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Brief communication

The relationship between "food addiction" and visceral adiposity in young females

Kirrilly M. Pursey [a,b], Ashley N. Gearhardt [c], Tracy L. Burrows [a,b,*]

[a] School of Health Sciences, Faculty of Health and Medicine, University of Newcastle, Callaghan, NSW, Australia
[b] Priority Research Centre in Physical Activity and Nutrition, University of Newcastle, Callaghan, NSW, Australia
[c] Department of Psychology, University of Michigan, Ann Arbor, MI, United States

HIGHLIGHTS

- No studies have investigated "food addiction" and visceral adiposity.
- Visceral fat more sensitive indicator of chronic disease risk than BMI
- "Food addiction" assessed using the Yale Food Addiction Scale
- YFAS "symptom scores" predicted increases in visceral fat area.
- "Food addiction" related to sensitive indicator of increased cardiometabolic risk

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ABSTRACT

Objectives: There is increasing interest in the role of addictive-like eating in weight gain. No studies have investigated associations between addictive-like eating and specific patterns of fat deposition which are sensitive indicators of chronic disease risk. This exploratory study aimed to evaluate relationships between Yale Food Addiction Scale (YFAS) assessed "food addiction" and visceral adiposity.
Methods: Australian adults aged 18–35 years were recruited to an online survey including demographics and the YFAS. The YFAS is a 25-item tool designed to assess addictive-like eating behaviors and uses two scoring outputs, "diagnosis" and "symptom scores". Participants had their anthropometric measurements taken [height, weight and body composition (visceral fat, fat mass, percentage body fat)] using a standardized protocol.
Results: Ninety-three female participants (age 24.3 ± 4.0years, BMI 24.3 ± 6.0 kg/m^2) completed all measurements. Twenty-one participants (22.3%) met the predefined criteria for YFAS "diagnosis". YFAS "symptom scores" were moderately correlated with visceral fat area ($r = 0.36$, $p < 0.001$), and "symptom scores" predicted increases in visceral fat area [$r^2 = 0.17$, $\beta = 1.17$, $p = 0.001$]. Effect sizes were moderate for all variables.
Conclusion: This study showed that YFAS assessed FA was associated with visceral fat deposition, a sensitive indicator of increased cardiometabolic risk. Future research is required to investigate whether FA predicts future weight gain.

1. Introduction

Obesity is an international issue and is associated with considerable physical, psychosocial and economic burden [1]. Obesity is a complex condition and there is a pressing need to better understand possible underlying factors contributing to its development in order to identify more effective management strategies. There has been increasing scientific interest in the potential role that addictive-like eating behaviors may play in overeating and weight gain [2,3]. Although "food addiction" (FA) is not a clinically recognized disorder, it has been suggested that excessive consumption of energy-dense, hyper-palatable, processed foods in an addictive-like way could be contributing to weight gain in vulnerable individuals [4].

The Yale Food Addiction Scale (YFAS) is a tool specifically designed to assess the behavioral indicators of addictive-like eating by applying the diagnostic criteria for substance dependence to eating behaviors [5]. Previous studies have demonstrated an association between YFAS assessed FA and weight status using body mass index (BMI) [3,6–8]. However, an inherent caveat of using BMI as a measure of adiposity is that it does not differentiate between lean and fat mass. In a 2010 meta-analysis that pooled data from 32,000 individuals, approximately

* Corresponding author at: School of Health Sciences, Priority Research Centre for Physical Activity and Nutrition, University of Newcastle, Callaghan, NSW, Australia.
E-mail addresses: Kirrilly.pursey@newcastle.edu.au (K.M. Pursey), agearhar@umich.edu (A.N. Gearhardt), Tracy.burrows@newcastle.edu.au (T.L. Burrows).

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half of the individuals with excessive body fat were not identified as overweight or obese using BMI [9]. Other measures such as total fat mass and visceral fat are therefore a more specific indicator of adiposity and health status [10].

Although a 2014 systematic review identified that 21 of the 25 published YFAS studies assessed the weight status of participants [3], only two studies have investigated the association between YFAS assessed FA and body composition [11,12]. The first of these reported that the prevalence of YFAS assessed FA was higher in individuals with higher percentage body fat (%BF) [11], while the second found no significant differences in %BF between "food addicted" and "non-food addicted" participants, but this study was limited to an overweight/obese sample only [12]. Importantly, neither of these studies have investigated relationships between YFAS assessed FA and visceral adiposity, the fat located around the organs in the abdominal cavity. Visceral fat is a more sensitive indicator of chronic disease risk than BMI and %BF [13] and high levels are associated with a high-risk cardiometabolic profile [10]. Investigating the relationship between FA and particular patterns of fat deposition could provide a better understanding of the association of addictive-like eating with increased health risk. This exploratory study aimed to evaluate potential relationships between YFAS assessed FA and visceral adiposity as well as overall adiposity in young females.

2. Methods

The current study was conducted as part of a broader online survey investigating FA in young adults. Details of the survey are published elsewhere [14]. Briefly, Australian adults aged 18–35 years were recruited to the web-based FA survey via a University media release. Participants were excluded if they were pregnant or not living in Australia. This study was approved by the University of Newcastle Human Research Ethics committee.

The 174-item survey included questions on demographics, the YFAS and dietary intake. The YFAS is a 25-item self-report tool used to assess addictive-like eating in the previous 12-months [5]. The tool uses two predefined scoring outputs: a "symptom score" out of seven, and a "diagnosis" of FA (≥3 symptoms plus satisfying the clinical impairment/distress criteria). At the end of the survey, participants who were geographically located in the Hunter Region, NSW, were invited to attend a voluntary anthropometric measurement session. Prior to the measurement session written informed consent was obtained.

Participants were provided with a standardized set of instructions to prepare for the session (2 h fast plus the avoidance of alcohol for 12 h and exercise for 2 h prior to the session) and had their measurements taken using a standardized protocol. Participant height was measured using the BSM370 Stadiometer and the InBody720 bioelectrical impedance analyzer (BIA) was used to measure body mass and adiposity including visceral fat area, total fat mass and %BF. The InBody BIA uses a small, alternating, multi-frequency current to measure impedance between electrodes placed on the body, and calculates body composition based on the principle that different body tissues have different electrical conductivity [15]. BIA is non-invasive and reduces participant burden associated with other types of body composition equipment [10]. The InBody720 has been shown to display a high level of agreement with dual energy x-ray absorption spectroscopy (DEXA), the gold standard of body composition analysis, in the measurement of body fat mass (ICC females = 0.97, ICC males = 0.93, $p < 0.001$) [15], and compared to computed tomography when measuring visceral fat area ($r = 0.76$) [16]. For the purposes of this paper, analyses were restricted to females to reduce potential variability related to sex-based hormonal differences and fat deposition [17].

2.1. Data analysis

Demographics and anthropometrics were analyzed using Chi squared tests and *t*-tests. The InBody data output was checked for implausible results and no participants were excluded as a result. Pearson correlation coefficients and linear regression models were used to examine the relationships between YFAS symptom scores and adiposity variables. In addition, logistic regression was used to calculate odds ratios for YFAS "diagnosis" according to adiposity variables. The models were adjusted for age as previous research has shown an association between YFAS assessed FA and age [3]. Cohen's *d* was calculated to compare effect sizes across variables [18].

3. Results

Ninety-three female participants with a mean age of 24.3 ± 4.0 years (range 18–35 years) completed all measurements (Table 1). Twenty-one participants met predefined criteria for FA "diagnosis" (22.3%) with the mean "symptom score" for the total sample 2.6 ± 1.7 out of 7. Mean BMI for the total female sample was 24.3 ± 6.0 kg/m^2 and BMI was significantly higher in those who met the criteria for FA "diagnosis" compared to those who did not ($p < 0.001$).

YFAS "symptom scores" were moderately correlated with all adiposity variables ($p \leq 0.003$) (Table 2). Specifically, higher YFAS "symptom scores" were related to higher visceral adiposity when adjusted for age [$r^2 = 0.17$, $\beta = 1.17$, $p = 0.001$]. Effect sizes were interpreted as moderate for all variables including visceral fat, with Cohen's *d* ranging from 0.28–0.34. In addition, increases in cross-sectional area of visceral fat of 10 cm^2 were associated with 13% higher odds of FA "diagnosis" [95%CI (1.03, 1.25), $p = <0.001$].

4. Discussion

This study found that YFAS "symptom scores" predicted higher overall adiposity, notably visceral adiposity. In addition to visceral fat, YFAS assessed FA was associated with elevated BMI and %BF, which is

Table 1
Participant characteristics of the young female sample who completed the anthropometric measurements ($n = 93$) by Yale Food Addiction Scale "diagnosis".

Participant characteristics	Total sample ($n = 93$)	No YFAS "diagnosis" ($n = 72$)	YFAS "diagnosis" ($n = 21$)	*p*
Age	24.3 ± 4.0	24.0 ± 3.8	24.3 ± 4.0	0.31
Indigenous heritage	2 (2.2%)	2 (2.8%)	0 (0%)	0.44
BMI category				
Underweight	3 (3.2%)	3 (4.2%)	0 (0%)	
Normal weight	67 (72.0%)	54 (75.0%)	13 (61.9%)	
Overweight	12 (12.9%)	10 (13.9%)	2 (9.5%)	
Obese	11 (11.8%)	5 (6.9%)	6 (28.6%)	0.047
SES[a]				
Mean SEIFA decile[a]	5.7 ± 2.2	5.8 ± 2.3	5.3 ± 2.0	0.33
SES classification via SEIFA[a]	Moderate	Moderate	Moderate	
Marital status				
Married	14 (15.1%)	11 (15.3%)	3 (14.3%)	
Cohabitating	7 (7.5%)	5 (6.9%)	2 (9.5%)	
Never married	72 (77.4%)	56 (77.8%)	16 (76.2%)	0.92
Qualifications				
School certificate or higher school certificate	48 (51.6%)	36 (50.0%)	12 (57.1%)	
Vocational training	18 (19.4%)	11 (15.3%)	1 (4.8%)	
University degree or higher university degree	27 (29.0%)	25 (34.8%)	8 (38.1%)	0.07
Mean YFAS symptoms	2.6 ± 1.7	2.0 ± 1.4	4.6 ± 1.2	<0.001

BMI = body mass index, SES = socioeconomic status, YFAS = Yale Food Addiction Scale.
[a] Socioeconomic status was calculated using the Socioeconomic Indexes For Areas (SEIFA) where areas of residence are given a score out of 10, with higher scores denoting higher socioeconomic status (Australian Bureau of Statistics, 2011).

Table 2
Relationships between Yale Food Addiction Scale "symptom scores" and adiposity measures in young females.

Variable	Total sample ($n = 93$)	No YFAS diagnosis ($n = 72$)	YFAS diagnosis ($n = 21$)	p[a]	Correlation coefficient	Overall linear regression model [b, c]	β-coefficient [b, c]	95% CI [b, c]	p[b,c]	Cohen's d[c]
Visceral fat area (10 cm^2)	6.7 ± 5.9	5.5 ± 3.3	10.5 ± 10.2	<0.001	0.36; $p < 0.001$	$r^2 = 0.17$; $p < 0.001$	1.17	(0.50, 1.83)	0.001	0.34
Weight (kg)	66.5 ± 17.8	63.5 ± 11.6	76.8 ± 28.8	0.002	0.36; $p < 0.001$	$r^2 = 0.18$; $p < 0.001$	3.44	(1.47, 5.41)	0.001	0.33
BMI (kg/m^2)	24.3 ± 6.0	23.1 ± 3.7	28.2 ± 9.8	<0.001	0.36; $p < 0.001$	$r^2 = 0.20$; $p < 0.001$	1.17	(0.51, 1.83)	0.001	0.33
Fat mass (kg)	20.3 ± 13.3	17.9 ± 8.7	28.4 ± 21.4	0.001	0.36; $p < 0.001$	$r^2 = 0.19$; $p < 0.001$	2.57	(1.10, 4.04)	0.001	0.33
%BF (%)	28.5 ± 9.3	27.1 ± 8.1	33.4 ± 11.4	0.006	0.31; $p = 0.003$	$r^2 = 0.17$; $p < 0.001$	1.51	(0.47, 2.55)	0.005	0.28

BMI = body mass index, %BF = percentage body fat, YFAS = Yale Food Addiction Scale.
[a] p-Value derived from t-tests between YFAS "diagnosis" and no "diagnosis" groups.
[b] Linear regression models for "symptom scores" and adiposity variables.
[c] Model adjusted for age. Unless otherwise specified, results are presented as mean ± SD.

consistent with previous literature [11,12]. The concept of FA as an explanatory factor in the development of obesity remains controversial in the scientific arena [19], which may be due in part to the non-linear relationship between FA and BMI [20], as well as the lack of consistent reward-related neural activation to food cues according to BMI [21]. Although BMI is associated with negative health outcomes and is useful to describe adiposity at the population level, it cannot always discriminate the risk of chronic disease at the individual level [10]. While the association between FA and weight status requires further research, this study extends existing literature by demonstrating a relationship between FA and specific patterns of fat deposition, which may provide more useful insight into an individual's health risk compared to the use of BMI alone.

Certain patterns of fat deposition carry increased risk of negative health outcomes, and higher visceral fat area is strongly associated with cardiometabolic risk factors such as insulin resistance, hypertension and abnormal blood lipid profiles [13]. This study provides preliminary evidence that YFAS assessed FA is associated with greater visceral fat area, which is a more sensitive indicator of health risk than BMI. These findings suggest that individuals displaying addictive-like eating tendencies could be at increased risk of developing chronic health conditions such as type 2 diabetes. This study also dovetails with emerging evidence in the FA field which suggests that energy-dense, processed foods, with high levels of saturated fat and sugars, are likely to be those associated with addictive-like eating [14,22]. Higher dietary intake of certain foods and nutrients, particularly saturated fat, are associated with visceral adiposity [23]. Further investigation is therefore necessary to identify if addictive-like eating is associated with specific dietary factors and predicts the development of health conditions, such as cardiometabolic syndrome.

This was a cross-sectional study and thus causality cannot be conferred. Studies employing longitudinal designs are warranted to examine the relationship between FA and adiposity further. The generalizability of the current study is limited by the predominantly normal weight, young adult, female convenience sample. Although YFAS symptoms appear to be more prevalent in females than males [3], it would be important to replicate this study in males and in a more nationally representative sample. Although BIA is not the gold standard of body composition measurement, the equipment used in this study has been shown to display a high degree of accuracy [15,16]. Future studies could consider the use of other commonly used methods to assess body composition such as DEXA or air displacement plethysmography (e.g. BOD POD) to replicate the findings of the current study.

5. Conclusions

This exploratory study showed that YFAS assessed FA was associated with greater visceral fat area as well as greater overall adiposity in young female adults. This is the first study to demonstrate that addictive-like eating is related to a specific pattern of fat deposition that is a sensitive indicator of increased cardiometabolic risk and could thus help to inform future treatment targets for obesity. Future research is required to investigate whether FA, as assessed by the YFAS, predicts future weight gain over the lifespan and the development of diet-related health conditions.

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Disclosure

The authors declare no conflict of interest.

Author contributions

KMP, TLB and ANG designed the study. KMP conducted the study and analyzed data. All authors were involved in writing the manuscript and had final approval of the submitted and published versions.

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