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Characterizing rates of physical activity in individuals with binge eating disorder using wearable sensor technologies and clinical interviews

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Abstract

Objective: Research suggests physical activity (PA) improves behavioural, psychological and behavioural symptoms in individuals with binge eating disorder (BED), yet self-reported PA is notably low. Little remains known about objective rates of PA and subclinical levels of maladaptive PA (i.e., compensatory or driven PA), and few studies have attempted to understand the role that dissatisfaction and overvaluation with shape and weight plays in promoting PA in individuals with BED. We sought to characterize PA and investigate whether elevated rates of shape and weight concerns contribute to rates of PA in individuals with BED.

Method: Individuals meeting DSM-5 diagnosis of BED (N = 56) completed the Eating Disorder Examination and wore a Fitbit Flex 2 for 1 week.

Results: On average, participants recorded 7621.12 (SD = 3034.20) daily steps and 194.30 (SD = 161.45) weekly moderate-to-vigorous PA minutes. About 21% of participants reported subclinical levels of maladaptive PA. Greater shape and weight overvaluation predicted lower duration of compensatory PA.

Conclusion: A small percentage of individuals with BED are engaging in subclinical levels of maladaptive PA, and there is a need to identify factors that influence rates of PA in individuals with BED.

Keywords

binge eating disorder; physical activity; shape and weigh overvaluation

1 | INTRODUCTION

Binge eating disorder (BED) is characterized by repeated episodes of loss of control over eating with the absence of recurrent use of compensatory behaviours (American Psychiatric

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CONFLICTS OF INTEREST

All authors declare that they have no conflict of interest.

Association, 2013). Individuals with BED are more likely to have overweight and obesity compared to individuals without BED and accordingly are at increased risk of numerous health concerns associated with obesity (Kessler et al., 2013; Udo & Grilo, 2018, 2019, 2020). Increasing rates of physical activity (PA) is a common recommendation for mitigating the health consequences associated with obesity in individuals with (Vancampfort et al., 2014c) and without BED (Jakicic & Otto, 2005). PA interventions in individuals with BED have demonstrated promise of increasing PA for improving the physical health consequences associated with obesity (Blanchet et al., 2018) and additional BED symptoms such as binge eating frequency (Blanchet et al., 2018; Pendleton, Goodrick, Poston, Reeves, & Foreyt, 2002; Vancampfort, Probst, et al., 2014), body satisfaction (Vancampfort et al., 2014b), and mood and anxiety (Blanchet et al., 2018; Fossati et al., 2004). These results suggest there is considerable benefit to increasing PA in individuals with BED.

Despite the many known benefits of PA for individuals with BED, it is notoriously difficult to increase rates of PA, even when compared with individuals with obesity without BED (Vancampfort et al., 2015). One challenge is that most studies have found that baseline rates of self-reported PA in BED are low, even when compared with obese populations generally (Udo & Grilo, 2020; Vancampfort et al., 2014a). Furthermore, interventions designed to increase PA in individuals with BED have led to only marginal increases in PA (Fossati et al., 2004; McIver, O'Halloran, & McGartland, 2009; Pendleton et al., 2002) and the degree to which small increases in activity are maintained long term remains unknown (Blanchet et al., 2018).

One way to improve PA interventions for individuals with BED is to understand the function of PA for individuals with BED. A systematic review conducted in 2014 found that negative body attitude was associated with low rates of PA, and expectations from societal roles (e.g., marriage), and access to convenient facilities were contributing factors to low PA participation (Vancampfort et al., 2014c). Since this review, studies have found that factors such as poor physical health (Carr, Lydecker, White, & Grilo, 2019) and low perceived physical competence (Vancampfort et al., 2014a) are associated with lower rates of PA in individuals with BED.

Although the factors described above can begin to provide direction for intervention development that can target the unique barriers to PA experienced by individuals with BED, we identified three key limitations in the existing literature. First, all but one existing study of PA in individuals with BED have relied entirely on self-report measures of PA, which are known to be highly inaccurate (Prince et al., 2008). To better characterize rates of PA in BED, studies using objective measures of PA are necessary (e.g., wearable sensors).

Second, there has been insufficient attention paid to the role that elevated shape and weight concerns play in motivating PA for individuals with BED and whether this contributes to maladaptive exercise behaviours. A large body of literature suggests that individuals with BED are more likely to experience shape and weight concerns (Hrabosky, Masheb, White, & Grilo, 2007) than individuals with obesity without BED. Given that one of the most commonly stated reasons for exercising in individuals without BED is to control weight (Furnham, Badmin, & Sneade, 2002), it is reasonable to suspect that elevated rates of shape

and weight concerns could play a predictive role in rates of PA in individuals with BED. However, to date, only two studies have tested this. One found that overvaluation and dissatisfaction with shape and weight are not related rates of PA in individuals with BED (Carr et al., 2019) and one found that overvaluation and dissatisfaction with shape and weight are related to rates of noncompensatory PA and are not related to rates of compensatory PA in a mixed BED and bulimia nervosa (BN) sample (Kerrigan, Lydecker, & Grilo, 2019).

If rates of PA in individuals with BED are strongly driven by dissatisfaction and overvaluation of weight and shape, it is also possible that at least some portion of PA is maladaptive. To date, only one study has tested the degree to which individuals with BED engage in maladaptive PA, however, maladaptive PA was assessed in a combined sample of individuals with BED and BN (Kerrigan et al., 2019). To date, no study has tested the degree to which a strictly BED sample engage in subthreshold compensatory (e.g., any form of PA used to compensate for a binge episode [Holland, Brown, & Keel, 2014]) or driven PA (e.g., PA, i.e., compulsive and has a sense of feeling out of control [Stiles-Shields, Goldschmidt, Boepple, Glunz, & Le Grange, 2011]), which could influence the rates of PA for some individuals with BED. Likely this is because, by definition, individuals with BED cannot *regularly* engage in driven or compensatory exercise and meet diagnostic criteria for BED. However, even if these behaviours are not frequent, individuals with BED might *episodically* engage in driven or compensatory exercise. If rates of PA in BED are largely due to driven or compensatory exercise, even at subclinical levels, this would suggest a need to approach PA interventions differently in a population with BED to ensure that any increases in PA are not maladaptive. Gaining a better understanding of how factors such as shape and weight concerns influence both (1) maladaptive exercise and (2) overall rates of PA are essential in understanding the motivating factors underlying PA engagement in individuals with BED.

The current study aimed to address the limitations described above by (1) characterizing total objective PA levels in individuals with BED over 1 week using average daily step count and moderate-to-vigorous physical activity (MVPA) minutes collected via a wearable fitness tracker, (2) characterizing rates of driven and compensatory PA in individuals with BED as assessed by the Eating Disorder Examination (EDE) and (3) testing the hypothesis that dissatisfaction and overvaluation with shape and weight will predict higher rates of both total PA and driven and compensatory PA.

2 | METHODS

2.1 | Participants

Participants were 56 individuals recruited as part of a clinical trial comparing the efficacy of two behavioural weight-loss interventions in individuals with BED. Participants were only included in the study if they met a DSM-5 diagnosis of BED, were 18–75 years old, had a BMI between 27 and 55 (kg/m^2), and were able to engage in at least 15 min of PA per occasion. While 69 individuals with BED have enrolled in the clinical trial to date, 11 individuals were excluded from the current study because they had more than 3 days of missing or invalid objective PA data over the 7 days, and 2 individuals were excluded because they did not meet full threshold DSM-5 diagnosis of BED. It is important to note

that 10 out of the 11 participants that were excluded for having missing or invalid objective PA data did not have a single day of valid data and 1 participant had only 1 valid day of data. Of the 56 participants included, 11 (19.6%) were male, and 45 (80.4%) were female. The average age was 50.71 (SD = 12.69), and the average BMI was 36.12 (SD = 5.52). The sample was 1.79% Asian (n = 1), 25.00% African American (n = 14), 73.21% Caucasian (n = 41) and 5.36% of the total sample identified as Hispanic (n = 3).

Written informed consent was obtained from all participants. The study protocol and procedures were approved by Drexel University's Institutional Review Board.

2.2 | Procedures

Participants were recruited from the community using a variety of advertising media (i.e., newspaper, radio, television and online postings). Phone screens were conducted to preliminarily assess for BED. Participants who met the eligibility criteria attended an in-person assessment where they completed a semi-structured clinical interview with trained personnel to diagnose eating pathology and assess driven and compensatory exercise. At the first treatment session, participants were provided with a Fitbit Flex 2 to wear for 1 week and return at the following treatment session. As part of the treatment, all participants were asked to engage in 15-min of PA three times a week at the first treatment session.

2.3 | Measures

2.3.1 | Eating Disorder Examination—Rates of driven and compensatory exercise and shape and weight concerns were measured using the EDE (Cooper & Fairburn, 1987; Grilo, Masheb, Lozano-Blanco, & Barry, 2004), a semi-structured interview that assesses the presence of an eating disorder and severity of symptoms. Compensatory exercise was assessed using an added item by our team, 'When you exercised over the past month, were any times in reaction to or in an effort to compensate for (refer to objective and subjective binge episodes)?'. Any exercise that was directly tied to compensating for a binge episode was coded as compensatory, even if it was not extreme in nature. Presence of driven exercise was assessed, and participants were asked to report the frequency in days of exercise that was both driven and compensatory, only driven and only compensatory separately. Exercise that was both driven and compensatory exercise was measured based on frequency in days and average number of minutes per episode over the 12 weeks prior to beginning the study.

Per DSM-5 diagnostic criteria, individuals who engaged in 12 or more combined episodes of compensatory laxative use, diuretic use, driven PA or other extreme weight control behaviours (e.g., chewing and spitting, diet pills, stimulant abuse and excessive fasting) in the past 12 weeks were excluded from the study as they did not meet criteria for BED. Individuals with less than once weekly engagement in driven PA (i.e., 11 episodes or less in the past three months) were eligible for the parent study. Individuals who reported compensatory PA that was not excessive or driven in nature (e.g., walking for a half-hour after a binge episode) were also included in the parent study.

Dissatisfaction and overvaluation with weight and shape were measured using the dissatisfaction and the overvaluation of weight and shape items. This scoring structure was

used because previous research suggests that this structure is a better fit for individuals with BED (Grilo et al., 2010; Machado, Grilo, & Crosby, 2018).

2.3.2 | Fitbit Flex 2—The Fitbit Flex 2 is a waterproof wrist-worn activity sensor that uses an accelerometer sensor to measure PA, including daily step count and MVPA. The Fitbit Flex 2 is an accurate and reliable measure of step count (Bender, Hoffstot, Combs, Hooshangi, & Cappos, 2017) and measuring MVPA (Alharbi, Bauman, Neubeck, & Gallagher, 2016).

2.4 | Analytic strategy

Missing Fitbit data (n = 18 participants) were imputed by carrying forward all Fitbit data from the other 4–6 days of complete Fitbit data. Parallel analyses were done using individuals without imputed data to ensure that those with imputed data did not have a significant impact on results. Parallel analyses results did not differ.

The Fitbit Flex 2 used metabolic equivalents (METs) to calculate PA minutes (Alharbi et al., 2016). In accordance with previous research, MVPA was considered minutes of PA >3 METs (Alharbi et al., 2016). Pearson correlations were performed to assess if overvaluation and dissatisfaction with shape and weight predict higher rates of total PA and driven and compensatory PA.

3 | RESULTS

3.1 | Total objectively measured PA

Sample characteristics are presented in Table 1. On average, participantsrecorded7621.12 (SD = 3034.20) daily steps and 194.30 (SD = 161.45) weekly MVPA minutes.

3.2 | Driven and compensatory PA

About 10 individuals (17.86% of the sample) reported engaging in compensatory exercise on an average of 22.20 days (SD = 11.34) for 52.50 min (SD = 47.21) over the previous 12 weeks 2 individuals (3.57% of the sample) reported engaging in driven exercise on an average of 8.00 days (SD = 1.41) for 120.00 min (SD = 0.00) over the last 12 weeks.

3.3 | Shape and weight concerns

Pearson correlations representing the relationships between rates of PA and dissatisfaction and overvaluation with shape and weight are presented in Table 2. Greater overvaluation of shape and weight predicted lower average duration of compensatory exercise.

4 | DISCUSSION

The current study sought to characterize total objective PA as well as driven and compensatory PA in individuals with BED and test whether dissatisfaction and overvaluation with shape and weight predicted higher rates of total PA and driven and compensatory PA. Our findings suggest that rates of PA in individuals with BED may be higher than previously reported rates from studies that relied on self-report PA measures. Based on current PA

recommendations, from the Center for Disease Control and Prevention and the American College of Sports Medicine (minimum of 150–300 min of MVPA per week [Piercy et al., 2018]), only 50% of individuals were insufficiently active. This finding is comparable to the only other study that has objectively measured rates of PA in individuals with BED (Mathisen et al., 2018). Contrarily, prior studies that used self-report measures found that 64% of individuals with obesity with BED were insufficiently active (Carr et al., 2019). Our results suggest that individuals with BED might under-report rates of PA through self-report measures.

While PA was greater than expected, nearly 17% of the sample engaged in compensatory PA and 3% engaged in driven PA. Although most of the maladaptive PA in this sample was very mild (e.g., going for a light walk following a binge episode), we do not know to what degree this type of maladaptive PA was problematic. This highlights the need to understand when maladaptive PA becomes problematic, and if maladaptive PA is always problematic in individuals with BED. To our knowledge, this is the first study to characterize the percent of total PA in individuals with BED that may be driven by maladaptive forms of PA as prior studies have not taken into consideration that individuals with BED might engage in episodic driven or compensatory PA, while still meeting BED diagnostic criteria.

Contrary to our hypotheses, dissatisfaction with shape and weight did not predict greater rates of total or maladaptive PA. This finding might be due to sample specific characteristics. For example, it was a weight loss seeking sample. Additionally, the sample was predominantly female and middle to older age, (a population that often places less importance on physical appearance, becomes more accepting of various body types as they age, and faces physical and biological changes that affect their bodies as they age [Peat, Peyerl, & Muehlenkamp, 2008]), we may have seen less of an impact on dissatisfaction and overvaluation with weight and shape on PA than we would in a younger or more diverse population with BED. However, greater overvaluation of shape and weight did predict lower average duration of compensatory exercise. This finding does not support previous work supporting that overvaluation of shape and weight is not related to compensatory exercise in a mixed sample of individuals with BED and BN (Kerrigan et al., 2019). These findings demonstrate the need to further explore the relationship between overvaluation of shape and weight and compensatory PA in a strictly BED sample. Lastly, we need to identify other factors that influence rates of PA in individuals with BED, so PA interventions can target these factors when reducing maladaptive PA and increasing total PA.

There were a number of limitations in the study design including low sample size, PA data were collected over a short period, participants were asked to engage in moderate PA (e.g., brisk walking) three times a week for 15 min while wearing the Fitbit, there was no control group, and data was imputed. Additionally, PA was measured objectively and via a self-report interview, and during different time periods, making it challenging to interpret the relationship between rates of driven, compensatory and objective PA. To increase confidence in these findings, a replication of the current study across a larger sample, over a more extended period, and measuring all PA objectively is granted. Additionally, more factors that predict PA in individuals with BED must be identified to better understand how to appropriately tailor PA interventions for individuals overweight or with obesity with BED.

Lastly, continuing the use of PA sensor technology, coupled with ecological momentary assessment, may allow for a better understanding of real-time factors that predict engagement in PA.

Despite the study's limitations, the current study is the first study to characterize both total objective and maladaptive rates of PA in individuals with BED. Objective rates of PA in BED are higher than previous studies have found, suggesting that more studies need to measure exercise objectively in a BED sample. Furthermore, given that some individuals with BED are engaging in maladaptive PA, future PA interventions for individuals with BED might benefit from evaluating maladaptive PA prior to the intervention and incorporating techniques that reduce maladaptive PA while promoting greater rates of adaptive PA. Developing such a PA intervention is an area worth further exploring.

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Abbreviations:

ACSM	American College of Sports Medicine
BED	binge eating disorder
BN	bulimia nervosa
CDC	Center for Disease Control and Prevention
EDE	Eating Disorder Examination
METs	metabolic equivalents
MVPA	moderate-to-vigorous physical activity
PA	physical activity

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Highlights

- Objectively measured rates of PA in individuals with BED were greater compared with previous self-reported rates of PA in individuals with BED
- A small percentage of individuals with BED engaged in subclinical levels of maladaptive forms of PA
- Greater shape and weight overvaluation predicted lower average duration of compensatory PA. Dissatisfaction with shape and weight did not predict rates of PA

TABLE 1

Sample characteristics

	Mean	(SD)	Range
Baseline characteristics			
Age	50.71	12.13	29.00–71.00
BMI	36.11	5.52	27.18–46.71
Dissatisfaction and overvaluation of shape and weight			
Dissatisfaction with weight	4.43	1.33	0.00–6.0
Dissatisfaction with shape	4.86	1.00	2.00–6.00
Overvaluation with weight	3.92	1.66	0.00–6.0
Overvaluation with shape	4.16	1.65	0.00–6.0
Rates of objectively measured PA			
Mean daily steps	7621.12	3034.20	2064.14–15017.14
Weekly MVPA minutes	194.30	161.45	0–750.00
Maladaptive PA characteristics in only individuals that reported maladaptive PA			
Compensatory exercise days	22.20	11.34	8.00–36.00
Compensatory exercise duration (minutes)	52.50	47.21	5.00–180.00
Driven exercise days	8.00	1.41	7.00–9.00
Driven exercise duration (minutes)	120.00	0.00	0.00–120.00

Abbreviations: MVPA, moderate-to-vigorous PA; PA, physical activity.

TABLE 2

Correlations of objectively measured PA, maladaptive PA and shape and weight concerns

	EDE diss. with weight	EDE diss. with shape	EDE overval. with weight	EDE overval. with shape	Days of compensatory exercise	Compensatory exercise duration	Days driven exercise	Driven exercise duration	Daily steps
EDE diss. with weight	-	-	-	-	-	-		-	-
EDE diss. with shape	0.40**	-	-	-	-	-	-	-	-
EDE overvaluation with weight	0.11	0.19	-	-	-	-	-	-	-
EDE overvaluation with shape	0.04	0.33*	0.78**	-	-	-	-	-	-
Days of compensatory exercise	−0.12	−0.02	−0.25	−0.23	-	-	-	-	-
Compensatory exercise duration	0.03	0.12	−0.35*	−0.35*	0.74**	-	-	-	-
Days of driven exercise	−0.00	0.11	0.05	−0.12	0.31*	0.63*	-	-	-
Driven exercise duration	0.01	0.13	0.01	−0.14	0.27*	0.55**	0.99**	-	-
Daily steps	−0.08	−0.10	0.01	−0.10	0.22	0.29	0.29*	0.27*	-
Weekly MVPA minutes	−0.07	−0.09	0.01	−0.01	0.15	0.31[a]	0.30*	0.28*	0.82**

Abbreviations: Diss., dissatisfaction; EDE, Eating Disorder Examination; MVPA, moderate-to-vigorous PA; Overval., overvaluation; PA, physical activity.

[a]Effect size is moderate but not statistically significant.

*$p < 0.05$.

**$p < 0.01$.