UNIVERSITY OF CALIFORNIA, MERCED

The Role of Difficulties in Emotion Regulation and Depressive Symptoms in Insulin Omission to Lose Weight

A Thesis in partial satisfaction of the requirements for the degree of Master of Arts

in

Psychological Sciences

by

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The Thesis of Aislinn Brenna Beam is approved, and it is acceptable in quality and form for publication on microfilm and electronically:

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Table of Contents

List of Tables

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Abstract

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by Aislinn Brenna Beam for the partial satisfaction of the requirements for

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University of California, Merced 2020

Dr. Deborah Wiebe, Chair

Insulin omission is a serious concern for those with type 1 diabetes (T1D), predicting subsequent complications and mortality. It is, thus, imperative to understand factors that may elevate insulin omission, especially during late adolescence when risk behaviors are increasing and T1D management is low. We examined how two interrelated factors – emotion dysregulation and depressive symptoms – may be related to insulin omission during late adolescence. A mediation model examined whether emotion dysregulation was associated indirectly with insulin omission through enhanced depressive symptoms, as has been shown in prior disordered eating literature. A moderation model examined whether emotion dysregulation exacerbated associations of depressive symptoms with insulin omission. Seniors in high school with T1D longer than one year (N = 236) completed measures of depressive symptoms, difficulties in emotion regulation (DERS), and diabetes self-management behaviors, as well as a one-item measure of insulin omission for the purpose of losing weight, and a mail-in assay kit to assess HbA1c. Consistent with prior research, most participants reported they never skip insulin to lose weight, but 39 (17%) reported they skip insulin for the specific purpose of losing weight at least some of the time. Individuals who indicated they sometimes skip insulin to lose weight had higher (poorer) HbA1c than those who never skip insulin, M = 8.94 vs 8.14%, which is a clinically meaningful difference. Each of the six DERS subscales and depressive symptoms were individually correlated with greater insulin omission (*r*s > .140). Logistic regressions in MPLUS were utilized to examine whether DERS subscale scores were associated with insulin omission both directly, as well as indirectly through greater depressive symptoms. This mediation model was supported, as the indirect path through depressive symptoms was significant for each facet of emotional dysregulation on insulin

omission. Tests of moderation revealed no significant interactions between depressive symptoms and DERS subscales, suggesting that depressive symptoms pose risks for insulin omission even among those with good emotion regulation skills. Programs to develop emotion regulation skills and minimize depressive symptoms, and screening for insulin omission especially among those with elevated depressive symptoms may be helpful at this high-risk time of development

Introduction

Late adolescence is a high-risk time for managing type 1 diabetes. Across the adolescent years, individuals with type 1 diabetes display decreases in adherence to diabetes management and increases in HbA1c, indicating deteriorating glycemic control (Ingerski, Anderson, Dolan, & Hood, 2010; King, Berg, Butner, Butler, & Wiebe, 2014). Poorer diabetes health at this age is particularly worrying due to the increased risk for later microvascular complications (e.g., organ failure, blindness, and death) (Nathan, 1993; Rydall, Rodin, Olmsted, Devenyi, & Daneman, 1997; Takii, Uchigata, Tokunaga, Amemiya, Kinukawa, Nozaki, Iwamoto, & Kubo, 2008). One factor that may contribute to these patterns is that adolescents have higher rates of risk-taking behaviors compared to other developmental periods (DiClemente, Hansen, & Ponton, 2013), which may undermine diabetes health. In addition, by late adolescence most individuals are managing their diabetes without as much help or input from parents (Schilling, Knafl, & Grey, 2006), which may make risky behaviors regarding diabetes management more likely.

One especially risky behavior for those with type 1 diabetes is insulin omission, a dangerous practice in which individuals with diabetes reduce their insulin intake against treatment recommendations. Although insulin omission occurs for a variety of reasons, it commonly is used for weight management, and has been conceptualized as a purging behavior (Fairburn, Peveler, Davies, Mann, & Mayou, 1991; Rydall et al., 1997; Shaban, 2013). Insulin omission increases across adolescence (Colton, Olmsted, Daneman, & Rodin, 2013), with prevalence rates as high as 33% (Peveler, Bryden, Neil, Fairburn, Mayou, Dunger, & Turner, 2005). This is quite concerning, as insulin omission increases the risk of hyperglycemia, ketoacidosis, retinopathy, nephropathy (de Groot, Golden, & Wagner, 2016; Takii et al., 2008) and even mortality. In fact, those who engaged in this behavior had three times the risk of death over an eleven-year period compared to those who did not (Goebel-Fabbri, Fikkan, Franko, Pearson, Anderson, & Weinger, 2008).

Given the dangers associated with insulin omission, it is important to understand who is most at risk for engaging in this behavior. Difficulties in regulating negative emotion are likely to be associated with higher risk for insulin omission. Emotion dysregulation refers to dysfunctions or difficulties in the process of evaluating and modifying emotional reactions and has been associated with many psychological disorders in adolescents (McLaughlin, Hatzenbuehler, Mennin, & Nolen-Hoeksema, 2011; Weinberg & Klonsky, 2009). In the general eating disorder literature, emotion dysregulation has been found to be associated with disordered eating (Lavender, Wonderlich, Engel, Gordon, Kaye, & Mitchell, 2015; Ruscitti, Rufino, Goodwin, & Wagner, 2016; Svaldi et al. 2012), and to be predictive of subsequent eating disorder severity and treatment outcomes (Racine & Wildes, 2015; Speranza, Loas, Wallier, & Corcos, 2007). In particular, aspects of emotion dyregulation involving difficulty accessing strategies for emotion regulation when experiencing negative emotions, difficulty with clarity of emotions (not understanding why one is experiencing an emotion), and nonacceptance of emotions have been associated with disordered eating (Lavender & Anderson, 2010; Ruscitti et al., 2012). Emotion dysregulation has also been linked to general bulimia symptoms among adolescents with type 1 diabetes (Young-Hyman et al. 2016). Because insulin omission has been conceptualized as purging

behavior, it may follow that emotion dysregulation is linked to insulin omission in similar ways to other disordered eating behaviors, but we are unaware of studies directly examining this association.

Emotion dysregulation may increase risk of omitting insulin indirectly through increasing one's experience of depressive symptoms. It is well established that difficulties in regulating emotions are associated with heightened levels of depressive symptoms (Becerra, Cruise, Murray, Bassett, Harms, Allan, & Hood, 2013; Brockmeyer, Skunde, Wu, Bresslein, Rudofsky, Herzog, & Friederich 2014; Ehring, Fischer, Schnülle, Bösterling, & Tuschen-Caffier, 2008; Weinberg & Klonsky, 2009), and there is growing evidence that depressive symptoms are associated with insulin omission. For example, both cross-sectional (Allan 2015; Trief, Xing, Foster, Maahs, Kittelsrud, Olson, Young, Peters, Bergenstal, Miller, Beck, & Weinstock, 2014) and longitudinal (Colton et al., 2013; Goebel-Fabbri, Anderson, Fikkan, Franko, Pearson, & Weinger, 2011) data reveal that individuals with higher depressive symptoms are at risk for insulin omission. Mediation models linking emotion dysregulation to disordered eating through depressive symptoms have been supported in the general eating disorder literature (Gilboa Schechtman Avnon, Zubery, & Jeczmien, 2006; Eizaguirre, de Cabezón, de Alda, Olariaga, & Juaniz, 2004; Paxton, & Diggens, 1997), but have not been tested in the context of insulin omission among those with type 1 diabetes.

There is also reason to theorize that emotion dysregulation may serve as a moderator of the links between negative emotion and insulin omission. Using ecological momentary assessment, Merwin and colleagues found that when participants experienced momentary increases in negative affect, they were more likely to omit insulin at their next meal (Merwin, Dmitrieva, Honeycutt, Moskovich, Lane, Zucker, Surwit, Feinglos, & Kuo, 2015). Although the authors did not examine whether this pattern was exacerbated among those who have difficulty regulating emotions, theories of emotion dysregulation (e.g., Weinberg & Klonsky, 2009) posit that individuals who do not have the skills to react to negative emotions in functional ways are more likely to engage in maladaptive behaviors when distressed. Indeed, Young-Hyman and colleagues (2016) found evidence that depressive symptoms were more strongly linked to bulimic symptoms among individuals with type 1 diabetes who had higher scores on a measure of emotion dysregulation. Similarly, a recent study found that negative affect was linked to disordered eating behaviors only among adolescents with type 1 diabetes who reported higher "negative urgency," a trait characterized by impulsivity when experiencing negative emotions (Rose, Streisand, Tully, Clary, Monaghan, Wang, & Mackey, 2020). Although such findings support the possibility that facets of emotion dysregulation will moderate links between depression and insulin omission, these studies did not examine insulin omission specifically. We are not aware of any studies that have examined whether emotion dysregulation moderates associations between depression and insulin omission.

The present study examined whether and how emotion dysregulation and depressive symptoms are associated with insulin omission among late adolescents with type 1 diabetes. Given the increased risk-taking that occurs in adolescence (DiClemente, Hansen, & Ponton, 2013) as well as the decrease in parental involvement in diabetes management (Schilling, Knafl, & Grey, 2006), this study focused specifically on late

adolescents. The first aim was to examine the relationship between emotion dysregulation and insulin omission. We hypothesized that higher rates of emotional dysregulation would be associated with higher rates of insulin omission. The second aim was to examine whether this association was mediated by depressive symptoms. We hypothesized that higher emotion dysregulation would be indirectly associated with insulin omission through higher depressive symptoms. Aim three was to examine whether emotion dysregulation moderated the relationship between depression and insulin omission. We hypothesized a moderation model such that the relationship between depressive symptoms and insulin omission would be stronger for those with higher emotion dysregulation. It is important to distinguish between mediation and moderation models as they have different treatment implications. Evidence for a mediation model would suggest that the most proximal variable to target is depressive symptoms, while the moderation model would suggest that treating depressive symptoms is primarily important for those who have difficulties with emotion regulation.

Method

Participants

Data for the present study were taken from a larger multisite longitudinal project examining diabetes management from late adolescence into early emerging adulthood (see Berg et al. 2019). All study procedures were approved by the relevant Institutional Review Board (IRB). For the purposes of this exploratory study, we examined baseline data as neither the mediation nor moderation models have been tested in the prediction of insulin omission specifically, especially during the high risk time of late adolescence. In addition, at the later time points participants were transitioning to the developmental period of emerging adulthood, which could have skewed results and implications.

Participants were high school seniors aged 17-18 years recruited from pediatric endocrinology clinics in two southwestern US cities. Eligibility requirements included diagnosis of type 1 diabetes for more than one year, English as their primary language (required for the objectives of the larger study), current high school senior status, living with at least one parent, and no condition that would prohibit study completion (such as severe intellectual disability). Of eligible individuals approached for recruitment, 48.7% agreed to participate in a three-year longitudinal study ($N = 247$). The most common reasons for declining to participate were being too busy (34%) and lack of interest (33%); 20% declined to give a reason. At one site, IRB allowed review of medical records comparing those who did versus did not participate. Participants and non-participants did not differ on HbA1c, illness duration, gender or pump status. Of those who agreed to participate, eleven were excluded from analyses due to insufficient data (final $N = 236$). For further descriptions of the sample see Table 1.

Procedure

Participants were invited to an initial assessment in a laboratory setting, where they provided consent (18 or older) or assent (< 18), and parents provided consent for minor participants. Participants were trained on using the online survey at this in-person meeting and provided a blood sample to assay blood glucose levels. Participants then completed the surveys online at home. Participants were paid $50 for completing the survey and HbA1c assay.

Measures

Glycemic Control. HbA1c was used to indicate average blood glucose over the prior few months as it is the medical standard for measuring glycemic control. Higher HbA1c generally reflects poorer glycemic control and is associated with long-term microvascular complications (Nathan 1993). HbA1c was analyzed via mail-in dried blood spot assay kits provided and processed by CoreMedica laboratories (accredited by the College of American Pathologists; https://www.coremedicalabs.com/). This measure was highly correlated with point-of-care HbA1c assays in medical records ($r = .74$, $p < .001$).

Emotional Dysregulation. Emotional dysregulation was assessed with the Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004). The scale is comprised of six subscales, each of which measures difficulties with important regulation skills including: *awareness* and *acceptance* of negative emotions, *clarity* of what emotions are being experienced, *accessing strategies* to regulate negative emotions, and *impulse control* and engaging in *goal-directed behavior* when experiencing negative

emotions. Each subscale consists of 5-8 items, which are answered using Likert-scale ranging from 1 (almost never) to 5 (almost always).
These questions assess overall difficulties with emotion regulation ("I experience my emotions as overwhelming and out of control") as well as specifically when experiencing negative emotions ("When I'm upset, I feel out of control"). In the present sample, internal consistency was good for the composite score (α = .965), and all subscales (nonacceptance: α = .924; goals: α = .894; impulse control: α = .872; awareness: α = .816; strategies: α = .906; clarity: α = .842). The composite score was calculated by summing all items, and subscale scores were calculated by summing subscale items (Gratz & Roemer, 2004).

Depression Symptoms. Symptoms of depression were assessed via the Center for Epidemiologic Studies - Depression Scale (CES-D; Radloff, 1977), which asks participants to rate the frequency with which they experienced depressive symptoms in the past week. Questions such as "I felt lonely" and "I talked less than usual" were rated using a 4-point Likert type scale ranging from 0 (rarely or none of the time) to 3 (most or all of the time). Internal validity was excellent (α = .931). The cutoff for mild symptoms in this scale is a score of 16, and this sample showed that 99 participants (42%) were over this cutoff. Of those 99 participants, 57 (25% of total sample) were above the cutoff of 24, showing severe depressive symptoms.

Adherence. The Diabetes Behavior Rating Scale (DBRS) is a measurement of diabetes self-care across 37 items. The DBRS has shown good concurrent validity with longer interview measures of self-care, and predictive validity of HbA1c (Iannotti Nansel, Schneider, Haynie, Simons-Morton, Sobel, Zeitzoff, Plotnick, & Clark, 2006). The DBRS measures a variety of behaviors that are necessary for optimal diabetes health, and problem-solving that is a necessary component of diabetes self-management. Per manual guidelines, scores were computed as a proportion ranging from 0 to 1. In this sample, internal consistency for this measure was good (α = .840).

Insulin Omission. Insulin omission has been assessed in a variety of ways. One common method uses a single item asking if individuals take less insulin than they should (Goebel-Fabbri et al., 2011; Peyrot, Rubin, Kruger, & Travis, 2010; Peyrot, Barnett, Meneghini, & Schumm-Draeger, 2012). Others have measured insulin omission to lose weight specifically, either asking if individuals perform any purging behaviors including insulin omission, measuring this concept in the broader concept of disordered eating behaviors (Colton et al., 2013), or using single items to assess insulin omission for the purpose of weight loss (d'Emden, Holden, McDermott, Harris, Gibbons, Gledhill, & Cotterill, 2012; Meltzer, Johnson, Prine, Banks, Desrosiers, & Silverstein, 2001). In the present study, we measured insulin omission generally by asking "How often do you take less insulin than you should?" with Likert-scale answers ranging from 1 (never) to 5 (always). A similar item has longitudinally predicted higher rates of death for those who indicate insulin omission (Goebel-Fabbri et al., 2008). We measured insulin omission for the specific purpose of losing weight via a second question "How often do you take less insulin or skip a dose of insulin to lose weight or keep from gaining weight?" with Likert-scale answers ranging from 1 (never) to 5 (usually). Similar items have been found to be associated with higher HbA1c (Battaglia, Alemzadeh, Katte, Hall, & Perlmuter, 2006). To be clear on the differences between different measures of insulin omission, insulin

omission for the purpose of weight loss will be referred to as IOLW.

Statistical Analyses

Preliminary analyses were conducted in SPSS version 26, while mediation and moderation models were analyzed in Mplus version 7.4 (Muthén & Muthén, 1998–2012); full information maximum likelihood (FIML) was used to account for missing data (missing data was less than 4% for all variables). Preliminary analyses indicated that most participants never omit insulin to lose weight (N = 197, 83.5%), with remaining participants reporting a range of frequencies. We thus dichotomized IOLW to indicate "never" versus "ever" engaging in this behavior (i.e., those who reported scores > 1 were categorized into the ever category). Goebel-Fabbri and colleagues (2008) found an increased risk of mortality for answering "yes" to ever omitting insulin, suggesting that the dichotomous item is capturing a significant risk regardless of frequency.

We first conducted bivariate correlations to assess the associations among emotion dysregulation, depressive symptomology, IOLW, glycemic control, and adherence. Logistic regression analyses were then used to test mediation and moderation models in Mplus, as the outcome of IOLW was dichotomous. All models used emotion dysregulation and depressive symptomology as predictors of IOLW. Separate models were conducted for the DERS composite and each DERS subscale score in order to explore whether some facets of emotion dysregulation are more strongly associated with IOLW than others (e.g., impulsivity). In the mediation models, we tested the direct paths linking emotion dysregulation to depressive symptoms and to IOLW and linking depressive symptoms to IOLW. We then used bootstrapping methods with bias-corrected confidence intervals to test the indirect path from emotion dysregulation to insulin omission through depressive symptoms. For the moderation model, we tested whether emotion dysregulation, depressive symptoms, and the interaction between these variables was associated with IOLW. The variables of gender, ethnicity, and pump status were considered as covariates in both models but were excluded for parsimony as these were not significantly correlated with IOLW (r values ranged from -.114 to .090, p values > .081).

Results

Bivariate correlations among study variables are shown in Table 2. We initially examined whether the general insulin omission and IOLW items could be combined into a single index. These variables were not correlated with each other and were associated with different diabetes outcome measures. Most interestingly, IOLW was associated with higher HbA1c but not with adherence, while the opposite was true for general insulin omission as it was associated with decreased adherence but was not significantly related to HbA1c. It is notable that HbA1c was higher among individuals who indicated they do, M(SD) = 8.94% (1.93), versus do not skip insulin to lose weight, M(SD) = 8.14% (1.54), $t(232) = -2.852$, $p = .005$. This is a clinically meaningful difference given that a one percentage increase in HbA1c (e.g., 8 to 9%) is associated with a 40% increased risk of developing retinopathy (Hood, Peterson, Rohan, & Drotar, 2009; Lachin, Genuth, Nathan, Zinman, & Rutledge, 2008). Because the two insulin omission items were uncorrelated, and only IOLW was associated with HbA1c, the following analyses focused on predicting this specific risk behavior only.

Mediation and Moderation Analyses

Consistent with a mediation model, correlations revealed that all facets of emotion dysregulation were associated with higher depressive symptoms, and both emotion dysregulation and depressive symptoms were associated with IOLW (see Table 2). Mediation analyses confirmed an indirect path for all facets of emotion dysregulation through depressive symptoms to IOLW (see Table 3). In fact, for all subscales except Lack of Awareness of Emotions, there was full mediation as evidenced by significant indirect paths through depressive symptoms, while the direct paths were rendered insignificant. For the Awareness subscale, both the direct and indirect paths to IOLW were significant, suggesting partial mediation. Somewhat surprisingly, however, when the composite DERS score was analyzed, neither the direct nor indirect paths linking emotion dysregulation to IOLW were statistically reliable. This may reflect the high correlation between the DERS Composite and depressive symptoms (r = .77), such that their unique associations with insulin omission were difficult to discern.

Given that all DERS subscales were associated with IOLW and with each other, we explored whether a subset of emotion dysregulation facets may be uniquely associated with insulin omission. Stepwise logistic regression analyses used the forward likelihood ratio method to assess the subscales that accounted uniquely for the most variance in IOLW. In these analyses, IOLW was regressed on all the DERS subscales, and the subscales accounting for significant variance were added, with the rest being left out of the model. The subscales of *limited access to emotion regulation strategies* ($B = .081$, $p = .001$) and *lack of awareness of emotions* ($B = .099$, $p = .008$) met forward entry criteria, with other subscales no longer significantly adding to the model.

To evaluate moderation, emotion dysregulation and depressive symptomology scores were centered on their mean and entered simultaneously in Step 1 and their interaction was entered on Step 2. Separate analyses were conducted for each of the emotion dysregulation subscales. As shown in Table 4, emotion dysregulation was unrelated to IOLW when entered simultaneously with depressive symptoms in Step 1 (supporting the mediation models described above). However, there was no evidence of

moderation. That is, the interaction between emotion dysregulation and depressive symptoms was not significant in any analysis.

Discussion

The present study is among the first to examine the central roles of emotion dysregulation and depression in the risky behavior of insulin omission among late adolescents with type 1 diabetes, a high-risk group for managing diabetes. This study contributes to better understanding what factors may predict this dangerous practice. Findings demonstrated that all facets of emotion dysregulation were associated with greater risk of insulin omission specifically for the purpose of weight management, and that these associations occurred indirectly through heightened depressive symptoms. Importantly, IOLW was also associated with higher HbA1c at a level that enhances risk for long-term microvascular complications (Hood et al., 2008). These findings indicate that IOLW is dangerous for diabetes health outcomes, and that emotion dysregulation may provide points of intervention for this behavior.

Study findings extend the literature on disordered eating in non-diabetes samples to enhance our understanding of IOLW among those with type 1 diabetes. Prior research suggests emotion dysregulation is associated with disordered eating (McLaughlin et al. 2011; Sim & Zeman 2005), with some evidence that depression mediates that association (Gilboa□Schechtman et al. 2006). Our findings that depression mediated the relationship between every subscale of emotion dysregulation and IOLW suggests that emotion dysregulation risks extend to this dangerous behavior and that depression is an important part of this relationship. Somewhat surprisingly, however, this mediation did not hold true for the composite scale of emotion dysregulation. Neither the direct nor indirect paths were significant once depressive symptoms were entered in the model, which may have been due to a high level of shared variance between these variables. Indeed, Gilboa-Schechtman and colleagues (2006) found that only one measure of emotion dysregulation remained significant when controlling for depression and anxiety, although this may be due to the clinical nature of the DERS measure.

There may be specific areas of emotion dysregulation that are important to target to prevent IOLW. All dimensions of emotion dysregulation were significantly associated with IOLW and this association occurred indirectly through symptoms of depression. This suggests that all facets of emotion dysregulation are important in engaging in IOLW. These findings are consistent with general disordered eating literature, where individuals with bulimia and anorexia show broad difficulties with emotion regulation and higher overall emotion dysregulation compared to those without (Lavender et al., 2015; Ruscitti et al., 2016). However, there is also evidence that those with disordered eating had specific difficulties with strategies for regulating emotions and emotional clarity (Ruscitti et al., 2016). We similarly found that limited access to strategies to regulate emotions and lack of awareness of emotions were the strongest unique predictors of IOLW. These facets of emotion dysregulation could be points of intervention on insulin omission, and future research should look more into these aspects of emotion dysregulation.

This study also tested the model of emotion dysregulation moderating the relationship between depressive symptoms and IOLW. We expected levels of emotion dysregulation to moderate the relationship between depressive symptoms and IOLW such that at high levels of emotion dysregulation, depressive symptoms would be more strongly related to IOLW than at low levels. There has been evidence of emotion dysregulation moderating the relationship between negative affect and disordered eating,

and recent studies have shown evidence of this moderation in adolescents with type 1 diabetes (Rose et al., 2020; Young-Hyman et al., 2016). However, the current study did not find these associations; neither the composite scale of emotion dysregulation nor any subscales moderated the relationship between the depressive symptoms and IOLW. This was surprising, as the previous literature specifically on adolescents with type 1 diabetes has supported the moderation hypothesis. It is possible that findings reflect numerous methodological differences across studies. For example, one of those studies (Rose et al., 2020) looked generally at negative affect (combining anxiety and depression), which may be important as some studies suggest that specific types of negative emotion are more linked to insulin omission in daily life (Merwin et al., 2015). Rose and colleagues also measured a specific type of emotion dysregulation that appears conceptually similar to the impulsivity subscale in the present study, while Young-Hyman et al. (2016) used a measure of emotion dysregulation specifically in the context of disordered eating. It is also the case that neither of these studies looked specifically at insulin omission, potentially suggesting that IOLW may manifest differently than other disordered eating behaviors.

An important finding of the current study is that the measures of insulin omission in general and insulin omission for the specific purpose of weight control appear to be tapping different constructs. These items were unrelated to each other and were associated with different aspects of diabetes management. Although prior literature has used these measures somewhat interchangeably, Peyrot and colleagues (2012) argued for the need to identify reasons for general insulin omission. The results of their study were inconsistent with the literature as general insulin omission was not associated with having a history of depression, which they theorized may be due to unmeasured differences in reasons for engaging in insulin omission. Although we did find that general insulin omission was modestly associated with depressive symptoms, our findings support the argument that there may be different predictors and outcomes of different reasons for omitting insulin. We found that general insulin omission was associated with poorer adherence, while only IOLW was associated with higher HbA1c. These findings have implications for how we measure constructs of insulin omission in future research. General omission of insulin (e.g., skipping a dose of insulin, taking less insulin than one should, or not taking as prescribed by a doctor) could have many causes such as anxiety regarding hypoglycemia, simply forgetting when busy with other things, or trying to reduce health costs. Each of these may have different predictors and suggest different types of intervention. Refining measurements of this behavior could allow future research to narrow in on who is at risk and guide interventions to reduce the risk behavior of insulin omission to manage weight.

There are limitations to this study that should be considered when interpreting the findings. First, this was a correlational cross-sectional analysis and thus causal claims regarding the relationships cannot be made. Although there has been some evidence that cross-sectional mediation analyses can increase bias, Bullock and colleagues (2010) found that biases also existed in longitudinal mediation analyses and suggested that multiple methods are needed to assess these models. Future research examining these relationships across time (e.g., longitudinal studies; daily diary studies) will be necessary to further assess associations. Second, this study was a secondary analysis using an

already-collected dataset and, therefore, was limited by the measures that were available. In particular, depressive symptomatology was the only measure of negative emotion that was available, and other negative emotions may show different associations. Third, although the race and ethnic composition of this sample was similar to youth who have type 1 diabetes in the United States (Petitti, Klingensmith, Bell, Andrews, Dabelea, Imperatore, Marcovina, Pihoker, Standiford, Waitzfelder, & Mayer-Davis, 2009), the sample was mostly non-Latino White and all participants were seniors in high school. The findings, therefore, may not generalize to individuals of different ethnic backgrounds or at different ages. In addition, the measures included in this study were all self-reported, and thus may have been subject to participant biases. Finally, both types of insulin omission were measured by single items. However, similar items have been linked to important clinical outcomes in prior studies (Battaglia et al., 2006; d'Emden et al., 2012; Goebel-Fabbri et al., 2011; Meltzer et al., 2001), and there has not been a consistent measurement of IOLW in the literature. Our data suggest that different measures may be tapping into different constructs, creating inconsistencies in the literature, and that as a field we need to better define and measure these constructs.

This study has clinical implications for individuals with type 1 diabetes, as IOLW appears to be a dangerous behavior. In the present study, IOLW was associated with clinically meaningful elevations in HbA1c, which have been shown to increase risk for future complications (Nathan 1993; Rydall et al., 1997; Takii et al., 2008). Our study identified that emotion dysregulation and depressive symptoms have interrelated associations with IOLW. The findings that depressive symptoms mediated the relationship between emotion dysregulation and IOLW suggest that depressive symptoms are a more proximal variable for engaging in IOLW. Thus, screening for and treatment of depression may be useful for IOLW. In addition, our findings suggest that enhancing emotion regulation skills may simultaneously address both elevations in depressive symptoms and engaging in IOLW. Indeed, emotion regulation interventions have been shown to decrease depressive symptoms in adolescents (Deplus, Billieux, Scharff, & Philippot, 2016) and emotion regulation training in addition to cognitive-behavioral therapy (CBT) for major depressive disorder has shown to be more effective than CBT alone (Berking, Ebert, Cuijpers, & Hofmann, 2013). While less is known regarding emotion regulation and depression interventions on IOLW, the current findings suggest that these are potential routes of intervention to help late adolescents at risk for engaging in this dangerous behavior.

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Table 1

Means and standard deviations

Variable	Mean (SD)
Age	17.7 (0.40)
Gender (% female)	61%
Years since diagnosis	7.36 (3.92)
Pump status (% using insulin pump)	44.4%
Covered by parent's insurance (% either partially or fully)	72.5%
Race/Ethnicity	
% Non-Hispanic White	75%
% Hispanic/Latino	14%
% African American	5%
% Other	6%
Insulin omission (% who have ever)	88.4%
Insulin omission to lose weight (% who have ever)	16.5%
HbA1c	8.27 (1.64)
Adherence	0.61 (0.12)
Difficulty in Emotion Regulation Composite	80.17 (25.14)
Nonacceptance of Emotions	13.09 (6.47)
Goal Directed Behavior	13.30 (5.03)
Impulse Control Difficulties	11.38 (4.96)
Awareness of Emotions	15.18 (5.20)
Strategies for Negative Emotions	16.83 (7.31)
Clarity of Emotions	10.62 (4.32)
Depressive Symptoms	16.56 (12.00)

Table 2
Correlations of relevant variables

	1	2	3	4	5	6	7	8	9	10	11
1. IO	1										
2. IOLW	.059										
3. HbA1c	.123	.184**									
4. DBRS	-.339**	-.102	-.235**								
5. DERS Comp	.246**	.277**	.140*	-.394**							
6. Non-acceptance	.260**	.180**	.017	-.238**	.784**						
7. Goals	.207**	.147*	.090	-.283**	.730**	.487**					
8. Impulse Control	.199*	.253**	.208**	-.293**	.815**	.538**	.590**				
9. Awareness	.051	.217**	.052	-.316**	.492**	.256**	.077	.244**			
10. Strategies	.202**	.255**	.178**	-.319**	.895**	.660**	.704**	.751**	.230**		
11.Clarity	.175**	.187**	.081	-.355**	.766**	.508**	.412**	.531**	.526**	.604**	
12. CES-D	.164*	.289**	.235**	-.327**	.767**	.537**	.579**	.621**	.309**	.768**	.601**

Note: IO is general insulin omission, IOLW is insulin omission specifically for weight loss, DBRS is The Diabetes Behavior Rating Scale, CES-D is Center for Epidemiologic Studies Depression Scale
*$p < .05$ **$p < .01$

Table 3

Mediation models testing indirect paths from emotion dysregulation to insulin omission through depressive symptoms

	Standardized *B*(SE)	Unstandardized *B*(SE)	*p*	CI
Composite Scale				
Indirect Effect Through CES-D	.007 (.004)	.013 (.008)	.105	-.003-.029
Direct Effect	.008 (.006)	.016 (.011)	.161	-.006-.038
Nonacceptance				
Indirect Effect Through CES-D	.028 (.009)	.054 (.018)	.003	.018-.090
Direct Effect	.008 (.017)	.016 (.032)	.629	-.048-.079
Goal-Directed Behavior				
Indirect Effect Through CES-D	.044 (0.013)	.086 (.027)	.001	.034-.138
Direct Effect	-.007 (0.024)	-.014 (.047)	.758	-.106-.077
Impulse Control				
Indirect Effect Through CES-D	.034 (.013)	.066 (.028)	.017	.012-.121
Direct Effect	.031 (.022)	.061 (.043)	.158	-.024-.146
Awareness				
Indirect Effect Through CES-D	.019 (.006)	.037 (.013)	.005	.011-.064
Direct Effect	.042 (.018)	.084 (.038)	.026	.010-.158
Strategies				
Indirect Effect Through CES-D	.030 (.014)	.058 (.028)	.041	.002-.114
Direct Effect	.016 (.019)	.030 (.037)	.416	-.043-.103
Clarity				
Indirect Effect Through CES-D	.048 (.015)	.094 (.031)	.003	.032-.155
Direct Effect	.009 (.026)	.017 (.051)	.733	-.082-.117

Note: *p* -values and CI based on unstandardized coefficients; CES-D is Center for Epidemiologic Studies Depression Scale

Table 4

Moderation models testing indirect paths from emotion dysregulation to insulin omission through depressive symptoms

		Standardized *B*(SE)	Unstandardized *B*(SE)	*p*	95% CI
Composite Scale	Step 1 DERS	.007 (.006)	.015 (.011)	.198	-0.008-0.037
	CES-D	.019 (.012)	.036 (.023)	.139	-0.012-0.085
	Step 2 DERS*CES-D	.000 (.000)	.000 (.001)	.984	-0.001-0.001
Nonacceptance of Emotions (NOA)	Step 1 NOA	.010 (.018)	.019 (.036)	.591	-0.051-0.089
	CES-D	.028 (.008)	.055 (.018)	.002	0.020-0.090
	Step 2 NOA*CES-D	.000 (.001)	-.001 (.002)	.811	-0.005-0.004
Goal Directed Behavior (GOA)	Step 1 GOA	-.008 (.025)	-.015 (.048)	.756	-0.109-0.079
	CES-D	.033 (.009)	.064 (.020)	.001	0.026-0.102
	Step 2 GOA*CES-D	.000 (.002)	-.001 (.003)	.813	-0.007-0.005
Impulse Control Difficulties (IM)	Step 1 IM	.029 (.023)	.057 (.046)	.218	-0.034-0.147
	CES-D	.023 (.009)	.044 (.020)	.023	0.006-0.083
	Step 2 IM*CES-D	.000 (.002)	.000 (.003)	.967	-0.006-0.006
Awareness of Emotions (AW)	Step 1 AW	.039 (.019)	.077 (.040)	.054	-0.001-0.155
	CES-D	.026 (.007)	.051(.016)	.001	0.020-0.082
	Step 2AW*CES-D	.000 (.001)	.000 (.003)	.919	-0.005-0.006
Strategies for Negative Emotions (ST)	Step 1 ST	.014 (.020)	.028 (.039)	.478	-0.049-0.104

	CES-D	.024 (.012)	.046 (.024)	.049	0.000-0.093
	Step 2 ST*CES-D	.000 (.001)	.000 (.002)	.947	-0.004-0.004
Clarity of Emotions (CL)	Step 1 CL	.010 (.028)	.020 (.056)	.725	-0.089-0.128
	CES-D	.029 (.009)	.057 (.018)	.002	0.021-0.093
	Step 2 CL*CES-D	-.001(.002)	-.001 (.003)	.738	-0.008-0.005

Note: *p* -values and CI based on unstandardized coefficients; CES-D refers to Center for Epidemiologic Studies Depression Scale