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Eating patterns in adolescents with type 1 diabetes: Associations with metabolic control, insulin omission, and eating disorder pathology

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ABSTRACT

Objective: The purpose of this study was to investigate eating patterns among male and female adolescents with type 1 diabetes (T1D), and the associations with age, zBMI, eating disorder (ED) pathology, intentional insulin omission, and metabolic control.
Method: The sample consisted of 104 adolescents (58.6% females) with child-onset T1D, mean age of 15.7 years (SD 1.8) and mean zBMI of 0.4 (SD 0.8). The Child Eating Disorder Examination (ChEDE) assessed meal/snack frequency and ED pathology. T1D clinical data was obtained from the Norwegian Childhood Diabetes Registry.
Results: A significantly lower proportion of females than males (73.8% vs 97.7%) consumed breakfast on a daily basis. Approximately 50% of both genders ate lunch and 90% ate dinner daily. Among females, skipping breakfast was significantly associated with higher global ED psychopathology, shape concerns, self-induced vomiting, binge eating, insulin omission due to shape/weight concerns, and poorer metabolic control. Less frequent lunch consumption was significantly associated with poorer metabolic control. Skipping dinner was significantly associated with older age, higher dietary restraint, eating concerns, self-induced vomiting, and insulin omission. Among males, less frequent consumption of lunch and evening snacks was associated with attitudinal features of ED, including shape/weight concerns and dietary restraint.
Discussion: Among adolescents with T1D, irregular or infrequent meal consumption appears to signal potential ED pathology, as well as being associated with poorer metabolic control. These findings suggest the importance of routinely assessing eating patterns in adolescents with T1D to improve detection of ED pathology and to facilitate improved metabolic control and the associated risk of somatic complications.

Type 1 diabetes (T1D) is a chronic illness caused by an autoimmune destruction of the insulin producing beta cells in the pancreas. Lack of insulin leads to poor metabolic control as indicated by elevated blood glucose levels and measured by HbA1c. Over time, elevated levels of HbA1c can lead to the onset of severe acute and late T1D complications (Control & Group, 1995; Dahl-Jorgensen, 1987; Groupa, 1994; Nathan et al., 2003). T1D appears to be a risk factor for the development of disturbed eating behaviors (DEB) and eating disorders (ED), with the prevalence of ED being 2–3 times higher among individuals with T1D compared to peers without diabetes (Mannucci et al., 2005; Nielsen, 2002; Young et al., 2012). Although estimates vary based upon measurement specificity (Young et al., 2012), the prevalence of

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disturbed eating behaviors in females with T1D ranges from approximately 30 to 40% (Baechle et al., 2014; Wisting, Froisland, Skrivarhaug, Dahl-Jorgensen, & Ro, 2013), with some reporting rates of up to 50% at 14-years follow-up (Colton et al., 2015). Available prevalence estimates of DEB in male adolescents are lower, at approximately 9% (Bachle, Stahl-Pehe, & Rosenbauer, 2016; Wisting et al., 2013). Intentional insulin restriction (reducing or omitting insulin to influence shape or weight) is a uniquely available, diabetes-specific compensatory behavior engaged in by an estimated 21–37% of young females with T1D (Baechle et al., 2014; Goebel-Fabbri et al., 2008; Wisting et al., 2013). Adolescents with T1D who engage in disturbed eating behaviors have poorer metabolic control (Young et al., 2012), and insulin restriction is associated with a threefold increase in mortality rates (Goebel-Fabbri et al., 2008).

Irregular or infrequent meal consumption is a dietary restriction behavior observed across individuals with ED (Elran-Barak et al., 2014). There is evidence that skipping meals is an unhealthy weight control behavior engaged in by approximately 28% of female and 7% of male adolescents with T1D (Neumark-Sztainer et al., 2002). A core therapeutic component in the clinical management of ED involves the normalization of erratic eating behavior, with the introduction of regular timing, frequency, and pattern of meals and snacks (Fairburn, 2008; Wonderlich et al., 2014). The frequency of consuming specific meals and snacks may variably affect disordered eating behaviors, in addition to the total number of meals/snacks consumed (Shah, Passi, Bryson, & Agras, 2005) (Ellison et al., 2016).

Despite advances in treatment which have enabled less strict dietary regimes, careful planning to secure appropriate insulin dosage remains a cornerstone of diabetes management (Smart, Annan, Bruno, Higgins, & Acerini, 2014), as regularity in meal times and eating routines are important for optimal glycemic outcomes (Overby, Margeirsdottir, Brunborg, Andersen, & Dahl-Jorgensen, 2007; Patton, Williams, Dolan, Chen, & Powers, 2009). However, research on eating patterns and associated clinical outcomes in adolescents with T1D is scarce, lagging behind similar lines of investigation in healthy pre-adolescent and adolescent schoolchildren (Bruening, Larson, Story, Neumark-Sztainer, & Hannan, 2011; Cooper, Bandelow, & Nevill, 2011; Kral, Whiteford, Heo, & Faith, 2011), youth with anorexia nervosa (Elran-Barak et al., 2014), adults with T1D (Heller et al., 2015), obesity (Berg et al., 2009), bulimia nervosa (Ellison et al., 2016), binge eating disorder (Cachelin, Thomas, Vela, & Gil-Rivas, 2016; Harvey, Rosselli, Wilson, Debar, & Striegel-Moore, 2011; Masheb, Grilo, & White, 2011), type 2 diabetes (Mekary, Giovannucci, Willett, van Dam, & Hu, 2012), and bariatric surgery candidates (Mitchell et al., 2015).

Given the importance of eating behavior for insulin administration and metabolic control, greater knowledge about the frequency and pattern of meal and snack consumption among adolescents with T1D is warranted. The present study addressed three main aims: (1) How frequently are meals and snacks consumed by male and female adolescents with type 1 diabetes? (2) Is the frequency and pattern of meal and snack consumption associated with age, zBMI, eating disorder pathology, insulin omission due to shape/weight concerns or metabolic control? (3) Are there gender differences in the pattern of eating and associations with ED pathology and metabolic control?

1. Method

1.1. Participants and procedure

As described in previous studies (Wisting, Bang, Skrivarhaug, Dahl-Jorgensen, Ro, 2015; Wisting et al., 2015; 2016), the Norwegian Childhood Diabetes Registry (NCDR) is a nationwide, population-based registry, which includes all newly diagnosed children with diabetes since 1989. In the Norwegian healthcare system, all children aged 0–14.9 years with suspected diabetes are referred to pediatric services, which perform and report annual findings of standardized examinations to the NCDR. Children registered in the NCDR are treated at hospitals and clinics across Norway, representing a large geographic area. The current study is part of a larger register-based research study of the NCDR, which originally included 850 participants aged 12–20 years. Between 2011 and 2012, these 850 individuals were invited to participate in an ancillary study using a structured interview to assess psychosocial aspects and functioning related to T1D. The assessment was conducted at Oslo University Hospital or another location of the participants' choice (usually their home or school). A subtotal of 105 individuals (12%) aged 12–20 years agreed to participate and returned a signed consent form via postal mail. To test baseline differences between participants and non-participants, we compared our sample to the background T1D population in the NCDR, which has a completeness of 95% (Kral et al., 2011). No differences were found for age, zBMI, T1D duration, number of consultations with the diabetes team, number of consultations with dieticians, or mode of treatment. Participants were slightly older at the onset of T1D than the background NCDR population (9.6 vs 8.8 years, $p < 0.05$), had somewhat lower HbA1c (8.6% (70 mmol/mol) vs 8.9% (74 mmol/mol), $p < 0.05$), and had fewer episodes of diabetes ketoacidosis (0.02 vs 0.05, $p < 0.05$). However, all effect sizes were small (0.2, −0.2, and −0.2, respectively). The Regional Ethics Committee for Medical and Health Research (REK) (#2009/1737a) and the data protection office at Oslo University Hospital approved the study. Written informed consent was obtained from all participants and their parents if the participant was below the age of 16 years.

1.2. Assessment

The *Child Eating Disorder Examination, v. 12.0 (ChEDE)* is a valid and reliable semi-structured, investigator-based interview which assesses core eating-disorder specific attitudes and behaviors in children and young adolescents up to the age of 18 years (Bryant-Waugh, Cooper, Taylor, & Lask, 1996). A ChEDE global score provides an overall index of ED psychopathology that comprises four subscales: shape concern, weight concern, eating concern, and dietary restraint. Additionally, the ChEDE assessed frequency of binge eating (days), self-induced vomiting (days), excessive exercise (days), and insulin omission due to weight/shape concerns (days) during the past 28 days. The Norwegian version of the ChEDE was found to have adequate psychometric properties (Frampton, Wisting, Overas, Midtsund, & Lask, 2011), including high inter-rater reliability. The internal consistency of the ChEDE subscales *dietary restraint, eating concern*, *weight concern*, and *shape concern* was satisfactory for the present study, with Cronbachs alpha's of 0.73, 0.85, 0.84, and 0.93, respectively.

Frequency of meal (breakfast, lunch, dinner) and snack (mid-morning, mid-afternoon, evening) consumption over the past week (7 days) was assessed using the "Pattern of Eating" ChEDE item. We note that the one-week timeframe differs from the 28-day period covered by the adult version of the Eating Disorder Examination interview (Fairburn, Cooper, & O'Connor, 2008), in line with ChEDE guidelines to improve accuracy of recall in youth (Bryant-Waugh et al., 1996). A 7-point Likert scale is used, with responses ranging from 0 (meal/snack not consumed) to 6 (meal/snack consumed every day). Since the response format is ordinal, but based upon an underlying continuous variable (days), we followed the procedures outlined by Matheson et al (Matheson et al., 2012). and Elran-Barak