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RESEARCH ARTICLE

Prevalence, associations and health outcomes of binge eating in adults with type 1 or type 2 diabetes: Results from Diabetes MILES – The Netherlands

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Abstract

Aims: To examine the prevalence and health risks of binge eating in people with diabetes.

Methods: Self-report data were analysed from a subsample ($n = 582$ type 1 diabetes/735 type 2 diabetes) of Diabetes MILES – the Netherlands, an online survey. Prevalence of binge eating was compared across diabetes type and treatment and between participants with and without binges for eating styles, diabetes treatment and outcomes, weight, BMI and psychological comorbidity. Associations between binge eating, HbA_{1c}, BMI, diabetes distress were assessed using hierarchical linear regression analyses.

Results: 23% ($n = 308$) of participants reported eating binges, with 16% at least monthly, and 6% at least weekly. Prevalence and frequency of binges did not differ across diabetes type or treatment. People reporting binges scored higher on dietary restraint, emotional and external eating and reported higher weight and BMI than those without binges. Only people with type 1 diabetes and eating binges had a higher HbA_{1c}.

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Hierarchical regression analyses demonstrated that binge eating was independently associated with higher HbA_{1c} ($\beta = 0.12, p=0.001$), BMI ($\beta = 0.13, p < 0.001$) but not with diabetes distress.

Conclusions: This study found binge eating to be associated with eating styles, BMI and HbA_{1c}. However, our cross-sectional data do not allow for conclusions on causality. Future studies could further examine the directions of these associations and their clinical implications.

KEY WORDS

diabetes, comorbidity, binge eating, eating styles

1 | INTRODUCTION

People with diabetes are at greater risk of eating problems, including eating disorders (EDs) and disordered eating behaviours (DEB), than people without diabetes.^{1–3} Whereas EDs refer to specific psychiatric conditions, identified by clinically defined symptoms, DEBs refer to unhealthy or dysfunctional eating behaviours that do not (yet) meet diagnostic criteria of full EDs.^{3–5} The prevalence rates of eating problems in diabetes diverge, ranging from <5% to >50%^{1,6} due to inconsistencies in definitions, methodologies and small study samples.^{7,8} Differences in type and prevalence of eating problems are found across diabetes type,^{2,4,8} gender^{3,5,8} and age groups.^{4,5,8} Women with diabetes appear more vulnerable for eating problems than men, but studies in men are scarce.^{4,5,8} Insulin restriction to influence weight (loss) is a particular DEB in type 1 diabetes.^{4,9}

Binge eating has been suggested the most common eating problem among people with type 1¹⁰ and type 2 diabetes.^{11,12} Binge eating is defined as 'recurrent episodes of uncontrolled eating of abnormally large quantities of food in a discrete period of time, accompanied by a sense of lack of control'.² Binge eating disorder (BED) is defined by additional DSM-V criteria, describing accompanying emotions, lack of compensatory behaviour and duration and frequency of binges.⁷

It is hypothesised that the relationship between binge eating and diabetes builds upon two distinct mechanisms.⁷ The first mechanism, specific for type 2 diabetes, holds that pre-existing symptoms of binge eating contribute to gaining weight, which increases the risk for diabetes.^{13,14} The second mechanism, so-called the 'dieting dilemma',¹⁵ describes how dietary restraint and awareness of weight or carbohydrates in people with diabetes may contribute to binge eating.

The impact of dietary restraint has been studied mainly in the context of eating styles. Dietary restraint, emotional eating and external eating are eating styles that have been

What's new?

- People with diabetes are at greater risk of eating problems and disorders than people without diabetes. Binge eating is the most common eating problem in people with diabetes.
- The current study shows that the prevalence of binge eating in people with diabetes is independent of diabetes type and treatment, and has cumulative physical and psychological health risks.
- The findings regarding the prevalence of binge eating in people with diabetes support the call for screening for disordered eating in clinical diabetes practice

found to relate to food preferences and quantity of food intake.¹⁶ To our knowledge, only few studies have examined eating styles in people with diabetes,^{15,17} all focussing on (prevention of) type 2 diabetes and none examining the relation with binge eating.

Binge eating is related with higher body mass index (BMI) in the general population¹³ and people with type 2 diabetes.^{6,11,18,19} The relationship between binge eating and glycaemia is less clear.^{11,19} Consistent evidence shows that binge eating is related to psychological conditions, such as negative affect or depression in the general population²⁰ and people with diabetes.¹¹

The first aim of the current study was to examine the prevalence of binge eating in a large sample of adults with diabetes, allowing comparisons across type 1 and type 2 diabetes and treatment modalities. Secondly, differences were assessed between people with and without eating binges, regarding eating styles (*restraint, emotional, external*), diabetes treatment (*injections, pump, oral antidiabetics, other injectables, lifestyle*), weight, BMI and diabetes outcomes (*HbA_{1c}, hypo- and*

hyperglycaemia, hospitalisations, complications) and psychological comorbidity (symptoms of depression and anxiety, eating disorder, diabetes distress). Thirdly, associations between binge eating, HbA_{1c}, BMI and diabetes distress were examined.

2 | METHODS

2.1 | Participants

The present study is part of Diabetes MILES (Management and Impact for Long-term Empowerment and Success) – The Netherlands, a national online survey about the psychosocial impact of diabetes. The rationale, design and methods have been published.²¹ Participants were recruited through Dutch diabetes and health-related media channels. Participants who completed the core set of study questions ($n = 1,417$ type 1 diabetes and $n = 1,884$ type 2 diabetes, 73% of people who registered for the study) were randomly assigned to one of five modules with additional questions, of which two focused on eating behaviours ($n = 1332$). The current study sample includes those who completed questions on eating behaviours ($n = 1,317$).

The study received approval from the Psychological Research Ethics Committee of Tilburg University, The Netherlands (EC-2011-5).

2.2 | Measures

Binge eating was assessed using the general questions of the Dutch Eating Behavior Questionnaire (DEBQ)²² ('Do you have eating binges now and then? (e.g. eating what other people of your age and gender would regard as an unusually large amount of food, within a short period of time?'). The frequency of binges was assessed in (maximum) three additional questions ('How often do you have eating binges?' (not in the past three months/at least every month/at least every week), 'How many eating binges do you have per month?', 'How many eating binges do you have per week?'). Finally, participants were asked about loss of control: 'During binges, do you ever feel that you cannot stop?'

People who reported having binges were compared with people who did not report binges based on their response to the question 'Do you have eating binges now and then?' (yes/no).

Eating styles were assessed with the 33-items DEBQ,²² assessing (1) restrained eating (10 items), (2) external eating (10 items) and (3) emotional eating (13 items). Restrained eating refers to intentional restrictions of food to influence body weight. External eating refers to eating

in response to food-related stimuli, regardless of sensations of hunger/satiety. Emotional eating comprises two subdimensions about eating in response to diffuse emotions and eating in response to clearly labelled emotions.²² Response options on a five-point Likert scale range from 1 (never) to 5 (very often). Satisfactory validity and reliability of the DEBQ have been published.²² In the present study Cronbach's α of the subscales ranged from 0.83 to 0.86.

Self-reported demographic and clinical data included gender, age, weight and height (to calculate BMI), type of diabetes, diabetes duration and treatment, most recent HbA_{1c}, hospitalisations, severe hypoglycaemia in past 12 months (defined as low blood glucose requiring assistance from others), severe hyperglycaemia in past 12 months (defined as needing help from a doctor/health professional) and diabetes-related complications (diagnosis from a doctor/specialist for nephropathy/kidney failure, retinopathy, neuropathy, diabetic foot).

Psychological comorbidity was assessed by asking about any formal diagnosis of depression, anxiety or ED, use of related medication and psychological/psychiatric care (defined as any consultation with a psychologist/psychiatrist). Participants who consulted a psychologist or psychiatrist at least twice in the past 12 months were considered 'receiving psychological/psychiatric care'.

The 9-item Patient Health Questionnaire (PHQ-9)²³ assesses depressive symptoms. Response options on a four-point Likert scale range from 0 (not at all) to 3 (nearly every day), with total scores between 0 and 27. A cut-off score of ≥ 10 is indicative of major depressive disorder.²³ Cronbach's α in the current study was 0.86.

The 7-item Generalised Anxiety Disorder (GAD-7) Questionnaire²⁴ assesses symptoms of anxiety. Response options on a four-point Likert scale range from 0 (not at all) to 3 (nearly every day), with total scores between 0 and 21. A cut-off score of ≥ 10 is indicative of anxiety disorder.²⁴ Cronbach's α was 0.90.

The 20-items Problem Areas In Diabetes scale²⁵ assesses diabetes distress. Response options on a five-point Likert scale range from 0 (not a problem) to 4 (serious problem) and are transformed into 0–100 total scores. Total scores of ≥ 40 are indicative of significant diabetes distress that may need further psychological assessment or care. Cronbach's α was 0.95.

2.3 | Statistical analysis

SPSS version 23 (IBM Corporation, 2016) was used.

Frequencies of binge eating and loss of control were compared across diabetes type and treatment with chi square tests.

To acknowledge possible differences in diabetes related variables (e.g. lifestyle vs. insulin treated, duration of diabetes, weight), we created three subgroups: (a) type 1 diabetes (b) type 2 diabetes insulin-treated and (c) type 2 diabetes non-insulin-treated. Within these three subgroups, differences in eating styles, weight, BMI, diabetes outcomes, diabetes treatment and psychological comorbidity were compared between participants with and without binges. All differences were analysed with chi square tests for categorical data and independent sample *t*-tests for continuous data. *p*-values were adjusted for multiple testing using Bonferroni corrections for multiple testing. Effect sizes were calculated using ϕ for chi square tests and Cohen's *d* for independent sample *t*-tests. For reported ϕ , effect sizes of 0.1 were considered small, 0.3 medium and 0.5 large effects. For Cohen's *d* effect sizes of 0.2 were considered small, 0.5 medium and 0.8 large effects. Tables 1–3 report all differences between people reporting binge eating, and people without binges, within the three groups. Only significant results are described in the text.

To examine the adjusted association of binge eating with HbA_{1c}, BMI and diabetes distress in the total sample, three separate hierarchical linear regression analyses were conducted with HbA_{1c}, BMI and diabetes distress (PAID total score) as dependent variables. Variables were entered in four steps:

1. Demographics: gender and age.
2. Diabetes related variables: diabetes type, diabetes duration (years), insulin injections (no/yes), insulin pump (no/yes), (BMI), (HbA_{1c}).
3. Symptoms of depression and anxiety and diabetes distress: PHQ-9 total score, GAD-7 total score, PAID total score.
4. Binge eating: binges (no/yes).

3 | RESULTS

3.1 | Baseline characteristics and binge eating frequency

Of the 1,317 people who completed the DEBQ 55% were female, with an average age of 55 (SD = 14) years, diabetes duration of 16 (SD = 13) years, BMI of 28 (SD = 6) and HbA_{1c} of 56 (SD = 12) mmol/mol, 7.3% (SD = 1.1). Most participants (*n* = 737, 56%) had type 2 diabetes, of whom 29% (*n* = 381) insulin-treated. Most participants (72%, *n* = 420 of type 1 diabetes, 74%, *n* = 262 of type 2 diabetes without insulin and 61%, *n* = 234 of type 2 diabetes insulin-treated) did not report diabetes complications.

In total, 23% (*n* = 308) of the participants reported eating binges, with 16% (*n* = 206) at least once a month and 6% (*n* = 79) at least once a week (Table S1). Furthermore, 16% (*n* = 215, =70% of the people who reported eating binges) reported losing control during binges. There were no differences between groups according to diabetes type or treatment (insulin/no insulin) with regard to prevalence or frequency of binges or loss of control (Table S1).

People reporting eating binges had higher average scores on the DEBQ eating style subscales than people without binges, within all diabetes type subgroups (Table 1). Differences in eating styles between people reporting binges and people without binges were substantial, reflected in most effect sizes (Cohen's *d*) being > 1.

3.2 | Binge eating in subgroups

When comparing groups according to age, gender, treatment and clinical variables (Table 2), people reporting eating binges were younger than those without binges, within all diabetes type subgroups. For type 1 diabetes and non-insulin treated type 2 diabetes, people who reported eating

TABLE 1 Differences in eating styles between people with and without eating binges according diabetes type and treatment

Binge eating yes/no	T1DM N = 579			T2DM (non-insulin) N = 352			T2DM (insulin) N = 381		
	Yes = 146	No = 433	Effect size <i>d</i>	Yes = 78	No = 274	Effect size <i>d</i>	Yes = 83	No = 298	Effect size <i>d</i>
Restraint	3.0 (0.7)	2.6 (0.8)	0.6***	3.1 (0.6)	2.9 (0.8)	0.3*	3.1 (0.8)	2.8 (0.8)	0.4***
Emotional	2.7 (0.9)	1.9 (0.8)	1.0***	3.0 (0.9)	1.9 (0.8)	1.2***	2.9 (0.9)	1.8 (0.8)	1.3***
Emotional diffuse	3.0 (1.0)	2.1 (0.9)	1.0***	3.2 (0.9)	2.1 (0.8)	1.2***	3.2 (0.9)	2.0 (0.8)	1.4***
Emotional clear	2.6 (1.0)	1.8 (0.8)	0.9***	2.9 (0.9)	1.8 (0.8)	1.2***	2.8 (0.9)	1.7 (0.8)	1.2***
External	2.9 (0.6)	2.4 (0.6)	0.9***	3.0 (0.6)	2.4 (0.6)	1.0***	3.0 (0.6)	2.4 (0.5)	1.1***

p* = 0.024.; **p* < 0.001.

TABLE 2 Differences in demographic, diabetes treatment and clinical variables per diabetes type and treatment ('binge eating' vs. no binge eating)

	T1DM N = 582		T2DM (non-insulin) N = 353		T2DM (insulin) N = 382		Effect size d or ϕ
	Yes = 146	No = 436	Yes = 79	No = 274	Yes = 83	No = 299	
Binges yes/no							
Gender (male)	40 (27%)	184 (42%)	30 (38%)	141 (51%)	37 (45%)	158 (53%)	0.1
Age (years)	40.0 (13.1)	48.9 (14.5)	55.7 (8.8)	62.4 (8.9)	58.8 (10.2)	63.3 (9.4)	0.5 ^{***}
Treatment							
Insulin injections	61 (42%)	230 (53%)	na	na	70 (84%)	269 (90%)	0.1
Insulin pump	85 (58%)	206 (47%)	na	na	13 (16%)	32 (11%)	0.1
Oral antidiabetics	10 (7%)	34 (8%)	72 (91%)	247 (90%)	66 (80%)	189 (63%)	0.1*
Other injectables (non-insulin)	na	na	2 (3%)	10 (4%)	2 (2%)	6 (2%)	0.0
Lifestyle only	na	na	5 (6%)	26 (10%)	na	na	0.1
Clinical variables							
HbA1c mmol/mol, mean \pm SD (%, mean \pm SD)	63 \pm 12 (7.9 \pm 1.1)	57 \pm 11 (7.4 \pm 1.0)	53 \pm 13 (6.9 \pm 1.2)	50 \pm 9 (6.7 \pm .8)	59 \pm 11 (7.5 \pm 1.0)	57 \pm 14 (7.4 \pm 1.2)	0.1
Diabetes duration (years)	20.8 (12.5)	23.6 (14.9)	5.9 (4.6)	8.2 (6.0)	13.1 (7.8)	14.1 (8.1)	0.1
Severe hyperglycaemic episode past year	1.0 (8.4)	.9 (8.0)	1.0 (8.1)	.1 (.8)	.5 (1.8)	.8 (6.7)	0.1
Severe hypoglycaemic episodes past year	0.6 (1.6)	1.2 (4.4)	0.1 (.5)	0.2 (1.8)	0.4 (1.5)	0.6 (3.5)	0.1
Hospitalisation past year	0.3 (.7)	0.3 (.7)	0.2 (.6)	0.2 (.7)	0.5 (1.3)	0.4 (.9)	0.1
No complications	103 (71%)	317 (72%)	53 (67%)	209 (76%)	51 (61%)	183 (61%)	0.0
1 complication	27 (19%)	75 (17%)	19 (24%)	47 (17%)	18 (22%)	67 (22%)	0.0
>1 complication	16 (11%)	44 (10%)	7 (9%)	17 (6%)	14 (17%)	49 (16%)	0.1
Weight, kg	79.5 (16.1)	75.2 (15.1)	90.4 (16.8)	83.6 (15.1)	98.9 (20.6)	89.8 (19.7)	0.5 ^{***}
BMI	26.6 (5.4)	24.8 (4.7)	30.5 (5.4)	27.8 (4.9)	32.7 (6.7)	30.3 (6.2)	0.4 ^{**}

Note: na, not applicable.

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

TABLE 3 Differences in psychological health between people with or without 'binge eating' according to diabetes type and treatment

Binges yes/no	T1DM N = 582		T2DM (non-insulin) N = 353		T2DM (insulin) N = 382		Effect size ϕ or <i>d</i>		
	Yes = 146	No = 436	Effect size ϕ or <i>d</i>	Yes = 79	No = 274	Effect size ϕ or <i>d</i>		Yes = 83	No = 299
Depressive disorder (y)	17 (12%)	24 (6%)	0.1*	13 (17%)	14 (5%)	0.2***	13 (16%)	16 (5%)	0.2**
Anti-depressants (y)	13 (9%)	13 (3%)	0.1**	8 (10%)	9 (3%)	0.1*	11 (13%)	10 (3%)	0.2***
Anxiety disorder (y)	5 (3%)	2 (1%)	0.1**	3 (4%)	4 (1%)	0.1	1 (1%)	9 (3%)	0.1
Anxiety medication (y)	2 (1%)	1 (0%)	0.1	2 (3%)	3 (1%)	0.1	1 (1%)	4 (1%)	0.0
Eating disorder (y)	11 (8%)	7 (2%)	0.2***	3 (4%)	3 (1%)	0.1	5 (6%)	1 (0%)	0.2***
Psychologist (y)	37 (25%)	40 (10%)	0.2***	6 (8%)	8 (3%)	0.1	13 (16%)	16 (5%)	0.2**
Psychiatrist (y)	9 (6%)	13 (3%)	0.1	7 (9%)	6 (2%)	0.2	7 (8%)	6 (2%)	0.2**
PHQ9 total score	6.1 (5.5)	3.6 (4.2)	0.5***	6.9 (5.7)	3.3 (4.3)	0.7***	6.7 (5.3)	3.8 (4.2)	0.6***
PHQ9 score			0.2***			0.2			0.2
<10	115 (79%)	394 (90%)		58 (73%)	253 (92%)		62 (75%)	275 (91%)	
≥10	31 (21%)	42 (10%)		21 (27%)	21 (8%)		21 (25%)	24 (8%)	
GAD7 total score	4.2 (3.9)	2.6 (3.3)	0.4***	4.4 (4.8)	2.2 (3.2)	0.5***	4.1 (4.1)	2.3 (3.2)	0.5***
GAD7 score			0.1			0.1			0.2
<10	134 (92%)	417 (96%)		70 (89%)	264 (96%)		73 (88%)	288 (96%)	
≥10	12 (8%)	19 (4%)		9 (11%)	10 (4%)		10 (12%)	11 (4%)	
PAID total	29.0 (21.1)	19.8 (17.2)	0.5***	26.3 (19.6)	14.9 (17.6)	0.6***	29.8 (20.1)	18.4 (17.6)	0.6***
PAID score			0.1***			0.2			0.1*
<40	105 (72%)	369 (85%)		58 (73%)	252 (92%)		62 (75%)	256 (86%)	
≥40	41 (28%)	67 (15%)		21 (27%)	22 (8%)		21 (25%)	43 (14%)	

p* < 0.05.; *p* < 0.01.; ****p* < 0.001.

binges were more likely to be female than people without eating binges, however effect sizes were small (0.1). For type 1 diabetes, people reporting binges were more likely using an insulin pump than people not reporting binges, but again with a small effect size (0.1). Within the group of people with insulin-treated type 2 diabetes, people reporting eating binges used oral anti-diabetics more often than people not reporting eating binges.

For type 1 diabetes and non-insulin treated type 2 diabetes, people reporting eating binges had a shorter diabetes duration than people without eating binges.

Within all diabetes type subgroups, weight and BMI were higher among people with than in people without eating binges. For type 1 diabetes, HbA_{1c} was higher in people reporting eating binges, compared to those without binges.

3.3 | Self-reported psychological associations of binge eating

For psychological comorbidities (Table 3), people with eating binges reported higher scores on most variables. In all diabetes type subgroups, people with eating binges reported more diagnoses of depressive disorder, as well as use of antidepressants. Within the group of people with type 1 diabetes, people with eating binges also reported anxiety disorders more often, as well as EDs and being treated by a psychologist. For insulin-treated type 2 diabetes, people with eating binges also reported more diagnoses of ED, being treated by a psychologist and being treated by a psychiatrist. Within all diabetes type subgroups people with eating binges had higher total PHQ-9 and GAD-7 scores, indicating more symptoms of depression and anxiety in people with eating binges, compared to those without eating binges. Diabetes distress (total PAID score) was also higher in people with eating binges than in people without binges, in all diabetes type subgroups.

3.4 | Binge eating and HbA_{1c}, BMI and diabetes distress

In the multiple regression analysis with HbA_{1c} as dependent variable (Table 4), the fully adjusted model showed that binge eating was independently associated with higher HbA_{1c}. Furthermore, insulin treatment irrespective of modality and higher PAID scores were associated with higher HbA_{1c}.

In the multiple regression analysis with BMI as dependent variable, the fully adjusted model showed that binge eating was independently associated with higher BMI. Furthermore, female gender, type 2 diabetes, longer

diabetes duration, higher PHQ-9 scores, lower GAD-7 scores and higher PAID scores were all associated with higher BMI.

In the multiple regression analysis with diabetes distress as dependent variable, the fully adjusted model showed no association between binge eating and diabetes distress. Female gender, type 1 diabetes, higher BMI and HbA_{1c}, longer diabetes duration, using insulin injections, using an insulin pump and higher PHQ-9 and GAD-7 scores were all related to higher levels of diabetes distress.

4 | DISCUSSION

This study explored the prevalence of binge eating and associations with clinical and psychological outcomes in a large sample of Dutch adults with diabetes, according to diabetes type and treatment. A comparable prevalence rate of 22-25% was found across all diabetes type subgroups, with 16% having binges at least once a month and 6% at least once a week. Furthermore, 16% (=70% of people who reported eating binges) reported losing control during binges. Compared with those without eating binges, people with eating binges were more likely to report restraint, emotional and external eating, as well as higher weight, BMI, diabetes outcomes and psychological outcomes. Contrary to previous studies,^{2,4} these findings did not show differences in the prevalence or frequency of binge eating according to diabetes type and treatment. In general, people reporting binges were younger. People with type 1 diabetes and eating binges reported shorter duration of their diabetes and used insulin pumps more often, both of which could also be related to younger age.

The relatively high prevalence of binge eating and the higher scores on all eating styles could be related to dietary restraint and weight awareness associated with diabetes self-management.¹⁵ This 'dieting dilemma' explains how restriction of food intake may either suppress or promote excessive food intake and weight gain.¹⁵ Overeating in response to hypoglycaemia could be another factor that contributes to the relatively high prevalence of binge eating in people using glucose lowering medications.³³ Unfortunately, the current study only assessed severe hypoglycaemia and did not differentiate between binges associated with self-treated hypoglycaemia and binges that were not hypoglycaemia-related. Previous studies demonstrated a relationship between external eating and increased intake of energy and fat¹⁷ and emotional eating and weight gain in people with type 2 diabetes.¹⁵ This study was the first to examine the relationship between eating styles and binge eating in people with diabetes. The link between binge eating and emotional eating has long been described in various

TABLE 4 Fully adjusted hierarchical linear regression models examining the association of binge eating with HbA_{1c}, BMI and diabetes distress

	HbA _{1c}			BMI			Diabetes distress (PAID total score)				
	β	<i>t</i>	<i>p</i> -value	Adj. R ²	β	<i>t</i>	<i>p</i> -value	β	<i>t</i>	<i>p</i> -value	Adj. R ²
Demographical variables (step 1)											
			0.014*				0.054*				0.074*
Gender (men = ref. gr)	0.020	0.605	0.545	0.090	2.914	0.004	0.068	2.579	0.010		
Age	0.016	0.351	0.726	0.036	0.831	0.406	0.11	0.289	0.773		
Diabetes and treatment (step 2)											
			0.076*				0.187*				0.120*
Diabetes type (1 or 2) (T1DM = ref. gr.)	-0.047	-1.021	0.307	0.451	11.252	0.000	-0.074	-2.036	0.042		
Diabetes duration in years	0.033	0.803	0.422	0.145	3.770	0.000	-0.104	-3.170	0.002		
Insulin injections (no/yes)	0.255	5.735	0.000	-0.034	-0.814	0.416	0.129	3.604	0.000		
Insulin pump (no/yes)	0.232	4.778	0.000	-0.020	-0.426	0.670	0.122	3.122	0.002		
HbA _{1c}	—	—	—	0.044	1.440	0.150	0.097	3.757	0.000		
BMI	0.050	1.440	0.150	—	—	—	0.055	1.985	0.047		
Psychological comorbidity (step 3)											
			0.097*				0.205*				0.429*
Depressive symptoms (PHQ-9 total)	0.027	0.526	0.599	0.140	2.934	0.003	0.423	10.959	0.000		
Anxiety symptoms (GAD-7 total)	-0.058	-1.209	0.227	-0.144	-3.233	0.001	0.182	4.794	0.000		
Diabetes distress (PAID total)	0.153	3.757	0.000	0.076	1.985	0.047	—	—	—		
Binge eating (no/yes) (step 4)	-0.115	-3.428	0.001	0.107*	-4.552	0.000	-0.043	-1.600	0.110		0.430*

**p* < 0.001.

populations without diabetes.²⁶ Eating in response to negative emotions is considered a core feature of over-eating and binge eating, as explained by the affect regulation model of binge eating.²⁷ However, more recent studies challenge the affect regulation model of binge eating and state that reductions in negative affect can no longer be seen as maintenance factor for binge eating, since binge eating more often leads to an increase of negative affect.²⁸

The link between external eating and binge eating has been described in individuals with EDs.²⁰ Schulz and Laessle²⁰ studied psychopathological features, eating behaviour and eating habits in 84 obese women with and without BED. People with BED showed higher levels of psychological comorbidity (in particular mood-, anxiety- and substance-related disorders) and higher scores of external and emotional eating. Similarly, the results of our study revealed higher levels of depressive and anxiety symptoms and diabetes distress in people with eating binges. However, the prevalence rate of anxiety disorders was low (<5%), which impacts the generalisability of these findings.

Our findings regarding binges and elevated BMI are in line with previous studies on health correlates of binge eating in the general^{14,18} and diabetes population.⁶ Contrary to previous studies,^{6,11} our findings demonstrated associations between binge eating and higher HbA_{1c}.

Contrary to our expectations, this study showed no differences in the prevalence of binge eating between diabetes subgroups. Our findings support the idea that eating binges in people with diabetes can impact both physical and psychological health, regardless of gender, age, type of diabetes and treatment. We are aware that the cross-sectional nature of our data does not allow for any conclusions on causality. The relationship between binge eating, eating styles, HbA_{1c}, BMI and psychological health is probably bi-directional and deserves more longitudinal attention in future research.

Further study limitations include the use of self-report measures of HbA_{1c}, weight, length, BMI, eating behaviours, depression, anxiety and diabetes distress that all may have been subject to recall bias. Furthermore, the assessment of binge eating was based on a single item.

Future studies could further examine the relationship between binge eating, clinical outcomes and psychological health in people with diabetes, making use of (more) objective instruments to assess physical and psychological health. In addition, it would be recommended to distinguish between glucose related and unrelated binges, as previously suggested by Araia and colleagues⁹ and to further examine the relationship between following diabetes and weight recommendations and binge eating. It would

also be valuable to better understand people's perceptions of binge eating, regarding amounts of food, duration, frequency and whether or not hypoglycaemia related over-eating is perceived as binge eating or not.

We believe that these study findings are in line with the more general call for screening for disordered eating in clinical diabetes practice and primary care.^{3,4,29} It is suggested, that a stepwise screening, using brief diabetes-specific instruments (e.g. the Diabetes Eating Problem Survey-Revised, DEPS-R)³⁰ that enable early detection of problematic eating behaviours may facilitate timely treatment of eating problems in people with diabetes.^{23,25} Despite the strong need for more research on interventions to treat EDs and DEBs in people with diabetes, there is a consensus that a multidisciplinary approach, including licensed nutritional and mental health professionals is needed in supporting people with diabetes and comorbid EDs or DEBs.^{4,8,29}

AUTHOR CONTRIBUTIONS

Sasja D. Huisman analysed the data and prepared the manuscript. Giesje Nefs researched data, reviewed/edited the manuscript and contributed to the discussion. Christel Hendriekx, Mariska Bot and François Pouwer reviewed/edited the manuscript and contributed to the discussion. Giesje Nefs, Mariska Bot and François Pouwer contributed to data collection.

Guarantor: Sasja D. Huisman takes full responsibility for the contents of the article. An abstract of this study has been published in *Nederlands Tijdschrift voor Diabetologie*, November 2018, issue 4. 'Binge eating amongst adults with type 1 or type 2 diabetes: prevalence and relationship with clinical factors (MILES-Study, NL)'.

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CONFLICT OF INTEREST

No conflicts of interest.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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