

Food addiction scale measurement in 2 cohorts of middle-aged and older women^{1–3}

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ABSTRACT

Background: Excess weight is a major threat to public health. An addiction-like tendency toward certain foods may contribute to overeating.

Objective: We aimed to describe the prevalence and associated characteristics in relation to a food-addiction scale in middle-aged and older women.

Design: We examined the prevalence and associated characteristics of a food-addiction scale measure in a cross-sectional analysis of 134,175 women participating in 2 ongoing prospective cohort studies of US nurses.

Results: Overall, 7839 (5.8%) of the women surveyed met the criteria for food addiction measured by using the modified Yale Food Addiction Scale. The prevalence of food addiction was 8.4% in the younger cohort of women aged 45–64 y and 2.7% in the older cohort of women aged 62–88 y. In the multivariate model, body mass index (BMI; in kg/m²) ≥ 35.0 (compared with 18.5–22.9) was associated with food addiction, a prevalence ratio (PR) of 15.83 (95% CI: 12.58, 19.91) in the younger cohort of women, and a PR of 18.41 (95% CI: 11.63, 29.14) in the older cohort of women. Several other demographic characteristics and other factors were associated with the food-addiction measure in both cohorts of women.

Conclusions: To our knowledge, for the first time in a large, US-based population of women, we documented the prevalence of food addiction by using a novel measurement scale in middle-aged and older women. The results may provide insight into the strong association between behavioral attributes of food consumption and the development of obesity. *Am J Clin Nutr* doi: 10.3945/ajcn.113.068965.

INTRODUCTION

The potential contribution of an addictive process to obesity is a topic of growing interest and debate in the scientific community. Behavioral (eg, bingeing and withdrawal) and biological (eg, dopaminergic downgrading and opioid release) indicators of addiction have been identified in animal models of palatable food consumption (1, 2). In humans, obesity and substance dependence are associated with parallel neural mechanisms (3), and some types of disordered eating associated with obesity [eg, binge eating disorder (BED)⁴] are marked by behaviors commonly associated with addiction, namely the loss of control over consumption and continued use despite negative consequences.

Despite the proposed association of addictive-like eating with obesity, it is highly unlikely that all obese individuals are addicted to food. Obesity is a heterogeneous medical endpoint that can

result from a number of factors other than compulsive food consumption (eg, medical side effects and physical inactivity). In addition, an addictive-like eating behavior could be masked by compensatory behaviors. In other words, a normal body weight does not necessarily equate to a healthy relation with food. To more fully assess whether an addictive process is contributing to obesity and other health risks, it is important to operationalize addictive-like eating behaviors. The Yale Food Addiction Scale (YFAS) (4, 5) is a psychometrically sound tool to identify food addiction that translates the substance-dependence diagnostic criteria (6) to apply to the consumption of highly palatable foods (eg, chocolate and French fries). Elevated scores on the YFAS have been linked to more frequent binge-eating episodes (7–9), elevated impulsivity (8), increased depression (7, 8, 10), higher rates of craving (11), reduced weight loss in response to treatment (7), and elevated weight regain after bariatric surgery (12). In addition, addictive eating in both lean and obese participants is related to patterns of neural activation implicated in other addictive disorders (13).

Despite this growing evidence, significant gaps in the literature on food addiction exist. To our knowledge, addictive-like eating has only previously been examined in small, selective populations, such as obese patients seeking treatment of BED. There have been no previous studies of food addiction in large-scale epidemiologic studies, which has limited understanding about the

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⁴ Abbreviations used: BED, binge eating disorder; MET, metabolic equivalent task; mYFAS, modified Yale Food Addiction Scale; NHS, Nurses' Health Study; NHS II, Nurses' Health Study II; PR, prevalence ratio; YFAS, Yale Food Addiction Scale.

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general prevalence of addictive-like eating and its association with obesity and other health-related constructs.

To address this gap in the literature, we explored the construct of food addiction as assessed by using a modified version of the YFAS [the modified Yale Food Addiction Scale (mYFAS)] in the Nurses' Health Study (NHS) and Nurses' Health Study II (NHS II), which are 2 large cohorts of adult women in the United States. In addition, to understand the potential health consequences, we describe the prevalence of food addiction measured by using the mYFAS in relation to demographic characteristics and obesity as well as other known risk factors for chronic disease (ie, physical activity and smoking).

SUBJECTS AND METHODS

Study populations

The NHS cohort was established in 1976 with the enrollment of 121,700 female nurses aged 30–55 y at study entry. Participants completed baseline and follow-up biennial questionnaires to report medical history and health-related behaviors. Detailed data on food addiction were collected in the 2008–2010 questionnaire cycle, at which time participants ranged in age from 62 to 88 y.

The NHS II cohort was established in 1989 with the enrollment of 116,609 female nurses from 14 states aged 25–44 y. Participants completed baseline and follow-up biennial questionnaires, with detailed data on food addiction collected in 2009–2011, when participants ranged in age from 45 to 64 y.

Of 70,328 women in the NHS who completed the full written questionnaire in 2008–2010, 60,886 women (86.6%) provided sufficient data on food-addiction questions and key covariates and were included in the study. A total of 90,486 women in the NHS II completed either the online web-based questionnaire or the written questionnaire in 2009–2011, of whom 73,289 women (81.0%) provided sufficient data for inclusion. Participants who responded to food addiction questions were not substantially different from those who did not with respect to age, BMI, or smoking status.

In 2012, the full YFAS and mYFAS, which was contained within the full YFAS, were administered to a sample of 2061 participants in the NHS II who were selected randomly.

Assessment of food addiction

YFAS

The YFAS is composed of 25 questionnaire items that are used to assess diagnostic criteria for food addiction. The YFAS translates the diagnostic criteria for substance dependence outlined in the Diagnostic and Statistical Manual for Mental Disorders-Text Revision-IV (6) to apply to the consumption of high-fat and -sugar foods. The YFAS provides both a count of food addiction symptoms and a diagnosis of food addiction as scoring options. The diagnostic threshold measure is based on the presence of ≥ 3 (of 7) addiction symptoms in addition to the presence of significant impairment or distress. The initial validation of the YFAS in a nonclinical sample showed the measure to have an adequate internal reliability as well as convergent, discriminant, and incremental validity (4) in addition to validity in relation to BED (14) and neuroimaging (15).

In a sample of 81 obese men and women aged 28–64 y with BED, 57% of the sample met the criteria for food addiction

measured by using the YFAS (16). Subjects with food addiction had significantly higher levels of depression, negative affect, emotion dysregulation, eating disorder psychopathology, and lower self-esteem (16).

mYFAS

We developed the mYFAS for use in large epidemiologic cohorts by adapting the validated YFAS to a core of 9 questionnaire items with 1 question from each of the symptom groups that compose the 7 diagnostic criteria plus 2 individual items that assess the presence of clinically significant impairment and distress, respectively (Table 1).

To assess the psychometric properties of the mYFAS relative to the original YFAS, the mYFAS was computed from the data collected in the original validation study sample of 353 undergraduates, and analyses that were conducted to validate the YFAS were replicated for the mYFAS. As with the validation of the original YFAS (4), this validation consisted of the assessment of the reliability, convergent, discriminant, and incremental validity of the mYFAS.

Assessment of covariates

Ancestry category was self-reported at baseline in 1989 in the NHS II and 1992 in the NHS. The geographic region was assigned according to most recent postal mailing address for the questionnaire. Marital status was by self-report on the concurrent questionnaire.

BMI (in kg/m^2) was ascertained by self-reported height and weight and categorized by using standard WHO categories for healthy weight, overweight, and 3 categories of obesity. The healthy weight range was divided into 2 parts, with a reference category of 18.5–22.9 and a high normal category of 23.0–24.9. Underweight participants (< 18.5) were excluded.

Cigarette smoking status was categorized as current, former, or never. Physical activity was assessed through questions on the average total time per week spent on each of 10 activities over the previous year, a metabolic equivalent task (MET) score was assigned to each activity on the basis of its energy cost (17), and the product of the MET score and time spent per week was used to compute the total MET-hours per week.

Hypercholesterolemia, hypertension, and diabetes were ascertained by self-report of a physician diagnosis, was has previously been shown to be highly valid in this population of nurses (18). Depression was determined by self-report of a clinician diagnosis in the previous 8 y.

With the exception of ancestry (collected in early questionnaire cycles), all covariates were collected concurrently with food addiction measures. Age was derived from the date of birth and date of the questionnaire return.

Statistical analysis

We conducted a cross-sectional analysis of demographic factors and other characteristics in relation to food addiction measured by using the mYFAS. The Cochran-Mantel-Haenszel statistic was used to estimate multivariate-adjusted prevalence ratios (PRs) (19), associated with each characteristic, with the main effect of each a priori-selected covariate adjusted for the main effect of all other covariates and all joint combination interactions of covariates. All estimates were adjusted for age.

TABLE 1 Response frequencies meeting diagnostic criteria for each symptom by using the mYFAS in the NHS (2008–2010) and NHS II (2009–2011)¹

Symptom	Threshold criterion	NHS II criterion met	NHS criterion met
The following question asks about your eating habits in the past year. People sometimes have difficulty controlling their intake of certain foods such as sweets, starches, salty snacks, fatty foods, sugary drinks, and others.			
I find myself consuming certain foods even though I am no longer hungry.	≥4 times/wk	17.8	9.0
I worry about cutting down on certain foods.	≥4 times/wk	22.9	9.0
I feel sluggish or fatigued from overeating.	≥2 times/wk	16.8	5.7
I have spent time dealing with negative feelings from overeating certain foods, instead of spending time in important activities such as time with family, friends, work, or recreation.	≥2 times/wk	10.4	2.2
I have had physical withdrawal symptoms such as agitation and anxiety when I cut down on certain foods. (Do NOT include caffeinated drinks: coffee, tea, cola, energy drinks, etc.)	≥2 times/wk	2.6	0.7
I kept consuming the same types or amounts of food despite significant emotional and/or physical problems related to my eating.	Yes	22.3	15.6
Eating the same amount of food does not reduce negative emotions or increase pleasurable feelings the way it used to.	Yes	17.4	18.4
Clinical significance			
My behavior with respect to food and eating causes significant distress.	≥2 times/wk	9.5	4.0
I experience significant problems in my ability to function effectively (daily routine, job/school, social activities, family activities, health difficulties) because of food and eating.	≥2 times/wk	4.6	1.7
Food addiction by using the mYFAS	—	8.4	2.7

¹All values are percentages. mYFAS, modified Yale Food Addiction Scale; NHS, Nurses' Health Study; NHS II, Nurses' Health Study II.

An age × BMI interaction was not significant ($P > 0.20$) and was therefore left out of additional models.

RESULTS

Validation of mYFAS

We applied the mYFAS to data from the Yale sample of 353 undergraduates whose data were previously reported in the validation analyses of the YFAS (4). In the sample, 9.0% of participants met the criteria for food addiction by using the mYFAS compared with 11.4% of participants who met the threshold in the original validation of the YFAS.

The internal consistency of the 7 symptom questions that compose them in the mYFAS resulted in an adequate internal consistency (Kuder-Richardson $\alpha = 0.75$), which was identical to the internal consistency for diagnostic criteria for the full version of the YFAS (Kuder-Richardson $\alpha = 0.75$).

The convergent validity of the scale was established by exploring the correlation between the mYFAS and emotional eating (20) and eating difficulty (21) scales. Correlations for both the symptom count and diagnostic version of the mYFAS with these measures (range: 0.40–0.50) were similar to those of the original YFAS (0.46–0.61). Correlations for the mYFAS (–0.04 to 0.27) with discriminant measures were also similar to those for the original YFAS (–0.06 to 0.35). The mYFAS diagnostic version ($t = 4.88, \beta = 0.30, P < 0.001$) and mYFAS symptom count ($t = 7.28, \beta = 0.43, P < 0.001$) were also significantly associated with binge-eating scores above and beyond other measures of eating pathology compared with for the original YFAS diagnostic version ($t = 5.05, \beta = 0.33, P < 0.001$) and YFAS symptom count ($t = 9.05, \beta = 0.48, P < 0.001$).

The mYFAS has similar psychometric properties relative to the original YFAS. Thus, the mYFAS likely captured addictive-like eating behavior in a manner similar to the full measure.

Data from the 2012 administration of the YFAS (and the mYFAS contained within it) to 2061 participants in the NHS II who had also answered the 2009 mYFAS showed a strong correlation in scores (Pearson's $r = 0.89$) and internal consistency (Cronbach's coefficient $\alpha = 0.84$).

Food-addiction measures in NHS cohorts

Data on measures of the food-addiction scale were available on 73,466 women in the NHS II (aged 45–64 y) and 60,927 women in the NHS (aged 62–88 y) for a total of 134,393 participants. For each of the diagnostic criteria, the frequency threshold from the original YFAS was used, and all questions were summed for a total score from 0 to 7. The proportion of participants in each cohort who met the frequency threshold for each of the 7 symptoms of food addiction measured by using the mYFAS is shown in Table 1. These proportions ranged from a low of 0.7% for the symptom of withdrawal in the NHS to a high of 22.9% in the NHS II for the symptom of worry about cutting down on certain foods.

Overall, 7839 (5.8%) of the 134,175 women surveyed met the criteria for food addiction. In the NHS II, the prevalence of food addiction measured by using the mYFAS was 8.4%. Demographic characteristics of these women are shown in **Table 2**. Women with food addiction were more likely to be overweight,

TABLE 2

Demographic characteristics and prevalence of food addiction measured by using the modified Yale Food Addiction Scale in 134,411 women aged 45–88 y in the NHS (2008–2010) and NHS II (2009–2011)¹

Characteristics	NHS II		NHS	
	In category	Prevalence of food addiction	In category	Prevalence of food addiction
Age				
45–49 y	15.9	8.0	—	—
50–54 y	31.3	8.5	—	—
55–59 y	34.0	8.8	—	—
60–64 y ²	18.7	7.8	10.5	6.0
65–69 y	—	—	23.6	3.9
70–74 y	—	—	24.5	2.4
75–88 y	—	—	41.5	1.4
Ancestry				
White	92.8	8.5	91.0	2.8
African American	1.3	6.3	1.1	2.3
Hispanic	1.4	7.6	0.6	1.6
Asian	1.5	2.9	0.7	0.9
Other	3.0	8.5	6.6	2.6
Geographic region				
Northeast	31.5	8.1	47.8	2.7
Midwest	32.3	8.8	17.6	3.1
South	20.0	8.7	20.6	2.7
West	16.2	7.8	14.0	2.5
BMI				
18.5–22.9 kg/m ²	24.0	1.3	25.5	0.4
23.0–24.9 kg/m ²	16.2	2.8	18.2	1.0
25.0–26.9 kg/m ²	14.2	4.9	16.1	1.6
27.0–29.9 kg/m ²	16.3	8.4	18.1	2.7
30.0–34.9 kg/m ²	16.4	14.6	15.0	6.1
≥35.0 kg/m ²	12.8	24.7	7.2	11.1
Smoking				
Never	65.5	7.8	45.8	2.4
Former	28.5	10.3	49.1	3.1
Current	6.0	6.4	5.1	1.9
Physical activity				
0–2.9 METs	18.5	13.9	26.9	3.8
3–8.9 METs	19.2	10.1	20.8	2.7
9.0–14.9 METs	13.0	7.9	11.8	2.6
15.0–23.9 METs	15.7	6.8	15.1	2.6
≥24.0 METs	33.7	5.4	25.5	1.8
Hypertension				
No	65.7	6.4	33.6	2.2
Yes	34.3	12.3	66.4	3.0
Hypercholesterolemia				
No	49.3	6.2	25.3	2.1
Yes	50.7	10.5	74.7	3.0
Diabetes				
No	92.9	7.7	86.3	2.5
Yes	7.1	17.3	13.7	4.3
Depression				
No	75.0	5.8	87.2	2.1
Yes	25.0	16.1	12.8	7.3
Relationship status				
Married	78.8	7.8	63.9	2.8
Never married ³	5.2	12.5	—	—
Divorced or separated	13.0	10.5	7.8	4.2
Widowed	3.0	8.3	28.3	2.1

(Continued)

not married, and not currently smoking. In the NHS, which is a sample of older women, the prevalence of food addiction was 2.7%. Demographic characteristics of these women are shown in Table 2. Women with food addiction were similarly more likely to be overweight, not married, and not currently smoking,

Data from both cohorts were combined to provide estimates of food addiction measured by using the mYFAS across the broadest age range (**Figure 1**). From age 45 to 61 y, the prevalence varied only modestly between 7.4% and 9.4%. From age 62 to 70 y, with the curve transition to the NHS, the prevalence decreased steeply to ~2–3% and generally continued to decrease, although less steeply, for women aged 71–88 y.

The prevalence of food addiction was most strongly associated with age and BMI. Therefore, before the addition of age and BMI to a multivariate model of food addiction, these relations were explored in more detail. The prevalence of food addiction jointly by age and BMI categories in combined cohorts is shown in **Figure 2**. The prevalence ranged from a low of 0.3% in women aged 70–74 y with BMI from 18.5 to 23.0 to a maximum of 25.5% in women aged 45–49 y with BMI ≥35.0.

Next, we developed a multivariate prediction model for food addiction measured by using the mYFAS and run separately within each of the 2 cohorts (**Table 3**). BMI was shown to be strongly associated with food addiction in both cohorts. In the NHS II, compared with the reference group BMI of 18.5–22.9, the PR was 2.01 (95% CI: 1.65, 2.44) for BMI from 23.0 to 24.9. In women with BMI ≥35.0, the PR was 15.83 (95% CI: 12.58, 19.91). In older women of the NHS, food addiction was also strongly associated with BMI, ranging from a PR of 2.44 (95% CI: 1.66, 3.60) associated with BMI from 23.0 to 24.9 to 18.41 (95% CI: 11.63, 29.14) in women with BMI ≥35.0 compared with the in reference group. In analyses restricted to women who did not report depression and reported low levels of physical activity, the PR was 8.84 (95% CI: 4.74, 16.50) for women in the NHS II and 12.51 (95% CI: 3.79, 41.30) in the NHS for women with BMI ≥35.0 compared with 18.5–22.9).

The food addiction prevalence varied significantly with ancestry in the NHS II cohort in participants who reported being of African American compared with white ancestry (PR: 0.66; 95% CI: 0.48, 0.92). In the NHS, no association by ancestry was observed, although the prevalence of nonwhite ancestry categories was very low. Geographic region was modestly associated with food addiction in the NHS II in the West region (PR: 1.13; 95% CI: 1.02, 1.24) and the NHS in the South (PR: 1.16; 95% CI: 1.00, 1.36) and West (PR: 1.40; 95% CI: 1.16, 1.69) compared with East regions.

Compared with never smoking, former smoking was positively associated with food addiction in both the NHS II (PR 1.19; 95% CI: 1.12, 1.26) and NHS (1.20; 95% CI: 1.07, 1.36). Current smoking was inversely associated with food addiction in the NHS II (PR 0.69; 95% CI: 0.59, 0.81), although not significantly so in the NHS.

Food addiction was less common in women who were moderately to vigorously active (ie, >3 MET-h/wk), but the association did not vary consistently by the level of activity. Neither hypertension nor diabetes was associated with food addiction in the multivariate model. Hypercholesterolemia was positively associated with food addiction both in the NHS II (PR: 1.17; 95% CI: 1.10, 1.24) and NHS (PR: 1.26; 95% CI: 1.07, 1.48). Depression was positively associated with food addiction in both

TABLE 2 (Continued)

Characteristics	NHS II		NHS	
	In category	Prevalence of food addiction	In category	Prevalence of food addiction
Live alone				
No	88.1	8.0	71.9	2.8
Yes	11.9	11.3	28.1	2.7

¹ All values are percentages. MET, metabolic equivalent task; NHS, Nurses' Health Study; NHS II, Nurses' Health Study II.

² NHS participants in this age category ranged from 62 to 64 y.

³ As a condition of entry into the NHS, all participants were married at the time of enrollment in 1976.

the NHS II (PR: 2.05; 95% CI: 1.93, 2.17) and NHS (PR: 2.60; 95% CI: 2.28, 2.97).

Relationship status was not consistently associated with food addiction in either cohort, although in older women of the NHS, living alone was positively associated with food addiction (PR: 1.44; 95% CI: 1.07, 1.94).

DISCUSSION

In 2 large studies of middle-aged and older women, we showed that the prevalence of food addiction measured by using the validated mYFAS ranged with age from ~1% to 9% and was strongly inversely associated with age and strongly positively associated with obesity. We also showed that other habitual demographic characteristics such as former smoking (positive) and physical activity (negative) were significantly associated with food addiction, with age and BMI controlled for.

The prevalence of food addiction in 45–61-y-old women ranged from 7.4% to 9.4%. This prevalence was similar to that we showed in a sample of Yale undergraduate students by using the mYFAS (9.0%). Taken together, these results suggest that food addiction measured by using the mYFAS affects a fair proportion of young and middle-aged women in the United States. The prevalence of YFAS-measured food addiction has

been reported as 8.8% in a sample of 750 predominantly normal-weight college-aged individuals (22). The withdrawal symptom had the lowest prevalence in both NHS cohorts, resulting in a relatively low contribution to the prevalence of food addiction.

We showed strong positive associations between BMI and food addiction in both cohorts, even in women in the healthy weight range. For example, women with BMI between 23.0 and 24.9 were approximately twice as likely as women with BMI between 18.5 and 22.9 to report food addiction. The association with BMI increased substantially through the range of overweight and obesity. Because this was a cross-sectional analysis, we could not directly infer the temporal relational or causal nature of this strong association. If food addiction measured by using the mYFAS is a contributing cause of overweight and obesity, it represents a potentially modifiable risk factor with possibilities for both clinical and public health intervention. If food addiction occurs in part as a result of excess weight, this relation too would have important clinical implications in the management of patients who are overweight or obese. Long-term, prospective studies are needed to quantify the relation between food addiction measured by using the mYFAS and weight gain over time.

The few previous cross-sectional studies on BMI and food addiction have not shown a consistent, strong, positive association (23). These studies were conducted in smaller populations with limited range in BMI, either predominantly normal weight (4) or morbidly obese (11, 24).

Compared with never smokers, current smokers had a lower prevalence of food addiction, but former smokers reported a higher prevalence of food addiction. These results suggest that food addiction may substitute (25) or act as a replacement for nicotine addiction or vice versa. Again, a longitudinal study of food addiction measured by using the mYFAS in, for example, women who successfully quit smoking could help to provide a better understanding of this relation. The finding could have implications of relevance for the clinical management of both smoking and overeating.

We showed an ~2-fold higher prevalence of food addiction in women who reported depression. This association was consistent

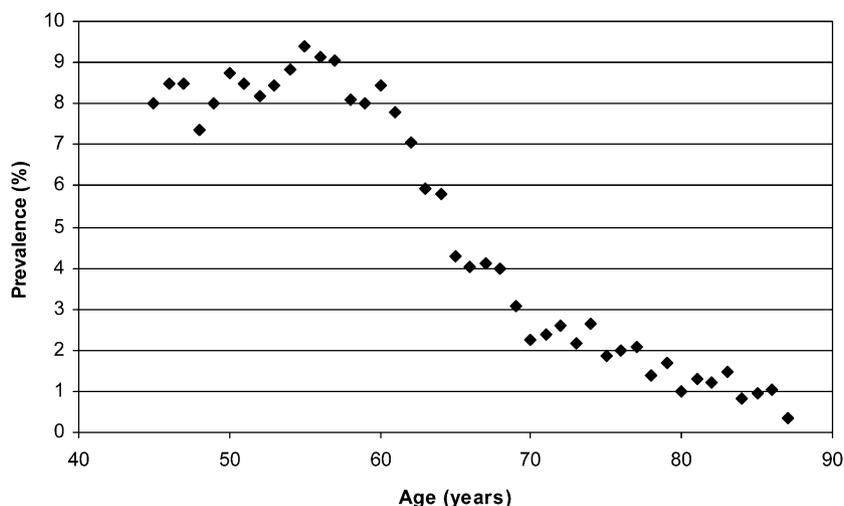


FIGURE 1. Prevalence of food addiction measured by using the modified Yale Food Addiction Scale by age in 134,411 women aged 45–88 y in the Nurses' Health Study (2008–2010) and Nurses' Health Study II (2009–2011).

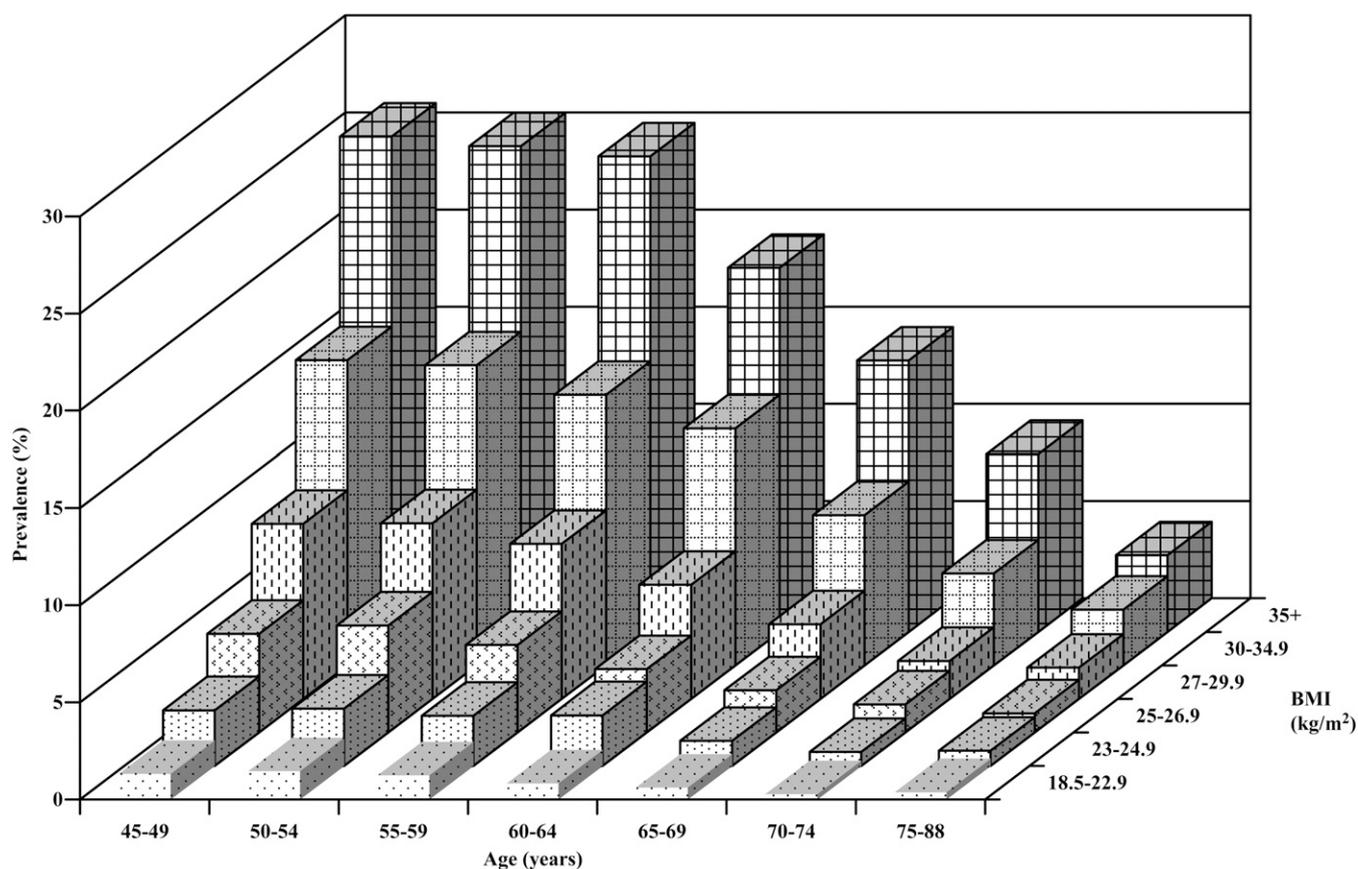


FIGURE 2. Prevalence of food addiction measured by using the modified Yale Food Addiction Scale by age and BMI in 134,411 women aged 45–88 y in the Nurses' Health Study (2008–2010) and Nurses' Health Study II (2009–2011).

with the previously reported high rates of comorbid alcohol and substance addiction in individuals with diagnosed depression (26, 27) and higher rates of depression in obese BED patients who also met YFAS food-addiction criteria (16). Members of our group have also reported an association between a history of child abuse and subsequent food addiction measured by using the mYFAS in the NHS II (28).

Both hypertension and diabetes were positively associated with food addiction, but these relations were not statistically significant after adjustment for covariates, most importantly for BMI. Because BMI is strongly associated with the incidence of both hypertension and diabetes, the attenuation was not surprising. The positive association between food addiction and hypercholesterolemia persisted after multivariate adjustment. If causal, components of the diet or patterns of consumption (1) in women with food addiction that increases risk of dyslipidemia are independent or in addition to the more direct role that diet has on weight gain in women (29).

Basic research in both animals and humans has provided evidence in support of the addictive properties of certain foods. In animal models, there has been evidence of a shared activation of opiate and dopamine systems both by food and drugs of abuse (30–32), and brain imaging has shown similar responses to both food and addictive drugs (33–35). Neuroimaging studies in humans have also identified a number of similarities between obesity and addiction. For example, both obesity and substance dependence have been associated with reduced D2-receptor

availability (34, 36), hyperresponsivity in the mesolimbic dopaminergic system in response to relevant cues (37–41), and reduced activity in the caudate during consumption (42–44). In addition, the *Taq A1* allele of the *DRD2* gene appears to increase risk of both obesity and addiction (42, 45, 46), and a family history of substance-use problems has been associated with increased risk of obesity (47). These neurobiological similarities are mirrored by shared behavioral features of problematic eating behavior and substance-use problems. For example, substance dependence and obesity have both been related to continued use despite a negative consequence, difficult cutting down on consumption, and high rates of relapse (5).

Major strengths of our study included the large number of participants in 2 longstanding and ongoing prospective, epidemiologic studies of women, detailed information on demographic characteristics, and data on food addiction assessed by using a validated measure.

Our study also has some limitations that should be considered. In this cross-sectional design, it was not possible to infer a temporal relation between food addiction measured by using the mYFAS and many of the characteristics we considered. As in any observational study, the possibility of residual or unmeasured confounding could not be eliminated. Our study did not include concurrent measures of other eating disorders, which limited our ability to examine an overlap with food addiction in relation to findings in this population. Our study population, which consisted of female nurses in the United States, was not representative of

TABLE 3
 PRs of food addiction measured by using the modified Yale Food Addiction Scale by covariate category in 134,411 women aged 45–88 y in the NHS (2008–2010) and NHS II (2009–2011)¹

	NHS II		NHS	
	Age adjusted	Multivariate	Age adjusted	Multivariate
Ancestry				
White	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
African American	0.74 (0.58, 0.94)	0.66 (0.48, 0.92)	0.89 (0.55, 1.44)	0.86 (0.45, 1.64)
Hispanic	0.89 (0.72, 1.11)	0.81 (0.57, 1.14)	0.60 (0.27, 1.34)	0.45 (0.16, 1.26)
Asian	0.34 (0.24, 0.48)	0.71 (0.47, 1.06)	0.36 (0.14, 0.96)	0.73 (0.16, 3.30)
Other	1.00 (0.87, 1.15)	1.03 (0.86, 1.23)	0.96 (0.79, 1.16)	0.83 (0.63, 1.09)
Geographic region				
Northeast	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Midwest	1.10 (1.03, 1.16)	1.02 (0.95, 1.09)	1.15 (1.02, 1.31)	1.14 (0.98, 1.33)
South	1.07 (1.00, 1.15)	0.99 (0.92, 1.08)	1.04 (0.92, 1.18)	1.16 (1.00, 1.36)
West	0.97 (0.90, 1.05)	1.13 (1.02, 1.24)	1.05 (0.90, 1.22)	1.40 (1.16, 1.69)
BMI				
18.5–22.9 kg/m ²	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
23.0–24.9 kg/m ²	2.14 (1.81, 2.52)	2.01 (1.65, 2.44)	2.28 (1.67, 3.12)	2.44 (1.66, 3.60)
25.0–26.9 kg/m ²	3.70 (3.17, 4.31)	3.49 (2.87, 4.23)	3.92 (2.92, 5.27)	3.42 (2.39, 4.89)
27.0–29.9 kg/m ²	6.34 (5.51, 7.30)	5.52 (4.63, 6.57)	6.30 (4.77, 8.32)	5.60 (3.93, 7.97)
30.0–34.9 kg/m ²	11.02 (9.63, 12.61)	9.28 (7.78, 11.07)	13.69 (10.44, 17.96)	11.98 (8.26, 17.38)
≥35.0 kg/m ²	18.66 (16.34, 21.31)	15.83 (12.58, 19.91)	24.00 (18.01, 31.98)	18.41 (11.63, 29.14)
<i>P</i> -trend	—	<0.0001	—	<0.0001
Smoking				
Never	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Former	1.33 (1.26, 1.40)	1.19 (1.12, 1.26)	1.28 (1.16, 1.42)	1.20 (1.07, 1.36)
Current	0.82 (0.73, 0.92)	0.69 (0.59, 0.81)	0.69 (0.53, 0.90)	0.77 (0.52, 1.14)
Physical activity				
0–2.9 METs	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
3–8.9 METs	0.72 (0.68, 0.77)	0.93 (0.86, 1.00)	0.64 (0.56, 0.72)	0.92 (0.78, 1.07)
9.0–14.9 METs	0.57 (0.52, 0.62)	0.89 (0.81, 0.98)	0.56 (0.48, 0.66)	0.75 (0.61, 0.92)
15.0–23.9 METs	0.49 (0.45, 0.53)	0.84 (0.76, 0.93)	0.56 (0.48, 0.65)	0.90 (0.75, 1.09)
≥24.0 METs	0.39 (0.36, 0.41)	0.82 (0.75, 0.90)	0.38 (0.33, 0.44)	0.76 (0.63, 0.91)
<i>P</i> -trend	—	< 0.0001	—	0.01
Hypertension				
No	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Yes	1.98 (1.88, 2.07)	1.00 (0.94, 1.07)	1.63 (1.46, 1.82)	0.88 (0.76, 1.02)
Hypercholesterolemia				
No	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Yes	1.73 (1.64, 1.81)	1.17 (1.10, 1.24)	1.61 (1.43, 1.82)	1.26 (1.07, 1.48)
Diabetes				
No	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Yes	2.26 (2.11, 2.41)	0.99 (0.92, 1.08)	1.85 (1.65, 2.08)	0.92 (0.79, 1.07)
Depression				
No	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Yes	2.77 (2.64, 2.90)	2.05 (1.93, 2.17)	3.22 (2.92, 3.55)	2.60 (2.28, 2.97)
Relationship status				
Married	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Never married	1.61 (1.47, 1.76)	0.93 (0.77, 1.12)	— ²	— ²
Divorced or separated	1.36 (1.27, 1.45)	1.06 (0.95, 1.18)	1.41 (1.22, 1.64)	0.75 (0.49, 1.15)
Widowed	1.09 (0.94, 1.26)	0.73 (0.56, 0.93)	1.12 (0.99, 1.27)	0.82 (0.62, 1.07)
Live alone				
No	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Yes	1.42 (1.33, 1.52)	1.09 (0.93, 1.28)	1.25 (1.13, 1.40)	1.44 (1.07, 1.94)

¹ All values are PRs; 95% CIs in parentheses. The Cochran-Mantel-Haenszel statistic was used to estimate PRs. The multivariate model was adjusted for age and the other listed covariates. MET, metabolic equivalent task; NHS, Nurses' Health Study; NHS II, Nurses' Health Study II; PR, prevalence ratio.

² As a condition of entry into the NHS, all participants were married at the time of enrollment in 1976.

the general population, although many previous associations that we have reported in this cohort have mimicked reported associations in nationally representative samples. In addition, the range of key risk factors such as overweight and obesity, physical

activity, and smoking were broad and overlapped with estimates in those of the general US population and have been previously reported in association with important disease endpoints in these cohorts (29, 48–55). Additional work is needed to determine

rates of food addiction in men and other populations with very different educational levels, incomes, or distributions of race and ethnicity.

In conclusion, we report our findings from the first large, US-based epidemiologic study of the prevalence of food addiction measured by using the mYFAS in middle-aged and older women. We showed that food addiction is associated with several demographic characteristics and strongly associated with overweight and obesity. Additional research is needed to better understand potential causal relations between food addiction and chronic disease risk as well as to investigate relations between dietary intake and food addiction. These findings and additional research may yield insight into behavioral factors that contribute to the development of overweight and obesity.

The authors' responsibilities were as follows—AJF: had full access to all data in the study and took responsibility for the integrity of data and the accuracy of the data analysis; AJF, ANG, and EBR: analyzed data, performed statistical analyses, and wrote the manuscript; and all authors: designed and conducted the study. None of the authors had a conflict of interest.

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