Published in final edited form as:

Int J Eat Disord. 2015 September ; 48(6): 563–569. doi:10.1002/eat.22435.

Mindfulness and Eating Behavior in Adolescent Girls at Risk for Type 2 Diabetes

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Abstract

Objective—The purpose of this investigation was to examine the relationship of dispositional mindfulness to binge eating and associated eating attitudes and behaviors among adolescent girls at risk for type 2 diabetes (T2D).

Methods—Participants were 114 overweight or obese adolescents enrolled in a study of girls with a family history of T2D and mild depressive symptoms. Adolescent self-reports of mindfulness, eating in the absence of hunger, and depressive symptoms were collected. An interview was administered to determine presence of binge eating episodes and a behavioral task was used to assess the reinforcing value of food relative to other non-snack food rewards. Body composition was assessed using dual-energy x-ray absorptiometry.

Results—In analyses accounting for race, percent body fat, lean mass, height, age, and depressive symptoms, dispositional mindfulness was associated with a lower odds of binge eating ($p = .002$). Controlling for the same potential confounds, mindfulness was also inversely

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associated with eating concern, eating in the absence of hunger in response to fatigue/boredom, and higher food reinforcement relative to physical activity (all $p < .05$).

Conclusions—In girls with a family history of T2D, independent of body composition and depressive symptoms, intra-individual differences in mindfulness are related to binge eating and associated attitudes and behaviors that may confer risk for obesity and metabolic problems. Further research is needed to determine the extent to which mindfulness plays a role in the etiology and/or maintenance of disinhibited eating in adolescents at risk for T2D.

Keywords

type 2 diabetes; adolescents; mindfulness; disordered eating attitudes; food reinforcement; binge eating

Type 2 diabetes (T2D) is a chronic disease accompanied by heightened risk for a host of severe health complications including cardiovascular and peripheral vascular disease and stroke (1). There has been a dramatic rise in the prevalence of T2D over the past half-century, with a striking 40% of individuals in the U.S. currently estimated to develop this disease in their lifetime (2). Moreover, whereas T2D was once a disease limited to older adults, the incidence and prevalence of T2D among adolescents and young adults has risen alarmingly, particularly in racial/ethnic minority groups including non-Hispanic Blacks, Hispanics, and Native Americans (3).

Well-established risk factors for T2D include excess body fat and insulin resistance, referring to decreased sensitivity to the effects of insulin—a key hormone that regulates blood sugar. Indeed, T2D can be delayed or prevented among at risk adults through intensive lifestyle modification aimed to reduce body fat and improve insulin resistance (4). However, long-term weight-loss maintenance remains a challenge, particularly in adolescence (5). Illuminating inter-individual heterogeneity in the eating patterns that promote excess body fat, insulin resistance, and ultimately, T2D, may be crucial to informing targeted preventive and treatment efforts.

In particular, binge eating is prevalent among individuals with T2D. Estimates of full-syndrome binge eating disorder in adults with T2D range from 10–33%, which is greater than what is observed in overweight individuals without T2D, as well as in the general population (6–9). As with adults, binge eating and related disinhibited eating behaviors and attitudes are more prevalent in adolescents with T2D as compared to those without T2D (10). The Treatment Options for T2D in Adolescents and Youth (TODAY) Study Group (11) found that within a sample of nearly 700 adolescents with T2D, subclinical binge eating (20%) and binge eating disorder (6%) were associated with significantly higher levels of obesity, disordered eating symptoms, and depressive symptoms, as well as reduced quality of life. In samples of children and adolescents without T2D, presence of binge eating episodes predicts excessive weight gain and overweight/obesity onset (12–15), in addition to the exacerbation of metabolic problems that promote T2D risk (16).

The concept of mindfulness may be especially useful for understanding susceptibility to disinhibited eating behaviors, particularly among individuals at risk for T2D. Mindfulness,

as described by Kabat-Zinn (17), is the process of bringing a nonjudgmental attention to one's moment-by-moment experience without immediately attempting to change it. Mindfulness has been conceptualized as a dispositional trait, meaning that it varies among individuals, but also can be enhanced with training (18). Mindfulness may protect individuals from engaging in disinhibited eating through increased self-awareness, acceptance, and lessened emotional reactivity. Indeed, individuals are more likely to engage in disinhibited actions, including binge eating, when experiencing distress (19, 20).

Empirical findings in adults provide support for these relationships. Dispositional mindfulness was related to less emotional and external eating in a recent study of adults with T2D (21). In college students, dispositional mindfulness is associated with fewer symptoms of binge eating (22) and bulimia nervosa (23), less global disordered eating pathology and greater body satisfaction (24, 25), and less frequent emotional and external eating (26). In community samples of adults, mindfulness has been inversely associated with uncontrolled/loss of control eating, emotional eating, and caloric intake (27, 28). These findings highlight the potentially salient role of mindfulness in binge eating and associated eating attitudes and behaviors in adults, including adults who have developed T2D (21). Yet, the relationship between mindfulness and eating behaviors or attitudes in adolescents has, to our knowledge, not been described.

The purpose of the current investigation was, therefore, to examine the relationship of mindfulness to binge eating and associated eating attitudes and behaviors among adolescents at risk for T2D. Understanding the relationship between mindfulness and eating behaviors and attitudes in this particular group is highly relevant for a number of reasons. Binge eating and related disinhibited eating features are prevalent in populations at-risk for, as well as with, T2D, and have the potential to promote weight gain and metabolic problems (6–9, 11–16). Elucidating the role of mindfulness in such eating patterns among adolescents at risk for T2D is paramount, because dietary patterns play a role in furthering or mitigating T2D risk (e.g., 29). Further, mindfulness interventions improve psychological functioning in adults with T2D (30). Determining to what extent mindfulness is related to eating features that affect cardio-metabolic risk in at-risk adolescents is an important, initial step in determining if mindfulness interventions would be a potentially valuable preventative strategy for this high-risk group.

In addition to binge eating, we examined how mindfulness was associated with two potentially related phenomena: i) eating in the absence of hunger (EAH), referring to eating palatable foods in the absence of physiological hunger, and ii) relative reinforcing value of food (RRV), the degree to which individuals find food reinforcing and are willing to work for preferred, palatable snack foods relative to other rewards. Both EAH (31) and food reinforcement (32) have been positively associated with binge eating in adolescents or adults. We hypothesized that adolescents reporting binge eating episodes would exhibit poorer dispositional mindfulness than those without binge eating, and we further predicted that mindfulness would be inversely related to disordered eating attitudes, EAH, and food reinforcement. We also hypothesized that these relationships would be observed even after accounting for inter-individual differences in depressive symptoms and body fat.

METHODS

Participants

The study sample included adolescent (12–17 years) girls participating in a T2D prevention trial ([ClinicalTrials.gov: NCT01425905](https://clinicaltrials.gov/ct2/show/study/NCT01425905)). The current investigation utilized baseline data only, prior to girls' participation in the intervention phase. All adolescents were at risk for T2D, as determined by being overweight or obese (BMI ≥ 85th percentile for age) and having a positive family history of T2D, pre-diabetes, or gestational diabetes in at least one first- or second-degree relative. Other criteria for study inclusion were elevated symptoms of depression as indicated by the 20-item Center for Epidemiologic Studies-Depression Scale (CES-D) (33) total score of ≥ 16; good general health; and English speaking. Exclusion criteria included current psychiatric symptoms that required treatment (e.g., current major depressive disorder); a major medical problem such as T2D (fasting glucose level > 126 mg/dL or 2-hour glucose after an oral glucose administration > 200 mg/dL); medication use such as anti-depressants or stimulants that could affect insulin resistance, body weight, or mood; current involvement in a structured weight loss or psychotherapy treatment program; and pregnancy. Participants were recruited through the NIH clinical trials website, local area community postings, letters and flyers to physician offices, and direct mailings to homes within a 60-mile radius of Bethesda, Maryland. The Institutional Review Board of the Eunice Kennedy Shriver NICHD approved all procedures. Written consent and assent were provided by parents and adolescent participants, respectively.

Procedure and Assessment

Participants were seen at the NIH Mark O. Hatfield Clinical Center (Bethesda, MD) following an overnight fast. All youth underwent a medical history and a physical examination conducted by either an endocrinologist or nurse practitioner. Weight was measured in kilograms using a calibrated scale, and height was measured in centimeters in triplicate by stadiometer. BMI (kg/m^2) was computed by dividing weight (kg) by the square of height (m), and BMI-z scores were derived from the Centers for Disease Control and Prevention 2000 growth charts. Total percent body fat (fat mass/total body mass*100) and total lean mass (kg) were derived from dual-energy x-ray absorptiometry (iDXA, GE Healthcare, Madison, WI).

Participants completed the reliable and well-validated 15-item *Mindful Attention and Awareness Scale* (34) to measure dispositional mindfulness. Participants responded to items such as, “I find myself doing things without paying attention” and “I find myself preoccupied with the future or the past” on a Likert scale ranging from 1 (almost always) to 6 (almost never). A total score was calculated as the mean of all items; higher scores are indicative of greater (more positive) dispositional mindfulness. Internal reliability for the current sample was good ($\alpha = .86$).

To assess objective binge eating in the past month, the Overeating Section of the *Eating Disorder Examination (EDE)* version 12.0D (35) was administered to each participant by a trained interviewer. Consistent with prior studies (e.g., 12–14, 15), we evaluated binge eating as a categorical variable (absence or presence). The *Eating Disorder Examination*

Questionnaire (EDE-Q) (36), a 36-item self-report measure derived from the EDE interview, was also administered. The EDE-Q includes a global disordered eating attitudes total score (in the current sample, $\alpha = .91$), as well as four specific subscales including dietary restraint ($\alpha = .75$), eating concern ($\alpha = .62$), shape concern ($\alpha = .88$), and weight concern ($\alpha = .73$). In the current study, we utilized the total score and all four subscales; all scales were treated as continuous variables. In previous child and adolescent samples, the EDE and EDE-Q have both demonstrated strong inter-rater reliability and discriminant validity for eating episodes and attitudes/concerns, respectively (37, 38).

Participants responded to the 14-item Eating in the Absence of Hunger Questionnaire for Children and Adolescents (31) intended to assess the frequency of EAH in the past week in youth aged 6–19 years. The three factor-analytically derived, internally reliable subscales (31) were calculated as the sums of items for each respective scale: EAH in response to negative affect (in the current sample, $\alpha = .88$), EAH in response to external cues ($\alpha = .80$), and EAH in response to fatigue/boredom ($\alpha = .75$).

The *Relative Reinforcing Value (RRV) of Food Task* was administered to determine the reinforcing value of each participant's preferred palatable snack food relative to three alternate rewards (39). In this task, the participant is asked a series of hypothetical questions about whether she would prefer to work for a preferred snack food item or three alternate non-snack food rewards including money, fruit, or physical activity. At the outset of the task, participants were queried regarding their preferences, and it is clarified that no actual rewards (food or non-food) will be given. The hypothetical “work” required to obtain one of the two reinforcers consists of clicking a handheld tally counter a prescribed number of times. The first question begins with an equal amount of work required to obtain either reinforcer (i.e., 20 presses). With each subsequent item, the work to obtain the food reinforcer increases on a fixed ratio progressive schedule of reinforcement while the work required to obtain the non-snack food reward is held constant. The outcome is the switch point—the point at which the participant switches from choosing the preferred snack food to choosing the alternate reinforcer on two consecutive occasions. This measure has demonstrated convergent validity with computer-generated paradigms assessing RRV of food (40).

Data Analytic Plan

All analyses were performed with SPSS 22.0 (IBM Corp, 2013). Descriptive statistics were generated for all study variables. All variables approximated a normal distribution. Binary logistic regression was used to evaluate the association of mindfulness (independent variable) with binge eating status (presence v. absence; dependent variable), after controlling for race, percentage body fat, lean mass (kg), height (cm), age (years), and depressive symptoms. A series of general linear models were then employed to evaluate the associations of mindfulness (independent variable) with disordered eating attitudes, EAH, and food reinforcement (dependent variables), including the same covariates in each model. In order to determine which eating constructs had a unique, cross-sectional association with mindfulness, we evaluated a final parsimonious model in which mindfulness (dependent

variable) was predicted from any eating behavior/attitude variables that were significant (at the $p < .05$ level) in the separate models, retaining all pre-specified covariates.

RESULTS

Descriptive information

One hundred fourteen adolescent girls (age $M \pm SD$ 14.5 $\pm$ 1.61 years) participated (Table 1). Mean weight was 87.6 kg ($SD = 19.2$), ranging from 56.0 to 133.4 kg. Mean BMI percentile was 95.6 ($SD = 3.7$) and ranged from 85 to 99. Nearly two thirds of the sample (60.5%) identified as non-Hispanic Black, 17.5% as non-Hispanic White, 11.5% as Hispanic, and 10.5% as other (including multiple races and Asian/Pacific Islander).

Thirteen percent ($n = 15$) of participants reported at least one episode of binge eating in the past month. Of those who reported binge eating, the majority ($n = 8$) reported 1 episode in the past month, 5 reported 2 episodes in the past month, and 2 participants reported 4 or more episodes in the past month. One participant met DSM-5 criteria for binge eating disorder.

Mindfulness-eating behavior univariate models

After accounting for race, percent body fat, lean mass, height, age, and depressive symptoms, mindfulness was associated with a significantly lower odds of having binge eating ($OR = .239, p = .002$). Accounting for the abovementioned covariates, mindfulness also was inversely associated with eating concern ($B = -.29, SE = .13, p = .032$). However, mindfulness was not significantly related to shape concern ($p = .96$), weight concern ($p = .59$), restraint ($p = .36$), or global score ($p = .59$). Adolescents' mindfulness was inversely associated with perceived EAH in response to fatigue/boredom ($B = -.22, SE = .10, p = .04$). Yet, the relationships of mindfulness to either perceived EAH in response to negative affect or external cues did not reach significance (all $p > .06$). In addition, mindfulness was inversely associated with RRV of favorite snack food, when compared to preferred physical activity, after adjusting for all covariates ($B = -11.67, SE = 4.99, p = .021$). Girls who were willing to do more hypothetical work to earn a preferred snack food had lower dispositional mindfulness scores. The relationships of mindfulness to either RRV of favorite snack food relative to money, or RRV of favorite snack food relative to fruit, were not significant (all $p > .75$). For scatterplot figures depicting the relationships of dispositional mindfulness to eating behaviors and attitudes, please refer to the eSupplement.

Parsimonious multivariate model

A final, parsimonious, multivariate model was used to evaluate the associations of dispositional mindfulness with binge eating, eating concern, perceived EAH in response to fatigue/boredom, and RRV of snack food compared to physical activity—the eating behaviors and attitudes significant ($p < .05$) in the separate, univariate models—and including the pre-specified covariates of age, race, percent body fat, lean mass, height, and depressive symptoms. The results of this model are displayed in Table 2. Binge eating ($p = .01$) and RRV of snack food compared to physical activity ($p = .026$) remained significantly,

uniquely, related to mindfulness, whereas eating concern and perceived EAH in response to fatigue/boredom were no longer significant (all $p > .41$).

DISCUSSION

In this study, we investigated the relationship of dispositional mindfulness to reports of objective binge eating episodes and additional disinhibited eating attitudes and behaviors in adolescent girls at heightened risk for type 2 diabetes (T2D). Girls who reported recent binge eating (in the past month) had lower mindfulness scores than those who did not report binge eating. These data are consistent with prior studies relating mindfulness to disordered eating attitudes and behaviors among college students and adult samples (22, 23, 26–28).

Heatherton and Baumeister (20) proposed that binge eating is an escape from self-awareness; more specifically, that highly critical and aversive patterns of heightened self-awareness bring about emotional distress from which an individual feels driven to escape. Central to this notion is the understanding that some individuals attempt to self-regulate their mood through binge eating patterns and emotional eating. While escape theory was originally described for adults, recent work suggests that community samples of youth with loss of control eating patterns, including binge eating, report the use of more maladaptive emotion regulation skills and a greater desire to eat in response to the experience of negative emotions (41, 42). Since mindfulness encapsulates nonjudgmental, acute awareness of one's moment-by-moment emotional experience without the need to immediately change that experience, it follows that individuals who engage in binge eating would be expected to exhibit lower dispositional mindfulness. The cross-sectional nature of these data precludes a determination of the directionality of the poorer mindfulness-binge eating association; poor mindfulness could promote binge eating, but it is also possible that binge eating worsens present-moment awareness. Experimental studies manipulating dispositional mindfulness or negative affective states might shed light on potential causal relationships.

In the present study, we also found that adolescent girls' eating concern, but not shape concern, weight concern, or dietary restraint, was inversely related to mindfulness. Girls with poorer dispositional mindfulness endorsed greater eating concern, which includes an individual's fear of losing control over eating, as well as related features such as preoccupation with food and calories, eating in secret, guilt about eating, and concerns with eating in front of others (35). In a more parsimonious model, we found that binge eating—as opposed to eating concern—remained uniquely related to mindfulness.

Similarly, mindfulness was associated with adolescents' perceived EAH in response to fatigue/boredom—a frequently endorsed trigger for disinhibited eating in youth (31)—such that youth with poorer mindfulness reported more frequent EAH. However, this effect was no longer significant after accounting for other eating variables. To our knowledge, this is the first study to report the relationship of mindfulness to EAH. In theory, an association between poor dispositional mindfulness and EAH might be explained by shared deficits in body awareness, as both of these phenomena are inherently linked to the degree of awareness of physical and bodily sensations.

Adjusting for possible confounds as well as binge eating, eating concern, and EAH, mindfulness was related to the degree to which adolescents found food reinforcing, specifically the extent to which they were willing to work for palatable, preferred snack foods relative to physical activity. Said differently, the more adolescents were dispositionally mindless (versus mindful), the more they found food highly reinforcing. Preliminary evidence suggests that food reinforcement is heightened under certain psychological states, namely depression and stress, and following caloric deprivation (39). One possibility is that mindfulness impacts the reinforcing value of food via emotional acceptance and lessened reactivity and, in turn, preventing caloric deprivation through greater awareness of bodily sensations such as hunger. Conversely, individuals who find food highly reinforcing—accompanied by the tendency to act impulsively and pursue immediate reward—may be more likely to develop state and/or trait-like deficits in present moment awareness (39). These hypotheses warrant explicit testing. It is noteworthy that both binge eating and food reinforcement were uniquely related to dispositional mindfulness—and showed no significant association with each other in this sample—suggesting that both of these factors may be independently important in relation to mindfulness.

Taken together, findings from the current study revealed a number of important relationships between dispositional mindfulness and disinhibited eating patterns and associated attitudes in adolescent girls at risk for T2D. The associations of mindfulness with binge eating and RRV of food are particularly salient given the prevalence of binge eating in a significant subset of individuals at risk for T2D and the role that disinhibited eating may play in promoting excessive energy intake, adiposity, and risk for T2D. Mindfulness-based interventions in adults may produce decreases in disordered eating (43). Findings from the current study suggest that it may be valuable to test to what extent the delivery of mindfulness training has the potential to alter adolescents' eating attitudes and behaviors that promote excessive weight gain and T2D.

Few investigations, to date, have examined the role of mindfulness in relationship to adolescent eating behavior. Strengths of the current study include the utilization of an interview-based measure of binge eating and a structured task assessing food reinforcement; the inclusion of objective measurements of body composition using DXA; and the examination of mindfulness and eating in a racially/ethnically diverse sample at disproportionate risk for obesity and T2D. Because the current data were cross-sectional and correlational, the direction of any relations between adolescents' mindfulness and eating cannot be established. Further, we acknowledge the small to modest size of the observed effects between mindfulness and eating, which underscores that additional factors contribute to adolescent eating behaviors. Prospective examinations of the relationship of mindfulness to adolescent eating behavior are required. Also, a single self-report measure of mindfulness was utilized in the present study and may not represent the entire dynamic, multidimensional construct of dispositional mindfulness. The present findings also are limited in generalizability, given the specific characteristics of the sample—adolescent girls selected to be at risk for T2D with some degree of depressive symptomatology. It is unknown to what extent the findings would generalize to other populations, such as all adolescents with disinhibited eating.

In conclusion, mindfulness, a nonjudgmental attention to one's moment-by-moment experience, was related to a range of disinhibited eating behaviors and attitudes among adolescent girls at heightened risk for T2D. In particular, deficits in mindfulness were uniquely and robustly tied to the presence of objective binge eating and higher food reinforcement. Future research is needed to determine the extent to which mindfulness may play a role in the etiology and/or maintenance of disinhibited eating and related weight problems in youth at risk for T2D.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Funding: Supported by K99/R00HD069516 (PI: Shomaker) from NICHD, NIH Intramural Research Program Grant 1ZIAHD000641 (PI: Yanovski) from NICHD with supplemental funding from the NIH Bench to Bedside Program (PIs: Yanovski, Tanofsky-Kraff, Shomaker), the Office of Disease Prevention, NIH (PI: Yanovski), and the Office of Behavioral and Social Sciences Research (PI: Yanovski). C. K. Pickworth's effort on this project was supported by the NIH Office of Intramural Training and Education.

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Table 1

Descriptive Information for Key Variables

Variable	M ± SD
Age (y)	14.5 ± 1.6
Body fat (%)	41.8 ± 5.8
Mindfulness	3.9 ± .9
Depressive symptoms	24.4 ± 8.7
Restraint	1.3 ± 1.2
Eating concern	1.3±1.0
Shape concern	2.8±1.5
Weight concern	2.7±1.4
Global disordered eating	2.1±1.1
Eating in the absence of hunger - negative affect	2.1±.9
Eating in the absence of hunger - external cues	3.0±.9
Eating in the absence of hunger - fatigue/boredom	2.2±.9
Relative reinforcing value - snack v. physical activity	17.9±38.8
Relative reinforcing value - snack v. money	52.7±68.5
Relative reinforcing value - snack v. fruit	39.6±47.3
	% (n)
Race (non-Hispanic black)	60.5 (69)
Binge eating (presence)	13 (15)

Table 2

General Linear Model Evaluating the Cross-sectional Associations between Eating Behaviors and Attitudes and Dispositional Mindfulness in Adolescent Girls at Risk for Type 2 Diabetes (T2D)

Predictor	Mindfulness		
	<i>B (SE)</i>	95% CI	<i>p</i> Value
Age (y)	.10 (.05)	.01 – .20	.04
Race (non-Hispanic black)	.18 (.15)	–.12 – .47	.24
Body fat (%)	.03 (.01)	.01 – .06	.02
Lean mass (kg)	<.001 (.01)	–.03 – .03	.99
Height (cm)	–.04 (.01)	–.06 – –.01	.01
Depressive symptoms	–.04 (.01)	–.06 – –.02	<.01
Binge eating (presence)	–.57 (.22)	–.13 – –1.01	.01
Eating concern	–.07 (.08)	–.23 – .10	.42
EAH $\pm$ fatigue/boredom	–.07 (.11)	–.28 – .14	.48
RRV $\pm$ snack v. physical activity	–.004 (.002)	–.01 – .00	.03

Race was coded 0=Other, 1=non-Hispanic Black. Binge eating was coded 0=absence, 1=presence. EAH=eating in the absence of hunger. RRV=relative reinforcing value.