belgian population, but the generalizability to other populations where ethnic diversity is more pronounced is limited. Finally, the cross-sectional nature of the present data prevents discussing directionality of effects among the variables of interest. Well-being and diabetes-functioning were considered outcome measures. However, it is likely that youths' well-being and diabetes-management may impact how youth appraise and perceive the support that they receive. Directional paths from well-being and functioning to peer relationships have been

established in the present sample and in community samples (Meeus, 2016); Raymaekers et al., 2017; Raymaekers, Prikken, Vanhalst, et al., 2020).

In conclusion, receiving diabetes-specific support from friends was associated with more diabetes-specific distress, but not for youth who were satisfied with the received support. These results suggest that the degree of satisfaction with support can be as important as the actual support that youth with T1D receive. When considering previous findings together with ours, evidence that diabetes-specific support from friends is beneficial for youth with T1D remains inconclusive. Nevertheless, friends may be valuable for recipients' well-being and diabetes-management when they provide support that is general (i.e., not diabetes-specific), emotional, and/or non-directive in nature, as suggested by previous studies (Helgeson et al., 2014; La Greca et al., 1995; Raymaekers et al., 2017). It is clear that the role of peer support for youth with T1D is intricate and that more studies are needed to uncover the conditions under which peer support is helpful and unhelpful.

References

Andrews, B., Brewin, C. R., & Rose, S. (2003). Gender, social support, and PTSD in victims of violent crime. *Journal of Traumatic Stress, 16*(4), 421-427.

Arnett, J. J. (2000). Emerging adulthood: A theory of development from the late teens through the twenties. *American Psychologist, 55*(5), 469-480.

Barry, C. M., Madsen, S. D., & DeGrace, A. (2016). Growing up with a little help from their friends in emerging adulthood. In J. J. Arnett (Ed.), *The Oxford Handbook of Emerging Adulthood* (pp. 215-229). Oxford: Oxford University Press.

Bearman, K. J., & La Greca, A. M. (2002). Assessing friend support of adolescents' diabetes care: The diabetes social support questionnaire-friends version. *Journal of Pediatric Psychology, 27*(5), 417-428.

Beckerle, C. M., & Lavin, M. A. (2013). Association of Self-Efficacy and Self-Care With Glycemic Control in Diabetes. *Diabetes Spectrum, 26*(3), 172-178.

Berg, C. A., Butner, J., Wiebe, D. J., Lansing, A. H., Osborn, P., King, P. S., . . . Butler, J. M. (2017). Developmental model of parent-child coordination for self-regulation across childhood and into emerging adulthood: Type 1 diabetes management as an example. *Developmental Review, 46*, 1-26.

Berg, C. A., Wiebe, D. J., Lee Tracy, E., Kelly, C. S., Mello, D., Turner, S. L., . . . White, P. C. (2019). Parental involvement and executive function in emerging adults with type 1 diabetes. *Journal of Pediatric Psychology, 44*(8), 970-979.

Bolger, N., & Amarel, D. (2007). Effects of social support visibility on adjustment to stress: Experimental evidence. *Journal of Personality and Social Psychology, 92*(3), 458-475.

Bolger, N., Zuckerman, A., & Kessler, R. C. (2000). Invisible support and adjustment to stress. *Journal of Personality and Social Psychology, 79*(6), 953-961.

Bouma, J., Ranchor, A., Sanderman, R., & Van Sonderen, E. (1995). Het meten van symptomen van depressie met de CES-D. Een handleiding. *Groningen, Noordelijk Centrum voor Gezondheidsvraagstukken*.

Brazeau, A.-S., Nakhla, M., Wright, M., Henderson, M., Panagiotopoulos, C., Pacaud, D., . . . Dasgupta, K. (2018). Stigma and Its Association With Glycemic Control and Hypoglycemia in Adolescents and Young Adults With Type 1 Diabetes: Cross-Sectional Study. *Journal of Medical Internet Research, 20*(4), e151.

Commissariat, P. V., Kenowitz, J. R., Trast, J., Heptulla, R. A., & Gonzalez, J. S. (2016). Developing a personal and social identity with type 1 diabetes during adolescence: A hypothesis generative study. *Qualitative Health Research, 26*(5), 672-684.

Daneman, D. (2006). Type 1 diabetes. *The Lancet, 367*(9513), 847-858.

Doe, E. (2018). An analysis of the relationships between peer support and diabetes outcomes in adolescents with type 1 diabetes. *Journal of Health Psychology, 23*(10), 1356-1366.

Fisher, E. B., Boothroyd, R. I., Coufal, M. M., Baumann, L. C., Mbanya, J. C., Rotheram-Borus, M. J., . . . Tanasugarn, C. (2012). Peer support for self-management of diabetes improved outcomes in international settings. *Health Affairs, 31*(1), 130-139.

Fisher, J. D., Nadler, A., & Whitcher-Alagna, S. (1982). Recipient reactions to aid. *Psychological Bulletin, 91*(1), 27-54.

Gignac, G. E. (2016). The higher-order model imposes a proportionality constraint: That is why the bifactor model tends to fit better. *Intelligence, 55*, 57-68.

Hains, A. A., Berlin, K. S., Davies, W. H., Smothers, M. K., Sato, A. F., & Alemzadeh, R. (2007). Attributions of adolescents with type 1 diabetes related to performing diabetes care around friends and peers: The moderating role of friend support. *Journal of Pediatric Psychology, 32*(5), 561-570.

Helgeson, V. S., Palladino, D. K., Reynolds, K. A., Becker, D. J., Escobar, O., & Siminerio, L. (2014). Relationships and health among emerging adults with and without type 1 diabetes. *Health Psychology, 33*(10), 1125-1133.

Idalski Carcone, A., Ellis, D. A., Weisz, A., & Naar-King, S. (2011). Social support for diabetes illness management: Supporting adolescents and caregivers. *Journal of Developmental & Behavioral Pediatrics, 32*(8), 581-590.

King, P. S., Berg, C. A., Butner, J., Butler, J. M., & Wiebe, D. J. (2014). Longitudinal trajectories of parental involvement in Type 1 diabetes and adolescents' adherence. *Health Psychology, 33*(5), 424-432.

Kline, R. B. (2015). *Principles and practice of structural equation modeling.* New York, NY: Guilford Press.

Kowitt, S. D., Ayala, G. X., Cherrington, A. L., Horton, L. A., Safford, M. M., Soto, S., . . . Fisher, E. B. (2017). Examining the support peer supporters provide using structural equation modeling: Nondirective and directive support in diabetes management. *Annals of Behavioral Medicine, 51*(6), 810-821.

La Greca, A. M., Auslander, W. F., Greco, P., Spetter, D., Fisher, E. B., Jr., & Santiago, J. V. (1995). I get by with a little help from my family and friends: Adolescents' support for diabetes care. *Journal of Pediatric Psychology, 20*(4), 449-476.

Lambert, V., & Keogh, D. (2015). Striving to live a normal life: A review of children and young people's experience of feeling different when living with a long term condition. *Journal of Pediatric Nursing, 30*(1), 63-77.

Lane, J. A., & Fink, R. S. (2015). Attachment, social support satisfaction, and well-being during life transition in emerging adulthood. *The Counseling Psychologist, 43*(7), 1034-1058.

Lau, E. Y. H., Chan, K. K. S., & Lam, C. B. (2018). Social support and adjustment outcomes of first-year university students in Hong Kong: Self-esteem as a mediator. *Journal of College Student Development, 59*(1), 129-134.

Lazarus, R. S., & Folkman, S. (1984). *Stress, appraisal, and coping.* New York, NY: Springer

Lepore, S. J., Glaser, D. B., & Roberts, K. J. (2008). On the positive relation between received social support and negative affect: A test of the triage and self-esteem threat models in women with breast cancer. *Psycho-Oncology, 17*(12), 1210-1215.

Luszczynska, A., Sarkar, Y., & Knoll, N. (2007). Received social support, self-efficacy, and finding benefits in disease as predictors of physical functioning and adherence to antiretroviral therapy. *Patient Education and Counseling, 66*(1), 37-42.

Malik, F. S., Panlasigui, N., Gritton, J., Gill, H., Joyce, P., & Moreno, M. A. (2019). Adolescent perspectives on the use of social media to support type 1 diabetes management: Focus group study. *Journal of medical Internet research, 21*(6), e12149.

Malik, J. A., & Koot, H. M. (2012). Assessing diabetes support in adolescents: Factor structure of the modified Diabetes Social Support Questionnaire (DSSQ–Friends). *Diabetic Medicine, 29*(8), 232-240.

Markowitz, B., Parsons, J. A., & Advani, A. (2016). Diabetes in emerging adulthood: Transitions lost in translation. *Canadian Journal of Diabetes, 41*(1), 1-5.

Mattacola, E. (2020). "They think it's helpful, but it's not": A qualitative analysis of the experience of social support provided by peers in adolescents with type 1 diabetes. *International Journal of Behavioral Medicine, 27*(4), 444-454.

Meeus, W. (2016). Adolescent psychosocial development: A review of longitudinal models and research. *Developmental Psychology, 52*(12), 1969-1993.

Morelli, S. A., Lee, I. A., Arnn, M. E., & Zaki, J. (2015). Emotional and instrumental support provision interact to predict well-being. *Emotion, 15*(4), 484-493.

Naar-King, S., Podolski, C.-L., Ellis, D. A., Frey, M. A., & Templin, T. (2006). Social ecological model of illness management in high-risk youths with type 1 diabetes. *Journal of Consulting and Clinical Psychology, 74*(4), 785-789.

Nadler, A., Fisher, J. D., & Itzhak, S. B. (1983). With a little help from my friend: Effect of single or multiple act aid as a function of donor and task characteristics. *Journal of Personality and Social Psychology, 44*(2), 310-321.

Newsom, J. T., Rook, K. S., Nishishiba, M., Sorkin, D. H., & Mahan, T. L. (2005). Understanding the relative importance of positive and negative social exchanges: Examining specific domains and appraisals. *The Journals of Gerontology: Series B, 60*(6), 304-312.

Oris, L., Rassart, J., Prikken, S., Verschueren, M., Goubert, L., Moons, P., . . . Luyckx, K. (2016). Illness identity in adolescents and emerging adults with type 1 diabetes: Introducing the illness identity questionnaire. *Diabetes Care, 39*(5), 757-763.

Pihlaskari, A. K., Wiebe, D. J., Troxel, N. R., Stewart, S. M., & Berg, C. A. (2018). Perceived peer support and diabetes management from adolescence into early emerging adulthood. *Health Psychology, 37*(11), 1055-1058.

Polonsky, W. H., Anderson, B. J., Lohrer, P. A., Welch, G., Jacobson, A. M., Aponte, J. E., & Schwartz, C. E. (1995). Assessment of diabetes-related distress. *Diabetes Care, 18*(6), 754-760.

Radloff, L. S. (1977). The ces-d scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement, 1*(3), 385-401.

Raymaekers, K., Oris, L., Prikken, S., Moons, P., Goossens, E., Weets, I., & Luyckx, K. (2017). The role of peers for diabetes management in adolescents and emerging adults with type 1 diabetes: A longitudinal study. *Diabetes Care, 40*(12), 1678-1684.

Raymaekers, K., Prikken, S., Vanhalst, J., Moons, P., Goossens, E., Oris, L., . . . Luyckx, K. (2020). The social context and illness identity in youth with type 1 diabetes: A three-wave longitudinal study. *Journal of Youth and Adolescence, 49*(2), 449-466.

Rosenberg, M. (1965). *Society and the adolescent self-image*. Princeton, NJ: Princeton University Press.

Rosseel, Y. (2012). Lavaan: An R package for structural equation modeling. *Journal of Statistical Software, 48*(2), 1-36.

Snoek, F. J., Pouwer, F., Welch, G. W., & Polonsky, W. H. (2000). Diabetes-related emotional distress in Dutch and U.S. diabetic patients: Cross-cultural validity of the problem areas in diabetes scale. *Diabetes Care, 23*(9), 1305-1309.

Sparud-Lundin, C., Öhrn, I., & Danielson, E. (2010). Redefining relationships and identity in young adults with type 1 diabetes. *Journal of Advanced Nursing, 66*(1), 128-138.

Symister, P., & Friend, R. (2003). The influence of social support and problematic support on optimism and depression in chronic illness: A prospective study evaluating self-esteem as a mediator. *Health Psychology, 22*(2), 123-129.

Vallis, M., Willaing, I., & Holt, R. I. G. (2018). Emerging adulthood and Type 1 diabetes: Insights from the DAWN2 Study. *Diabetic Medicine, 35*(2), 203-213.

Van der Linden, F., Dijkman, T. A., & Roeders, P. (1983). *Metingen van kenmerken van het persoonssysteem en sociale systeem [Measurements of features of the person system and the social system]*. Nijmegen, The Netherlands: Hoogveld Instituut.

van der Ven, N. C. W., Weinger, K., Yi, J., Pouwer, F., Adèr, H., van der Ploeg, H. M., & Snoek, F. J. (2003). The confidence in diabetes self-care scale: Psychometric properties of a new measure of diabetes-specific self-efficacy in Dutch and U.S. patients with type 1 diabetes. *Diabetes Care, 26*(3), 713-718.

Van Vleet, M., & Helgeson, V. S. (2020). Friend and peer relationships among youth with type 1 diabetes. In A. M. Delamater & D. G. Marrero (Eds.), *Behavioral Diabetes: Social Ecological Perspectives for Pediatric and Adult Populations* (pp. 121-138). Cham: Springer International Publishing.

Weinger, K., Butler, H. A., Welch, G. W., & La Greca, A. M. (2005). Measuring diabetes self-care: A psychometric analysis of the self-care inventory-revised with adults. *Diabetes Care, 28*(6), 1346-1352.

Wilson, V. (2010). Students' experiences of managing type 1 diabetes. *Nursing Children and Young People, 22*(10), 25-28.

Young, M. T., Lord, J. H., Patel, N. J., Gruhn, M. A., & Jaser, S. S. (2014). Good cop, bad cop: quality of parental involvement in type 1 diabetes management in youth. *Current Diabetes Reports, 14*(11), 546-558.

Zimmerman, C., Albanese-O'Neill, A., & Haller, M. J. (2019). Advances in Type 1 Diabetes Technology Over the Last Decade. *European endocrinology*, *15*(2), 70-76.

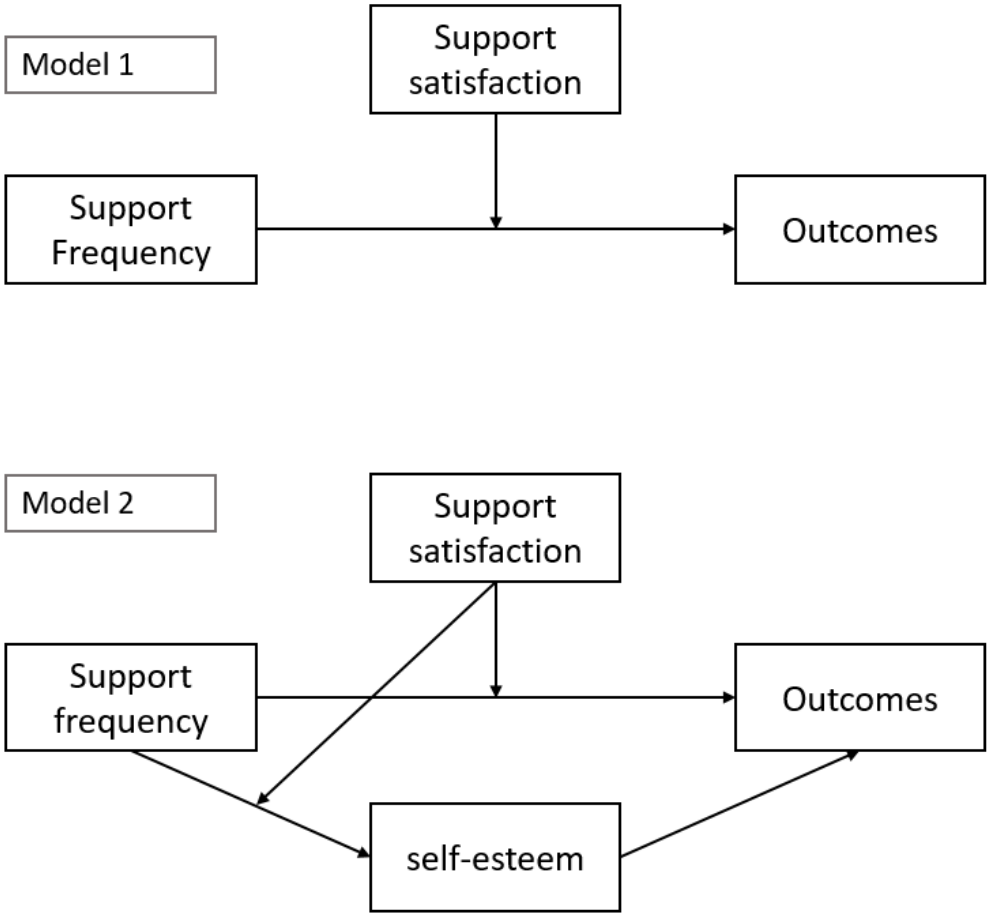

Figure 1. Two path models were analyzed to examine the relation between support frequency on the one hand and diabetes-specific distress, depressive symptoms, self-care, and HbA1c on the other hand. Model 1 includes moderation by support satisfaction and model 2 includes a moderated mediation with self-esteem as the mediator and support satisfaction as the moderator of the mediation.

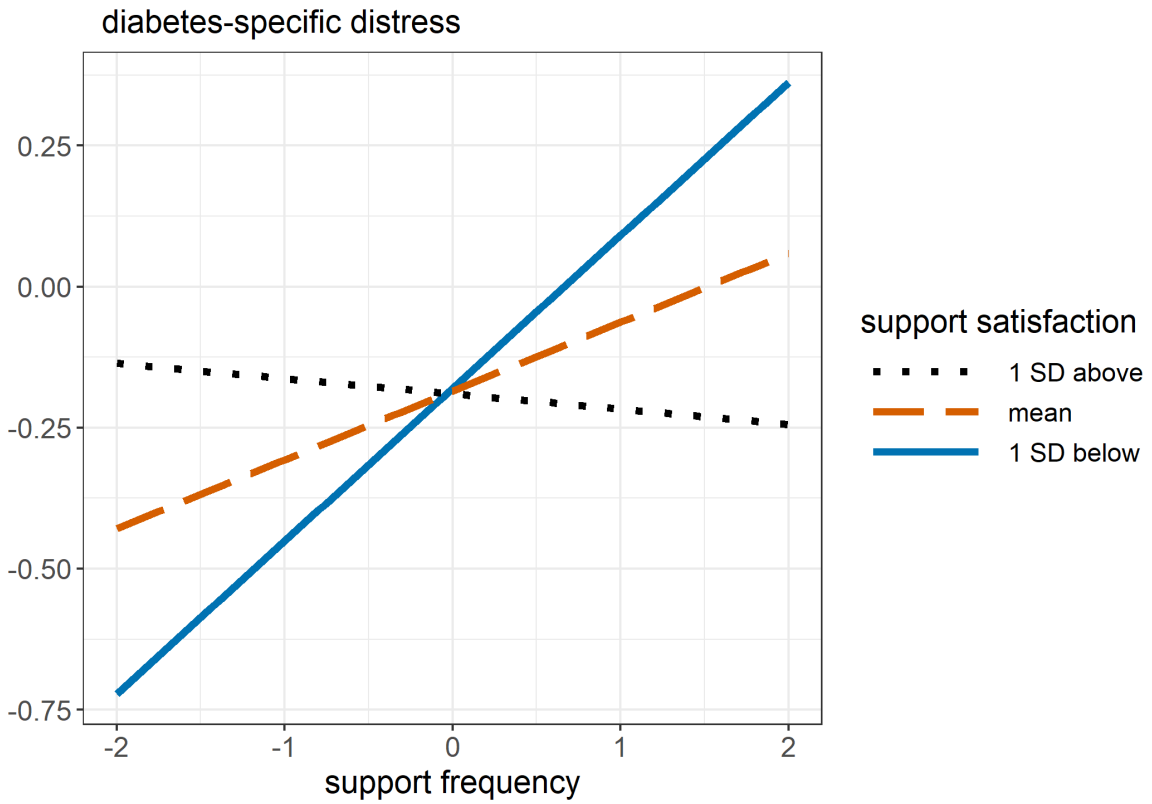

Figure 2. This graph depicts the relationship between support frequency and diabetes-specific distress, for average age and across men and women. All variables are standardized with a mean of zero and a standard deviation of one. At one standard deviation below the mean of support satisfaction, the effect of support frequency on diabetes-specific distress is positive and significant (β = .245, *p* = .001). At the mean level of support satisfaction (β = .122, *p* = .052), and at one standard deviation above the mean of support satisfaction, the effect of support frequency on diabetes-specific distress was not significantly different from zero (β = -.027, p = .999).

Table 1. Participants' characteristics at baseline (T1)

	participated at T4 (*n* = 324)	T4 non responders (*n* = 183)	t/χ^2 - test p-value
HbA_{1c} % [a]	**7.6 (1.3)**	**8.0 (1.6)**	**.038**
Gender			**.029**
Male	**136**	**96**	
Female	**188**	**87**	
Age [a]	18.8 (3.3)	18.9 (3.0)	.905
Age at diagnosis [a]	11.3 (5.6)	10.9 (5.3)	.465
Insulin administration			.621
Injection	248	144	
Pump	75	38	

Note. [a] Mean value with standard deviation between brackets
Values in bold indicate statistically significant differences at T1 between T4 responders and T4 non-responders

Table 2

Variable	*M*	*SD*	1	2	3	4	5	6	7	8
1. Illness duration	9.75	4.95								
2. Age	21.70	3.50	.12*							
3. HbA_{1c}	7.54	0.98	.08	-.00						
4. Support frequency	-0.02	0.78	-.06	-.14*	.05					
5. Support satisfaction	-0.01	0.43	-.04	-.00	-.09	.45**				
6. Self-care	3.93	0.51	-.01	-.12*	-.29**	.11	.12*			
7. Depressive symptoms	11.27	9.79	.01	.03	.14*	.03	-.08	-.21**		
8. Diabetes-specific distress	1.00	0.76	.02	.03	.13	.08	.02	-.29**	.47**	
9. Self-esteem	3.28	0.57	-.03	.04	-.11	.01	.05	.25**	-.76**	-.48**

Means, standard deviations, and correlations among the continuous study variables. Multiple imputation was used for estimating and pooling the correlations. Five datasets were imputed with predictive mean matching using the r-package 'mice'.

Note. M and SD are used to represent mean and standard deviation, respectively. * indicates $p<.05$. ** indicates $p<.01$.

Table 3. Univariate ANOVAs for Gender

Variables	Men M (SD)	Women M (SD)	F-value (1,193)	p-value	η^2
HbA_{1c} %	7.364 (.95)	7.685 (.92)	6.275*	.013	.03
Support frequency	-.08 (.71)	.04 (.79)	2.035	.155	<.01
Support satisfaction	.002 (.38)	.003 (.47)	0.0	.999	<.01
Self-care	3.94 (.52)	3.849 (.53)	.456	.5	<.01
Depressive symptoms	9.007 (8.34)	13.94 (10.68)	17.95***	<.001	.06
Diabetes-specific distress	.848 (.70)	1.15 (.80)	8.5**	.004	.04
Self-esteem	3.36 (.53)	3.12 (.62)	10.97**	.001	.04

Note. M = Mean, SD = Standard deviation, η^2 = eta-squared

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table 4. Beta coefficients and p-values for the path model testing moderation by support satisfaction.

Outcome: Predictor	Self-care	HbA_{1c}-values	Depressive symptoms	Diabetes-specific distress
Gender	B = -.202, *p* = .067	**B = .339, *p* = .015**	**B = .483, *p* < .001**	**B = .410, *p* < .001**
Age	**β = -.123, *p* = .016**	β = -.092, *p* = .155	β = .052, *p* = .354	β = .057, *p* = .291
Support frequency	β = .057, *p* = .411	β = .115, *p* = .086	β = .070, *p* = .278	β = .122, *p* = .051
Support satisfaction	β = .096, *p* = .164	β = -.150, *p* = .065	β = -.103, *p* = .129	β = -.005, *p* = .938
frequency*satisfaction	not significant	not significant	not significant	**β = -.122, *p* < .001**

Note. All variables except gender are standardized. Gender was coded 0 for men and 1 for women. Coefficients significant at *p*<.05 are in bold.