

Original Article

# Prevalence of 'Food Addiction' as Measured with the Yale Food Addiction Scale 2.0 in a Representative German Sample and Its Association with Sex, Age and Weight Categories

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## Key Words

'Food Addiction' · Yale Food Addiction Scale 2.0 · Underweight · Obesity · Body mass index

## Abstract

**Background/Aims:** To assess the prevalence and correlates of addictive-like eating behavior in Germany. **Methods:** The German version of the Yale Food Addiction Scale (YFAS) 2.0 was used to investigate, for the first time, the prevalence of 'food addiction' in a representative sample aged 18–65 years (N = 1,034). **Results:** The prevalence of 'food addiction' measured by the YFAS 2.0 was 7.9%. Individuals meeting criteria for 'food addiction' had higher BMI and were younger than individuals not meeting the threshold. Underweight (15.0%) and obese (17.2%) individuals exhibited the highest prevalence rate of 'food addiction'. Addictive-like eating was not associated with sex, education level, or place of residence. **Conclusion:** YFAS 2.0 'food addiction' was met by nearly 8% of the population. There is a non-linear relationship between addictive-like eating and BMI, with the highest prevalence among underweight and obese persons. These findings suggest that 'food addiction' may be a contributor to overeating but may also reflect a distinct phenotype of problematic eating behavior not synonymous with obesity. Further, the elevated prevalence of YFAS 2.0 'food addiction' among underweight individuals may reflect an overlap with eating disorders and warrants attention in future research.

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Published by S. Karger GmbH, Freiburg

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## Introduction

Obesity is a pressing public health problem in Germany, with approximately 23–24% of the population currently categorized as obese [1]. Obesity has multifactorial origins, including sedentary lifestyle and the overconsumption of calorie-dense foods [2]. Though there is evidence for factors contributing to the development of obesity (e.g. calorie imbalance, lack of physical exercise, genetic conditions) [3–5], current non-surgical intervention approaches for weight loss have limited long-term success [6]. In an attempt to further elucidate contributors to obesity and eating-related problems, recent studies have examined whether some individuals may experience 'food addiction' [7]. The 'food addiction' construct posits that highly processed foods, with added fats and/or refined carbohydrates, (e.g., pizza, chocolate, sugar-sweetened beverages) may be capable of triggering an addictive-like response in some individuals [8, 9]. 'Food addiction' reflects a substance-based perspective, whereby the potentially addictive nature of highly processed foods interacts with an individual's susceptibility to addiction to result in a phenotype consistent with addictive-like eating [8]. In this article, the terms 'food addiction' and 'addictive-like eating behavior' both reflect this substance-based perspective.

'Food addiction' is controversial [10] given that few studies have yet examined which foods may be addictive [9, 11], though the topic is of growing scientific and public interest [12–15]. In support of the 'food addiction' theory, animal models provide evidence that highly processed foods (e.g., cheesecake, Oreo cookies) or ingredients added to highly processed foods (e.g., sugar) may be capable of triggering biological (e.g., downregulation of dopamine) and behavioral (e.g., bingeing, use despite negative consequences) processes in a manner similar to drug abuse [16–21].

In humans, the Yale Food Addiction Scale (YFAS) [22] is the only validated instrument to operationalize addictive-like eating behavior [23–25] based on Diagnostic and Statistical Manual of Mental Disorders (DSM) criteria for substance use disorders. Recently, a revised version based on the DSM, version 5 (DSM-5), substance-related and addictive disorders (SRAD) criteria was developed and validated (YFAS 2.0) [25]. Generally, approximately 5–10% of individuals in community-based samples exhibit indicators of YFAS 'food addiction' [24, 25], though prevalence is higher among individuals with obesity [26] and binge eating disorder [27, 28]. The YFAS has been translated into multiple languages to assess the prevalence of addictive-like eating behavior worldwide [23, 26, 29].

Previous studies utilizing the YFAS have observed that in some individuals addictive-like processes may contribute to problematic eating behavior via key mechanisms underlying addictive disorders, e.g., greater impulsivity, emotion dysregulation, and elevated craving [30–33]. For example, individuals reporting behavioral indicators of YFAS 'food addiction' exhibit similar patterns of reward-related neural responses when anticipating and receiving a highly processed food (e.g. ice cream) as individuals with substance use disorders with respect to the relevant drug [34]. In summary, individuals who endorse indicators of 'food addiction' on the YFAS may share biological and behavioral characteristics with persons with substance use disorders, and highly processed high-calorie foods appear to be particularly associated with addictive-like eating behavior. Elevated YFAS scores have also been associated with indicators of impulsivity (e.g., negative urgency) [35, 36] and greater endorsement of emotion regulation difficulties on self-report measures [27, 28, 36].

Recently, the YFAS was translated into the German language [37] to evaluate the prevalence and correlates of 'food addiction' in a German sample. Similar to previous studies utilizing the original YFAS [24], this preliminary work observed that 9.7% of individuals met the threshold for 'food addiction' and had an elevated BMI, relative to those who did not meet for a 'food addiction' [37]. However, this previous study had several limitations that reduce

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the generalizability of the findings, such as limited generalizability to the German population, as participants were university students, and an overrepresentation of females (89%). Thus, investigation of the prevalence and associations of addictive-like eating behavior in a more representative German sample is warranted.

The current study aims to address limitations and build upon previous work [37] in two significant ways. First, the present sample uses standard practices for representative research to yield a more demographically representative sample of the German population (e.g., age, gender, education level). Second, a German translation of the most current version of the YFAS 2.0, adapted from the DSM-5 criteria for SRAD, is used to assess addictive-like eating behaviors. The present study aims at examining the prevalence of 'food addiction' in a large, more representative German sample and investigate the correlates of 'food addiction' with weight class and demographic variables (e.g., age, sex). This study is an essential further step in elucidating whether 'food addiction' may have relevance to obesity and eating-related problems in the German population as well as in identifying individual characteristics (e.g., sex) that may be particularly associated with 'food addiction.'

### *Hypotheses*

Based on previous research, it is hypothesized that the prevalence rate of 'food addiction' in the German population is between 5 and 10% [23]. Among persons with obesity, the occurrence of 'food addiction' will be higher compared to those with normal weight [23]. The authors furthermore hypothesize that the occurrence of 'food addiction' is higher among underweight individuals, compared to those with normal weight, as one previous study observed that 'food addiction' prevalence is elevated in eating disorders associated with underweight (e.g., anorexia nervosa) [29]. Consistent with previous literature, we expect that 'food addiction' will be more prevalent among women [22, 24, 25] and negatively related to age [38].

## **Material and Methods**

### *Ethics Statement*

The study was approved by the ethical guidelines of 'Lightspeed-Research' by Taylor Nelson Sofres (TNS) Infratest. The ethical guidelines ICC/ESOMAR were adhered to. Certifications are ISO 20252, ISO 9001 and ISO 27001. Written informed consent was obtained from all participants.

### *Study Sample*

Participants were recruited via the German part of the global panel 'Lightspeed-Research' by Taylor Nelson Sofres (TNS) Infratest, which served as recruiting associate to ensure the representative character of the study. Participants were invited via a personalized link for a self-administered online survey to complete the questionnaire and fill in demographic information (sex, age, height, weight). Individuals (n = 14,086) were electronically invited to participate in the study, and a subset (n = 1,662) clicked on the link. Participants were excluded for having incomplete data (n = 59), the allocated quota for representativeness was achieved (n = 507), not meeting age or education criteria (n = 45), or for providing poor quality data (n = 17). Thus, 1,034 German participants were included into the study. Informed consent was given by the participants in the course of a panel registration, and participants received 20 Eurocents for completing this study, similar to compensation rates for other TNS Infratest studies with this length.

Participants self-reported sex, age, educational level, city size, region, weight, and height (table 1). A quota sample was conducted for sex (male, female), age group (18–29, 30–39, 40–49, 50–65 years), educational level (low/medium, high/higher), city size (up to 20,000, 20,000–100,000, more than 100,000) and region (16 German states). Participants were aged 18–65 years (mean = 41.3 years, SD = 11.9 years, range = 18–63 years), 51% were male, and mean BMI was 26.7 kg/m<sup>2</sup> (SD = 5.8 kg/m<sup>2</sup>, range = 15.6–59.5 kg/m<sup>2</sup>). BMI was used to categorize study participants into different weight classes (defined by WHO with measurement unit (kg/m<sup>2</sup>) [39]). BMI categories are as follows: underweight <18.5 kg/m<sup>2</sup>, normal weight

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**Table 1.** Demographic characteristics of the sample compared to the German population (18–65 years)\*

Demographic characteristics	Study sample (n = 1,036)	German population (58.8 million)
Age, years	41.3	42.7
Sex, %		
Male	51.0	50.4
Female	49.0	49.6
BMI, kg/m <sup>2</sup>	26.7	25.9 <sup>#</sup>
Federal state, %		
Schleswig-Holstein	3.0	3.3
Hamburg	2.0	2.2
Lower Saxony	10.0	9.6
Bremen	1.0	0.8
North Rhine-Westphalia	22.0	21.8
Hesse	8.0	7.5
Rhineland-Palatinate	5.0	5.0
Baden-Württemberg	13.0	13.0
Bavaria	15.0	15.6
Saarland	1.0	1.2
Berlin	4.0	4.5
Brandenburg	2.0	3.0
Mecklenburg-West Pomerania	3.0	2.0
Saxony	5.0	5.0
Saxony-Anhalt	2.0	2.8
Thuringia	3.0	2.7
Size of municipality, %		
<20,000 inhabitants	39.0	40.4
20,000–100,000 inhabitants	28.0	27.4
>100,000 inhabitants	33.0	32.3
Education level, %		
Intermediate/low	66.0	65.4
High (university entrance diploma / university degree)	33.0	34.6
Amount of people within the household, %		
1	24.0	20.9
2	34.0	33.1
3	22.0	21.2
≥4	20.0	24.8
Age groups, %		
18–29 years	23.0	22.0**
30–39 years	19.0	19.0**
40–49 years	27.0	26.0**
50–65 years	31.0	33.0**

\* Data provided by b4p [59].

<sup>#</sup> Data provided by microcensus 2013 (age group 18 – ≥75 years) [60].

\*\* Data provided by world population database by TNS Infratest (internal data).

**Table 2.** Symptoms, illustrative items\* and item count\* (number of questions adding up for each of the symptoms) of the YFAS 2.0

Symptoms	Original example items *	Count
Loss of control	'When I started to eat certain foods, I ate much more than planned.'	3
Unsuccessful cut-down	'I worried a lot about cutting down on certain types of food, but I ate them anyways.'	4
Time spent	'I spent a lot of time feeling sluggish or tired from overeating.'	3
Activities given up	'I avoided work, school or social activities because I was afraid I would overeat there.'	4
Aversive consequences	'I kept eating in the same way even though my eating caused emotional problems.'	2
Tolerance	'Eating the same amount of food did not give me as much enjoyment as it used to.'	2
Withdrawal	'When I cut down on or stopped eating certain foods, I felt irritable, nervous or sad.'	5
Interpersonal problems	'I had problems with my family or friends because of how much I overate.'	3
Impaired daily functioning	'My overeating got in the way of me taking care of my family or doing household chores.'	2
Dangerous situations	'I was so distracted by eating that I could have been hurt (e.g., when driving a car, crossing the street, operating machinery).'	3
Craving	'I had such strong urges to eat certain foods that I couldn't think of anything else.'	2
Clinically significant impairment	'My eating behavior caused me a lot of distress.'	2

\*According to [25].

18.5–24.9 kg/m<sup>2</sup>, overweight 25–29.9 kg/m<sup>2</sup>, obese ≥30 kg/m<sup>2</sup>. Men and women did not differ in age ( $\chi^2$  (42) = 36.04;  $p < 0.73$ ), but men had higher BMI ( $\chi^2$  (714) = 864.69;  $p < 0.001$ ).

#### 'Food Addiction' Assessment

The current version of the YFAS (YFAS 2.0) applies the eleven DSM-5 [40] criteria for SRAD (e.g., craving, continued use despite negative consequences) to the consumption of foods [40]. The YFAS 2.0 is a 35-item self-report questionnaire designed to operationalize indicators of addictive-like eating, based on the eleven DSM-5 criteria for SRAD (table 2 provides an exhaustive list of symptoms). The YFAS 2.0 can be scored on a continuous scale to measure the number of DSM-5 SRAD criteria an individual meets, ranging from 0–11. A second scoring method utilizes a threshold for a YFAS 2.0 'food addiction' 'diagnosis' which can be met by endorsing two or more DSM-5 SRAD criteria when the substance is certain foods, plus clinically significant distress or impairment. Given that the DSM-5 does not recognize 'food addiction' as a SRAD, the term 'diagnosis' in the current paper reflects meeting the described YFAS scoring criteria. Additionally, the term 'YFAS 2.0 food addiction' reflects meeting criteria for this 'diagnostic' threshold. The YFAS 2.0 has demonstrated internal reliability ( $\alpha = 0.90$ ) and convergent validity with other measures of problematic eating [22, 24, 25]. In the current sample the German version of the YFAS 2.0 was used [37], and internal consistency was Kuder-Richardson's  $\alpha = 0.91$ .

**Table 3.** Frequencies of endorsed YFAS 2.0 ‘food addiction’ symptoms, by weight class

YFAS-‘food addiction’ criteria	Underweight		Normal		Overweight		Obese		Total	
	n*	%#	n*	%#	n*	%#	n*	%#	n*	%#
Loss of control	5	25	74	16.9	58	16.1	62	28.8	199	19.2
Unsuccessful cut-down	4	20	49	11.2	50	13.9	58	27.0	161	15.6
Time spent	4	20	45	10.3	29	8.0	42	19.5	120	11.6
Activities given up	6	30	77	17.6	53	14.7	59	18.9	195	18.9
Aversive consequences	5	25	42	9.6	35	9.7	49	22.8	131	12.7
Tolerance	2	10	26	5.9	20	5.5	29	13.5	77	7.4
Withdrawal	3	15	78	17.8	53	14.7	57	26.5	191	18.5
Interpersonal problems	6	30	74	16.9	53	14.7	56	26.0	189	18.3
Impaired daily functioning	4	20	76	17.4	47	13.0	52	24.2	179	17.3
Dangerous situations	4	20	73	16.7	53	14.7	59	27.4	189	18.3
Craving	3	15	43	9.8	31	8.6	37	17.2	114	11.0
Clinically significant impairment	3	15	27	6.2	18	5.0	40	18.6	88	8.5
People overall within the weight class	20		438		361		215		1,034	
‘Food addiction’ within the weight class	3	15	24	5.5	18	5.0	37	17.2	82	7.9

*Statistical Analyses*

To assess whether continuous data (BMI, age, number of symptoms) were normally distributed, Kolmogorov-Smirnov-tests were applied. Differences between individuals with and without YFAS 2.0 ‘food addiction’ were examined with  $\chi^2$ -tests for categorical variables (sex, BMI categories). Spearman’s correlation coefficients were used to examine associations between the number of YFAS 2.0 symptoms and continuous variables (age, BMI).

This analytic approach allowed us to evaluate i) the prevalence of YFAS 2.0 ‘food addiction’ symptoms in the German population and ii) the correlation between sociodemographic and anthropometric variables with addictive-like eating behavior.

**Results**

Scores of BMI (D (1,034) = 0.11,  $p < 0.001$ , skewness = 1.52), age (D (1,034) = 0.11,  $p < 0.001$ , skewness = -0.34) and amount of symptoms (D (1,034) = 0.33,  $p < 0.001$ , skewness = 1.78) differed significantly from normal. Data on educational level, city size, and region did not differ significantly between those who met for a YFAS 2.0 ‘diagnosis’ of ‘food addiction’ and those who did not.

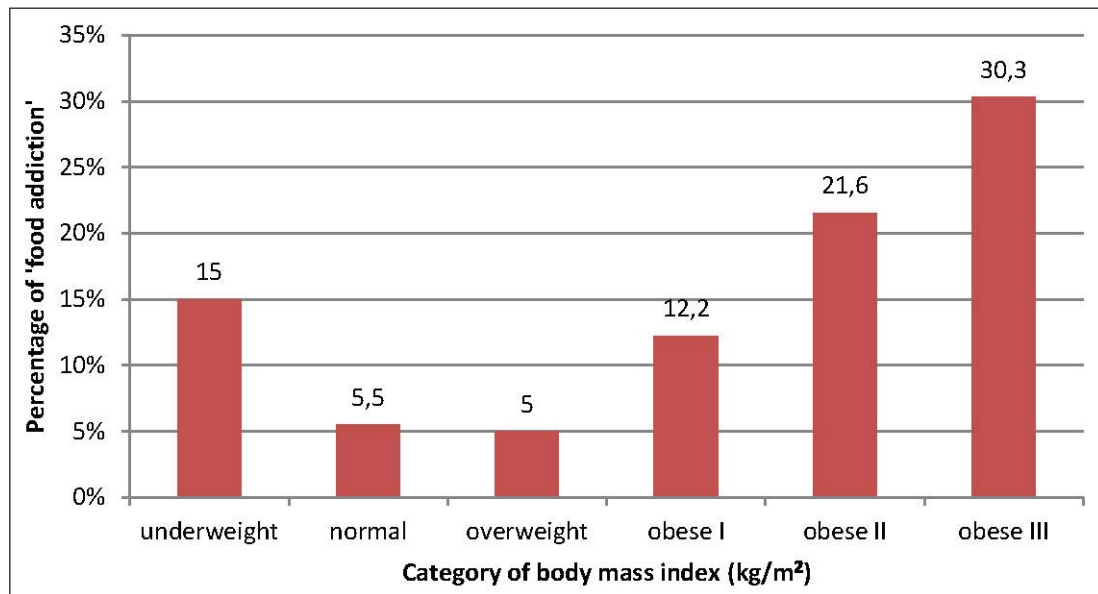
*Prevalence of ‘Food Addiction’*

In the current sample, the mean number of YFAS 2.0 symptoms was 1.69 (SD 2.88, range 0–11, Median 0), and prevalence of YFAS 2.0 ‘food addiction’ was 7.9% (n = 82). Comparisons were drawn between the two categories of ‘food addiction’ and no ‘food addiction’.

*‘Food Addiction’ and Weight Category*

Table 3 shows the breakdown of individuals who met criteria for ‘food addiction’, as assessed by the YFAS 2.0, by weight class. When combining all three obese categories into one, a prevalence of 17.2% of YFAS 2.0 ‘food addiction’ occurred among obese participants. Figure 1 shows the percentage of persons meeting YFAS 2.0 threshold for ‘food addiction’ according to weight category. A significant association was found between BMI and both YFAS 2.0 ‘food addiction’ ( $\chi^2 (3) = 34.61, p < 0.001$ ) and the number of endorsed symptoms





**Fig. 1.** YFAS 2.0 'food addiction' by weight class.

( $r_s = 0.11$ ,  $p < 0.001$ ), such that individuals with higher BMI reported elevated symptoms of 'food addiction'. The odds of meeting criteria for YFAS 2.0 'food addiction' was 3 times higher for underweight and 3.5 times higher for obese, when combined into one category, relative to normal-weight participants.

The association of YFAS 2.0 'food addiction' and symptoms with weight category appears to be best represented with a J-shaped curve (fig. 1), elevated endorsement rates of YFAS 2.0 symptoms ( $M$ ) and greater percentage of individuals meeting the YFAS 2.0 'food addiction' threshold were observed for those categorized as underweight ( $M = 2.3$ ; 15%) and obese grade I ( $M = 2.2$ ; 12.2%), obese grade II ( $M = 3.1$ ; 21.6%) and obese grade III ( $M = 3.5$ ; 30.3%), compared to normal weight ( $M = 1.5$ ; 5.5%) and overweight ( $M = 1.3$ ; 5%).

#### *Symptoms of 'Food Addiction'*

Table 3 furthermore details the prevalence of YFAS 2.0 symptom endorsement in the general sample and according to weight class. In order to preserve clarity within the table, all three obese categories are summed up into one category named 'obese'. Overall, the most frequently met symptoms were as follows: 'loss of control' (19.2%), 'activities given up' (18.9%), and 'withdrawal' (18.5%). The least frequent were 'craving' (11.0%), and 'tolerance' (7.4%). There was variance in symptom endorsement by weight class, with underweight and obese participants endorsing each of the eleven symptoms, as well as clinically significant impairment/distress, more frequently than normal-weight and overweight participants (table 3).

Table 4 illustrates the percentage of individuals with and without YFAS 2.0 'food addiction' that reported each of eleven symptoms, in order to elucidate whether those meeting criteria for YFAS 2.0 'food addiction' exhibit different indicators of addictive-like eating. Among individuals who met the YFAS 2.0 'food addiction' threshold, the most frequent symptoms reported were 'withdrawal' (81.7%) and 'unsuccessful cut-down' (85.4%) as well as 'clinically significant impairment/distress' (100%), though impairment/distress is a required symptom to meet for 'food addiction'. 'Tolerance' (52.5%) and 'craving' (63.4%) were the

**Table 4.** Frequencies of endorsed YFAS 2.0 ‘food addiction’ symptoms, by YFAS 2.0 ‘food addiction’ ‘diagnostic’ categorization

‘Food addiction’ criteria measured by YFAS 2.0	‘Food addiction’		No ‘food addiction’	
	n	%	n	%
Loss of control	64	78.0	135	14.2
Unsuccessful cut-down	70	85.4	91	9.6
Time spent	57	65.5	63	6.6
Activities given up	59	72.0	136	14.3
Aversive consequences	63	76.9	68	7.1
Tolerance	43	52.5	34	3.6
Withdrawal	67	81.7	124	13.0
Interpersonal problems	59	72.0	130	13.7
Impaired daily functioning	56	68.3	123	12.9
Dangerous situations	56	68.3	133	14.0
Craving	52	63.4	62	6.5
<i>Clinically significant impairment</i>	82	100.0	6	0.6

least frequent symptoms among individuals with a ‘food addiction’. Those participants without ‘food addiction’ most frequently endorsed ‘activities given up’ (14.3%), ‘loss of control’ (14.2%), and ‘dangerous situations’ (14%) (table 4).

#### Demographic Data

Women exhibited a greater prevalence of YFAS 2.0 ‘food addiction’ (9.6%) than men (6.3%), though the overall sex difference was not significant ( $\chi^2(1) = 3.74$  ( $p = 0.053$ )). Among underweight participants, only women ( $n_1 = 3$ ) met for YFAS 2.0 ‘food addiction’, and all were classified as severe. Relative to the overall prevalence of YFAS 2.0 ‘food addiction’ in the current sample of 7.9%, individuals between the ages of 18 and 29 exhibited the highest prevalence of YFAS 2.0 ‘food addiction’, which was 13%. Age was negatively correlated with the number of YFAS 2.0 symptoms endorsed ( $r_s = -0.22$   $p < 0.001$ ), meaning younger participants reported increased symptomology.

## Discussion

In a German sample, representing a nationally representative subgroup, 7.9% of individuals ( $n = 82$ ) met criteria for YFAS 2.0 ‘food addiction’. In the current sample, the average number of symptoms endorsed was 1.69 out of eleven. These prevalence rates are consistent with community-sample prevalence rates (5–10%) from previous studies using the original version [23]. Relating this occurrence rate to the total population of Germany, 7.9% represents more than 4 million German adults (of 51.07 million adult Germans in 2014) [41]. Thus, it appears that ‘food addiction’, as measured by the YFAS 2.0, might be a relevant phenotype that may contribute to overeating and elevating rates of obesity and eating-related problems.

#### ‘Food Addiction’ and Weight Category

The odds of meeting the YFAS 2.0 threshold for ‘food addiction’ were higher for persons with either underweight or obesity. Of all surveyed underweight participants, 15% ( $n = 3$ ) met for YFAS 2.0 ‘food addiction’, as did 17.2% ( $n = 37$ ) of all obese participants. On the other hand, merely 5.5% of those classified as normal weight and 5% of all overweight persons met



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YFAS 2.0 criteria. Further, there was a significant association of BMI and YFAS 2.0 'food addiction' and number of YFAS 2.0 symptoms endorsed. Thus, there appears to be a relationship between both low and high BMI and the prevalence of YFAS 2.0 'food addiction'.

The higher YFAS 2.0 'food addiction' prevalence among underweight individuals is unexpected, though consistent with previous work [29]. Notably, in the current study, all three participants with underweight were in the youngest age range (18–29 years old), and their BMIs are within the range for anorexia nervosa according to the DSM-5 [40]. The present findings may reveal an issue regarding the interpretation of the YFAS 2.0 for individuals with restrictive eating behavior. For example, the item 'When I started to eat certain foods, I ate much more than planned' may be endorsed by an individual who restricts their eating or has anorexia nervosa, possibly because the plan was to eat only 100 calories and 200 calories were eaten instead. However, this does not reflect objective overeating that may be endorsed by some individuals with obesity or binge eating disorder. One potential way to reduce variability in interpreting the YFAS 2.0 may be to develop a clinical interview version of the measure, akin to the Eating Disorder Examination [42]. This would allow for exploration of how individuals of varying weight classes conceptualize indicators of addictive-like eating (e.g., consuming more than intended). Based on the present findings, future studies should focus on assessing the validity of the YFAS 2.0 as a measure of 'food addiction' across weight classes, especially in underweight persons.

While obesity and YFAS 2.0 'food addiction' were positively associated, the prevalence rate of YFAS 2.0 'food addiction' was only one in six among obese individuals (17.2%) suggesting that 'food addiction' may be a contributor to some, but not all forms of obesity. Additionally, akin to other studies of 'food addiction' [37, 43], it appears to be prevalent across all weight classes. This suggests that addictive-like eating may represent a unique phenotype of problematic eating behavior that is not synonymous with BMI and obesity. Thus, it will be essential to investigate individual characteristics that contribute to an elevated risk of YFAS 2.0 'food addiction' across weight classes.

#### *Endorsement Rates for 'Food Addiction' Symptoms*

Overall, 'loss of control' (19.2%), 'activities given up' (18.9%), and 'withdrawal' (18.5%) were the three most frequent YFAS 2.0 symptoms endorsed by the current sample.

Loss of control, defined as the frequent consumption of a substance in greater quantities or over longer periods of time than initially intended, appears to be a relevant mechanism in both substance use disorders and eating-related problems like binge eating [40, 44, 45]. In line with the current findings, previous studies have found that 'loss of control may contribute to overconsumption of addictive substances (e.g., alcohol) and certain foods (e.g., high-fat, high-sugar foods) outside the context of a substance use and eating disorder, respectively [46–48]. Thus, loss of control may reflect a more common indicator of problematic eating behavior and may be an appropriate target in interventions.

The second most common symptom was 'giving up important social, occupational, or recreational activities because of eating' (19%). It has been found that individuals match [49] their food intake to the amount eaten by others in social contexts [50] and perceived intake norms exert a strong bi-directional effect on snack food intake [51]. Similarly, in order to escape social pressure, individuals who exhibit addictive-like eating behavior may avoid social settings where certain foods are freely available. Furthermore this symptom was the most frequently scored for individuals who did not meet YFAS 2.0 criteria (14.3%) and underweight participants (30%), which further underscores that this behavior may contribute to subclinical eating-related problems.

The third most commonly reported symptom in the current sample, with 18.5% endorsement, was 'withdrawal'. Given that withdrawal from certain foods (e.g., sugar) has

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only been examined in animal studies with very high dosages [52], this represents an essential area for future research in humans.

The least frequent symptoms reported overall were 'craving' (11.0%) and 'tolerance' (7.4%) (e.g., the need to consume greater quantities of certain foods to achieve a desired effect like reducing negative mood). There has been a long debate about the symptom of craving in the context of addictive disorders [53, 54]. In the field of addictive-like eating, craving has been found as one mediator for specific types of foods, BMI, and binge episodes [55]. In the current study, craving was not highly endorsed by individuals meeting criteria for 'food addiction', as assessed by the YFAS 2.0. As a result, this discrepancy warrants examination in future research. Further, low endorsement rates for tolerance have been observed in previous studies examining prevalence of addictive-like eating, measured by the YFAS [15, 56]. Tolerance to certain foods has not been systematically examined, though one study observed diminished reward responsiveness to consumption of ice cream in individuals who reported frequently eating that food, independent of BMI [34]. Thus, future studies should aim to evaluate whether tolerance may develop to certain foods akin to drugs of abuse.

#### *Demographic Data*

No significant sex differences in the prevalence of YFAS 2.0 'food addiction' were observed, though descriptively, women had higher prevalence than men, which is consistent with previous literature [57]. This may be related to data suggesting that German women exhibiting higher rates of eating-related problems than German men [58].

Age was negatively correlated with the number of endorsed YFAS 2.0 'food addiction' symptoms, with highest endorsement rates between the ages of 18 and 29 (13%). It may be that younger people are more impacted by the modern food environment with abundant availability of calorie-dense food. Research is needed to examine whether individuals meeting criteria for a YFAS 2.0 'food addiction' would benefit from public health initiatives aimed to reduce the influence of the food environment on vulnerable populations, such as implementing restrictions on marketing these foods to younger people or additional taxes.

#### **Limitations**

Although the standard method for representative research was used in the current study, the use of the term 'representative' is an idealization. Thus, while the present results may not directly be generalized to the German population, this study utilizes rigorous methodology to optimize representativeness in research samples.

Anthropometric data of the participants were self-reported and provided by TNS Infratest, but no additional data on physical or psychological conditions were collected, which does not allow the current findings to control for eating disorders (e.g., binge eating disorder) or conditions that may lead to elevated BMI (e.g., medication side effects). This approach also limits the ability to examine the associations between YFAS 2.0 and BMI with other potentially relevant factors like dieting, restraint, weight cycling, or impulsivity. While a strong correlation between eating disorders and addictive-like eating has been observed [23], previous studies have demonstrated that individuals may exhibit YFAS indicators of addictive-like eating without also meeting criteria for an eating disorder and still exhibit clinically significant impairment or distress [27]. Yet, future work is needed to understand the relationship between 'food addiction' and other forms of eating pathology.

Additionally, the current study only examined individuals aged 18–65 years, which limits generalizability of these findings to individuals aged younger or older. Furthermore, the elevated rates of YFAS 2.0 'food addiction' within the BMI category of underweight in the

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present work has to be interpreted with caution, as it might rather reflect symptoms of eating disorders that were not controlled for in this study (e.g., anorexia nervosa). Given that few underweight individuals were included in the current sample, it is difficult to draw conclusions about the potential association between 'food addiction' and low BMI. Further, few studies have been conducted on 'food addiction' concerning underweight people, thus providing only a small data basis for comparative purpose and raising a need for future work. Finally, the present study shows a cross-sectional nature. Therefore no causal statements can be drawn.

## Conclusion

The current study was the first to utilize standard practices for representative research to examine 'food addiction' and its correlates in a large, representative German sample. The present study observed a YFAS 2.0 'food addiction' prevalence of 7.9% for persons aged between 18 and 65 years, which suggests that addictive-like eating may be a relevant construct for approximately 4 million Germans. YFAS 2.0 'food addiction' 'diagnoses' and symptoms were significantly associated with extreme BMI (underweight and obesity) and younger age, and women exhibited a trend-level higher prevalence of YFAS 2.0 'food addiction' than men. Thus, these findings elucidate groups of individuals that might benefit from prevention and treatment efforts for addictive-like eating. This study also presents the need to investigate how items on the YFAS 2.0 may be interpreted differently by individuals with restrictive eating behaviors, relative to those who struggle with overeating. Finally, this work may motivate future research to evaluate the relationship and potential overlap between 'food addiction' and problematic eating behavior, including eating disorders and obesity.

## Author Contributions

Carolin Hauck and Thomas Ellrott designed the study and acquired data. Carolin Hauck, Annegret Weiß, Adrian Meule, Erica Schulte, and Thomas Ellrott played an important role in interpreting the results. Annegret Weiß played the leading part in analyzing the data. Carolin Hauck, Annegret Weiß, and Erica Schulte drafted the manuscript. All authors revised the manuscript and approved the final version.

## Disclosure Statement

This research was funded by a Fellowship provided by 'Institut Danone – Ernährung für Gesundheit e.V.'. The funders had no role in study design, data collection and analysis, decision to publish or preparation of the manuscript. Data collection was performed by Helmut Leopold/TNS Infratest. The authors declared no conflict of interest, despite the research fellowship provided by Institute Danone. The material is original research and has not been previously published or submitted for publication elsewhere.

## References

- 1 Mensink GBM, Schienkiewitz A, Haftenberger M, Lampert T, Ziese T, Scheidt-Nave C: Übergewicht und Adipositas in Deutschland: Ergebnisse der Studie zur Gesundheit Erwachsener in Deutschland (DEGS1). Bundesgesundheitsbl Gesundheitsforsch Gesundheitsschutz 2013;56:786–794.
- 2 Qi L, Cho YA: Gene-environment interaction and obesity. Nutr Rev 2008;66:684–694.
- 3 Bulik CM, Sullivan PF, Kendler KS: Genetic and environmental contributions to obesity and binge eating. Int J Eat Disord 2003;33:293–298.
- 4 Taubes G: Demographics: as obesity rates rise, experts struggle to explain why. Science 1998;280:1367–1368.
- 5 Wright SM, Aronne LJ: Causes of obesity. Abdom Imaging 2012;37:730–732.

- 6 Wadden TA, Butryn ML, Byrne KJ: Efficacy of lifestyle modification for long-term weight control. *Obes Res* 2004;12(suppl):151S–162S.
- 7 Meule A: Back by popular demand: a narrative review on the history of food addiction research. *Yale J Biol Med* 2015;2015:295–302.
- 8 Gearhardt AN, Davis C, Kuschner R, D. Brownell K: The Addiction potential of hyperpalatable foods. *Curr Drug Abuse Rev* 2011;4:140–145.
- 9 Schulte EM, Avena NM, Gearhardt AN: Which foods may be addictive? the roles of processing, fat content, and glycemic load. *PLoS One* 2015;10:e0117959.
- 10 Ziauddeen H, Fletcher PC: Is food addiction a valid and useful concept? *Obes Rev* 2013;14:19–28.
- 11 Pursey KM, Collins CE, Stanwell P, Burrows TL: Foods and dietary profiles associated with 'food addiction' in young adults. *Addict Behav Rep* 2015;2:41–48.
- 12 Smith DG, Robbins TW: The neurobiological underpinnings of obesity and binge eating: a rationale for adopting the food addiction model. *Biol Psychiatry* 2013;73:804–810.
- 13 Davis C, Curtis C, Levitan RD, Carter JC, Kaplan AS, Kennedy JL: Evidence that 'food addiction' is a valid phenotype of obesity. *Appetite* 2011;57:711–717.
- 14 Avena NM, Gearhardt AN, Gold MS, Wang G, Potenza MN: Tossing the baby out with the bathwater after a brief rinse? The potential downside of dismissing food addiction based on limited data. *Nat Rev Neurosci* 2012;13:514; author reply 514.
- 15 Meule A, Gearhardt AN: Food addiction in the light of DSM-5. *Nutrients* 2014;6:3653–3671.
- 16 Avena NM, Rada P, Hoebel BG: Evidence for sugar addiction: Behavioral and neurochemical effects of intermittent, excessive sugar intake. *Neurosci Biobehav Rev* 2008;32:20–39.
- 17 Johnson PM, Kenny PJ: Dopamine D2 receptors in addiction-like reward dysfunction and compulsive eating in obese rats. *Nat Neurosci* 2010;13:635–641.
- 18 Oswald KD, Murdaugh DL, King VL, Boggiano MM: Motivation for palatable food despite consequences in an animal model of binge eating. *Int J Eat Disord* 2011;44:203–211.
- 19 Avena NM, Murray S, Gold MS: Comparing the effects of food restriction and overeating on brain reward systems. *Exp Gerontol* 2013;48:1062–1067.
- 20 Avena N, Bocarsly M, Rada P, Kim A, Hoebel B: After daily bingeing on a sucrose solution, food deprivation induces anxiety and accumbens dopamine/acetylcholine imbalance. *Physiol Behav* 2008;94:309–315.
- 21 Hoebel BG, Avena NM, Bocarsly ME, Rada P: Natural addiction. *J Addict Med* 2009;3:33–41.
- 22 Gearhardt AN, Corbin WR, Brownell KD: Food addiction. *J Addict Med* 2009;3:1–7.
- 23 Meule A, Gearhardt AN: Five years of the Yale Food Addiction Scale: taking stock and moving forward. *Curr Addict Rep* 2014;1:193–205.
- 24 Gearhardt AN, Corbin WR, Brownell KD: Preliminary validation of the Yale Food Addiction Scale. *Appetite* 2009;52:430–436.
- 25 Gearhardt AN, Corbin WR, Brownell KD: Development of the Yale Food Addiction Scale Version 2.0. *Psychol Addict Behav* 2016;30:113–121.
- 26 Pursey KM, Stanwell P, Gearhardt AN, Collins CE, Burrows TL: The prevalence of food addiction as assessed by the Yale Food Addiction Scale: a systematic review. *Nutrients* 2014;6:4552–4590.
- 27 Gearhardt AN, White MA, Masheb RM, Grilo CM: An examination of food addiction in a racially diverse sample of obese patients with binge eating disorder in primary care settings. *Compr Psychiatry* 2013;54:500–505.
- 28 Gearhardt AN, A. White M, N. Potenza M: Binge eating disorder and food addiction. *Curr Drug Abuse Rev* 2011;4:201–207.
- 29 Granero R, Hilker I, Agüera Z, Jiménez-Murcia S, Sauchelli S, Islam MA, Fagundo AB, Sánchez I, Riesco N, Dieguez C, Soriano J, Salcedo-Sánchez C, Casanueva FF, La Torre R de, Menchón JM, Gearhardt AN, Fernández-Aranda F: Food addiction in a Spanish sample of eating disorders: DSM-5 diagnostic subtype differentiation and validation data. *Eur Eat Disord Rev* 2014;22:389–396.
- 30 Murphy CM, Stojek MK, MacKillop J: Interrelationships among impulsive personality traits, food addiction, and body mass index. *Appetite* 2014;73:45–50.
- 31 Pivarunas B, Conner BT: Impulsivity and emotion dysregulation as predictors of food addiction. *Eat Behav* 2015;19:9–14.
- 32 Gearhardt AN: Neural correlates of food addiction. *Arch Gen Psychiatry* 2011;68:808.
- 33 Schulte EM, Grilo CM, Gearhardt AN: Shared and unique mechanisms underlying binge eating disorder and addictive disorders. *Clin Psychol Rev* 2016;44:125–139.
- 34 Burger KS, Stice E: Frequent ice cream consumption is associated with reduced striatal response to receipt of an ice cream-based milkshake. *Am J Clin Nutr* 2012;95:810–817.
- 35 Murphy CM, Stojek MK, MacKillop J: Interrelationships among impulsive personality traits, food addiction, and Body Mass Index. *Appetite* 2014;73:45–50.
- 36 Pivarunas B, Conner BT: Impulsivity and emotion dysregulation as predictors of food addiction. *Eat Behav* 2015;19:9–14.
- 37 Meule A, Muller A, Gearhardt AN, Blechert J: German version of the Yale Food Addiction Scale 2.0: prevalence and correlates of 'food addiction' in students and obese individuals. *Appetite* 2016;DOI: 10.1016/j.appet.2016.10.003.
- 38 Schulte EM, Tuttle HM, Gearhardt AN: Belief in food addiction and obesity-related policy support. *PLoS One* 2016;11:e0147557.

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- 39 World Health Organization (ed): Obesity – Preventing and Managing the Global Epidemic: Report on a WHO Consultation. Geneva, World Health Organization, 2000.
- 40 Association AP: DSM-5 (2013) // Diagnostic and Statistical Manual of Mental Disorders (DSM-5®), 5th ed. Washington, American Psychiatric Publishing, 2013.
- 41 Statistisches Bundesamt.: Bevölkerung – Zahl der Einwohner in Deutschland nach Altersgruppen am 31. Dezember 2014 (in Millionen). <http://de.statista.com/statistik/daten/studie/1365/umfrage/bevoelkerung-deutschlands-nach-altersgruppen/>, Statista. <http://de.statista.com/statistik/daten/studie/1365/umfrage/bevoelkerung-deutschlands-nach-altersgruppen/> (last accessed January 27, 2017).
- 42 Fairburn CG: Cognitive Behavior Therapy and Eating Disorders. New York, Guilford Press, 2008.
- 43 Gearhardt AN, Corbin WR, Brownell KD: Preliminary validation of the Yale Food Addiction Scale. *Appetite* 2009;52:430–436.
- 44 Colles SL, Dixon JB, O'Brien PE: Loss of control is central to psychological disturbance associated with binge eating disorder. *Obesity* (Silver Spring) 2008;16:608–614.
- 45 Koob GF, Ahmed SH, Boutrel B, Chen SA, Kenny PJ, Markou A, Le O'Dell, Parsons LH, Sanna PP: Neurobiological mechanisms in the transition from drug use to drug dependence. *Neurosci Biobehav Rev* 2004;27:739–749.
- 46 Leeman RF, Patock-Peckham JA, Potenza MN: Impaired control over alcohol use: an under-addressed risk factor for problem drinking in young adults? *Exp Clin Psychopharmacol* 2012;20:92–106.
- 47 French SA, Jeffery RW, Sherwood NE, Neumark-Sztainer D: Prevalence and correlates of binge eating in a nonclinical sample of women enrolled in a weight gain prevention program. *Int J Obes Relat Metab Disord* 1999;23:576–585.
- 48 Everitt BJ, Robbins TW: Neural systems of reinforcement for drug addiction: from actions to habits to compulsion. *Nat Neurosci* 2005;8:1481–1489.
- 49 Robinson E, Tobias T, Shaw L, Freeman E, Higgs S: Social matching of food intake and the need for social acceptance. *Appetite* 2011;56:747–752.
- 50 Epel ES, Tomiyama JA, Dallmann MF: Stress and reward: neural networks, eating, and obesity; in Brownell KD, Gold MS (eds): *Food and Addiction: A Comprehensive Handbook*, Oxford, Oxford University Press, 2014, pp 266–272.
- 51 Robinson E, Benwell H, Higgs S: Food intake norms increase and decrease snack food intake in a remote confederate study. *Appetite* 2013;65:20–24.
- 52 Avena NM, Bocarsly ME, Rada P, Kim A, Hoebel BG: After daily bingeing on a sucrose solution, food deprivation induces anxiety and accumbens dopamine/acetylcholine imbalance. *Physiol Behav* 2008;94:309–315.
- 53 Kozlowski LT, Wilkinson DA: Use and misuse of the concept of craving by alcohol, tobacco, and drug researchers. *Addiction* 1987;82:31–36.
- 54 Cherpitel CJ, Borges G, Ye Y, Bond J, Cremonese M, Moskalewicz J, Swiatkiewicz G: Performance of a craving criterion in DSM Alcohol Use Disorders. *J Stud Alcohol Drugs* 2010;71:674–684.
- 55 Joyner MA, Gearhardt AN, White MA: Food craving as a mediator between addictive-like eating and problematic eating outcomes. *Eat Behav* 2015;19:98–101.
- 56 Meule A, Rezori V von, Blechert J: Food addiction and bulimia nervosa. *Eur Eat Disord Rev* 2014;22:331–337.
- 57 Meule A, Vögele C, Kübler A: Deutsche Übersetzung und Validierung der Yale Food Addiction Scale. *Diagnostica* 2012;58:115–126.
- 58 Jacobi F, Höfler M, Strehle J, Mack S, Gerschler A, Scholl L, Busch MA, Maske U, Hapke U, Gaebel W, Maier W, Wagner M, Zielasek J, Wittchen H: Psychische Störungen in der Allgemeinbevölkerung. *Nervenarzt* 2014;85:77–87.
- 59 Gesellschaft für integrierte Kommunikationsforschung mbH & Co. KG: *Berichtsband b4p 2016*. Munich, b4p best for planning, 2016, pp 1–323.
- 60 Statistisches Bundesamt: Mikrozensus – Fragen zur Gesundheit – Körpermaße der Bevölkerung 2013. [www.destatis.de/DE/Publikationen/Thematisch/Gesundheit/Gesundheitszustand/Koerpermasse5239003139004.pdf;jsessionid=4937BFCF1364160F41B8AD46314CF352.cae?\\_blob=publicationFile](http://www.destatis.de/DE/Publikationen/Thematisch/Gesundheit/Gesundheitszustand/Koerpermasse5239003139004.pdf;jsessionid=4937BFCF1364160F41B8AD46314CF352.cae?_blob=publicationFile) (last accessed January 27, 2017).