

# Disturbed eating, illness perceptions, and coping among adults with type 1 diabetes on intensified insulin treatment, and their associations with metabolic control

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## Abstract

This study investigated associations between psychological aspects and metabolic control among adults with type 1 diabetes ( $n=282$ ). Linear regression analyses demonstrated that the illness perception personal control and the coping strategy seeking emotional social support explained 23.2 percent of the variance in hemoglobin A1c among females ( $\beta=0.40$ ,  $p<0.001$  and  $\beta=-0.22$ ,  $p<0.01$ , respectively). Among males, only personal control remained significant, explaining 13.9 percent of the variance in hemoglobin A1c ( $\beta=0.37$ ,  $p<0.001$ ). The associations between psychological correlates and hemoglobin A1c indicate that addressing such aspects clinically may facilitate metabolic control, thereby potentially contributing to reduce the risk of complications.

## Keywords

coping, diabetes, eating disorders, health psychology, illness perception

## Introduction

Type 1 diabetes (T1D) is a chronic illness caused by an autoimmune selective destruction of the insulin-producing beta cells in the pancreas, and lack of insulin leads to elevated blood glucose levels. Hemoglobin A1c (HbA1c) is used as a measure of long-term blood glucose levels, over the preceding 8–12 weeks, and higher HbA1c indicates poorer metabolic control. The association between metabolic control and risk of diabetes complications, such as micro- and macrovascular disease, is well established (The Diabetes Control Complications Trial Research

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Group, 1993). Yet, most individuals with T1D do not reach the international treatment target of HbA1c <7 percent (53 mmol/mol) (Løvaas et al., 2017; Miller et al., 2015). Monitoring blood glucose levels and administering insulin is a never-ending and challenging regulation task, which places a significant burden on individuals with T1D and their families. Psychological aspects have been found to be associated with diabetes self-care and metabolic control, including disturbed eating (Colton et al., 2015; Wisting et al., 2013a; Young et al., 2012), illness perceptions (Fortenberry et al., 2014; Mc Sharry et al., 2011; McGrady et al., 2014; Wisting et al., 2015), coping strategies (Graue et al., 2004; Yi et al., 2008), and insulin beliefs (Belendez and Hernandez-Mijares, 2009; Broadbent et al., 2011). Demographic and personal factors have been associated with T1D self-care; however, such factors together typically explain <20 percent of the variance in HbA1c (Bott et al., 1994; Devries et al., 2004; Galler et al., 2011; Taylor et al., 2003), suggesting more research is needed to increase knowledge about potential predictors of metabolic control and subsequent risk of complications.

Various theoretical frameworks have been postulated to understand diabetes management and outcomes, including the health belief model (Gillibrand and Stevenson, 2006), the theory of reasoned action (Syrjala et al., 2002), the theory of planned behavior (Downie et al., 2019), and the common sense model of self-regulation (Huston and Houk, 2011). The common sense model (Leventhal et al., 1984) has been adopted to a wide range of illnesses (Hagger et al., 2017) and theorizes that individual perceptions of an illness or health threat guide subsequent coping mechanisms (i.e. cognitive and behavioral efforts made in response to a threat or stressor), which in turn influence illness outcomes. The relevance of illness perceptions and coping strategies for T1D has been supported empirically. Illness perceptions have been associated with outcome in a range of different health conditions, including cancer, psoriasis, chronic fatigue syndrome, Addison's

disease, rheumatoid arthritis, chronic obstructive lung disease, and diabetes (Edwards et al., 2001; Grace et al., 2005; Hopman and Rijken, 2014; Petrie et al., 2007). Furthermore, coping strategies have been shown to be associated with various aspects of somatic and psychological health (Baines and Wittkowski, 2013; Vernhet et al., 2018), including metabolic control in diabetes (Graue et al., 2004). Beliefs about insulin have been found to be associated with diabetes self-care and metabolic control (Belendez and Hernandez-Mijares, 2009; Broadbent et al., 2011; Brod et al., 2009). In addition, individuals with T1D, females in particular, are at a higher risk of developing disturbed eating and eating disorders, including deliberate insulin omission for weight control purposes (Mannucci et al., 2005; Nielsen, 2002; Young et al., 2012). The presence of eating disorder psychopathology in T1D is associated with poor metabolic control and advanced onset of complications (Cecilia-Costa et al., 2018; Colton et al., 2015), as well as increased mortality rates (Goebel-Fabbri et al., 2008; Nielsen et al., 2002).

Gender differences in psychological correlates have been reported among adolescents with T1D, with females generally being more concerned than males (Wisting et al., 2016). Furthermore, gender differences in the associations between psychological aspects and HbA1c have been reported among adolescents with T1D (Wisting et al., 2015). Less is known about gender differences in psychological aspects and impact on metabolic controls among adults with T1D, as most results to date are reported in total samples rather than separated by gender. This needs to be investigated as such findings may guide clinical practice for adult males and females with T1D.

In summary, despite technological advances in the management of T1D, a minority of patients with T1D achieve international targets for good metabolic control aimed to minimize the risk of late T1D complications. Given that T1D treatment is mainly based on individual self-care, further research is needed to

**Table 1.** Participant characteristics.

	All N = 282	Males N = 112 (40%)	Females N = 170 (60%)	Significance level	Effect size
Age	42.11 (15.19)	44.57 (15.92)	40.47 (14.49)	0.05	0.27
Diabetes onset (years)	15.14 (11.18)	15.43 (10.92)	14.94 (11.38)	ns	
HbA1c (%)	7.75 (0.91)	7.61 (0.89)	7.85 (0.91)	ns	
Diabetes duration (years)	27.09 (14.44)	29.14 (14.82)	25.71 (14.05)	ns	
BMI self-report	25.96 (4.13)	26.47 (3.82)	25.63 (4.30)	ns	
Mode of insulin treatment	56.3% pen, 43.3% pump	60.9% pen, 38.0% pump	53.4% pen, 46.6% pump		
DEPS-R total	13.83 (9.16)	11.18 (7.80)	15.57 (9.59)	0.001	−0.50

BMI: body mass index; HbA1c: hemoglobin A1c; DEPS-R: Diabetes Eating Problem Survey—Revised; ns: not statistical significant differences.

Data are mean (standard deviation). Significance level ( $p < 0.001$ , 0.01, and 0.05) and effect size estimation (Cohen's  $d$ ) is done when differences are significant.

investigate the influence of psychological aspects on metabolic control in adult males versus females with T1D.

The current study, therefore, aimed to investigate the impact of eating disorder psychopathology, illness perceptions, insulin beliefs, and coping strategies on metabolic control in adults with T1D, with a specific focus on gender differences.

## Materials and methods

### Design

This is a cross-sectional study of psychological aspects and metabolic control among adults with T1D.

### Participants and procedure

Patients with T1D were recruited from the Norwegian Diabetic Centre between February 2016 and October 2017. Questionnaires were completed as part of a routine T1D consultation at the outpatient clinic. Since patients usually have at least one appointment a year, the majority of males and females with T1D attending the clinic should have been asked to participate during the data collection period. However, in a busy clinical setting, this may not always have been the case. For practical reasons, since the

data collection proceeded in conjunction with clinical practice, it was unfortunately not possible to record exactly how many were asked to participate or why some did or did not participate in the study. A total of 282 males and females aged 18–79 years (60% females) participated in the study (mean age 42.11; standard deviation (SD): 15.19). Table 1 illustrates sample characteristics. The regional committees for medical and health research ethics South East approved the study, and written consent was obtained from all participants.

### Measures

The Diabetes Eating Problem Survey—Revised (DEPS-R) (Markowitz et al., 2010) is a diabetes-specific screening tool for disturbed eating and consists of 16 items. Responses are scored on 6-point Likert-type items and higher scores indicate greater pathology. The predetermined cutoff score for disturbed eating is set at 20 or above, indicating individuals with a level of DEB warranting further attention. The DEPS-R has been translated and validated in Norwegian adolescent (Wisting et al., 2013b) and adult samples with T1D (Wisting et al., 2019).

The BIPQ (Broadbent et al., 2006) is a brief (nine items) version of the Illness Perceptions Questionnaire (IPQ) (Weinman et al., 1996) and Illness Perceptions Questionnaire—Revised

(IPQ-R) (Moss-Morris et al., 2002), and is a valid and reliable measure of illness perceptions (Broadbent et al., 2006). The IPQ measures have been widely used in the context of a variety of illnesses, including T1D. Dimension of illness perceptions include *consequences* (perceived consequences of the illness), *personal control* (the extent to which the patient perceive they can control or cure the illness), *treatment control* (whether the patient believe that the treatment can control or cure the illness), *identity* (the label people use to describe the illness and accompanying symptoms), *coherence* (whether the person feels they understand the illness), *emotional representation* (whether the illness affects the patient emotionally), and *concern* (if the patient is concerned about the illness). Answers range from 0 to 10, and higher scores indicate more threatening/negative views of their T1D. Cronbach's alpha for the BIPQ was 0.81 in the current study (0.79 among females and 0.80 among males).

The COPE Inventory (Carver et al., 1989) measures a broad range of coping responses when confronted with difficult or stressful events in their lives. Participants are asked to indicate what they generally do and feel when faced with stressful events. It consists of several subscales, which can be used independently according to study scope. The current study included the subscales *focus on and venting of emotions*, *active coping*, *use of emotional social support*, and *denial* (16 items in total). Answers are ranged on a 6-point Likert-type scale, ranging from 0 (*I usually don't do this at all*) to 5 (*I usually do this a lot*). Cronbach's alpha for the four COPE subscales among the total population, females, and males was calculated in the current study, yielding alphas of 0.77, 0.76, and 0.76 for *venting emotions*, 0.74, 0.70, and 0.79 for *active coping*, 0.89, 0.87, and 0.90 for *emotional social support*, and 0.75, 0.77, and 0.72 for *denial*.

The Beliefs about Medicines Questionnaire (BMQ) (Horne and Weinman, 1999) is a measure of beliefs about medicines in general, and one specific medicine (insulin in this study). It consists of four subscales: specific (insulin)

necessity, specific (insulin) concern, general necessity, and general overuse. Answers range on a five-point Likert-type scale, ranging from 1=strongly disagree to 5=strongly agree. The specific subscale insulin concern was employed in this study (six items), and higher scores indicate stronger perceptions of insulin concern. The BMQ has been translated and validated in Norwegian (Jonsdottir et al., 2009).

Clinical data were assessed via the Norwegian Quality Improvement of Laboratory Examinations (NOKLUS) system, and were conducted as part of standard clinical T1D assessment at the Norwegian Diabetic Centre. T1D clinical data include HbA1c, treatment mode, and T1D onset. HbA1c is a measure of long-term blood glucose levels and reflects average blood glucose the preceding 8–12 weeks. HbA1c is used here as a measure of metabolic control. A reasonable HbA1c target for many nonpregnant adults is <7.0 percent (53 mmol/mol). The providers might suggest a more stringent HbA1c goal such as 6.5 percent (48 mmol/mol) for selected individual patients if this can be achieved without significant hypoglycemia or other adverse effects of treatment (31). Body mass index (BMI) was calculated based on self-reported weight and height (kg/m<sup>2</sup>).

### Data analysis

Pearson correlations were conducted to investigate associations between variables. In line with Cohen (1988), correlations of 0.10–0.29 were interpreted as small, 0.30–0.49 as medium, and 0.50–1.0 as large. Alpha level was set to  $p < 0.05$ . Independent-samples *t*-tests were carried out to investigate group differences. Effect sizes were calculated by means of Cohen's *d*. Following the guidelines by Cohen (1988), effect sizes >0.2 were interpreted as small, >0.5 as medium, and >0.8 as large. Subsequent to the correlation analyses, standard multiple regression (enter) analyses were conducted with significant correlations ( $p < 0.05$ ) in line with the backward elimination strategy described below, to investigate possible risk factors for poor

**Table 2.** Descriptive data on coping strategies, illness perceptions, and insulin beliefs for adult males and females with T1D.

	Males	Females	Significance level	Effect size
<b>COPE</b>				
Venting emotions	6.53 (3.77)	8.68 (4.00)	0.001	-0.6
Active coping	12.69 (4.11)	13.00 (3.58)	ns	-
Emotional social support	7.86 (4.83)	10.56 (4.79)	0.001	-0.6
Denial	2.82 (3.19)	2.64 (3.25)	ns	-
<b>BIPQ</b>				
Consequences	5.45 (2.36)	6.87 (2.23)	0.001	-0.6
Personal control	2.52 (1.52)	3.41 (2.17)	0.001	-0.5
Treatment control	1.42 (1.81)	1.62 (1.98)	ns	-
Identity	4.93 (2.40)	5.76 (2.29)	0.01	-0.4
Coherence	1.89 (1.62)	2.52 (2.01)	0.01	-0.3
Emotional representation	3.97 (2.86)	5.72 (2.86)	0.001	-0.6
Concern	4.29 (2.64)	6.06 (2.69)	0.001	-0.7
<b>BMQ</b>				
Insulin concern	10.72 (4.05)	12.06 (4.10)	0.01	-0.3

BIPQ: Brief Illness Perceptions Questionnaire; BMQ: Beliefs about Medicines Questionnaire; T1D: type 1 diabetes; ns: not statistical significant differences.

Data are mean (standard deviation). Significance level ( $p < 0.001$ , 0.01, and 0.05) and effect size estimation (Cohen's  $d$ ) is done when differences are significant.

metabolic control. Associations in the linear regression analyses were reported with standardized beta coefficients ( $\beta$ ). The analyses were split by gender. Statistical analyses were conducted using SPSS version 23 (SPSS IBM, NY, USA) (Corp, 2015).

## Results

### Participant characteristics

Mean age of T1D onset was 15.14 (SD: 11.18), mean HbA1c was 7.75 percent (SD: 0.91), and mean BMI was 25.96 (SD: 4.13). Mean diabetes duration was 27.09 years (SD: 14.44), range 0–71 years. All patients used modern, intensified insulin treatment: A total of 56.3 percent used a basal-bolus regimen with >4 injections a day with insulin pens, and 43.3 percent used insulin pumps. With regard to psychopathology, mean DEPS-R score was 13.83 (9.16) for the total population, 11.18 (7.80) for males, and 15.57 (9.59) for females. As reported in a previous study (Wisting et al., 2018), 13.3 percent of

the males and 24.8 percent of the females scored above the cutoff for disturbed eating on the DEPS-R.

### Descriptive data on coping and illness perceptions

Females reported significantly more use of the coping strategies *venting emotions* and *emotional social support* ( $p < 0.001$ , effect size  $-0.6$  for both) compared to males (Table 2). There were no significant gender differences on *denial* or *active coping*. As for illness perceptions, females had significantly more negative perceptions of their T1D than males on all BIPQ dimensions except *treatment control*, with effect sizes ranging from  $-0.3$  to  $-0.7$ .

### Associations

Table 3 shows that in males, metabolic control (HbA1c) was significantly correlated with the illness perceptions *personal control* and

**Table 3.** Correlations between illness perceptions, coping strategies, insulin beliefs, eating disorder psychopathology, and metabolic control among males and females with T1D.

	HbA1c	
	Males	Females
Illness perceptions		
BIPQ consequences	ns	ns
BIPQ personal control	0.37***	0.41***
BIPQ treatment control	ns	ns
BIPQ identity	ns	ns
BIPQ coherence	0.21*	0.22*
BIPQ emotional representations	ns	ns
BIPQ concern	ns	0.22*
Coping strategies		
Venting emotions	ns	ns
Active coping	-0.23*	ns
Emotional social support	ns	-0.28***
Denial	ns	ns
Insulin beliefs		
Necessity	ns	ns
Concern	ns	ns
Eating disorder psychopathology		
DEPS-R total score	ns	0.27**

BIPQ: Brief Illness Perceptions Questionnaire; DEPS-R: Diabetes Eating Problem Survey—Revised; HbA1c: hemoglobin A1c; T1D: type 1 diabetes.

Data are correlation coefficients (Pearson), significance level: \*\*\* $p < 0.001$ ; \*\* $p < 0.01$ ; \* $p < 0.05$ .

*coherence*, as well as *active coping*. For females, metabolic control was significantly associated with *personal control*, *coherence*, and *concern*, in addition to the coping strategy *emotional social support*, and DEPS-R total score. There were no statistically significant differences in HbA1c according to mode of insulin treatment (pens or pumps) among males of females.

The significant correlations were subsequently entered into separate regression models for males and females (Table 4). Among males, this model explained 17.1 percent of the variance in HbA1c. After removing nonsignificant variables one by one in line with the backward elimination strategy, only *personal control*

remained significant ( $\beta = 0.37$ ,  $p < 0.001$ ), explaining 13.9 percent of the variance in HbA1c among males. Among females, the overall regression model explained 26.5 percent of the variance in HbA1c. Subsequent to backward elimination, *personal control* and COPE *seeking emotional social support* remained significant ( $\beta = 0.40$ ,  $p < 0.001$  and  $\beta = -0.22$ ,  $p < 0.01$ , respectively), explaining 23.2 percent of the variance in HbA1c among females.

## Discussion

This study aimed to investigate illness perceptions, coping strategies, and insulin beliefs in adults with T1D, as well as their impact on metabolic control. Two main findings can largely be drawn: (1) illness perceptions and coping strategies were generally associated with HbA1c, with personal control being the strongest predictor among both males and females; (2) there were overall significant gender differences in psychological aspects, with more significant associations emerging among females than males.

Among females, the illness perception personal control and the coping strategy emotional social support explained 23.2 percent of the variance in HbA1c, that is more negative perceptions of degree of personal control and lower levels of seeking emotional social support were associated with higher HbA1c. Among males, only personal control remained significant in the regression analysis, explaining 13.9 percent of the variance alone. The relevance of psychological aspects for metabolic control in T1D, and of the illness perception personal control in particular, is in concordance with previous studies (Fortenberry et al., 2014; Hudson et al., 2014; Mc Sharry et al., 2011; McGrady et al., 2014). Rassart et al. (2015) reported that stronger perceptions of personal control in adults with T1D predicted a decrease in treatment-related problems at 5 years of follow-up, and underscore the importance of addressing patients' perceptions about their T1D. They conclude that clinicians should strive to find a balance between stressing the importance of

**Table 4.** Regression mode for adult males and females with T1D with HbA1c as the dependent variable, subsequent to adopting the backward elimination strategy.

	B	Standard error	$\beta$	t	Significance
<b>Males</b>					
BIPQ personal control	0.24	0.06	0.37	3.75	0.001
<b>Females</b>					
BIPQ personal control	0.18	0.04	0.40	5.00	0.001
COPE emotional support	-0.04	0.02	-0.22	-2.70	0.01

BIPQ: Brief Illness Perceptions Questionnaire; HbA1c: hemoglobin A1c; T1D: type 1 diabetes.

T1D care and preventing patients from feeling overwhelmed by the burden of T1D care.

Illness perceptions, personal control in particular, have also been reported to be associated with other important diabetes outcomes, including depression and anxiety in a mixed sample of adults with T1D or type 2 diabetes (T2D) (Hudson et al., 2014). Furthermore, personal control was found to fully mediate the association between the patient–doctor relationship and diabetes-related distress among adults with T1D and T2D aged 18–65 years (Bridges and Smith, 2016), supporting the relevance of personal control in patients with diabetes. It is worth noting that the measure we used to assess illness perceptions, the BIPQ, is a general measure of illness perceptions, and was not designed to investigate perceptions specific to T1D. It is designed to be used across a range of several illnesses, such that the word “illness” may be replaced by the specific illness in question (diabetes in the current study). Consequently, although the BIPQ is validated and has been adopted in a range of studies on a variety of mental and physical health conditions, including T1D (Broadbent et al., 2015), we cannot be certain that the BIPQ dimensions precisely mirror T1D-specific illness features. Such aspects may be taken into consideration when interpreting the results.

In addition to illness perceptions, coping was significantly associated with metabolic control in the current study. Various categorizations of coping mechanisms have previously been put forward, but the classification described by Lazarus and Folkman, distinguishing between

problem- and emotion-focused coping (Lazarus and Folkman, 1984) is most commonly used (Tamres et al., 2002). Whereas problem-focused coping strategies are focused toward the stressor (e.g. planning, active coping, and problem-solving), emotion-focused coping strategies focus on the emotional response to the stressor (e.g. venting emotions, ruminating, avoidance, and self-blame). The distinction between coping focused on problems versus emotional response and “good” versus “bad” coping strategies is not necessarily an absolute, and may at times be somewhat overlapping. Nevertheless, it is a widely used terminology, which can provide a framework for understanding coping mechanisms broadly. The importance of problem-focused coping for better outcomes is generally supported among individuals with T1D (Lawson et al., 2010). Specifically, the association between emotion-focused coping strategies and poorer metabolic control is previously demonstrated in adolescents (Graue et al., 2004; Wisting et al., 2015) as well as adults with diabetes. For example, anger coping style was found to be associated with higher HbA1c among adults (aged 18–75 years) with T1D and T2D (Yi et al., 2008). Furthermore, the use of emotion-focused coping strategies is associated with poorer outcomes in other populations, including hemodialysis patients (Hwang et al., 2018), multiple sclerosis (Mikula et al., 2018), and parents of children with autism spectrum disorder (Vernhet et al., 2018). Also, a recent study explored burnout syndrome and posttraumatic stress disorder (PTSD) among staff working in pediatric intensive care units and found that around 30 percent

of the variance in burnout and PTSD was predicted by frequent use of emotion-focused coping strategies and infrequent use of problem-focused coping (Rodriguez-Rey et al., 2018).

Finally, eating disorder psychopathology was only significantly associated with HbA1c among females in the current study. Taken together with extensive existing research (Mannucci et al., 2005; Nielsen, 2002; Young et al., 2012) that eating disorders are more common among females than males, this suggests that clinicians may be more alert to such issues among females with T1D. Screening is recommended to facilitate detection and subsequent early intervention among individuals with T1D, and this may be particularly important among young females. One available diabetes-specific screening instrument is the DEPS-R (Markowitz et al., 2010). However, although positively correlated among the females, eating disorder psychopathology did not remain significant in the regression analysis.

### *Gender differences*

The overall gender differences demonstrated in the present study are generally in conjunction with previous studies. For example, in line with our previous studies among adolescents with T1D (Wisting et al., 2016), females were generally more concerned than males in the current adult study (Table 2). Similar gender differences in illness perceptions have been reported in allergic rhinitis, showing that adult females generally perceived their illness as more threatening than males (Pesut et al., 2014), as well as in previous research among adults with T1D (Rassart et al., 2014). Although a few studies have demonstrated the association between metabolic control and psychological correlates such as illness perceptions and coping strategies, existing studies generally report these associations in the whole sample, including both males and females. Our previous study of an adolescent sample with T1D (Wisting et al., 2015), however, split the analyses by gender, and found that the significant associations between these psychological aspects and

HbA1c were driven only by the young females. There were no significant associations among the adolescent males. It was, therefore, of interest to investigate these associations separated by gender also among the adult sample in the current study. As mentioned above, personal control remained a significant predictor of HbA1c among males subsequent to the regression analysis using the backward elimination strategy. This may imply that psychological aspects are generally not relevant for males until they reach adulthood, but more research is needed to investigate this further.

Gender differences were also evident in the current study in terms of utilized coping strategies, with significant associations emerging between metabolic control and coping strategies often classified as emotion-focused coping among females, and problem-focused coping among males. This mirrors the general coping literature, in that emotion-focused coping is often viewed as maladaptive coping strategies typically conducted by females, and problem-focused coping as adaptive coping strategies more commonly endorsed by males (Tamres et al., 2002). Gender differences in coping have also been documented among individuals with T2D, in that males generally use less coping strategies than females, less emotion-focused coping, and more problem-focused coping (DeCoster and Cummings, 2004; Kaceroovsky-Bielez et al., 2009). Emotion-focused coping was associated with poorer self-assessed diabetes control, whereas problem-focused coping was associated with better control (DeCoster and Cummings, 2004). Taken together, this suggests that females may need more emotional support to manage their T1D, thereby improving their chances of better outcomes.

### *Strengths and limitations*

Although this study is strengthened by a wide adult age range and inclusion of males, there are also important limitations to be noted. First, this is a self-report, cross-sectional study and we can, therefore, not infer causality or directionality of our findings. For example, we



cannot establish whether more negative perceptions of personal control lead to poorer metabolic control or the other way around. Furthermore, a generic measure of coping was used, which may be viewed as a weakness given that previous literature suggests coping strategies to depend on the particular situation and characterization of the challenge at hand (Hagger and Orbell, 2003; Seiffge-Krenke et al., 2009). This could suggest that a diabetes-specific measure of coping would be ideal in this population. Similarly, as mentioned above, the BIPQ is a generic measure of illness perceptions, and not made specifically to describe T1D-specific aspects of illness perceptions. Finally, data were collected from one diabetes outpatient clinic only, and we cannot (1) provide exact reports of how many individuals were asked to participate in the study; or (2) be certain that this sample is representative for the T1D population in general.

### *Clinical and research implications*

Given the link between metabolic control and the development of serious diabetes late complications (The Diabetes Control Complications Trial Research Group, 1993) and the increased mortality rates associated with T1D (Gagnum et al., 2015; Skriverhaug et al., 2006), it is of interest to identify predictors of metabolic control to guide preventive efforts. Systematic reviews (Gloaguen et al., 2018; Neylon et al., 2013) found that metabolic control was associated with factors including demographic (e.g. age and gender), T1D-related (e.g. occurrence of diabetes ketoacidosis), T1D management-related (e.g. pump versus pen and self-care), genetic, and personal predictors (e.g. depression, anxiety, distress, family structure, and illness perceptions). However, in several studies, such factors together commonly explain only <20 percent of the variance in HbA1c (Bott et al., 1994; Devries et al., 2004; Galler et al., 2011; Taylor et al., 2003). The fact that personal control alone explained 23 percent of the variance in metabolic control among adolescent females (Wisting et al., 2015) and together with

the coping strategy seeking emotional social support explained 23.2 percent of the variance among the adult females in the current study supports the clinical relevance of personal control in efforts to minimize the risk of poor metabolic control and subsequent poor prognosis. This makes intuitive sense, given the crucial role of self-care in the treatment of T1D. Also, a previous systematic review concluded that there is no “one size fits all” when it comes to the management of T1D (Neylon et al., 2013), which further supports the relevance of knowledge about individual illness perceptions and coping mechanisms, and their potential impact on HbA1c. In fact, Shaban et al. (2009) suggest that targeting illness-specific cognitions may be more productive than treatment of general dysphoria in T1D. In addition, coping-oriented education has been suggested as a way of improving poor glycemic control (Devries et al., 2004). Promoting problem-focused coping strategies could be an aim based on the current evidence base discussed above. Facilitating emotional social support seems especially important for females with T1D, and this is relevant clinically as well as in designing future interventions. Intervention studies are needed to test potential effects of addressing such psychological aspects in T1D treatment. Personal control, the strongest potential predictor of metabolic control in the current study, has been reported to be among the most modifiable dimensions of illness perceptions measured by the BIPQ, and a central perception to assess and target to create behavior change (Broadbent et al., 2015). Finally, although the current study did not aim to test model fit, different theories of health behavior have been put forward, which could be further tested in future research to aid theory development.

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## Author contributions

L.W. planned the study, collected and analyzed the data, and wrote the manuscript. A.R. collected data and contributed to the manuscript. T.S. and K.D.-J. contributed to the planning of the study, the data collection, and to the manuscript. Ø.R. contributed to the planning of the study and to the manuscript.

## Declaration of conflicting interests

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