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Mother, father, and adolescent self-control and adherence in adolescents with type 1 diabetes

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Abstract

This study explored whether shared self-control across a family system, including adolescent, mother, and father self-control, as well as the interaction of mother and father self-control, was associated with ease of completing adherence tasks, and the completion of adherence behaviors related to the type 1 diabetes (T1D) regimen. 137 adolescents (*M* = 13.48 years), mothers, and fathers completed a self-report measure of self-control, while adolescents also self-reported on ease of completing adherence tasks and the frequency with which they completed adherence tasks. Higher adolescent, mother, father, and the interaction of mother and father self-control were each associated with greater adolescent perceptions of ease of completing adherence tasks. Also, greater adolescent perception of ease of adherence mediated the association of higher adolescent, father, and the interaction of mother and father self-control on more frequent adherence behaviors. The results are consistent with the idea that family members may share the load of self-control within the family system. The results point to the importance of assessing and intervening within the entire family system to support improved quality of life and better adherence to the medical regimen in adolescents with type 1 diabetes.

Keywords

self-control; adolescence; family system; chronic illness; adherence

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Optimal management of type 1 diabetes is a complex self-regulatory process that requires the completion of daily adherence behaviors, including multiple daily blood glucose checks, carbohydrate counting, and precise insulin dosage (Atkinson, Eisenbarth, & Michels, 2014). Adolescents with better self-control capacity, i.e., the ability to modulate behavior, emotion, and cognition toward a goal (Finkenauer, Engels, & Baumeister, 2005), engage more frequently in adherence behaviors and experience better metabolic control (Berg et al., 2014;

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Hughes, Berg, & Wiebe, 2012; King et al., 2012; Lansing & Berg, 2014; Lansing, Berg, Butner, & Wiebe, 2016). However, there is increasing recognition that self-control is both an individual and interpersonal process. In close relationships, better self-control in one member of a dyad (e.g., mother or father) can enhance an individual's engagement in goal-directed behaviors as the burden of self-control is shared across the dyad or family system, a process termed "load sharing" (Beckes & Coan, 2011; Lansing & Berg, 2014; Lougheed, Koval, & Hollenstein, 2015; Vohs, Finkenauer, & Baumeister, 2011). Research has yet to examine load sharing of self-control in the family system in adolescents with type 1 diabetes and how that might be linked with greater ease of completing complex daily adherence behaviors, facilitating better adherence. This study examined if adolescent, mother, and father self-control were simultaneously associated with adolescent reported ease of completing adherence behaviors, and if that ease in turn was associated with better adherence in adolescents with type 1 diabetes.

Adolescent self-control in youth with type 1 diabetes is associated with better diabetes self-management and metabolic control. Self-control is associated with better adherence (e.g., multiple daily blood glucose checks, insulin dosing, and carbohydrate counting), both at a daily level and over the preceding month (Berg et al., 2014). Adolescent self-control is also associated with better metabolic control, as indexed by glycosylated hemoglobin (HbA1c) percentages, as well as averages and variability in daily blood glucose levels (Berg et al., 2014; Lansing & Berg, 2014). The importance of self-control for understanding diabetes management is highlighted by findings that self-control predicts daily negative affect toward diabetes management and, in turn, daily blood glucose levels (Lansing, Berg, Butner, & Wiebe, 2016) and that high levels of self-control may buffer against worsening metabolic control over time (King et al., 2012).

Self-control, however, is both an individual and interpersonal process (Beckes & Coan, 2011; Lougheed et al., 2015; Vohs et al., 2011), and load sharing of self-control across the family system may help to explain ease of completing adherence behaviors in adolescents with type 1 diabetes. Self-control is subject to dyadic load sharing (Beckes & Coan, 2011), wherein each individual's self-control serves as an interpersonal resource that can be shared between close relationship partners (Vohs et al., 2011) or family members (Lougheed et al., 2015). Load sharing can occur through both automatic and unintentional (e.g., emotion co-regulation) as well as volitional mechanisms (e.g., instrumental support), with greater load sharing reducing the burden of self-control for an individual. For example, Lougheed et al. (2015) found physiological evidence to support load sharing between mother-daughter dyads, such that a mother-to-daughter transmission of resources seemingly reduced the arousal daughters experienced in a stressful situation (Lougheed et al., 2015). Within the family system of adolescents with type 1 diabetes, higher mother and father self-control may reduce the burden of self-control, making complex tasks like diabetes adherence feel easier to complete, thus increasing adolescent engagement in and completion of adherence behaviors.

It may be particularly beneficial for youth with type 1 diabetes to have both parents with higher self-control. Research examining self-control within dyads indicates that both partners must be highly regulated to fully benefit from load sharing (Dzhogleva &

Lamberton, 2014; Lougheed et al., 2015; Vohs et al., 2011). For example, Dzhogleva and Lamberton (2014) found that the presence of only one highly controlled individual in a dyad was associated with similar decision making capacity to that of two poorly self-controlled partners (Dzhogleva & Lamberton, 2014). However, research on load sharing of self-control has yet to be extended to specifically examining both mother and father self-control. When other aspects of parental or family functioning and adolescent outcomes have been examined with regard to both mother and father functioning, findings suggest that having two higher-functioning parents provides greater benefits compared to having only one or neither parent with higher levels of functioning (Johnson, Shulman, & Collings, 1991; McKinney & Renk, 2008; Simons & Conger, 2007). Thus, there may be an interaction between mother and father self-control in explaining adolescent reported ease of completing adherence behaviors, such that youth with both parents having higher self-control may report greater ease and, in turn, better adherence than youth with only one or no higher self-control parents.

The aim of this study was to examine how higher adolescent, mother, and father self-control was associated with greater ease of managing diabetes and thereby better adherence in adolescents with type 1 diabetes. It was hypothesized that higher adolescent, mother and father self-control as well as the interaction of mother and father self-control would be associated with greater adolescent reported ease of completing adherence behaviors, and that ease of adherence would then mediate the associations of higher self-control with better adherence. For the interaction, it was specifically hypothesized that higher mother and higher father self-control would each be associated with greater adolescent reported ease of adherence and in turn adherence behaviors, but that these associations would be stronger when the other parent also had higher self-control.

Methods

Participants

Participants included 137 (M = 13.48 years, SD = 1.51, 52.6% female) adolescents with type 1 diabetes, and their mother and father who participated in a larger longitudinal study. Participants largely were recruited from a university/private partnership clinic, and a community-based private practice that prescribed comparable medical treatments and followed similar clinical procedures. To be eligible, adolescents must have been literate in English or Spanish, between the ages of 10 to 14, had at least one parent willing to participate, and had diabetes for more than 1 year (M = 5.23, SD = 2.87). Over half (65%) of adolescents were on an insulin pump with the remainder using multiple daily injections. The vast majority of families were Caucasian (98%). In addition, almost all mothers were married to their child's biological father (95%), with the remainder either remarried (2%) or living with an unmarried partner (3%). Families generally were middle class, with more than half (60%) of households annually earning $50,000 or more. Fathers were slightly older (M = 44.08, SD = 6.36) than mothers (M = 41.78, SD = 6.21).

Participants were part of a larger longitudinal study where families were assessed every 6 months over two and a half years. This study utilized data from the 3rd assessment (Time 3), or one year into the longitudinal study. Given the focus of this study on mother and father self-control, participants at Time 3 who did not have both a mother and father participating in the study were excluded from these analyses (n = 114). Those excluded individuals did not differ from the included adolescents on measures of adherence ($t(250) = -.65$, $p = .51$), HbA1c ($t(250) = .31$, $p = .75$), and adolescent self-control ($t(250) = -.69$, $p = .49$). Further, there were 58 adolescents who had participated at prior time points that did not participate at Time 3, and those adolescents did not differ in initial HbA1c from participating adolescents at Time 3 ($t(249) = 1.54$, $p = .12$).

Procedure

This study was approved by the university institutional review board. Parents provided written consent and adolescents assent. Teens and fathers completed questionnaires on their self-control at home prior to the lab visit. They were given separate packets, asked not to discuss answers among each other and to direct any questions they might have had to research staff. Mothers completed their questionnaire on self-control during the lab visit. Teens completed the questionnaire on ease of adherence and adherence behaviors during the lab visit as well.

Measures

Self-control—Participants filled out an 11-item self-control measure that assessed ability to control thoughts, emotions, impulses, and regulate performance (Finkenauer et al., 2005). This abbreviated version of the Self-Control scale (Tangney, Baumeister, & Boone, 2004) was validated by Finkenauer et al. (2005) for samples of preadolescents and adolescents ($\alpha = .67$). Adolescents, mothers, and fathers rated on a 1–5 likert scale whether statements such as, “I am good at resisting temptation” were *not at all like me* (1) to *very much like me* (5). This measure had good reliability in the present sample ($\alpha = .73$).

Ease of adherence—The treatment adherence scale on the Pediatric Quality of Life Inventory (PedsQL) 3.0 Type 1 Diabetes Module was used to evaluate adolescents’ perceived ease of completing adherence behaviors (Varni et al., 2003). Adolescents reported on a 1–5 scale how hard it was to complete each adherence behavior (e.g., “It is hard for me to take blood glucose tests”) with 0 representing never a problem and 4 representing almost always a problem. Item scores were reverse scored and transformed to a 0–100 scale, consistent with the scoring of this subscale, so that higher item scores were associated with greater ease of completing adherence behaviors (i.e., lack of burden). An average across items was calculated to create the subscale score. This subscale includes 7-items in the 3.0 module and had moderate reliability ($\alpha = .67$). The 3.0 module has been previously validated in samples of adolescents with type 1 diabetes showing similar moderate reliability for adolescent report on this subscale (α’s > .61). In a more recent module (3.2) this subscale had one item removed regarding wearing a medical alert bracelet. In our sample, this same item had low loading on the subscale factor and reliability of the scale improved ($\alpha = .69$) with removal of the item (Varni et al., 2013). For the present analyses, we removed this item and used the remaining 6 items on the subscale only.

Adherence—To measure adherence to diabetes self-care clinical recommendations over the past month (e.g., “How well have you followed recommendations for checking blood glucose with a monitor?”), we used a modified 16-item version of the Self-Care Inventory

(La Greca, Follansbee, & Skyler, 1990). A consultation with a certified diabetes educator and a person with diabetes was used to guide the modifications, which included revising or adding items to reflect current treatment standards. Two items were added to assess adherence to carbohydrate counting and insulin dosage calculation (e.g., "How well have you followed recommendations for calculating insulin doses based on carbohydrates in meals and snacks?"). Adolescents assessed their own adherence on a 1–5 likert scale with 1 signifying *never did it* and 5 indicating *always did it as recommended without fail*. Analyses used average scores across items. In this sample the measure has good reliability (α = 83). This measure has shown good internal reliability in adolescents, α's ≥ .86 (Berg et al., 2008).

Metabolic Control—Metabolic control was indexed by glycosylated hemoglobin percentages (HbA1c) obtained from medical records. At all clinic sites, HbA1c was obtained using the Bayer DCA2000 by clinic staff.

Analysis Plan

Preliminary descriptive statistics and Pearson correlations between key variables were conducted in SPSS v.22. The hypothesized model was tested through structural equation modeling and estimated using maximum likelihood with bias-corrected bootstrap confidence intervals in Mplus v.7.3. Fit indices for the overall model included Chi Square, comparative fit index (CFI), and root mean square error of approximation (RMSEA). Chi square $p > .05$, CFI > .9, and RMSEA < .05 indicated good model fit.

Teen, mother, and father self-control were each grand mean centered. The interaction of mother and father self-control was calculated after the variables were centered, creating a continuous variable that was the product of the self-control scores of the mother and father. Post-hoc simple slopes testing was conducted to examine if the slopes in the interaction significantly differed from zero and the interaction was visualized at one standard deviation above and below the mean for mother and father self-control. These analyses controlled for the association of insulin pump use with adolescent reported ease of adherence as some previous research has suggested pump use was associated with improved diabetes related quality of life (Kakleas, Kandyla, Karayianni, & Karavanaki, 2009; Low, Massa, Lehman, & Olshan, 2005). Also, insulin pump use was allowed to covary with teen self-control, as insulin pump use is often contraindicated when there are major psychiatric issues, which typically also include impairments in self-control (Pickup, 2012; Tangney et al., 2004).

The clinical significance of the association of adolescent, mother, and father self-control on ease of completing adherence behaviors were described using the minimal clinically important difference score of 9.99 points for the ease of completing adherence subscale identified by Hilliard et al., (2013). Hilliard et al., identified the minimal clinically important difference scores in a sample of 3,988 youth with type 1 diabetes using a distribution-based method of one standard error of measurement where a change in score on the ease of completing adherence behaviors subscale of at least 9.99 points suggest meaningful variation that is not likely due to measurement error and is associated with outcomes such as glycemic control.

Results

Descriptive statistics and Pearson correlations between variables are provided in Table 1. Higher adolescent self-control had a bivariate association with higher mother self-control, but there was no association between adolescent and father, or mother and father self-control. Higher mother self-control was associated with greater adolescent reported ease of adherence and better adolescent reported adherence, but not with HbA1c. Higher father self-control was associated with greater adolescent reported ease of completing adherence behaviors and lower HbA1c, but not adolescent reported adherence, while greater adolescent self-control had a bivariate association with greater adherence and lower HbA1c, but not with ease of adherence. Ease of adherence and adherence were significantly correlated but modestly suggesting they were different constructs, and ease of adherence was not associated with HbA1c.

The hypothesized model (Figure 1) examined the association of adolescent self-control, mother self-control, father self-control, and the interaction of mother and father self-control in predicting adolescent reported ease of adherence, and ease of adherence as a mediator of the association of adolescent, mother, father, and the interaction of mother and father self-control with adherence. The full model had good fit, with a non-significant chi square test, X^2 (5) = 2.74, p = .74, CFI > .99, and RMSEA < .001, 90% CI [0, .09], and predicted 28% of variance in ease of adherence and 29% of variance in adherence.

Self-control predicting ease of adherence

Self-control of the adolescent (b = 6.83, p < .001, 95% CI [3.14, 10.64]), mother (b = 3.96, p = .04, 95% CI [.38, 7.80]), and father (b = 5.82, p = .004, 95% CI [1.83, 9.66]), as well as the interaction of mother and father self-control (b = 9.41, p = .003, 95% CI [2.70, 15.29]), significantly predicted ease of adherence. Pump status was not a significant predictor of ease of adherence (b = 3.69, p = .12, 95% CI [−.73, 8.28]). Teen self-control significantly covaried with mother self-control (b = .08, p = .01, 95% CI [.03, .15]) and pump status (b = .05, p = .03, 95% CI [.003, .10]), but not with father self-control (b = .02, p = .46, 95% CI [−.04, .08]). These findings suggest that adolescent, mother, and father self-control were each uniquely associated with ease of completing adherence behaviors, and that in addition, an interaction between mother and father self-control also was associated with adolescent reported ease of adherence.

The interaction (Figure 2) was consistent with the hypothesized direction of effects, where having two parents with higher self-control was associated with significantly greater ease of adherence, but having only one parent with higher self-control was not more beneficial than having no parents with higher self-control. Simple slopes analyses found that the slope of the association between mother self-control and ease of adherence at lower father self-control was not significantly different from zero (slope = −1.00, p = .68). There was no significant increase in ease of adherence when mother's had higher self-control. The association between mother self-control and ease of adherence at higher father self-control was significantly different from zero (slope = 8.92, p < .001), where for every unit increase in mother's self-control ease of completing adherence tasks increased by 8.92 points.[1]

Clinically meaningful differences in ease of adherence

The predicted level of adolescent reported ease of adherence was examined at one standard deviation above and below the mean for parent self-control. Differences in adolescent reported ease of adherence are clinically meaningful if greater than 9.99 points (Hilliard et al., 2013). There was a clinically meaningful difference in ease of adherence when comparing predicted levels of ease of adherence for both parents with higher self-control versus only mother with higher self-control (difference = 11.39) and with both parents with lower self-control (difference = 10.33). Thus, having two parents with higher self-control may be associated with clinically significant increases in adolescent reported ease of completing adherence behaviors.

Ease of adherence as a mediator of self-control and adherence

Both direct and indirect associations of adolescent, mother, father, and the interaction of mother and father self-control with adherence through ease of adherence were also examined in the model (see Figure 1). Ease of adherence was significantly associated with adolescent reported adherence (b = .01, p = .001, 95% CI [.01, .02]). In addition, there was a significant direct association of adolescent self-control on adolescent reported adherence (b = .25, p = .001, 95% CI [.10, .40]). There were not significant direct associations of mother self-control (b = .01, p = .241, 95% CI [−.07, .24]), father self-control (b = .02, p = .86, 95% CI [−.16, .16]), or the interaction of mother and father self-control (b = −.21, p = .08, 95% CI [−.43, .06]) with adolescent reported adherence.

There were significant indirect associations of adolescent self-control (indirect association = .09, p = .02, 95% CI [.04, .21]), father self-control (indirect association = .08, p = .04, 95% CI [.03, .18]), and the interaction of mother and father self-control (indirect association = .13, p = .04, 95% CI [.04, .29]) on adherence through ease of adherence. This suggested that greater ease of adherence might have, at least in part, mediated the association of teen, father, and the interaction of mother and father self-control with better adherence. However, there was not a significant indirect association of mother self-control with adherence through ease of adherence (indirect association = .05, p = .07, 95% CI [.01, .14][2]). Given that adolescent self-control and mother self-control were significantly associated and covaried in this model, this might suggest that mother self-control does not predict variance in adherence uniquely from adolescent self-control, while father's self-control which is

[1]While this study examined hypotheses about the benefits of having both parents high in self-control, it did not examine hypotheses about the interaction between teen self-control and mother or father self-control predicting diabetes outcomes. In post-hoc analyses, we examined three additional interactions (i.e., between mother and teen, father and teen, and the three way interaction between teen, mother, and father self-control) in addition to the associations examined in Figure 1. We found no support for this larger model, which had indicators of poor fit, with a significant Chi square test, X^2 (17) = 29.22, p = .03, CFI = .83, and RMSEA = .07, 90% CI [.02, .12]. Also, there were no significant associations between any of the additional interactions and ease of adherence or adolescent reported adherence (p's > .64), while all other significant pathways in Figure 1, including the mother and father self-control interaction, remained significant. This suggests that it was not higher mother or father's self-control buffering low self-control in teens that explained ease of adherence in teens with type 1 diabetes.

[2]There is a discrepancy between the p-value and confidence interval for this indirect association. While the p-value is greater than .05 indicating a non-significant association, the confidence interval does not include 0, which indicates a significant association. This discrepancy can occur because the confidence intervals were calculated using bias corrected bootstrapping, which uses a different sampling distribution than for calculating the p-value. The sample size (n=137) in this study was not large enough to support using only the bias corrected confidence interval, but rather indicates that at best there may be a very weak association. Accordingly, this association was interpreted according to the p-value as non-significant.

uncorrelated with both adolescent and mom self-control explains unique variance in adherence.[3]

Discussion

The findings of this study supported that adolescents' perception of the ease of adherence and their adherence to the diabetes management regimen were not only associated with their own self-control, but also with the self-control of their parents. Higher adolescent, mother, and father self-control were each uniquely associated with greater adolescent perceived ease of adherence. Moreover, the combination of higher mother and higher father self-control was significantly associated with further increased adolescent perceptions of adherence ease. This study also found that adolescent perceptions of ease of adherence mediated the association between family members' self-control and adolescent reported adherence. Specifically, there was a significant indirect association of higher adolescent self-control, father self-control and the interaction of mother and father self-control with better adherence through greater ease of adherence. These findings are consistent with self-control load sharing (Lougheed et al., 2015; Vohs et al., 2011) within the family system, where better self-control in members of a family system (e.g., mother or father) can enhance an individual's engagement in goal-directed behaviors due to the burden of self-control that is shared across the family system.

Inconsistent with our hypotheses, there was no direct or indirect association of mother self-control with adherence, and this was despite a significant bivariate association between mother self-control and adherence. Of note, mother and adolescent self-control were significantly correlated and covaried in the models examined, which suggests that the variance that mother self-control explained in adherence was not unique from that explained by covariation with adolescent self-control. This finding may denote how intricately adolescent and mother's self-control is linked, such that when shared variance is removed from the exogenous variables there is very little unique variance remaining to explain outcomes. That is, this finding does not necessarily conflict with research denoting that mothers have more social proximity and play a more important role in facilitating self-regulation for children than fathers. Rather this finding may be related to the foundation of developing adolescent self-control in the early mother-child attachment relationship, wherein high mother self-control may be beneficial in promoting the development of better child self-control (Bernier, Carlson, & Whipple, 2010; Posner & Rothbart, 2000). This also supports the importance of research that examines the development of adolescent self-control in the family context as it relates to adolescent chronic illness self-management (Lansing & Berg, 2014). In particular, research would benefit from examining longitudinally families with a youth with type 1 diabetes to elucidate the intricate links between mother and

[3]Of note, a comparative fit model with HbA1c as an outcome was not examined for this study. The primary aim of this paper was to examine load sharing of self-control on ease of adherence and adherence behaviors. The lack of a bivariate association between ease of adherence and HbA1c limited the exploration of indirect effects linking teen and parent self-control to HbA1c through ease of adherence. Post-hoc, a model with HbA1c as an outcome was examined to test these assertions. This model had overall good fit χ^2 (9) = 11.78, p = .23, CFI = .97, and RMSEA = .05, 90% CI [0, .11]. However, this model did not predict a significant percentage of variance in HbA1c (R^2 = .08, p = .40) and there was no significant indirect association of any self-control variable on HbA1c through ease of adherence and adherence, nor an indirect association of ease of adherence on HbA1c through adherence (p's > .43).

adolescent self-control in explaining diabetes outcomes and how those associations vary across childhood and adolescence.

The results are consistent with a growing literature on the importance of fathers to diabetes management. Fathers are important to diabetes management through processes including father-adolescent relationship quality, father monitoring and behavioral involvement, joint-family problem solving, and lower adolescent secrecy from and higher disclosure to fathers (Berg et al., 2008; Dashiff, Morrison, & Rowe, 2008; Drew, Berg, & Wiebe, 2010; Osborn, Berg, Hughes, Pham, & Wiebe, 2013; Palmer et al., 2009; Seiffge-Krenke, 2002). Neither adolescent self-control nor mother self-control were significantly associated with father self-control. Yet, there was an indirect effect of father self-control, but not of mother self-control, on adherence through ease of adherence. While father self-control was not as closely tied to adolescent and mother self-control, it remained a unique predictor of adolescent perceived ease of adherence. As future research examines self-control across the family system, these findings regarding father self-control and the additive benefit of high mother and high father self-control suggest that in addition to the adolescent and primary caregiver (in this sample largely mothers), it will be important to consider the self-control of fathers, and other caregivers in the family system (e.g., grandparents, older siblings, aunts/uncles, step-parents, and guardians).

Future research is needed to understand more specifically how parental self-control may operate as load sharing in the context of diabetes management. Research on load sharing of self-control, and more broadly interpersonal aspects of self-regulation, has identified many voluntary (i.e., instrumental support, emotional support) and involuntary (i.e. co-regulation of physiological arousal, shifts in goal pursuits) processes that might underlie the benefits of better self-control across a dyad or family system (Coan, 2008; Coan & Maresh, 2014; Hughes, Crowell, Uyeji, & Coan, 2012; Vohs et al., 2011). In post-hoc analyses, one possible general self-regulatory mechanism was examined wherein higher levels of parent self-control might buffer the influence of lower adolescent self-control on ease of adherence or engagement in adherence behaviors. The findings did not support this buffering mechanism (see Footnote 1). This suggests that, regardless of adolescent level of self-control, diabetes management may have benefitted from having two parents higher in self-control and there may have been multiple possible general self-regulatory mechanisms at play.

As adolescent diabetes management is a source of worry (Berg et al., 2013) and negative affect for parents (Queen, Butner, Wiebe, & Berg, 2016), parents with greater self-control may be better able to manage their own reactions to daily diabetes problems so that they are available to assist adolescents with such problems. Further, parents may support daily diabetes goals, especially when the adolescent’s resources are depleted from the daily grind of management of diabetes. The idea that self-control is enhanced in the context of others who themselves have better self-control is consistent with a growing literature on the role of social relationships in enhancing an individual’s self-regulation (Fitzsimons & Finkel, 2010). Adolescents may be better able to utilize their parents when parents themselves have greater self-control, in line with work on how individuals manage their interpersonal resources (Fitzsimons, Finkel, & vanDellen, 2015). For instance, disclosing one’s daily diabetes problems to a parent with greater self-control may elicit more instrumental support that is helpful to resolve daily problems. However, such disclosure to a parent with less self-control may elicit emotional reactions such as anger and worry that are counterproductive to diabetes management (Cameron, Young, & Wiebe, 2007; Wiebe et al., 2011). Moreover, these benefits of having two parents with higher self-control are also likely to be highly influenced by developmental processes in the family system. For example, the development of a warm and accepting parent-child relationship may establish a family context wherein parent self-control may be more useful in facilitating optimal disease management. These examples suggest multiple possible general self-regulatory mechanisms through which parents' self-control may affect adolescent abilities to maintain optimal adherence.

More specific to diabetes management, better mother and father self-control might also be associated with ease of adherence and adherence behaviors through enhanced parental instrumental support for, and behavioral involvement in, diabetes management. For example, better mother and father self-control may be associated with increased parental ability to maintain effective involvement in adolescent diabetes care and to provide higher quality parental monitoring—two processes that are important to adherence and metabolic control (Horton, Berg, Butner, & Wiebe, 2009; Palmer et al., 2004). Better parent self-control might also contribute to healthier, or perhaps more flexible, negotiation of the transfer of disease responsibility from parent to adolescent, which may be critical as adolescent independence increases often without similar consistency of readiness for independence in diabetes management (Palmer et al., 2004; Wiebe et al., 2014). Additionally, better self-controlled individuals are more likely to exhibit pro-relationship behaviors, and this may lead to less family conflict (Dzhogleva & Lamberton, 2014) and better family organization, which have also been linked to improved diabetes outcomes (Ellis et al., 2007). Each of these hypothesized general and diabetes-specific mechanisms that might underlie the benefit of greater load sharing of self-control and better mother and father self-control on diabetes management requires further exploration in adolescents with type 1 diabetes.

The findings of this study need to be considered in the context of some limitations. The sample in this study consisted almost entirely of White, intact, and middle-class families. Given that the development of self-control and self-control in the family system may vary across different family systems and cultural contexts (Posner & Rothbart, 2000), the findings in this study may not generalize to racial and ethnic minority, non-intact/non-traditional, or lower socioeconomic families. Research is especially needed to better understand how load sharing of self-control occurs within non-intact and non-traditional families, including commonly occurring single parent and blended families, where adolescents may not have the same resources of both mother and father self-control. In addition, this study was cross-sectional in nature and further exploration through longitudinal designs is needed to understand how changes in self-control across the family system, in particular for developing adolescents, are related to changes in diabetes management during the course of adolescence.

This study did not examine the associations of adolescent, mother, and father self-control with an objective measure of adherence (e.g., frequency of self-monitoring of blood glucose from glucometer downloads), or with daily or long term glycemic control, so it remains to be explored how self-control across the family system may be associated with these indicators of optimal diabetes management. Given the cross-sectional data, this study also could not examine if earlier problems with poor metabolic control despite high adherence might reduce one's sense of self-control and affect ongoing attempts at adherence throughout adolescence. Also, the measure used to index ease of adherence, a quality of life assessment, needs further examination to understand if that metric fully captures the benefits of load sharing of self-control in diabetes management. Self-control was also measured through a brief self-report format and future studies would benefit from considering the use of more elaborate or objective indicators of self-control (e.g., behavioral testing). It is important to note, however, that in other samples this brief measure of self-control has been related to more elaborate self-report measures (Berg et al., 2014).

In addition, load sharing has been traditionally explored using experimental paradigms (Coan, Schaefer, & Davison, 2005; Lougheed et al., 2015), and the use of such paradigms in a diabetes management context are warranted to further explicate the mechanisms underlying associations of load sharing of self-control with diabetes outcomes in adolescence. Future research should examine the mechanisms that underlie load sharing of self-control, including both micro- (i.e., daily or within daily) and macro (i.e., across longer spans of time) developmental and diabetes-specific processes in the family system. This would help to elucidate measurement models for load sharing of self-control that best capture this dynamic process as it plays out in daily life.

Finally, these findings support the importance of assessing and engaging the entire family system in interventions for adolescents with poorly controlled type 1 diabetes. This is consistent with findings from a meta-analysis of interventions for non-adherence in adolescents with type 1 diabetes (Hood, Peterson, Rohan, & Drotar, 2009), which noted the greater efficacy of multi-modal interventions that targeted the adolescent's social-emotional context, e.g., Multisystemic Therapy (Ellis et al., 2007) and Behavioral Family System Therapy for Diabetes (Wysocki et al., 2006). Clinical intervention approaches, and even parents or healthcare providers seeking support for problematic adolescent management of type 1 diabetes, may often emphasize the facilitation of autonomy and independent disease management as a goal of treatment. This research on load sharing supports a different view, one in which social resources are viewed as a baseline necessity for successful self-regulation, both in adolescence and across the lifespan (Coan & Maresh, 2014). Parents might play an important role in load sharing and diabetes management throughout emerging adulthood until the youth develops close adult relationships that can provide similar load sharing resources. Future research on load sharing of self-control and diabetes management can then also help to inform the development of innovative interventions that specifically target self-control across the family and social system to promote healthier diabetes management and disease outcomes in adolescence and across the lifespan.

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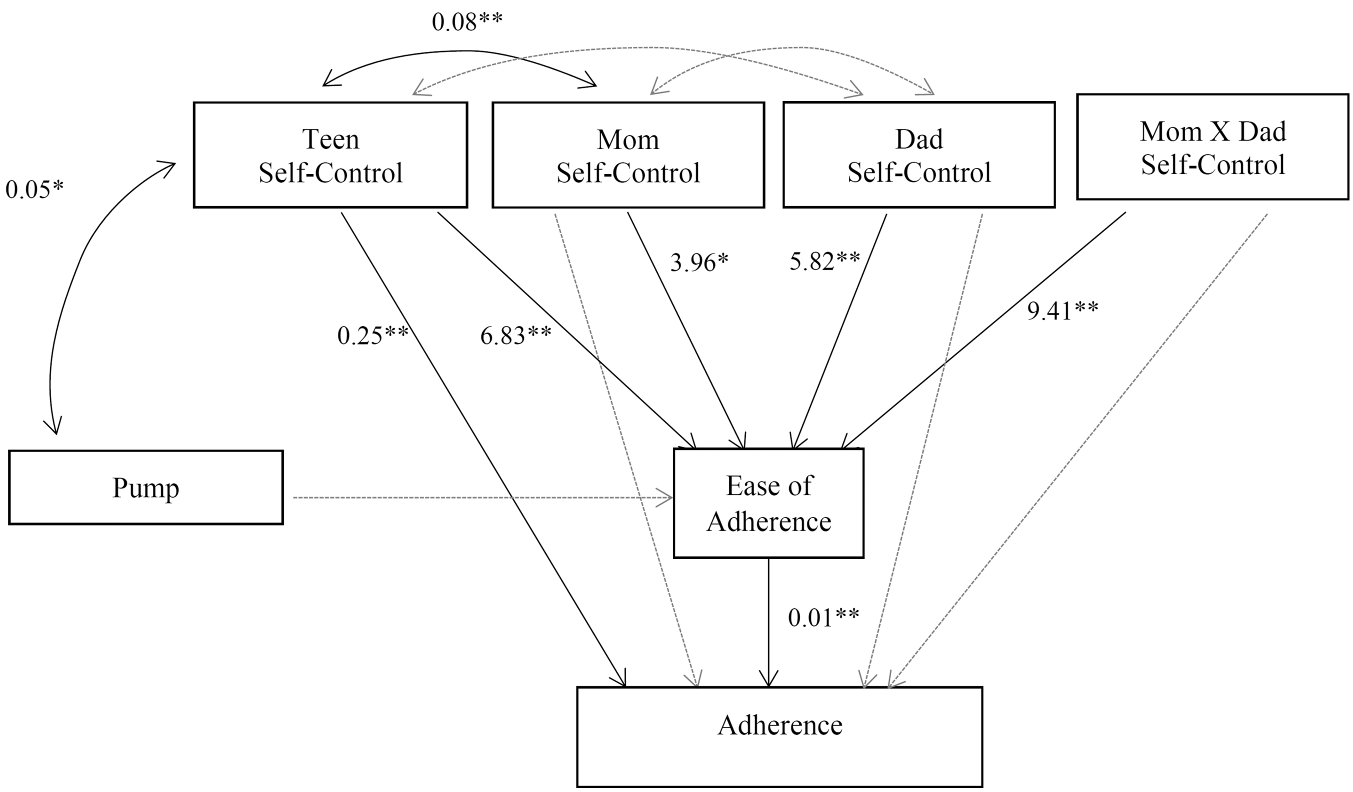

Figure 1.

The associations of teen, mother, father, and the interaction of mother and father self-control with ease of adherence and adherence.

Unstandardized coefficients are reported. Non-significant pathways are dashed.

*$p < .05$, **$p < 0.01$

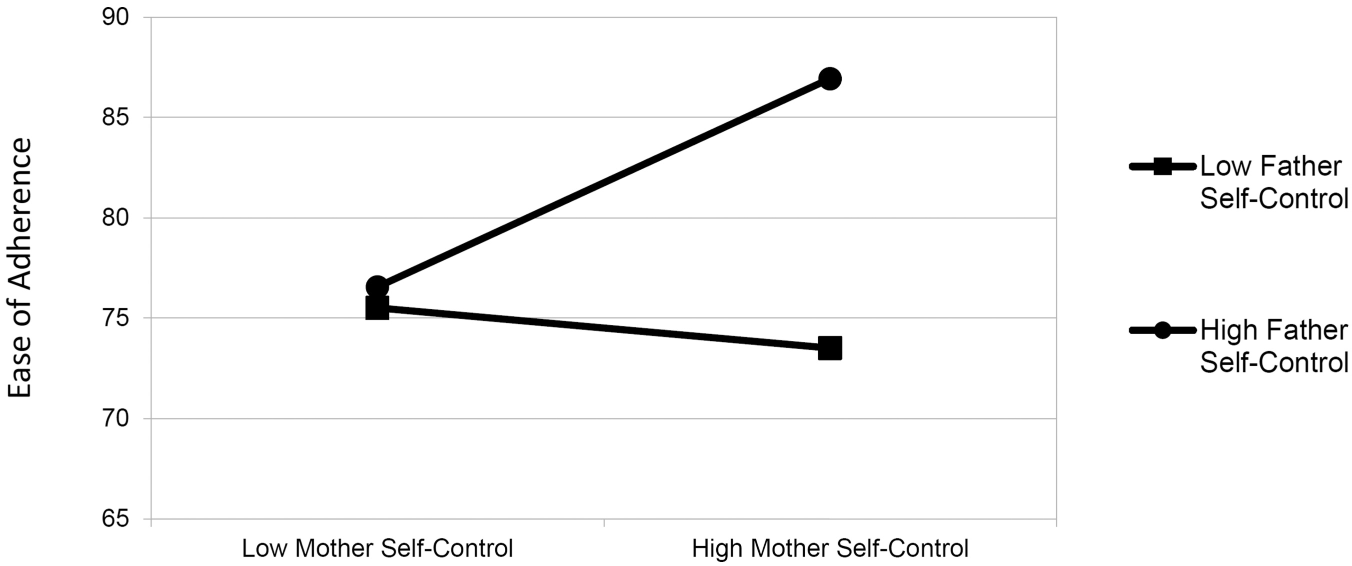

Figure 2.
The interaction of mother and father self-control predicted ease of adherence at one standard deviation above and below the mean for each variable.

Table 1

Means, Standard Deviations, Correlations of Key Study Variables

	M	*SD*	1	2	3	4	5	6
1. Adherence	3.90	0.57	1					
2. Ease of Adherence	80.10	28.25	.25**	1				
3. Teen self-control	3.53	0.61	.41**	.13	1			
4. Mom self-control	3.54	0.60	.24**	.24**	.23**	1		
5. Dad self-control	3.67	0.53	.14	.20*	.07	.09	1	
6. Hba1c	8.58	1.77	−.21*	−.07	−.21*	−.05	−.18*	1

* $p < .05$,

** $p < 0.01$