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ORIGINAL ARTICLE

The relationship between weight bias internalization and healthy and unhealthy weight control behaviours

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Abstract

Purpose Weight bias internalization (WBI) is associated with disordered eating symptomology and motivation to control weight. The relationship between WBI and specific weight control behaviours and how these behaviours differ between men and women is not well understood. The objectives of this study are to determine (1) the relationship between WBI and weight control behaviours, (2) whether weight perception is independently associated with weight control behaviours, and (3) whether these relationships differ between men and women.

Methods Canadian adults ($N = 161$; 52.8% women; body mass index [BMI] = 26.5 ± 4.99 kg/m^2) completed questionnaires pertaining to WBI, weight control behaviours (healthy, unhealthy, extreme) and weight perception (accurate, under-, or over-estimation compared with objectively measured BMI). The cross-sectional relationship between (1) WBI or (2) weight perception with the total number of healthy and unhealthy or extreme weight control behaviours, and likelihood of performing specific weight control behaviours were assessed with linear, and logistic regression models, respectively. All analyses were conducted adjusting for age, gender, and race. Subsequent analyses were stratified by sex.

Results WBI was associated with an increased likelihood of performing exercise for weight loss (OR 2.28, $p < 0.05$); increased likelihood of skipping meals in women (OR 2.57, $p < 0.01$), and consuming little amounts of food and food substitutes in men (OR 2.28, $p < 0.01$ and OR 2.17, $p < 0.05$, respectively). Weight perception was not associated with weight control behaviours.

Conclusions WBI was associated with various weight control behaviours. This study highlights the importance of assessing WBI in clinical practice with patients seeking to manage their weight. Future longitudinal research should be conducted to further understand the behavioural and health effects from WBI.

Level V Cross-sectional descriptive study.

Keywords Weight bias internalization · Weight bias · Weight perception · Weight control behaviours · Weight status

Introduction

Negative attitudes and beliefs toward individuals with large bodies (weight bias) has become increasingly prevalent, and has not been as widely contested as other forms of bias and discrimination [1]. Research has demonstrated several negative mental health and behavioural correlates associated with experiencing weight bias, such as depression, anxiety, eating disturbances [2], as well as future weight gain [3]. This growing interest in examining weight bias and its effects has led to the conceptualization and further investigation of self-directed stigma known as 'weight bias internalization' (WBI). WBI occurs when an individual is (1) made aware of the negative weight-based stereotypes that are held throughout society, (2) believes them to be true,

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and then (3) internalizes these attitudes to the detriment of their confidence in their own capabilities or social adequacy [4, 5]. Research has also shown that WBI is more common and more severe among women compared to men [6, 7]. People with greater WBI have poorer mental health, including greater anxiety, depression, and lower self-esteem and quality of life [8, 9].

Previous research has linked WBI to physical aspects, such as reduced physical health-related quality of life, increased body mass index (BMI) [8], and lower physical activity participation [8, 10]. These studies primarily consisted of individuals with large bodies. However, WBI can still be present among adults with normal body weight [8, 11] but research is limited. Thus, it is vital to include participants across the entire spectrum of BMI when examining WBI and physical health. As WBI has mental and physical health correlates, more research is needed to examine the relationship between WBI and health behaviours, such as weight control practices. The literature has highlighted that WBI is significantly associated with a greater desire to lose weight, attempting to lose weight or intending to eat healthily and engage in healthier behaviours [12–14]; however, the specific behaviours that are being performed in order to do so are currently understudied. The literature has broadly defined these as healthy, unhealthy, and extreme behaviours, which we continued to use in this study. The healthy weight control behaviours include performing exercise, consuming fruits and vegetables, consuming fewer high fat foods, consuming fewer sweets, drinking less soda, and watching one's serving sizes. The unhealthy weight control behaviours include fasting, eating little amounts of food, consuming food substitutes and skipping meals. The extreme weight control behaviours include taking diet pills, vomiting, taking laxatives and taking diuretics. The frequency of performing these behaviours has been examined in adolescent populations [15]. However, only one previous study investigated whether WBI was associated with weight control behaviours in adults. No significant associations were detected [16]. This previous study examined the same weight control behaviours that were assessed in this current study; however, the study was limited by the lack of participants classified as having normal weight status, a disproportionate number of female participants compared to male participants and that anthropometric data was self-reported. This current study addresses all of those previous limitations. One additional study investigating eating pathology in a sample of mostly women with overweight or obesity examined the relationship between WBI and general purging behaviours, which encapsulated specific behaviours that were classified as extreme in this study. A small positive correlation was reported between WBI and these purging behaviours; however, the specific behaviours that were more likely to be performed were not reported [17].

Despite the paucity in the literature examining the relationship between WBI and weight control behaviours, it is hypothesized that WBI will be negatively associated with healthy weight control behaviours and positively associated with unhealthy and extreme weight control behaviours. These predictions were based on a systematic review of the literature highlighting the negative physical and mental health correlates associated with WBI [8]. Although research has also suggested that a relationship exists between WBI and perceived weight status, whereby the percentage of those who perceived themselves as having overweight or obesity increased as the level of WBI increased [12], whether weight perception is independently associated with weight control behaviours after controlling for WBI is unknown. Perceived weight status can be defined as underestimated (subjective weight status less than objective weight status), overestimated (subjective weight status greater than objective weight status) or accurately estimated (concordance between both subjective and objective weight status). The relationship between perceived weight status and weight control behaviours has been thoroughly studied in adolescent samples, whereby overestimating one's weight status has been shown to be associated with an increased likelihood of engaging in unhealthy weight control behaviours, such as caloric restriction, diet pill and laxative consumption and reductions in both physical activity and fruit consumption, compared to those who accurately perceived their weight status [18–23]. However, one study concluded that among young adults aged 18–26 with overweight or obesity, those who underestimated their weight status as normal weight, were less likely to perform unhealthy weight control behaviours, such as meal skipping/fasting and taking diet pills/taking laxatives/diuretics than those who accurately estimated their weight status [24]. Although WBI has never been incorporated within these analyses, it is hypothesized that weight overestimation will be positively associated with weight control behaviours (healthy and unhealthy) and weight underestimation will be negatively associated with weight control behaviours (healthy and unhealthy). These relationships are especially important to examine in both men and women of multiple weight categories, to advance the research with the hopes of eventually establishing and implementing targeted weight bias and WBI reduction initiatives in the future.

Thus, the objectives of this study were to: (1) examine the relationship between WBI and healthy and unhealthy weight control behaviours, (2) examine the relationships between weight perception and weight control behaviours, and (3) determine if these relationships differed between men and women in this sample.

Methods

Procedure and participants

A convenience sample of adults were recruited to participate in the study ($N = 175$). A recruitment email was distributed to the mailing list of a research centre focused on health promotion and disease prevention associated with a university, as well as recruitment flyers and word-of-mouth. Exclusion criteria for this study included being pregnant, recently given birth (within 8 weeks) or currently nursing, being categorized as underweight (BMI < 18.5), or being less than 18 years of age. As participants completed a Dual Energy X-Ray Absorptiometry (DEXA) body composition scan that does not permit participants to wear any metal devices, individuals with an implanted electronic device (e.g., pacemaker) were also ineligible from study participation. Individuals categorized as underweight were excluded from study recruitment out of an abundance of caution to exclude persons who may have a history of an eating disorder. Study participation entailed a one-time in-person assessment at Concordia University's PERFORM Centre in Montreal, Quebec. All participants provided informed consent and were given a $25 gift card as compensation for their time. Recruitment and data collection for this study took place between June 2017 and June 2018. This study was approved by the research ethics committee of the ministry of health and social services (reference number CCER 17-18-01).

Measures

Trained research assistants measured the participants' height and weight (to the nearest cm or kg, respectively) in duplicate. The average of the two measures were used to compute BMI. Weight status was categorized as normal weight (18.5–24.99 kg/m^2), overweight (25.0–29.99 kg/m^2) or having obesity ($\geq$ 30.0 kg/m^2). Participants also completed the following questionnaires:

Modified weight bias internalization scale (WBIS-M; Pearl and Puhl 2014) is a ten-item measure which assessed the extent to which an individual values themselves based on their weight status [25]. This questionnaire was modified from the original version created in 2008 (*Durso and Latner)* [26], whereby the first item within the original 11-item questionnaire was removed from analyses as recommended in the literature due to poor psychometric properties [27]. Moreover, the modified version uses terminology, such as "because of my weight" rather than "because I'm overweight". Items (such as: "I don't feel that I deserve to have a really fulfilling social life, because of my weight") were assessed on a five-point Likert scale (strongly disagree to strongly agree). Two items were reverse coded to ensure that higher scores were indicative of more severe WBI. The mean WBIS-M score was calculated. Within this sample, the WBIS-M had high internal consistency (McDonald's $\Omega = 0.93$).

Healthy weight control behaviours (Neumark-Sztainer et al. *2012)* is a six-item measure which was assessed by asking participants the following question: "How often have you done each of the following things to lose weight or avoid gaining weight during the past year?" [15]. Items included performed exercise, ate more fruits and vegetables, ate fewer high-fat foods, ate fewer sweets, drank less soda pop (not including diet pop) and watched portion/serving sizes. Items were evaluated on a four-point Likert scale, providing participants with the following options: "never", "rarely", "sometimes" or "often". The test–retest agreement of never/rarely vs. sometimes/often has been shown to be 88% [15]. Thus, in accordance with the literature, response categories "never" and "rarely" were combined, and "sometimes" and "often" were combined [15] (McDonald's $\Omega = 0.79$ in this study).

Healthy weight control behaviours were further categorized into additive or restrictive weight control behaviours. Additive behaviours were those that had to be implemented as part of an individual's lifestyle (e.g., performing exercise and consuming more fruits and vegetables), while the restrictive behaviours (e.g., consuming fewer high-fat foods, fewer sweets, drinking less soda pop and watching portion sizes) are those that had to be removed from an individual's lifestyle to improve one's health. The number of behaviours were added together to obtain a subtotal of healthy weight control behaviours performed, as well as subtotals for additive and restrictive healthy weight control behaviours.

Unhealthy and extreme weight control behaviours (Neumark-Sztainer et al. *2012)* is a nine-item measure which was assessed by asking participants the following question: "Have you done any of the following things in order to lose weight or avoid gaining weight during the past year?" [15] (response options: "yes" or "no" for each item). Unhealthy items included fasting, eating very little food, using food substitutes (powders or special drinks), skipping meals and smoking more cigarettes. Extreme items included taking diet pills, forcing oneself to vomit, using laxatives and using diuretics. For this study, "smoking more cigarettes" was eliminated from the analysis due to the fact that it assumed that the individual was already a cigarette smoker. Moreover, few participants reported that they smoked more cigarettes in an attempt to control their weight. We ran analyses with and without the "smoking more cigarettes" item and the results did not differ. Thus, the final analyses excluded this item. In this sample, this questionnaire had moderate internal consistency for unhealthy/extreme behaviours (McDonald's $\Omega = 0.58$). The number of behaviours that were performed

were added together to obtain subtotals of unhealthy, or extreme weight control behaviours, as well as their combined total.

Perceived weight status. Participants were asked to complete the following statement, "At this time, do you feel that you are (blank)". Response options included: "very underweight", "somewhat underweight", "about the right weight", "somewhat overweight" or "very overweight". This response was then compared to weight status based on objectively measured height and weight resulting in BMI calculation, to identify whether the participant accurately perceived their weight, or whether there were discrepancies (underestimations and overestimations) between perceptions and objective measurements. For instance, if a participant perceived themselves as being "about the right weight", but their objective BMI classified them as having overweight or obesity, this would be an example of underestimation. Moreover, if a participant perceived themselves as being "somewhat overweight" but their BMI was above 30 kg/m^2, indicating that this was an individual with obesity, this would also be classified as weight underestimation. On the other hand, if a participant's objectively measured BMI classified them as being of "normal weight", but they felt as though they had overweight (somewhat or very overweight), this was considered weight status overestimation. If there were no discrepancies between one's subjective and objective weight status, this was considered accurate estimation. This analytical procedure has been utilized in previous studies as a manner in which to classify individuals based on weight perception [24]. It allows for researchers to take into account one's objective and subjective weight status using one variable in a manner that is able to assess concordance or discordance between the two.

Data analysis

All analyses were conducted using IBM SPSS Statistics 24. Fourteen participants were excluded from analyses. One participant was excluded because of a cognitive impairment rendering them unable to answer some of the study questions and one participant had a BMI just below 18.5 kg/m^2. The remaining participants were excluded because of incomplete questionnaires from the measures examined in this study. This resulted in a final analytic sample of 161 participants. Descriptive characteristics were analyzed with *t* tests and Chi-square to determine sex differences. Power analyses were conducted prior to collecting data for the primary outcomes of this study. To assess the primary objective, multiple linear regressions were performed to determine the relationship between mean WBI and the (1) total number of healthy and the (2) total number of unhealthy and extreme weight control behaviours. Linear regression assumptions were met for these outcomes except for the total number of extreme weight control behaviours. Therefore, a logistic regression was performed to determine the relationship between mean WBI and the likelihood of performing at least one extreme weight control behaviour. In addition, multiple logistic regressions were performed in order to determine the relationship between mean WBI and the likelihood of performing each specific healthy and unhealthy weight control behaviour. All regression models were adjusted for age, sex, race (White vs. non-White) and weight status discrepancy (overestimation vs. accurate estimation, underestimation vs. accurate estimation). Adjusting for weight status discrepancy in the regression models also fulfilled the secondary objective (whether discrepancies between one's subjective and objective weight status may be independently associated with weight control behaviours). Weight overestimation and weight underestimation were separate covariates in the model, with accurate weight estimation as the reference group. BMI was not included as a covariate in the regression models because it was used to derive the weight status discrepancy groups. Moreover, the inclusion of BMI into regression models did not largely affect results, it was omitted from the final models for concerns regarding collinearity with the weight status discrepancy groups. The tertiary objective (whether these relationships differed between men and women) was assessed by stratifying regression models by sex. A subsequent sensitivity analysis was performed, whereby participants with BMI values within 1 kg/m^2 of the BMI classification values were removed and were re-analyzed. This was conducted to reduce the likelihood of misclassification in weight perception groups if an individual's BMI was in close proximity to the BMI classification cutoff value. As results were mostly unaffected by the implementation of the sensitivity analysis, results for the entire sample population are presented.

Results

The total sample consisted of a nearly equal distribution of men and women, with 52.8% of the population being women (Table 1). None of the participants included in the analyses identified themselves as another category than being a man or a woman. The mean BMI among women was significantly higher compared to men (27.38 vs. 25.50 kg/m^2, $p = 0.02$). Mean WBI score was higher among women compared to men, although the difference was not statistically significant (2.26 vs. 1.99, $p = 0.08$). Discrepancy between weight perception and weight status significantly differed between women and men ($p = 0.03$), where more men underestimated their weight, and more women overestimated their weight. There were no significant differences between men and women in the mean number of healthy or unhealthy weight control behaviours performed. However, the mean

Table 1 Sample characteristics

Variable	Total sample ($N=161$)[a]	Men ($N=76$)[a]	Women ($N=85$)[a]	p[b]
Age, years	34.32 ± 17.11	31.80 ± 18.76	36.58 ± 18.76	0.07
BMI, kg/m^2	26.50 ± 4.99	25.50 ± 3.94	27.38 ± 5.64	0.02
Race/Ethnicity, *n* (%)				0.24
White	105 (65.20)	46 (60.50)	59 (69.40)	
Non-White	56 (34.80)	30 (39.50)	26 (30.60)	
Asian	21 (13.00)	17 (22.40)	4 (4.70)	
Black	7 (4.30)	1 (1.30)	6 (7.10)	
Hispanic	7 (4.30)	4 (5.30)	3 (3.50)	
Other	20 (12.40)	8 (10.50)	12 (14.10)	
Prefer not to say	1 (0.60)	0	1 (1.20)	
Objective weight status, *n* (%)				0.07
Normal weight	66 (41.00)	38 (50.00)	28 (32.90)	
Overweight	66 (41.00)	28 (36.80)	38 (44.70)	
Obesity	29 (18.00)	10 (13.20)	19 (22.40)	
Subjective weight status, *n* (%)				< 0.001
Somewhat underweight	11 (6.80)	10 (13.20)	1 (1.20)	
About the right weight	51 (31.70)	31 (40.80)	20 (23.50)	
Somewhat overweight	79 (49.10)	28 (36.80)	51 (60.00)	
Very overweight	20 (12.40)	7 (9.20)	13 (15.30)	
Weight perception, *n* (%)				0.03
Accurate estimation	100 (62.10)	44 (57.90)	56 (65.90)	
Over estimation	22 (13.70)	7 (9.20)	15 (17.60)	
Under estimation	39 (24.20)	25 (32.90)	14 (16.50)	
Weight bias internalization (1–5)	2.13 ± 0.96	1.99 ± 0.91	2.26 ± 0.98	0.08
Healthy weight control behaviours (1–6)	4.68 ± 1.69	4.51 ± 1.86	4.82 ± 1.53	0.25
Additive healthy weight control behaviours	1.75 ± 0.57	1.68 ± 0.64	1.81 ± 0.50	0.36
Exercise, *n* (%)	143 (88.80)	67 (88.20)	76 (89.40)	
Fruits and veg., *n* (%)	139 (86.30)	61 (80.30)	78 (91.80)	
Restrictive healthy weight control behaviours	2.93 ± 1.28	2.83 ± 1.37	3.01 ± 1.20	0.75
Fewer fat foods, *n* (%)	114 (70.80)	48 (63.20)	66 (77.60)	
Fewer sweets, *n* (%)	128 (79.50)	60 (78.90)	68 (80.00)	
Less soda, *n* (%)	129 (80.10)	61 (80.30)	68 (80.00)	
Serving sizes, *n* (%)	100 (62.10)	46 (60.50)	54 (63.50)	
Unhealthy and extreme weight control behaviours (0–8)	1.18 ± 1.34	1.16 ± 1.23	1.20 ± 1.43	0.29
Unhealthy weight control behaviours (0–4)	1.07 ± 1.23	1.13 ± 1.22	1.01 ± 1.24	0.48
Fasted, *n* (%)	35 (21.70)	20 (26.30)	15 (17.60)	
Little food, *n* (%)	57 (35.40)	27 (35.50)	30 (35.30)	
Food substitutes, *n* (%)	28 (17.40)	12 (15.80)	16 (18.80)	
Skipped meals, *n* (%)	52 (32.30)	27 (35.50)	25 (29.40)	
Extreme weight control behaviours (0–4)	0.11 ± 1.34	0.03 ± 0.23	0.19 ± 0.52	< 0.0001
At least one behaviour, *n* (%)	13 (8.10)	1 (1.30)	12 (14.10)	0.003
Diet Pills, *n* (%)	8 (4.90)	1 (1.30)	7 (8.20)	
Vomit, *n* (%)	5 (3.10)	0	5 (5.90)	
Laxatives, *n* (%)	2 (1.20)	0	2 (2.40)	
Diuretics, *n* (%)	3 (1.90)	1 (1.30)	2 (2.40)	

[a]Mean + standard deviation unless indicated otherwise
[b]Female compared to Male

number of extreme weight control behaviours was significantly higher in women compared to men (0.19 vs. 0.03, $p < 0.0001$).

WBI and healthy weight control behaviours

After adjusting for covariates, mean WBI was not significantly associated with the total number of healthy weight control behaviours in linear regression models in either men or women (Table 2). However, for every unit increase in mean WBI, the total number of additive healthy weight control behaviours significantly increased within the full sample ($B = 0.11$, $p = 0.03$) and among women ($B = 0.12$, $p = 0.04$). When examining the relationship between mean WBI and the likelihood of utilizing specific healthy weight control behaviours from multiple logistic regression, mean WBI was significantly associated with an increased likelihood of performing exercise for weight loss, within the full sample (OR 2.28, $p = 0.03$, Table 3). Mean WBI was not associated with any specific healthy weight control behaviours upon stratifying by sex.

WBI and unhealthy or extreme weight control behaviours

In contrast, for every unit increase in mean WBI, the total number of combined unhealthy and extreme weight control behaviours significantly increased in both men and women ($B = 0.43$, $p = 0.006$ and $B = 0.53$, $p = 0.001$, respectively, Table 4). Results were consistent when examining the relationship between mean WBI and the total number of unhealthy weight control behaviours in both men and women ($B = 0.39$, $p = 0.013$ and $B = 0.40$, $p = 0.005$, respectively, Table 4). In terms of the extreme weight control behaviours, mean WBI was significantly associated with an increased likelihood of performing at least one extreme behaviour within the entire sample and among women (OR 2.36, $p = 0.01$ and OR 2.08, $p = 0.03$, respectively, Table 4).

For specific unhealthy weight control behaviours, mean WBI was significantly associated with an increased likelihood of consuming little amounts of food, consuming food substitutes and skipping meals within the entire sample population (OR 1.68, $p = 0.007$, OR 1.66, $p = 0.02$ and OR 1.92, $p = 0.001$, respectively, Table 5). When stratifying by sex, mean WBI was significantly associated with an increased likelihood of consuming little amounts of food and consuming food substitutes in men (OR 2.28, $p = 0.008$ and OR 2.17, $p = 0.046$, respectively) and an increased likelihood of skipping meals in women (OR 2.57, $p = 0.002$, Table 5). The relationship between WBI and specific extreme weight control behaviours were not analyzed due to too few cases ($n = 18$).

Table 2 Multiple linear regressions: WBI and healthy weight control behaviours

Variable	Healthy weight control behaviours (B) (SE) (*p*)	Additive healthy weight control behaviours (*B*) (SE) (*p*)	Restrictive healthy weight control behaviours (*B*) (SE) (*p*)
	Total sample ($N = 161$)		
Mean WBI[a]	0.28 (0.14) ($p = 0.05$)	**0.11 (0.05) ($p = 0.03$)**	0.17 (0.11) ($p = 0.11$)
Weight underestimation[b]	0.22 (0.32) ($p = 0.50$)	0.06 (0.11) ($p = 0.59$)	0.16 (0.24) ($p = 0.51$)
Weight overestimation[b]	0.31 (0.40) ($p = 0.43$)	0.06 (0.13) ($p = 0.68$)	0.26 (0.30) ($p = 0.39$)
	Men ($N = 76$)		
Mean WBI[a]	0.28 (0.25) ($p = 0.26$)	0.07 (0.08) ($p = 0.43$)	0.21 (0.18) ($p = 0.25$)
Weight underestimation[b]	− 0.10 (0.48) ($p = 0.84$)	− 0.10 (0.16) ($p = 0.55$)	− 0.0001 (0.35) ($p = 1.00$)
Weight overestimation[b]	0.52 (0.78) ($p = 0.50$)	0.13 (0.27) ($p = 0.63$)	0.40 (0.57) ($p = 0.49$)
	Women ($N = 85$)		
Mean WBI[a]	0.25 (0.17) ($p = 0.15$)	**0.12 (0.06) ($p = 0.04$)**	0.13 (0.13) ($p = 0.34$)
Weight underestimation[b]	0.69 (0.45) ($p = 0.13$)	0.27 (0.15) ($p = 0.07$)	0.42 (0.35) ($p = 0.23$)
Weight overestimation[b]	0.23 (0.44) ($p = 0.60$)	0.06 (0.15) ($p = 0.67$)	0.17 (0.34) ($p = 0.62$)

B = parameter estimate

Additive healthy weight control behaviours include performing exercise and consuming fruits and vegetables

Restrictive healthy weight control behaviours include consuming fewer high fat foods, sweets, less soda and controlling portion sizes

Bold values represent statistically significant results

[a]Adjusted for age, gender and race (White vs. non-White), and other predictors shown here (mean WBI, weight perception) in a single model

[b]Reference level: accurate estimation

Table 3 Multiple logistic regressions: WBI and healthy weight control behaviours

Variable	Exercise (OR) [95% CI]	Fruits and vegetables (OR) [95% CI]	Less high-fat foods (OR) [95% CI]	Less sweets (OR) [95% CI]	Less soda (OR) [95% CI]	Serving sizes (OR) [95% CI]
			Total sample ($N=161$)			
Mean WBI[a]	**2.28 [1.10,4.71]***	1.56 [0.88,2.76]	1.25 [0.85,1.84]	1.28 [0.83,1.98]	1.20 [0.77,1.86]	1.31 [0.91,1.88]
Weight underestimation[b]	0.97 [0.29,3.24]	1.69 [0.54,5.29]	1.33 [0.55,3.21]	1.13 [0.43,2.98]	1.01 [0.40,2.55]	1.59 [0.68,3.73]
Weight overestimation[b]	1.21 [0.23,6.25]	1.53 [0.31,7.50])	1.04 [0.35,3.08]	1.21 [0.36,4.07]	6.54 [0.82,52.01]	1.24 [0.45,3.40]
			Men ($N=76$)			
Mean WBI[a]	1.52 [0.49,4.70]	1.35 [0.66,2.75]	1.12 [0.64,1.96]	1.68 [0.80,3.54]	1.82 [0.80,4.11]	1.18 [0.69,2.02]
Weight underestimation[b]	0.38 [0.08,1.87]	1.13 [0.32,3.96]	0.84 [0.29,2.42]	0.97 [0.28,3.31]	1.00 [0.29,3.46]	1.30 [0.45,3.77]
Weight overestimation[b]	NA	1.38 [0.14,13.65]	1.45 [0.24,8.84]	1.66 [0.16,16.71]	NA	1.12 [0.21,5.93]
			Women ($N=85$)			
Mean WBI[a]	2.85 [0.99,8.18]	2.03 [0.75,5.49]	1.40 [0.78,2.53]	1.08 [0.62,1.89]	0.90 [0.52,1.58]	1.44 [0.85,2.42]
Weight underestimation[b]	NA	NA	5.95 [0.65,54.65]	1.75 [0.32,9.50]	1.13 [0.26,4.80]	2.22 [0.52,9.54]
Weight overestimation[b]	1.01 [0.18,5.72]	1.79 [0.19,16.59]	0.78 [0.19,3.26]	0.93 [0.21,4.14]	4.62 [0.54,39.88]	1.33 [0.36,4.98]

Bold value represents statistically significant results

Note: OR = parameter estimate, * = $p< 0.05$, ** = $p< 0.01$, *** = $p< 0.001$, **** = $p< 0.0001$

NA: Results not available due to insufficient sample size for specific behaviours when stratified by sex

[a]Adjusted for age, sex & race (Caucasian vs. non-Caucasian), and other predictors shown here (mean WBI, weight perception) in a single model

[b]Reference level: accurate estimation

Weight perception and weight control behaviours

Weight perception discrepancy was not significantly associated with any of the total number of weight control behaviours in the full sample, nor when stratified by sex. Moreover, weight perception discrepancy was not significantly associated with the use of any individual specific healthy, unhealthy, or extreme weight control behaviours in the full sample, nor when stratified by sex.

Discussion

This study demonstrated that WBI was significantly associated with the number of additive healthy weight control behaviours performed, but more specifically, performing exercise for weight control in the full sample. This study also demonstrated that WBI was significantly associated with the total number of unhealthy weight control behaviours, as well as the combination of unhealthy and extreme weight control behaviours performed in the full sample.

Since the current study had approximately an equal distribution of men and women participants, it was possible to determine whether relationships differed by sex. Study results suggest that WBI was significantly associated with weight control behaviours among both women and men, but the specific behaviours differed by sex. For instance, WBI was significantly associated with the combined total of unhealthy and extreme weight control behaviours among both women and men, but only an increased likelihood of performing at least one extreme weight control behaviour among women. The results obtained in this current study support previous findings that extreme weight control behaviours are more common among women compared to men [28–31]. It has been shown that women are generally more likely than men to partake in unhealthy or extreme weight control behaviours due to the sociocultural ideals surrounding beauty and thinness [32, 33]. Research has also shown that women generally experience more frequent episodes of weight stigmatization compared to men [34]. It has been suggested that experiencing weight stigma and fearing being devalued may increase one's motivation to escape weight stigma by engaging in unhealthy or disordered eating behaviours [35]. Therefore, due to elevated levels of weight stigmatization experienced among women compared to men, the added pressure to achieve thinness, as well as an increased

Table 4 Multiple linear and logistic regressions: WBI and unhealthy and extreme weight control behaviours

Variable	Linear regression (*B*) (SE) (*p*) Unhealthy and extreme weight control behaviours	Linear regression (*B*) (SE) (*p*) Unhealthy weight control behaviours	Logistic regression (OR) [95% CI] (*p*) Extreme weight control behaviours
	Total sample ($N=161$)		
Mean WBI[a]	**0.47 (0.11) ($p<0.0001$)**	**0.37 (0.10) ($p=0.0003$)**	**2.36 [1.23, 4.53] ($p=0.01$)**
Weight underestimation[b]	− 0.14 (0.24) ($p=0.56$)	− 0.15 (0.23) ($p=0.50$)	0.60 [0.06, 5.82] ($p=0.66$)
Weight overestimation[b]	0.40 (0.30) ($p=0.18$)	0.29 (0.28) ($p=0.29$)	3.82 [0.86, 16.92] ($p=0.08$)
	Men ($N=76$)		
Mean WBI[a]	**0.43 (0.15) ($p=0.006$)**	**0.39 (0.15) ($p=0.013$)**	NA
Weight underestimation[b]	− 0.35 (0.30) ($p=0.24$)	− 0.37 (0.30) ($p=0.22$)	NA
Weight overestimation[b]	− 0.01 (0.48) ($p=0.98$)	− 0.28 (0.48) ($p=0.57$)	NA
	Women ($N=85$)		
Mean WBI[a]	**0.53 (0.16) ($p=0.001$)**	**0.40 (0.14) ($p=0.005$)**	**2.08 [1.06, 4.10] ($p=0.03$)**
Weight underestimation[b]	0.13 (0.40) ($p=0.76$)	0.13 (0.35) ($p=0.71$)	0.59 [0.06, 5.70] ($p=0.65$)
Weight overestimation[b]	0.64 (0.39) ($p=0.11$)	0.59 (0.35) ($p=0.09$)	2.59 [0.51, 13.06] ($p=0.25$)

Bold values represent statistically significant results

B = parameter estimate, OR = parameter estimate

Logistic regression: likelihood of performing at least one extreme weight control behaviour

Unhealthy weight control behaviours include fasting, eating little amounts of food, taking food substitutes and skipping meals

Extreme weight control behaviours include taking diet pills, laxatives, diuretics and vomiting

NA: Results not available due to insufficient sample size for specific behaviours when stratified by gender

[a]Adjusted for age, sex and race (White vs. non-White), and other predictors shown here (mean WBI, weight perception) in a single model

[b]Reference level: accurate estimation

Table 5 Multiple logistic regressions: WBI and unhealthy weight control behaviours

Variable	Fasted (OR) [95% CI] (*p*)	Little food (OR) [95% CI] (*p*)	Food substitutes (OR) [95% CI] (*p*)	Skipped meals (OR) [95% CI] (*p*)
	Total sample ($N=161$)			
Mean WBI[a]	1.28 [0.86,1.90] ($p=0.23$)	**1.68 [1.16,2.43] ($p=0.007$)**	**1.66 [1.08,2.55] ($p=0.02$)**	**1.92 [1.31,2.83] ($p=0.001$)**
Weight underestimation[b]	0.70 [0.26,1.84] ($p=0.48$)	0.64 [0.26,1.57] ($p=0.33$)	1.10 [0.38,3.20] ($p=0.86$)	0.87 [0.36,2.12] ($p=0.75$)
Weight overestimation[b]	0.73 [0.21,2.50] ($p=0.62$)	2.55 [0.94,6.90] ($p=0.07$)	1.18 [0.34,4.05] ($p=0.79$)	1.74 [0.63,4.86] ($p=0.29$)
	Men ($N=76$)			
Mean WBI[a]	1.06 [0.58,1.93] ($p=0.86$)	**2.28 [1.24,4.20] ($p=0.008$)**	**2.17 [1.01,4.67] ($p=0.046$)**	1.60 [0.91,2.79] ($p=0.10$)
Weight underestimation[b]	0.55 [0.16,1.90] ($p=0.35$)	0.49 [0.15,1.65] ($p=0.25$)	1.66 [0.37,7.45] ($p=0.51$)	0.40 [0.12,1.31] ($p=0.13$)
Weight overestimation[b]	0.25 [0.03,2.39] ($p=0.23$)	1.44 [0.24,8.54] ($p=0.69$)	0.85 [0.08,9.47] ($p=0.89$)	0.71 [0.13,3.93] ($p=0.70$)
	Women ($N=85$)			
Mean WBI[a]	1.72 [0.95,3.12] ($p=0.08$)	1.37 [0.84,2.24] ($p=0.21$)	1.60 [0.90,2.84] ($p=0.11$)	**2.57 [1.42,4.65] ($p=0.002$)**
Weight underestimation[b]	0.96 [0.17,5.47] ($p=0.96$)	0.95 [0.25,3.65] ($p=0.94$)	0.81 [0.15,4.34] ($p=0.81$)	2.84 [0.68,11.92] ($p=0.16$)
Weight overestimation[b]	1.77 [0.37,8.33] ($p=0.47$)	3.34 [0.95,11.74] ($p=0.06$)	1.30 [0.30,5.80] ($p=0.72$)	3.78 [0.97,14.72] ($p=0.06$)

Bold values represent statistically significant results

OR = parameter estimate

[a]Adjusted for age, sex and race (White vs. non-White), and other predictors shown here (mean WBI, weight perception) in a single model

[b]Reference level: accurate estimation

motivation to escape the fear of being devalued or stigmatized, might explain elevated levels of WBI among women and the development of unhealthy and extreme weight control behaviours [36]. However, experiencing weight bias does not exclusively lead to performing unhealthy or extreme weight control behaviours. Research has shown that

young females classified as having underweight have a significant increased likelihood of performing unhealthy weight control behaviours (i.e., taking diet pills) compared to those classified as having normal weight [37]. We suggest that more research should be conducted in populations of individuals with underweight to better comprehend the potential role of WBI in influencing weight control behaviours.

The secondary objective of this study was to determine how one's perceived weight status might additionally be associated with weight control behaviours in this model. However, neither overestimation nor underestimation was associated with any of the weight control behaviours. It is possible that the lack of significant results is due to the study's relatively small sample size. The number of individuals who were categorized as having inaccurate weight perceptions (either underestimation or overestimation) was relatively small compared with the accurate weight perception group. To counter this limitation, weight perception could have been classified as accurate perception or non-accurate perception (combining both over- and underestimation into a single group). However, this would not describe the full scope of weight perception and would bias results toward the null.

The literature also suggests discrepant sex differences in risk factors and motivations for performing unhealthy or extreme weight control behaviours [21]. Compared to women who generally experience more weight bias as body size increases, men experience weight bias when they are classified as having both underweight and/or obesity [38]. Moreover, the BMI value at which men perceive themselves as having overweight is typically higher than the BMI value at which women perceive themselves as having overweight [38, 39]. Therefore, the motives rooted behind disordered eating in men are often different than the thinness-oriented behaviours experienced among women. Disordered eating and the associated behaviours in male populations are more focused on muscularity-oriented behaviours [21] and their thinness-oriented behaviours are rooted in the pursuit of achieving greater muscularity [40]. These weight control behaviours are vastly overlooked and understudied as studies among women are more prevalent [41, 42]. In addition, the constructs utilized to assess disordered eating are often focused on behaviours that are more likely to be performed among women to achieve thinness, rather than some of the eating behaviours that are more commonly performed among men, such as drastically increasing protein consumption [43]. It is, therefore, possible that the lack of significant results could be due to the combination of a small sample, and behaviour measures that despite being well-established, may elicit gendered responses. Therefore, more research is needed to better understand WBI, weight control behaviours and weight perception in samples of men to clarify the specific behaviours that men are undertaking to control weight, and how that may differ from the behaviours being performed among women. Moreover, it is crucial to comprehend the varying motivations that are associated with undertaking unhealthy weight control practices in these different populations.

Strength and limits

This was the first known study to demonstrate a relationship between WBI and specific weight control behaviours. Previous studies reported no significant relationships between WBI and weight control behaviours. Importantly, this study was conducted in a sample of individuals across the BMI spectrum (normal weight, overweight and obesity), allowing for a greater comprehension of these relationships. In contrast, the majority of similar previous WBI studies were conducted exclusively among individuals with large bodies [12, 16, 44, 45].

This current study was able to extend the previous research by identifying the precise behaviours that individuals with higher WBI perform to control their weight. Previous research was heavily focused on motivation to diet, rather than focusing on the specific diet-related behaviours, and the findings were inconsistent [12, 13]. For example, while one study concluded that adults with higher levels of WBI were significantly more likely to report dieting in the past year [12], another study concluded that higher WBI was negatively associated with a motivation to diet [13]. It is possible that the discrepancy can be attributed to the fact that there may be a distinct difference between having a motivation to undergo weight loss behaviours, and actually implementing these behaviours as part of one's life. Moreover, these previous studies utilized self-reported anthropometric data, unlike this current study, where weight and height were objectively measured.

While this study contributed novel findings regarding the relationship between WBI and specific weight control behaviours, certain limitations should be noted. First, considering that this study was cross-sectional by nature, neither causality nor directionality can be inferred. Future longitudinal research should be performed to solidify the results obtained in this current study and to determine how these relationships change over time. Second, our classification of healthy and unhealthy weight control behaviours was based on previous literature [15]. However, it is possible that some of the healthy behaviours, done to extreme levels, can be considered unhealthy. For example, performing excess exercise or compulsively watching portion sizes, may be considered unhealthy or extreme lifestyle behaviours. Due to the manner in which these variables were assessed, we were unable to detect individual variations in weight control behaviours. Thirdly, the version of the WBIS utilized in this study assessed WBI on

a five-point Likert scale compared to the seven-point Likert scale. Therefore, the mean WBI value reported in this study may be relatively lower compared to other previous studies that have used the seven-point Likert scale [25]. However, research has shown that data quality may be improved moving to a five-point Likert scale from a seven-point Likert scale assessment [46]. Finally, BMI may not always accurately define an individual's weight status due to the crudeness of the measure. For example, an individual with high muscle mass and low levels of body fat could be classified as having "overweight" based on the commonly used BMI classifications. This limitation surrounding BMI classifications could have caused misclassification in the weight perception measure we utilized in this study. However, to counteract this potential limitation, we performed a sensitivity analysis, removing participants within 1 kg/m^2 of weight status categories ($n=48$) prior to defining each weight perception group. There were three relationships that were no longer significant when these participants were removed; the relationship between mean WBI and additive healthy weight control behaviours in women, the relationship between mean WBI and unhealthy weight control behaviours in men and the relationship between mean WBI and taking food substitutes in men. Considering that most previous significant relationships remained significant, the impact of misclassification on our results was likely minimal. Although there were many analytical outcomes in this study, the likelihood of a type I error was reduced due to the similar trends in the subgroup analysis results. However, the sample size of this study was relatively small and may have been insufficient for some of the sex-stratified weight control behaviours. In addition, the number of participants who performed the specific extreme weight control behaviours ($n=18$) was insufficient for some analyses. We assessed the likelihood of conducting 'at least one' extreme behaviour as a way to address the small sample size. Nevertheless, further research with larger sample sizes is needed. Moreover, considering the novelty of this study, we recommend a pre-registered replication of this study be conducted to provide greater validity and generalizability to the current findings. Cronbach's alpha was also relatively low for these unhealthy and extreme weight control behaviours. Therefore, interpretations of some of these estimates should be made with caution. Participants were from a convenience sample and results cannot be generalized to the larger population. Future research should focus on examining this research question in a larger, nationally representative sample of adults.

Conclusion

In conclusion, mean WBI was significantly associated with performing exercise for weight loss, a greater likelihood of eating little amounts of food, taking food substitutes and skipping meals. However, these relationships differed by sex. The results of this study emphasize the potential ramifications associated with experiencing WBI on the unhealthy manners in which individuals attempt to control their weight. Results from this study highlight the importance of measuring WBI in future research aimed at investigating weight bias, weight perception and weight control behaviours, and to continue to do so in samples of men and women. Continuing to conduct research in this field will improve our understanding of the impact of WBI, with the hopes of creating and implementing protocols to reduce weight bias and weight bias internalization.

What is already known on this subject?

This study highlights some of the precise weight control behaviours that individuals experiencing weight bias internalization (WBI) are performing to control their weight. Previous studies have attempted to examine similar relationships, but in samples consisting of more women or only individuals with large bodies.

What this study adds?

This study adds to the existing literature linking WBI to physical health correlates. The results of this study highlight the importance of continuing to examine WBI and weight control behaviours to hopefully create more targeted and effective protocols to reduce WBI and assist individuals in controlling weight in a healthy and sustainable manner.

Author contributions All authors conceived the research question. ML drafted the first version of the manuscript and conducted the statistical analysis. LK and ASA were responsible for study design, assisted with data analysis and interpretation of the findings. All authors contributed writing, editing and approval of the final draft submitted.

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Data availability The data set generated and analyzed during the current study is not publicly available but is available from the corresponding author on reasonable request.

Code availability Analyses were conducted using IBM SPSS Statistics 24. Code for this study is not publicly available.

Declarations

Conflict of interest The authors declare no conflict of interest.

Ethics approval This study was approved by the research ethics committee of the ministry of health and social services (reference number CCER 17-18-01). The procedures used in this study adhere to the tenets of the Declaration of Helsinki.

Consent to participate All participants provided informed consent prior to their participation.

Consent for publication No identifying details were included, and thus, consent for publication is not applicable.

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