Food addiction comorbid to mental disorder

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FOOD ADDICTION COMORBID TO MENTAL DISORDERS

BY
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FOOD ADDICTION COMORBID TO MENTAL DISORDERS

by
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ENGLISH SUMMARY

Background: Food addiction describes an addiction-like attraction to hyperpalatable foods with high content of refined carbohydrates and saturated fat. Hyperpalatable foods are rewarding and have an addictive potential analogue to that of substances of abuse such as alcohol and cocaine. Food addiction can be measured by the self-report Yale Food Addiction scale 2.0 (YFAS 2.0) in adults and by the dimensional Yale Food Addiction Scale for Children 2.0 (dYFAS-C 2.0) in children and adolescents, which are both based on the DSM-5 diagnostic criteria for substance use disorder. Due to the substance of abuse, food addiction is strongly associated with obesity. In individuals with mental disorder, addiction disorders are prevalent, and obesity rates are known to be high. Thus, food addiction is likely to represent a link between mental disorder and obesity. The association between food addiction and self-reported symptoms of mental disorder has been confirmed in previous studies, but only few studies are based on representative samples of individuals with a clinically verified mental disorder.

Aim: The primary aim of this PhD project was to investigate food addiction in adults and adolescents with a clinically verified mental disorder. A secondary aim was to estimate the prevalence of food addiction/dYFAS-C 2.0 score in the general population, which also served as reference for the populations with mental disorder.

Methods: This PhD dissertation is based on the Food Addiction Denmark (FADK) Project, which was conducted as a part of a three-year PhD fellowship at the Research Unit for Child and Adolescent Psychiatry, Aalborg University Hospital, Psychiatry. The FADK Project is a combined survey and register-based study, which was conducted in Denmark in 2018. Random samples of 5000 adults aged 18-62 years, 3529 adolescents aged 13-17 years with a mental disorder, and 5000 adults and 3750 adolescents of the same age from the general population were invited to participate in a web-based survey. The invitees were identified in the Danish Psychiatric Central Research Register and the Danish Civil Registration System, respectively. The compiled FADK questionnaire included Danish versions of the YFAS 2.0 and dYFAS-C 2.0 and other rating scales measuring eating pathology and general psychopathology. Data from Danish nationwide registers on health and socioeconomic aspects were linked to all invitees; this approach enabled attrition analyses and calculation of weighted prevalence estimates for all groups. Furthermore, to ensure the validity of the Danish versions of the YFAS 2.0 and dYFAS-C 2.0, psychometric analyses were conducted.

Results: The psychometric properties of the YFAS 2.0 were sound and confirmed a one-factor model in both adult populations. Food addiction was found to be relatively prevalent (9.4%) in a Danish general adult population, although not nearly as prevalent as in those with mental disorder (23.7%). The prevalence of food addiction varied across the diagnostic categories of mental disorder; it was found to

be particularly high in those with affective disorders, personality disorders, psychotic disorders, and eating disorders. The dYFAS-C 2.0 was a valid and sensitive measure of food addiction symptomatology among adolescents; this was seen in both the general population and in the population with mental disorder. The dYFAS-C 2.0 score was relatively low in the general population, but food addiction symptomatology seemed to be more prevalent in adolescents with psychotic and affective disorders compared to the general population. Food addiction was in general more prevalent in females and was associated with increasing BMI (especially obesity) across age and populations.

Conclusions: The studies presented in this PhD dissertation confirmed that food addiction is highly prevalent in individuals with a clinically verified mental disorder compared to the general population. These findings add to our current understanding of food addiction. Specifically, the studies presented in this dissertation confirm that food addiction often co-occur with other mental disorders. This may lead to obesity and could worsen the severity of the primary mental disorder. These are important avenues for further research, which may help disentangle the complex pathway to obesity in individuals with mental disorders and potentially inform prevention and treatment strategies in the future.

DANSK RESUME

Baggrund: Madafhængighed er et forholdsvist nyt begreb i Danmark. Madafhængighed beskriver en afhængighed af primært højt forarbejdet mad, der har et stort indhold af kulhydrater og mættet fedt. Indtag af højt forarbejdede madvarer er stærkt belønnende, og kan have et afhængighedsskabende potentiale som minder om det der ses ved afhængighed af andre typer af misbrugsstoffer, f.eks. alkohol og kokain. Madafhængighed kan "diagnosticeres" med det selvrapporterede spørgeskema Yale Food Addiction scale 2.0 (YFAS 2.0) til voksne og med Yale Food Addiction Scale for Children 2.0 (dYFAS-C 2.0) til unge, som begge er baseret på DSM-5 kriterierne for stofafhængighed. Studier har fundet en klar sammenhæng mellem madafhængighed og overvægt. Overvægt er hyppigt forekommende blandt individer med psykisk lidelse, desuden er der en høj forekomst af afhængighedslidelser i denne gruppe. Derfor kunne madafhængighed potentielt udgøre et vigtigt bindeled mellem psykisk lidelse og overvægt. Tidligere studier har påvist en sammenhæng mellem madafhængighed og selvrapporterede symptomer på psykisk lidelse, men der er kun ganske få studier som bygger på repræsentative datasæt fra populationer med klinisk diagnosticerede psykiske lidelser.

Formål: Det primære formål med dette ph.d.-projekt var at undersøge udbredelsen af madafhængighed hos voksne og unge med klinisk diagnosticerede psykiske lidelser. Et andet formål var at estimere udbredelsen af madafhængighed/dYFAS-C 2.0 score i den generelle befolkning, som også blev anvendt som kontrolgruppe for populationen med psykisk lidelse.

Metode: Denne ph.d.-afhandling er baseret på data fra Food Addiction Denmark (FADK) projektet, der blev gennemført som en del af et treårigt ph.d.-forløb ved Forskningsenheden for Børne- og Ungepsykiatri i Psykiatrien ved Aalborg Universitetshospital. Projektet omfatter en større spørgeskemaundersøgelse kombineret med data fra de danske registre. I alt 5.000 voksne (alder: 18-62 år) og 3.529 unge (alder: 13-17 år) med en psykisk lidelse blev tilfældigt udtrukket til at deltage i en web-baseret spørgeskemaundersøgelse sammen med 5.000 voksne og 3.750 unge i samme aldersgrupper fra den generelle befolkning. De inviterede blev identificeret i Det Psykiatriske Centralregister og Det Centrale Personregister. Det samlede FADK-spørgeskema inkluderede de danske versioner af YFAS 2.0 og dYFAS-C 2.0 samt andre spørgeskemaer, der kan anvendes til at måle spisepatologi og generel psykopatologi. Data fra de danske nationale registre vedrørende helbredsmæssige og socioøkonomiske aspekter blev koblet til alle de inviterede. Dermed blev det muligt at lave omfattende bortfaldsanalyser og beregne vægtede prævalensestimater - som tog højde for bortfald - for alle grupper. Derudover blev der foretaget en række psykometriske analyser for at sikre en høj validitet af de danske udgaver af YFAS 2.0 og dYFAS-C 2.0.

Resultater: De psykometriske egenskaber for spørgeskemaet YFAS 2.0 var tilfredsstillende, og analyserne bekræftede en en-faktor model i begge populationer af voksne. Madafhængighed blev fundet at være forholdsvist prævalent (9,4 %) i den generelle population af voksne i Danmark, om end betydeligt mere udbredt i populationen med psykisk lidelse (23,7 %). Prævalensen af madafhængighed varierede på tværs af de forskellige diagnostiske kategorier af psykiske lidelser. Den var særligt høj blandt dem, der var diagnosticeret med affektive lidelser, personlighedsforstyrrelser og spiseforstyrrelser. Spørgeskemaet dYFAS-C 2.0 blev også fundet at være et validt og følsomt instrument til måling af symptomer på madafhængighed hos unge i den generelle befolkning og i populationen af unge med psykisk lidelse. Scoren for dYFAS-C 2.0 var forholdsvist lav i den generelle befolkning, men symptomer på madafhængighed syntes at være oftere til stede hos unge med psykotiske og affektive lidelser sammenlignet med den generelle befolkning. Madafhængighed var generelt mere udbredt hos kvinder, og der sås en sammenhæng med højere BMI (særligt overvægt) på tværs af aldersgrupper og de forskellige populationer.

Konklusion: Studierne i denne ph.d.-afhandling bekræfter, at madafhængighed er udbredt blandt personer med en klinisk verificeret psykisk lidelse sammenlignet med den generelle befolkning. Disse resultater bidrager med ny viden til vores nuværende forståelse af madafhængighed. De præsenterede studier viser, at madafhængighed ofte forekommer samtidig med andre psykiske lidelser, hvilket kan føre til overvægt og måske endda forværre den primære psykiske lidelse. Disse fund er vigtige for den fremtidige forskning inden for feltet, da de er med til at belyse nogle af de komplekse mekanismer, der potentielt ligger til grund for udviklingen af overvægt hos personer med psykisk lidelse. Herved kan nye strategier udvikles, som fremover kan sikre bedre forebyggelse og behandling af overvægt hos mennesker med psykisk lidelse.

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ABBREVIATIONS

ADHD	Attention-Deficit Hyperactivity Disorder
ADD	Attention-Deficit Disorder
AIPW	Augmented inverse probability weighting
ANOVA	Analysis of Variance
AUDIT	Alcohol Use Disorder Test
BED	Binge eating disorder
BMI	Body mass index
CFA	Confirmatory factor analysis
CFI	Confirmatory fit index
CPR	Civil registration number
DCRS	Danish Civil Registration System
DPCRR	Danish Psychiatric Central Research Register
DSM	Diagnostic and Statistical Manual of Mental Disorders
ICD	International Classification of Diseases
EDE-Q	Eating Disorder Examination Questionnaire
FADK	Food Addiction Denmark
fMRI	Functional magnetic resonance imaging
NCDS	Non-communicable diseases
PTSD	Post-Traumatic Stress Disorder
RMSEA	Root mean square error of approximation
SCL	Symptom checklist

SCL-92-R	Symptom checklist 92 revised
SD	Standard deviation
SRAD	Substance-related and addiction disorders
SRMR	Standardized root mean square residual
TLI	Tucker-Lewis Index
YFAS 2.0	Yale Food Addictions Scale 2.0 (adults)
YFAS-C 2.0	Yale Food Addictions Scale for Children 2.0 (children)
WHO	World Health Organization

PREFACE

During my training as a young physician, I worked in both adult- and in child and adolescent psychiatry. Quite early, it became apparent to me that not only did the patients struggle with their mental illness; they often also had to deal with overweight or obesity and related diseases. Unfortunately, I found no helpful understanding of this complex problem, nor any treatment.

Obesity and the mechanisms leading to it have had my interest since medical school. My colleague, psychiatrist Ida Kattrup, was aware of this, and she provided me with handouts from an addiction conference presentation by professor Nora Volkow. Here professor Volkow compared results from neuroimaging studies of individuals with obesity to results from similar studies in addiction disorders; the key message being that there were several overlaps. This was my first encounter with the concept of “food addiction”, and it sparked my interest in this field.

My strong interest in the obesity epidemic in general, and my enthusiasm to explore the influence of mental disorders on the physical health (and the contrary), made it obvious to me that my PhD should focus on food addiction in individuals with mental disorder.

PAPERS

This PhD dissertation comprises an overview essay embracing five scientific papers. At the time of the writing of this dissertation, two of the papers have been published. Two are under review, and the fifth paper is in preparation.

I: Horsager C, Østergaard SD, Lauritsen MB. The Food Addiction Denmark (FADK) Project: A combined survey and register-based study. Acta Neuropsychiatrica. 2019;31(6):325-336. doi:10.1017/neu.2019.34

II: Horsager C, Færk E, Lauritsen MB, Østergaard SD. Validation of the Yale Food Addiction Scale 2.0 and estimation of the population prevalence of food addiction. Clinical Nutrition. 2020; 39(9):2917-2928. doi.org/10.1016/j.clnu.2019.12.030

III: Horsager C, Færk E, Lauritsen MB, Østergaard SD. Food addiction comorbid to mental disorder: A nationwide survey and register-based study. *Under review*

IV: Horsager C, Færk E, Gearhardt AN, Østergaard SD, Lauritsen MB. Validation of the dimensional Yale Food Addiction Scale for Children 2.0 and estimation of the dimensional food addiction score in a sample of adolescents from the general population. *Under review*

V: Horsager C, Færk E, Gearhardt AN, Lauritsen MB, Østergaard SD. Food addiction comorbid to mental disorders in adolescents: A nationwide survey and register-based study. *In preparation*

CHAPTER 1. INTRODUCTION

1.1. INTRODUCTION AND OVERALL AIM

To ease the reading of the dissertation, a short introduction to the overall aim of the PhD project is presented here. "Food addiction" describes an addiction to hyperpalatable foods that are highly rewarding and have an addictive potential similar to that of classic psychoactive substances such as alcohol, cocaine, and amphetamine. The "diagnosis" of food addiction can be established by the Yale Food Addiction Scale 2.0 (YFAS 2.0)[1], although this has not yet been formally accepted in the major diagnostic guidelines. The YFAS 2.0 is based on the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5)[2] criteria for substance use disorder, and it represents the only existing measure of food addiction. Due to the substance of abuse, food addiction is highly correlated with obesity.[3] Obesity is linked to several lifestyle-related diseases like cardiovascular diseases, diabetes, and certain cancers, which are again associated with excess mortality.

One of the most important challenges in modern psychiatry is how to address the excess mortality experienced by individuals suffering from mental disorders.[4,5] Specifically, for some mental disorders (especially the more severe disorders, e.g., schizophrenia and severe depression), a reduced life expectancy of up to 10-20 years is seen.[5–7] The high mortality is partly explained by the high obesity rates found in individuals with mental disorder.[5,8–13]

Based on the high degree of comorbidity between mental disorders and addiction disorders,[14–17] and the fact that obesity rates are high in individuals with mental disorder,[12,13] it seems likely that food addiction could be prevalent in this population and could represent a mechanism linking mental disorder and obesity, ultimately causing excess mortality (illustrated in Figure 1).

Therefore, the primary aim of this PhD dissertation was to investigate the hypothesized comorbidity between food addiction and mental disorder to determine whether food addiction is more prevalent in individuals with mental disorders compared to the general population.

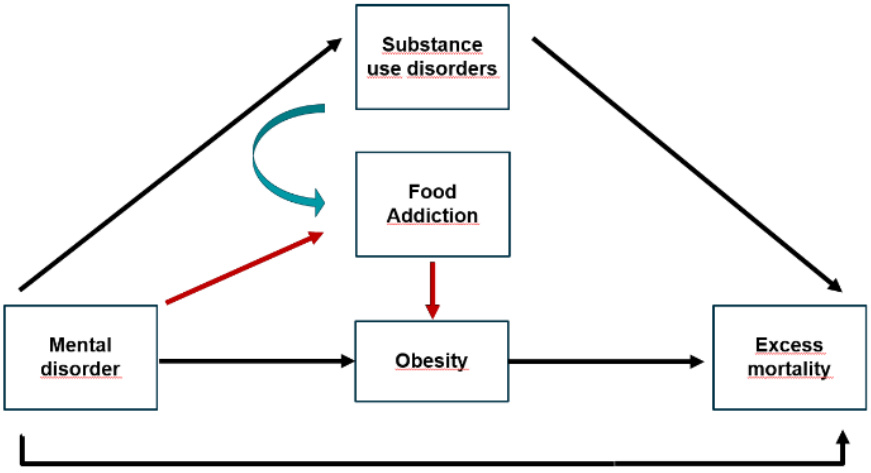

Figure 1. A simplified overview of known relationships (black arrows) between mental disorder and excess mortality, and the hypothesized relationship (red arrows) between mental disorder and food addiction. The turquoise arrow illustrates that food addiction is likely to be related to other addiction disorders.

1.2. BACKGROUND

1.2.1. THE ADDICTIVE FOOD ENVIRONMENT

The prevalence of obesity has risen dramatically since the 1970s.[18,19] This corresponds to more than 650 million adults and 349 million children and adolescents with obesity across the world. The World Health Organization (WHO) estimates that more than 2.8 million people die every year as a result of obesity; this number is higher than the number of deaths from hunger.[19]

The etiological pathways leading to obesity are numerous and complex. One theory that has sought to explain the behavioral aspect of the obesity epidemic is the changing food environment.[20,21] Since the 1960s and 1970s, highly processed foods that are high in refined carbohydrates and/or added fat have become cheap, easily accessible, and heavily marketed all over the world[22,23]. This development has coincided with the beginning of the obesity epidemic.[24] Processed foods are highly rewarding and seem to have an addictive potential resembling that of classical psychoactive substances such as alcohol, marijuana, cocaine, and heroine.[3,25–27]

Evolving evidence suggests that some foods, especially those of high palatability, and conventional substances of abuse have very similar effects on the brain.

Neuroimaging studies in humans and animal studies investigating the addictive potential of food have recently been thoroughly reviewed by Lindgren et al.,[26] Lennerz & Lennerz,[3] and Gordon et al.[28]. A concise and simplified overview of the most important findings is provided in the following, as a thorough review on the neurobiological aspects is beyond the scope of this dissertation.

The consumption of foods is rewarding, partly by activation of mesolimbic dopamine pathways, which is also implicated in drug addiction; this counts especially for foods that are high in sugar and fat (highly palatable foods). In addition, among other neurotransmitter systems, the dopamine system is involved in the prefrontal circuits of decision-making and self-control in relation to food intake as well as the use of conventional drugs. As a result of chronic administration of both highly palatable foods and conventional drugs (resulting in down regulation of especially D2-receptors), the dopamine signals dampens (resulting in tolerance), which may transpire into behavioral changes with excessive and compulsive intake/use of food/drugs.[26] Hardee et al.[29] also found impaired inhibitory control in children and adolescents with excessive intake of food.

Another key mechanism in addiction disorders is cue reactivity/incentive salience. Incentive salience describes the "wanting" or “desire” for a rewarding stimulus and includes motivational factors such as attention, approaching and seeking behavior in response to a certain cue related to the drug of choice. In other words, individuals with an addiction disorder experience increased “wanting”, and not necessarily “liking”, in response to cues associated with the drug of choice. These factors lead to strong cravings and drug seeking with a strong anticipation for the rewarding stimulus to come. Functional magnetic resonance imaging (fMRI) studies have found quite consistent brain activation patterns in relation to drug cues in conventional addiction disorders.[30] These findings have been replicated in obese samples[26] with cues related to hyper-palatable foods.[31,32] Furthermore, it has been found that this heightened “food cue reactivity” was able to predict energy intake and weight gain.[33]

Lastly, as in the case for conventional addiction disorders, it has been suggested that there is an individual proneness towards developing addiction-like overeating. Adams et al. (2019) proposed a “cycle of addiction-like eating”, including an initial vulnerability toward addiction related to the individual’s predefined reward sensitivity, impulsivity and inhibitory control; this makes some individuals at greater risk of experiencing the addictive potential of hyper palatable food.[34] Some studies on the possible underlying genetic characteristics of obesity and the addiction-like consumption of food have been conducted with mixed results. However, this line of research is still at an early stage.[26]

1.2.2. FOOD ADDICTION AND THE YALE FOOD ADDICTION SCALE (YFAS)

Although substance use disorders are characterized by changes in the neural functioning, the Diagnostic and Statistical Manual of Mental Disorders defines substance use disorders as a collection of behavioral, cognitive, and physiological symptoms, and the diagnosis is based on a pattern of pathological behaviors.[2] The diagnostic indicators of addictive disorders (e.g., loss of control, continued use despite negative consequences, intense cravings) are not only exhibited in response to conventional substances like alcohol and cocaine. Commonly, these symptoms are also seen in relation to consumption of highly processed food,[35] which is referred to as food addiction.[1,36–38]

The concept of food addiction dates back to the 19th century.[39] Yet, food addiction was first operationalized by researchers at the Yale University in 2009, therefore named the Yale Food Addiction Scale (YFAS).[1,36] The YFAS was originally based on the DSM-IV criteria for substance-dependence (e.g., loss of control, continued use despite negative consequences, withdrawal, tolerance), and questions were adapted to reflect the use of foods instead of conventional substances. The YFAS 2.0 is based on the DSM-5[2] and was developed in 2013[1] to replace the DSM-IV-based YFAS. In the DSM-5, substance dependence and substance abuse (failure to fulfill role obligations, use in physically hazardous situations, causing interpersonal problems) were merged into a one-dimensional construct. Furthermore, "craving" was included to reflect the preoccupation and anticipation stages of addiction.[2,40]
This means that the diagnostic criteria for substance-related and addiction disorders (SRAD) now include problem-focused symptoms and cover the 11 SRAD criteria: I) consumption of more than planned, II) unable to cut down or stop, III) much time spent, IV) important activities given up, V) use despite physical/emotional consequences, VI) tolerance; VII) withdrawal, VIII) craving, IX) failure in role obligation, X) use despite interpersonal consequences, and XI) use in physically hazardous situations. Two additional items cover the criterion on distress/impairment. Studies have demonstrated that both the YFAS and the YFAS 2.0 have sound psychometric properties, including adequate internal reliability, convergent, discriminant, and incremental validity.[1,36,41,42] Furthermore, the YFAS and the YFAS 2.0 have been validated successfully across different groups of age, populations, study settings, and in several languages.[42–55]

The Yale Food Addiction Scale for Children (YFAS-C) was developed in 2013 to allow for assessment of food addiction in children and adolescents. To ensure that the reading level and described behavior were age-appropriate, the YFAS questions were simplified into a lower reading level with age-appropriate content.[37] The YFAS-C has also shown acceptable psychometric properties.[37,56–58] However, with the adaption of YFAS-C to the DSM-5 and the inclusion of problem-focused symptoms in the food addiction construct, the psychometric properties of the full 35 items of the YFAS-C 2.0 showed to be suboptimal.[59] The suboptimal fit was predominantly caused by a

low endorsement rate (less than 10% of the respondents scored two or more on a certain question/item) of questions on problem-focused symptoms. This is in accordance with research on classic substance use disorders, where adolescents seem less likely to endorse problem-focused symptoms; this is probably due to the fact that adolescents have less responsibilities and role obligations and therefore not (yet) experience these problems.[60] Therefore, a 16-item dimensional version of the scale was developed, excluding the criteria on problem-focused symptoms; namely the dimensional YFAS-C 2.0 (dYFAS-C 2.0).[59] This version has shown promising psychometric features in a study by Schiestl et al. from 2018.[59] This study remains the only study using this dimensional approach.

1.2.3. CLINICAL CHARACTERISTICS OF FOOD ADDICTION

Since the food addiction construct was operationalized by the YFAS, the number of studies on food addiction has increased markedly, covering interdisciplinary research from preclinical animal studies to advanced neuroimaging studies in humans (described in section 1.2.1), clinical studies, and observational studies.[3,26,28,42,61] Across the clinical and observational studies using the YFAS/YFAS 2.0 as measure of food addiction, there are some relatively consistent characteristics related to the food addiction construct. Numerous studies find a preponderance of females with food addiction.[1,53,62–65] Furthermore, food addiction is found to be closely correlated with obesity, which is not particularly surprising due to the substance of abuse; the higher the YFAS total score, the higher BMI[1,43,49–51,53,66–75]. This is also seen in children and adolescents.[37,56,57,59,76] Food addiction has also been investigated in lifestyle related diseases like type 2 diabetes, where positive associations have been reported.[77–81]

It has been investigated whether food addiction and other addiction disorders share certain personality traits like impulsivity, emotional dysregulation, neuroticism, and elevated reward sensitivity.[82,83] Impulsivity (often negative urgency and elevated reward sensitivity)[64,66,84–91] and emotional dysregulation[87,88,91–94] are the most investigated traits and have been found to be common among individuals with food addiction. For instance, Brunault et al. (2018) found neuroticism, conscientiousness, impulsivity, and alexithymia to be more prevalent in bariatric surgery patients who fulfilled the criteria for food addiction.[95]

Generally, eating pathology is also found to correlate with food addiction; binge eating and emotional eating being the most investigated.[49,70,96–100] However, one study found a strong positive association between food addiction and “grazing” patterns of overeating (defined by unplanned and repetitive eating of small to moderate amounts of food throughout the day); this indicates that binge eating is not the only type of compulsive eating pattern.[83] This resembles compulsive use

patterns throughout the day, which are seen in conventional addiction disorders like alcohol addiction.[101]

Traumas such as abuse victimization in childhood and adolescence have also been associated with food addiction. Thus, individuals who have experienced traumas like early-life psychological and sexual abuse seem more likely to fulfill the criteria for food addiction.[63,72,102,103] Moreover, subjective wellbeing and quality of life seem to be affected in individuals with food addiction; they often report significantly lower wellbeing compared to individuals without food addiction.[63]

Finally, some studies indicate that individuals fulfilling the criteria for food addiction prior to bariatric surgery are at greater risk of developing an addiction towards another substance (e.g., alcohol or marihuana) after surgery, so-called "addiction shift".[104] This supports the idea that obesity and overconsumption of foods could "protect" one from evolving other substance use disorders.[105] Studies are, however, sparse, and the findings are inconsistent.[106] Furthermore, weight loss after bariatric surgery may lead to remission of food addiction symptoms.[99,104]

Despite the fairly consistent findings across cultures and countries as well as several overlaps between food addiction and conventional addiction disorders, it is important to note that the construct of food addiction is still a subject of debate, and some authors discuss its legitimacy.[107–109] Recently, Schulte et al. (2020)[110] did a comprehensive review in which they applied the criteria suggested by Blashfield et al. for a new diagnostic category on the food addiction construct. They concluded that a large body of literature support that food addiction may have clinical utility. However, there are still several gaps in the literature, and the authors point to two important focus areas in future research. First, they call for more extensive and qualitative examination of the phenotype of food addiction (via the development of a semi-structured interview). Second, they request further consolidation of the evidence on the addictive potential of hyperpalatable foods.

Taken together, the quite consistent clinical characteristics described above indicate that food addiction may be a clinical useful construct. However, as described initially, most results on food addiction rely on studies with great diversity in design, setting, and participants. In the next section, the current data on food addiction in the general population are covered. This is followed by a section on food addiction among adolescents – a vulnerable neurobiological period with increased susceptibility to addictive substances.

1.2.4. FOOD ADDICTION IN THE GENERAL POPULATION

The prevalence of food addiction in community samples has been estimated to range from 4% to 15% in adults [63,69,71] and from 2.6% to 9% [52,111] in adolescents. The

prevalence varies with country and culture and according to study design. Most studies performed in so-called "community samples" rely on consecutive nonprobability sampling methods, which are restricted to self-inclusion from survey invitations announced through different medias, such as the Internet, newspapers, flyers and by word of mouth. Therefore, there is a great risk of selection bias, and it is likely that these "community samples" are not representative samples from the general population.[61] Two studies have aimed at obtaining more representative samples and generalizable population estimates of food addiction prevalence by using quota-based sampling methods.[69,71] However, as quota-based sampling is nonprobability based,[112] the samples are not random; they are based on a cluster of predefined sociodemographic and economic variables. In addition, data were not available for non-participants; this precludes the opportunity for attrition analysis, which could help inform the extent of selection bias.

A lack of knowledge remains on representative prevalence estimates of food addiction in the general population. Valid population prevalence estimates are needed to inform and implement public health initiatives. Therefore, an important next step in the food addiction field is to obtain more valid population estimates of food addiction. In addition, the examination of food addiction in more representative samples would help expand our current knowledge on the construct of food addiction and further characterize the food addiction phenotype.

1.2.5. FOOD ADDICTION IN ADOLESCENCE

Adolescence is a vulnerable neurobiological developmental period with increased susceptibility to the addictive potential of psychoactive substances. This can partly be explained by an imbalance between a more rapidly developing reward system and a slower developing executive control system.[113–115] Furthermore, exposure to addictive substances early in development increases the likelihood of problematic patterns of use.[116] In the modern food environment, the exposure to hyperpalatable food typically begins in utero and continues to be consumed regularly – often on a daily basis – even very early in childhood.[117] Thus, adolescents have been regularly exposed to potentially addictive foods for years prior to reaching this developmental stage. In addition, adolescents are likely to be very sensitive (through reward mechanisms in the brain circuits) to commercials for fast food and likely to overconsume fast food after exposure.[118] In a world full of food stimuli, the immature brain of adolescents is likely to be at great risk of getting addicted to these highly processed foods.

The lack of studies using representative samples also applies to children and adolescents.[37,52,57,58,119–121] Likewise, data on food addiction in adolescents from the general population are sparse. For these reasons, it is highly relevant to investigate the emergence of addiction to highly rewarding foods in this population in general,

and to investigate the construct in a potential high-risk population with mental disorder. Studies in this age group could provide important information on the emergence and trajectories of food addiction and help determine if adolescents with mental disorder are at higher risk of developing food addiction.

1.2.6. MENTAL DISORDERS, ADDICTION, AND OBESITY

It is well known that addiction disorders often co-occur with mental disorders.[14–17] When addiction disorders accompany (other) mental disorders, the prognosis of the primary mental disorder tends to worsen significantly. Depending on the type of drug, this can be manifested by exacerbation of the symptomatology of the primary mental disorder. Furthermore, the co-occurrence of an addiction disorder with (other) mental disorders is associated with elevated risk of physical diseases[16,122–124]; all with a resulting excess mortality compared to individuals without a dual diagnosis.[9,16] Likewise, it has been suggested that obesity co-occurring with mental disorders could worsen the latter, and that obesity could increase the likelihood of suffering from a mental disorder.[125,126] Moreover, suffering from a mental disorder may increase the likelihood of experiencing obesity.[125] The link between obesity and mental disorder may thus be bidirectional, or even unidirectional in the direction from obesity to mental disorder.[127] The suggested profound connection between obesity, metabolism and psychopathology[125,128] underscores the importance of investigating the underlying mechanisms that lead to obesity in individuals with mental disorder.

Besides the potential association between obesity and psychopathology, there are other important consequences of the high obesity rates[12,13] found in individuals with mental disorder. Obesity is among the most important and preventable risk factors for non-communicable diseases (NCDs).[129] NCDs comprise a group of health conditions (e.g., cardiovascular diseases, diabetes, and cancer) that are responsible for a large part of the global disease burden, accountable for around 71% of all deaths globally.[130] Therefore, NCDs are also likely to be an important contributing cause of excess mortality in individuals with a mental disorder.[13,129] Because most NCDs are preventable, and an important risk factor is obesity, the exploration of alternative mechanisms are required to help understand the high prevalence of obesity in individuals with mental disorder.

Based on the high obesity rates found in individuals with mental disorder and the high degree of comorbidity with addiction disorders, it would be plausible to hypothesize that food addiction is a prevalent comorbid condition to mental disorders and may represent a potential link between mental disorder and obesity.

1.2.7. FOOD ADDICTION AND MENTAL DISORDERS

Depression, anxiety and eating disorder symptomatology are among the most investigated symptoms of mental disorder in relation to food addiction. A review and meta-analysis by Burrows et al.[131] (2018) examined food addiction in relation to self-reported mental health symptoms. The meta-analysis showed moderate associations between food addiction and depression (0.459 (95%CI: 0.358;0.550)), anxiety (0.483 (95%CI: 0.228;0.676)), and binge eating (0.602 (95%CI: 0.557;0.643)). The relatively consistent correlation between food addiction and self-reported symptoms of depression and anxiety has also been replicated in more recent large-scale studies from Brazil[63] and six Asian countries,[132] and in one study where individuals with symptoms of major depressive disorder were identified via a clinical interview.[133] The association between food addiction and symptoms of depression has also been reported to be present in adolescents.[58,121,134]

A relatively large overlap seems to exist in the symptomatology of eating disorders and food addiction, and food addiction has often undergone investigation in populations with eating disorder.[51,85,89,135–138] One quite consistent finding is the association between food addiction and bingeing sub-types of eating disorders, such as bulimia nervosa and binge eating disorder (BED).[51,86,137,139] Especially the overlap between food addiction and BED is widely discussed. Some authors argue for two different syndromes[62] based on the differences in symptoms, e.g., preoccupation with weight and shape in BED, and withdrawal, tolerance, and the importance of the type of food (hyperpalatable) in food addiction. Others argue that food addiction comorbid to BED represents a more pathological extreme of BED.[140,141] Based on eating pathology, personality traits, BMI, and psychopathology, Jiménez-Murcia et al.[138] identified three phenotypes of food addiction. The most dysfunctional phenotype was characterized by more severe eating pathology (bulimia nervosa and "other specified feeding and eating disorder"), psychopathology in general (symptoms of psychosis, depression, interpersonal sensitivity, anxiety, and paranoia, all measured by the SCL-90-R), and more dysfunctional personality traits. This is in line with existing evidence, suggesting that food addiction in eating disordered individuals seems to predict more severe eating pathology and psychopathology in general.[135,138,142,143]

Food addiction has also been studied in relation to other mental disorders. In a population with attention deficit hyperactivity disorder (ADHD)[144] diagnosed through a clinical interview and in two studies with self-reported symptoms of ADHD,[86,145] food addiction was found to associate with ADHD symptomatology. Furthermore, few studies have investigated whether individuals with post-traumatic stress disorder (PTSD) symptoms were more likely to have food addiction; all studies found significant associations.[91,146,147] This parallels with the association found between food addiction and lifetime traumas. Food addiction has also been studied sparsely in psychotic disorders; Goluza et al. (2018) [148] examined food addiction in

outpatients with a diagnosis of schizophrenia (and in treatment with clozapine) and found a prevalence of food addiction in 26.9% in the sample. Kucukerdonmez et al. (2019)[149] also investigated food addiction in outpatients with a diagnosis of schizophrenia. However, they found the prevalence of food addiction to be considerable higher, i.e., 62.9%. Among adolescents with a first episode of psychosis, Teasdale et al.[150] found that 50% fulfilled the criteria for food addiction.

Taken together, although the existing body of research suggests that food addiction is a prevalent condition among individuals with mental disorders, most studies are affected by two major limitations. First, most studies rely on self-reported measures of mental disorder[131], which holds a significant risk of information bias. Second, most studies have no information on the sociodemographic and economic characteristics of non-participants, which hinders analysis of attrition. Furthermore, the majority of studies are based on self-selected samples, which rules out the opportunity to identify the source population and increases the risk of selection bias.

To obtain more valid prevalence estimates of food addiction among individuals with mental disorders, we conducted the FADK Project. This project used register-based data on all invitees, which enabled comprehensive attrition analyses and estimation of weighted prevalence of food addiction. Moreover, the study populations were randomly sampled. In chapter 2, the aims and hypotheses of the project are further described.

CHAPTER 2. AIMS AND HYPOTHESES

Denmark has a longstanding tradition for combining survey data with demographic, socioeconomic and health data from nationwide registers.[151] Furthermore, the Danish registers allow for random sampling from the entire population, including nationwide samples from the general population and from defined clinical populations. Consequently, Denmark is likely to represent an almost ideal setting for a study aiming I) to attain valid population estimates of food addiction in the general population, and II) to estimate the prevalence of food addiction in well-defined populations with a mental disorder. Accordingly, those were the aims of the Food Addiction Denmark (FADK) Project.

2.1. AIMS AND HYPOTHESES

2.1.1. FOOD ADDICTION IN THE GENERAL ADULT POPULATION AND IN ADULTS WITH MENTAL DISORDER

Hypothesis: *Food addiction is more prevalent in individuals with a mental disorder compared to the general population.*

To allow for examination of this hypothesis, some preceding steps were completed:

I. Translation and validation of the Danish YFAS 2.0 in both the general population and in adults with mental disorder.

II. Conduction of a comprehensive attrition analysis using demographic, socioeconomic, and health register data on both respondents and non-respondents to evaluate the generalizability of the results (selection bias).

III. Calculation of a weighted prevalence estimate of food addiction in the general population and in adults with mental disorder.

IV. Comparison of the prevalence of food addiction between the general population and the adults with mental disorder, and examination of food addiction prevalence across diagnostic categories of mental disorders.

2.1.2. FOOD ADDICTION IN THE GENERAL ADOLESCENT POPULATION AND IN ADOLESCENTS WITH MENTAL DISORDER

Hypothesis: *Food addiction is more prevalent in adolescents with a mental disorder compared to adolescents from the general population*.

As no dichotomized version of the YFAS-C 2.0 is available for adolescents, we used the mean dYFAS-C 2.0 score to evaluate the food addiction "symptom load" in the two populations. Specifically, the following steps were carried out:

I. Translation and validation of the Danish dYFAS-C 2.0 in both the general adolescent population and in adolescents with mental disorder.

II. Conduction of a comprehensive attrition analysis using demographic, socioeconomic, and health register data on both respondents and non-respondents (and their parents) to evaluate the generalizability of the results (selection bias).

III. Calculation of the weighted mean dYFAS-C 2.0 score in the general adolescent population and in adolescents with mental disorder.

IV. Comparison of the weighted mean dYFAS-C 2.0 score between the general adolescent population and adolescents with mental disorder, and examination of the weighted mean dYFAS-C 2.0 score across diagnostic categories of mental disorders.

CHAPTER 3. METHODS

The methods section consists of the publication “The Food Addiction Denmark (FADK) Project: A combined survey- and register-based study” (Paper I)[152] and a supplementary methods section (3.1 “Additional methodological considerations“).

The supplementary material for Paper I is available in Appendix E and Appendix F.

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Protocol

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The Food Addiction Denmark (FADK) Project: a combined survey and register-based study

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Abstract

Background: Obesity represents a tremendous global health problem. Studies over the past decade have suggested that food addiction (FA), that is, physical cravings for certain foods – high in fat/sugar – and addiction-like overeating of these types of food, is a likely contributor to the obesity epidemic. While FA has been studied extensively, there are some significant gaps in the literature that need to be addressed: (I) Most estimates of the prevalence of FA are based on nonprobability sampling, which significantly limits the representativeness of the prevalence estimates. (II) Although addiction disorders are prevalent among individuals with mental disorders, large studies of FA among patients with clinically diagnosed mental disorders are lacking. (III) Most addiction disorders are heritable, but the familial transmission of FA remains virtually unknown. (IV) Due to a relative lack of longitudinal studies, little is known about the risk factors for and outcomes of FA. To close these gaps in the literature, we designed the Food Addiction Denmark (FADK) Project. *Methods*: The FADK study is a nationwide survey with retrospective and prospective register-based elements. Four randomly sampled cohorts were invited to participate in the survey: 5000 adults and 3750 adolescents from the general population and 5000 adults and 3529 adolescents with a mental disorder. The FADK questionnaire includes the Yale Food Addiction Scale 2.0 and rating scales measuring psychopathology. Data from Danish health and socio-economic registers will be linked to all invitees. *Discussion:* We expect that the FADK Project will contribute significantly to our understanding of FA.

Perspectives

- The Food Addiction Denmark (FADK) study will combine a rich dataset on food addiction with additional data from the Danish Registers on health and socio-economics, thus enabling a comprehensive attrition analysis.
- The study design and the use of Danish registers will provide a unique opportunity to gain more knowledge of food addition, including familial transmission, risk factors, and outcomes of food addiction.
- Food addiction seems to be a prevalent comorbidity to mental disorders, meaning that food addiction could be a link in the chain from mental disorders through obesity to excess mortality in some individuals.

Limitations

- The use of self-reported data on food addiction and body mass index (BMI) is associated with risk of information bias.
- Only cross-sectional measures of food addiction and BMI will be collected.
- Since not all invitees will participate in the study, there is a risk of selection bias. However, the attrition analyses will show whether the study results can be generalised to the populations from which the invitees were randomly drawn.

Background

Obesity rates continue to increase steeply, and more people worldwide now die from obesity than from hunger (World Health Organisation 2019). Hunger, satiety, and hormonal control of energy homeostasis no longer seem to play the leading role in controlling energy intake

(Tomasi & Volkow, 2013; Volkow *et al.*, 2013, 2017; Lennerz & Lennerz, 2018; Lindgren *et al.*, 2018). Indeed, it is becoming increasingly evident that our surroundings and the changing food environment are altering our brain and behaviour (Murray *et al.*, 2014) and that more interest should be devoted to this phenomenon to understand the rising obesity epidemic.

A prevailing theory potentially explaining part of the behavioural aspect of the obesity epidemic is the so-called 'food addiction' hypothesis, which claims that exposure to particular foods alters the brain and gives rise to addiction-like overeating (Volkow *et al.*, 2017; Lindgren *et al.*, 2018). Indeed, 'hyperpalatable' foods high in sugar and fat seem to have an addictive potential similar to that of conventional addictive drugs, at least in some individuals (Schulte *et al.*, 2015; Gordon *et al.*, 2018; Schulte *et al.*, 2019). To operationalise and delineate the food addiction phenotype, the self-reported Yale Food Addiction Scale (YFAS) was developed in 2009 (Gearhardt *et al.*, 2009). Originally, the YFAS was designed for adults; later, in 2013, a version for children (the YFAS-C) was developed (Gearhardt *et al.*, 2013). Since the development of the YFAS, the body of literature on food addiction has increased markedly and now includes hundreds of studies covering preclinical (animal models), clinical/experimental, and epidemiological studies (Pursey *et al.*, 2014a; Lindgren *et al.*, 2018; Gordon *et al.*, 2018; Penzenstadler *et al.*, 2018).

Despite the increased and interdisciplinary research interest in food addiction, there are substantial gaps in the literature that should be addressed to provide a better understanding of this phenotype. Specifically, the following four areas are in need of more attention:

The representativeness of populations used for prevalence estimates of food addiction

The prevalence of food addiction in general populations has been estimated to range from approximately 4% to 15% in adults (Hauck *et al.*, 2017; Nunes-Neto *et al.*, 2017; Schulte & Gearhardt, 2018) and from 2.6% to 9% (Chen *et al.*, 2015; Mies *et al.*, 2017) in adolescents. However, most studies rely on consecutive nonprobability sampling methods that are restricted to self-selected participants responding to survey invitations announced on the Internet or in public places. These 'community samples' are therefore not representative of the general population (Penzenstadler *et al.*, 2018). To overcome this problem, a few studies have used quota-based sampling methods to obtain more representative samples (Hauck *et al.*, 2017; Schulte & Gearhardt, 2018). However, as the applied approaches are nonprobability based, sampling is not random, and data for nonparticipants are not available. Hence, the results of these studies are likely biased due to self-selection to an extent that cannot be determined due to the unavailability of data describing nonparticipants.

Moreover, in order to make more representative socio-demographic characterisations of individuals with food addiction, it is necessary to study the phenotype in the general population. Also, knowing the true prevalence of food addiction at the population level is a fundamental requirement for informing potential public health initiatives.

The association between socio-demographic factors and food addiction has been investigated in several studies with somewhat mixed findings. The majority of the studies, most frequently conducted in clinical or self-selected community samples, found no association between food addiction and the investigated socio-demographic variables (with the exception of age and sex) (Berenson *et al.*, 2015; Ceccarini *et al.*, 2015; Burrows *et al.*, 2017; Hauck *et al.*, 2017; Nunes-Neto *et al.*, 2017). One study found that food addiction was more prevalent among individuals who were younger, who were Hispanic, and/or who had higher income (Meule *et al.*, 2017). However, the socio-demographic data were self-reported, thereby introducing a substantial risk for report bias.

Comorbidity of food addiction with (other) mental disorders

Due to the fact that (i) the association between mental disorder and obesity is well known (Simon *et al.*, 2006; Luppino *et al.*, 2010; Manu *et al.*, 2015; Hanć & Cortese, 2018; Reilly-Harrington *et al.*, 2018; Chao *et al.*, 2019), and (ii) addiction is a prevalent comorbidity to mental disorders, irrespective of the type of mental disorder or abused substance (Regier *et al.*, 1990), it seems reasonable to assume that the proneness to addiction among individuals with mental disorders applies to food addiction as well. If confirmed, this association could support the existence of a chain going from mental disorder via food addiction and obesity to excess mortality among some individuals with mental disorders (Walker *et al.*, 2015; Bhaskaran *et al.*, 2018). Several studies have found that food addiction is associated with a range of self-reported mental health symptoms, especially depressive symptoms and eating disorder symptoms (Burrows *et al.*, 2018). However, there is a lack of studies on food addiction among individuals with clinically verified mental disorders across the diagnostic spectrum.

Familial transmission of food addiction

It remains to be clarified whether food addiction should be considered a valid psychiatric entity. To encapsulate the validity of psychiatric constructs, Robins and Guze (Robins & Guze, 1970) defined five criteria. One criterion requires familial transmission of mental disorders as a prerequisite for a psychiatric construct to be valid. To date, only one study has investigated food addiction in both children and parents; it reported a positive association between the YFAS symptom scores of parents and children (Burrows *et al.*, 2017). Thus, further studies are needed to determine the degree of familial transmission of food addiction.

Trajectories of food addiction

While there are numerous cross-sectional studies of food addiction, longitudinal studies (both retrospective and prospective) are sparse. Thus, knowledge of the risk factors for developing food addiction is limited. Knowing the risk factors for a disorder is a prerequisite for identifying individuals at risk and for targeting interventions aimed at preventing progression to pathology. Furthermore, due to a relative lack of prospective data from individuals with food addiction, its long-term consequences are virtually unknown.

To cast further light on the four aspects outlined earlier, we designed the Food Addiction Denmark (FADK) Project, which is described in further detail here.

Methods/Design

Study design and setting

The FADK study was designed as a survey with associated retrospective and prospective epidemiological elements. The design of the study is illustrated in Fig. 1.

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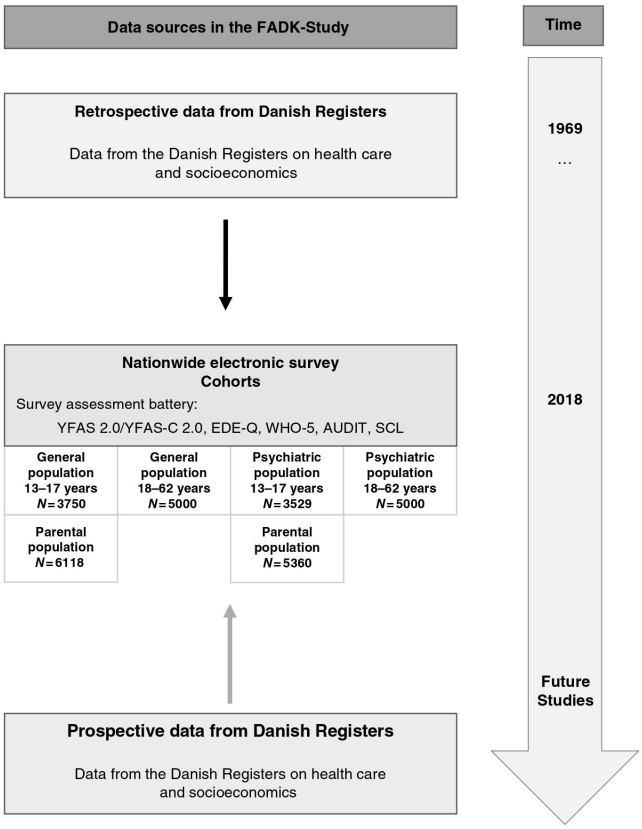

Fig. 1. FADK study design. The figure illustrates the cross-sectional survey with associated retrospective- and prospective epidemiological elements.

Participants

We employed random sampling to ensure that the invitees were representative of the source population. Invitees were randomly extracted from two nationwide Danish registers: the Danish Civil Registration System (DCRS) and the Danish Central Psychiatric Research Register (DPCRR). In the DCRS, all inhabitants of Denmark are registered with a unique 10-digit personal identifier that is used in all Danish public registers, thereby allowing the linkage of data from these registers at the individual level (Schmidt *et al.*, 2014). The DCRS was also used to link invited adolescents with their parents.

The DPCRR contains information (including diagnoses) regarding all in- and outpatient contacts with psychiatric hospital services in Denmark (Mors *et al.*, 2011). Fig. 2 shows a flow chart of the recruitment of participants.

To be eligible for invitation, individuals identified in the registers were required to have Danish-born parents who resided in Denmark at the potential invitees' date of birth. Adolescents had to live with at least one parent to be included, meaning that adolescents who were institutionalised or otherwise in the care of the authorities were not eligible. In addition, a valid Danish postal address was required. Those who were legally incapacitated and those with a protected address or protected name were not eligible. In Denmark, residents can choose to have their name and address protected, such that is not available in, for example, phonebooks or for surveys such as the one described in this paper. The residents must register the protection yearly online.

Individuals from the following four population samples who were randomly drawn from the DCRS and the DCPRR were invited to participate in the study:

Adults from the general population

A total of 5000 individuals aged 18–62 years from the general population were randomly drawn from the DCRS and invited to participate in the study.

Adolescents from the general population

A total of 3750 individuals aged 13–17 years from the general population were randomly drawn from the DCRS and invited to

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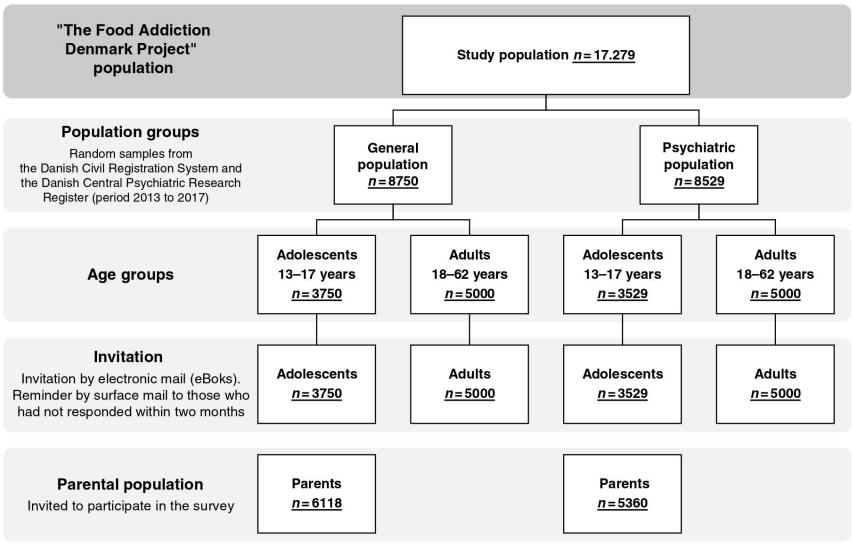

Fig. 2. Flow chart of the study populations in the FADK Project.

participate in the study. The adolescents were invited via their parent(s), who were also invited to participate in the survey.

Adults with a mental disorder

A total of 5000 individuals aged 18–62 years registered with a mental disorder in the DCPRR were invited to participate in the study. To ensure that all major mental disorders were studied in the psychiatric population, eight diagnostic categories were defined (Table 1) based on the 10th edition of the *International Classification of Diseases* (*ICD-10*) (World Health Organization Geneva, 1993). A total of 625 individuals were randomly drawn from each of the eight diagnostic categories. This extraction was based on the main diagnoses (the primary reason for contact with psychiatric hospital services) stemming from in- and outpatient contacts during the period from 2013 to 2017. The extraction of individuals was performed hierarchically, that is, the extraction of the sample from the F20 category (schizophrenia, schizotypal and delusional disorders) was performed first, followed by extraction the F30 category (mood disorders) and so on. The only exception to this rule was that the sample from the F10 category (mental and behavioural disorders due to psychoactive substance use) was drawn last. Individuals could be included only once.

Adolescents with a mental disorder

A total of 3529 individuals aged 13–17 years were invited via their parent(s), who were also invited to participate in the survey. For the adolescent population, six diagnostic categories were defined (see Table 1) based on the *ICD-10*. Because substance use disorders and personality disorders are rarely diagnosed among adolescents at Danish psychiatric hospitals, these diagnostic groups were not included for the adolescent psychiatric population, making this sample smaller than the sample of the adult psychiatric population.

The procedure for data extraction was the same as that described for the adult psychiatric population. The F20 diagnostic category (psychotic disorders), however, was smaller in the adolescent group as there were only 404 contacts within this diagnostic category available within the defined period. Siblings of invitees were also eligible for (random) extraction from the registers (and hence invited to participate in the study if identified in the DCRS and the DPCR).

Survey procedure

Individuals were invited to participate in the survey in February 2018 via a secure electronic mail system (eBoks, 2019) used by Danish public authorities to communicate with Danish citizens. eBoks is mandatory and linked to the personal registration number, and approximately 89% of Danish citizens have an eBoks mail account (Ebert *et al.*, 2018). The invitation included information on the purpose of the study and instructions on how to fill in the questionnaire. The invited adolescents were informed to fill in the questionnaire themselves.

In addition, the invitees were informed that their answers would be de-identified, meaning that it was not possible for the investigators to link the responses directly to them. Personal guidance in filling the questionnaire was offered by e-mail and telephone. Each personal invitation included a unique web link to the web-based survey via www.surveyexact.dk (Rambøll, 2018) and a corresponding unique login to the survey webpage if the link did not work. If siblings were extracted, all siblings were invited via their parents, and the invitation letter contained individual login information for each of the adolescents and for the parents, respectively.

A polite reminder to participate was sent by surface mail to those who had not responded within 2 months. For those who were exempted from receiving e-mail via eBoks ($N = 560$), the initial invitation was sent by surface mail, and the opportunity to request

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Table 1. Definition of the categories of mental disorders defining the psychiatric study population

ICD-10 code	Diagnostic categories	Number of invitees (adults/adolescents)
F10-F19	Mental and behavioural disorders due to psychoactive substance use*	625*
F20-F29	Schizophrenia, schizotypal and delusional disorders	625/404†
F30-F33	Mood disorders: mania, bipolar affective disorder, depressive episode, recurrent depressive disorder	625/625
F40-F42, F431	Phobic anxiety disorders, other anxiety disorders (including panic disorder and generalised anxiety disorder), obsessive-compulsive disorder, post-traumatic stress disorder	625/625
F50	Eating disorders	625/625
F60-F62.1	Disorders of adult personality and behaviour*	625*
F84.0, F84.1, F84.5, F84.8	Pervasive developmental disorders (including autism)	625/625
F90, F90.1, F90.8, F98.8	Behavioural and emotional disorders with onset usually occurring in childhood and adolescence (including ADHD)	625/625

ADHD, attention deficit hyperactivity disorder; *ICD-10*, *International Classification of Diseases-10*.
*Diagnostic categories not included in the adolescent population.
†In this category there were only 404 eligible individuals among the adolescents.
http://www.who.int/classifications/icd/en/

a paper version of the questionnaire, including a prepaid envelope, was offered. Participants who completed the full questionnaire were entered into a lottery for three iPads.

Ethics

The invitees received information regarding the purpose of the project and were informed that participation was voluntary. In addition, the participants were informed that they could withdraw their consent to participate at any time. The adolescent population was invited via their parents, thereby giving the parents the opportunity to decide whether the child should receive an invitation to participate.

The project was registered at the Danish Data Protection Agency (record number 2008-58-0028), and the use of register data was approved by the Danish Health Data Authority and Statistics Denmark. In Denmark, ethical review board approval is not required for surveys and studies based on register data.

Calculation of response rates

In the calculation of the overall response rates of the survey, both completed and partially completed questionnaires were considered. Partial completion was defined as 50–99% of all essential or crucial questions answered; complete surveys had responses to 100% of all the essential or crucial questions asked (The American Association for Public Opinion Research, 2016).

Regarding the different research questions that will be examined in the FADK study, the essential items (from the questionnaires included in the survey) will differ, meaning the study population will vary according to the items of interest, and the number of participants will change depending on the research question examined. Thus, for each analysis performed, the number (*N*) of participants included will always be specified.

The FADK questionnaire

The compiled questionnaire designed for the survey part of the FADK study consisted of validated questionnaires (available in the Danish language) that examine psychopathological constructs corresponding to those used in the original validation of the YFAS, conducted by Gearhardt *et al.* (Gearhardt *et al.*, 2009, 2016), thus enabling a validation of the Danish YFAS 2.0 and the YFAS-C 2.0. For women, five items regarding menstruation, birth control pill use, and pregnancy were added to the basic survey. In total, 112 questions were included in the questionnaire (the full questionnaire is provided in the supplement S1). The estimated time required to complete the questionnaire was 20–30 min.

Before launching the survey, a small pilot study ($n = 26$) was conducted to test the applicability of the questions and the questionnaire as a whole. Comments were discussed in the research group, and few corrections were made to optimise wording. The final version of the questionnaire consisted of the following components:

The Yale Food Addiction Scale 2.0 (YFAS 2.0). The YFAS 2.0 is a 35-item questionnaire that evaluates food addiction based on the *Diagnostic and Statistical Manual of Mental Disorders*-5 (*DSM-5*) (American Psychiatric Association, 2013) criteria for substance dependence (Gearhardt *et al.*, 2016). The questions are adapted to food consumption and problematic addiction-like overeating. Symptoms are reported for the past 12 months. Based on the completed questionnaire, 2 types of information can be extracted: a diagnosis with 4 levels: no food addiction, mild food addiction, moderate food addiction, and severe food addiction; and a dimensional symptom score with a range from 0 to 11. Prior studies have demonstrated that the YFAS has sound psychometric properties, including adequate internal consistency, convergent, discriminant, and incremental validity (Gearhardt *et al.*, 2009; Pursey *et al.*, 2014a; Gearhardt *et al.*, 2016). Furthermore, the YFAS has been validated successfully across different clinical, age, racial, and cultural groups and in several languages (Brunault *et al.*, 2014; Granero *et al.*, 2014; Chen *et al.*, 2015; Innamorati *et al.*, 2015; Ahmed *et al.*, 2016; Sanlier *et al.*, 2016; Swarna Nantha *et al.*, 2016; Ahmed & Sayed, 2017; Brunault *et al.*, 2017; Aloi *et al.*, 2017; Meule *et al.*, 2017; Torres *et al.*, 2017; Wiedemann *et al.*, 2018).

The Yale Food Addiction Scale for Children 2.0 (YFAS-C 2.0). The original YFAS was first adopted for children in 2013 (Gearhardt *et al.*, 2013); in 2018, it was updated to fit the *DSM*-5 criteria (version 2.0) (Schiestl & Gearhardt, 2018). The YFAS-C 2.0 has 35 items corresponding to the adult version, and the language is modified to ensure that the reading level and described behaviour are age-appropriate (Schiestl & Gearhardt, 2018). Symptoms are reported for the past 12 months.

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Only one preliminary validation study has been published on the YFAS-C 2.0 (Schiestl & Gearhardt, 2018). Due to the relatively low endorsement rate of most criteria, it was not possible for the authors to estimate a diagnostic cut-off. Instead, they suggest using a dimensional scoring approach, at least in general populations, as they argue that the symptoms of food addiction are less likely to be fully developed in childhood and adolescence (Schiestl & Gearhardt, 2018).

Translation of the YFAS 2.0 and the YFAS-C 2.0. The YFAS 2.0 and the YFAS-C 2.0 were translated into Danish in accordance with the World Health Organization (WHO) guideline for translation of psychometric instruments (Sartorius and Kuyken, 1994). Gearhardt approved the back-translated versions in order to ensure that the content corresponds with the original versions of the two scales (Gearhardt *et al*., 2009, 2016).

Eating Disorder Examination Questionnaire (EDE-Q). The EDE-Q is a 28-item questionnaire based on the clinical interview Eating Disorder Examination (EDE) that examines eating pathology during the past 28 days. The EDE is often referred to as the 'gold standard' questionnaire for eating disorders. The EDE-Q has satisfactory psychometric properties (Mond *et al*., 2004; Berg *et al*., 2012) and has been validated in a large range of settings, including adult community samples (Mond *et al*., 2004; Friborg *et al*., 2013), adolescent populations (Penelo *et al*., 2013), and eating disordered populations (Berg *et al*., 2012; Rø *et al*., 2015). In addition, the EDE-Q was found to be superior for capturing binge eating episode frequency compared with other self-report measures in a study of a population with binge eating disorders (BED) (Celio *et al*., 2004). EDE-Q contains four subscales: Dietary Restraint, Weight Concern, Shape Concern, and Eating Concern. Each subscale is scored individually, and a global score is obtained by adding up the scores for the four subscales. To our knowledge, the Danish version of the EDE-Q has not been validated. However, the Norwegian version is very well validated (Friborg *et al*., 2013; Rø *et al*., 2015), and Norwegian and Danish are mutually intelligible languages. In addition, the populations of Denmark and Norway are very similar with regard to socio-demographic factors and ethnicity. We, therefore, assume that the psychometric properties of Danish version of the EDE-Q are in line with those of the Norwegian version.

Body mass index. As a part of the EDE-Q, weight and height are reported. The text in the questionnaire encourages participants to be as precise as possible. Based on this information, we will compute the BMI for the adult participants. For the adolescent population aged 13–17 years, the BMI-z score will be used. The BMI-z score is a measure of relative weight adjusted for the age and sex of the child and converted to the equivalent BMI for age percentile via calculations (Must & Anderson, 2006).

The Symptom Checklist-92 (SCL-92). The SCL-92 is a questionnaire examining a broad range of psychopathology occurring within the past week. The SCL-92 is considered to provide valid information on psychopathology in community samples of both adults (Carrozzino *et al*., 2016) and adolescents with and without mental disorder (Rytilä-Manninen *et al*., 2016). The full SCL-92 consists of several subscales. The Danish version of the SCL-92, including some of the subscales, has undergone psychometric validation (Bech *et al*., 2014; Carrozzino *et al*., 2016). We included the following subscales because these psychopathological conditions have been shown to be associated with food addiction (Burrows *et al*., 2018): interpersonal sensitivity (IPS_5), major depression (excl. SCL-92 item #15 regarding suicidality, which was removed for ethical reasons), depression ($SCL\text{-}D_6$), anxiety ($SCL\text{-}ASS_8$) (Bech *et al*., 2014), and the attention deficit hyperactivity disorder subscale (Carrozzino *et al*., 2016). The subscale score is defined as the sum of the individual item ratings. Table 2 shows the included subscales from the SCL-92.

Table 2. Hopkins Symptom Checklist-92 subscales included in the FADK Project

Psychopathology construct	SCL-92 items
Major depression	#14, #15*, #19, #26, #30, #32, #41, #55, #66, #78
Depression ($SCL\text{-}D_6$)	#14, #26, #30, #31, #32, #71
Anxiety ($SCL\text{-}ASS_8$)	#2, #23, #31, #45, #50, #65, #72, #73
Interpersonal sensitivity ($SCL\text{-}IPS_5$)	#6, #21, #34, #36, #37, #41, #61, #69, #73
ADHD	#9, #11, #24, #28, #55, #78

ADHD, attention deficit hyperactivity disorder; SCL-92, Symptom Checklist-92.
*Question #15 regarding suicidality was removed for ethical reasons.

Alcohol Use Disorder Test (AUDIT). The AUDIT was developed by the WHO and has been translated into many languages, including Danish (Babor *et al*., 2001). AUDIT is a widely used screening instrument to detect alcohol dependence and problematic use of alcohol (Reinert & Allen, 2007). It consists of 10 items covering problematic alcohol consumption, including frequency and amount, during the past year. The AUDIT total score is defined as the sum of the individual item ratings (each item is rated from 0 to 4) and has a range from 0 to 40.

The AUDIT has been successfully validated in different age groups, including adolescents (Knight *et al*., 2003), and several studies have concluded that the AUDIT is a reliable screening tool for alcohol-related disorders in community samples and among individuals with mental disorders (Reinert & Allen, 2007; Lundin *et al*., 2015).

The WHO-5 Well-Being Index. The WHO-5 Well-Being Index is a widely used five-item questionnaire that examines subjective psychological well-being over the past 2 weeks. The WHO-5 total score is defined as the sum of the individual item scores (each item is rated from 0 to 5) – multiplied by 4 – and has a range from 0 to 100, with 100 representing maximal well-being. The WHO-5 has been validated across different age groups, cultures, and study settings, and has consistently demonstrated sound psychometric properties (Topp *et al*., 2015). This also holds true for the Danish version of the WHO-5 (Bech *et al*., 2003).

Register data for attrition analyses, characterisation of participants, and retrospective/prospective studies. Data from a wide range of registers containing individual-level data on health care and socio-economic aspects are available to researchers in Denmark following the approval of a research protocol describing how the data will be used (Munk-Jørgensen & Østergaard, 2011). The unique personal identifier from the Danish Civil Registration System allows data from these registers to be linked at the individual (but de-identified) level.

Most of the included registers contain data from as early as the 1970s, allowing for a retrospective investigation of the participants. Using these data it will be possible to investigate, for example, whether specific socio-demographic characteristics or prior somatic and psychiatric conditions are associated with food addiction. Furthermore, based on the assumption that food addiction is a relatively stable trait, we plan to conduct register-based follow-up of the cohort members (2, 5, and 10 years after the initial survey)

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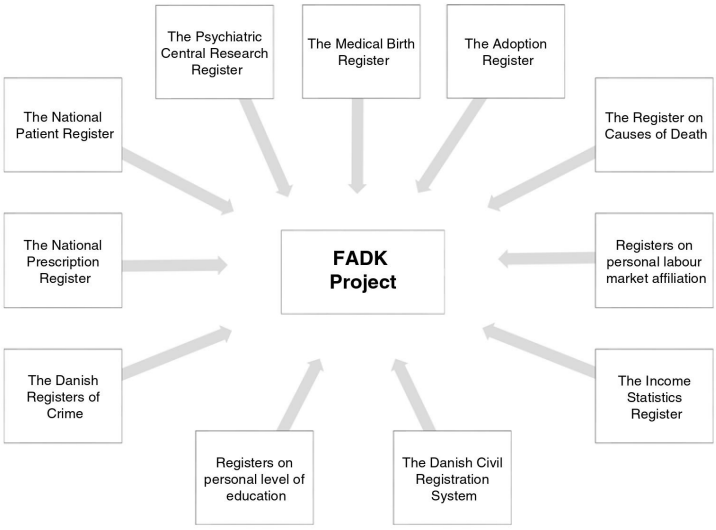

Fig. 3. An overview of the Danish registers providing data to the FADK Project.

to investigate potential outcomes of food addiction, such as lifestyle-related diseases (diabetes, cardiovascular disease, stroke, etc.) and excess mortality. Finally, we also plan to conduct a follow-up survey among the cohorts in this project. This will allow for an investigation of the stability of food addiction as well as identification of new cases of food addiction.

An overview of the registers used in the FADK Project is provided in Fig. 3. A more detailed overview of the specific socio-demographic and health-related variables included in the attrition analyses can be found in supplement S2.

Statistical analyses

Psychometric validation of the YFAS 2.0 and YFAS-C 2.0. The psychometric validation of the Danish versions of the YFAS 2.0 and YFAS-C 2.0 will be performed in agreement with the original work by Gearhardt *et al.*, including an examination of the internal reliability and a confirmatory factor analysis. The convergent, discriminant, and incremental validity (Gearhardt *et al.*, 2009, 2013, 2016; Schiestl & Gearhardt, 2018) of the YFAS 2.0/YFAS-C 2.0 will be tested by establishing the degree of correlation between the YFAS 2.0/YFAS-C 2.0 scores and scores on scales measuring related/discordant constructs (EDE-Q, SCL-92 subscales, and AUDIT), chosen in accordance with prior validation studies (Aloi *et al.*, 2017; Meule *et al.*, 2017; Granero *et al.*, 2018).

Attrition analyses. Data generated from the survey will predominantly be analysed using descriptive statistics, including attrition analyses comparing nonparticipants with participants. This comparison will include the following socio-demographic and health parameters obtained from the Danish national registries: age, sex, marital status, educational level, occupation status, income, urbanisation, prior mental disorder, and somatic illness/comorbidity, as measured by the Charlson Comorbidity Index (Charlson *et al.*, 1987). For the adolescent population, most data on these parameters will be reported for the cohabiting parent(s), as these data will be more informative.

Wave analyses. To handle potential non-response bias, we will conduct a wave analysis (Lin & Schaeffer, 1995; Lahaut *et al.*, 2003). Late responders have a tendency to be similar to nonparticipants in what is known as the 'continuum of resistance' model (Lin & Schaeffer, 1995; Gregory *et al.*, 2013). Differences in the distribution of defined socio-demographic variables between response waves, that is, early versus late responders, will be analysed to elucidate whether early responders differ from late responders.

Multiple imputation. Multiple imputation (Pedersen *et al.*, 2017) will be performed when relevant. Imputation is conducted for responses with a maximum of 5–10% missing values per rating scale, and sensitivity analyses of the imputation-modelled datasets will be performed.

Description of participants with food addiction compared to those without food addiction. Analyses addressing potential differences in socio-demographic and health status between participants with food addiction and those without food addiction will be conducted.

Means and standard deviations (SDs) for continuous variables and relative frequencies for categorical variables will be reported. Associations between food addiction status and socio-demographic/health status and self-reported mental health will be examined using analytical statistics enabling multivariate adjustment (e.g. logistic and linear regression including hierarchical regression models). By stratifying the regression analyses on individual socio-demographic factors, we will be able to assess if any of the factors are associated with food addiction. Such knowledge could lead to a better understanding of the 'poverty–obesity paradox' (Hruschka, 2012; Salmasi & Celidoni, 2017; Bentley *et al.*, 2018).

Comorbidity of food addiction with (other) mental disorders and familial transmission of food addiction. Making causal inference based on observational data is challenging. In an attempt to test

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whether the association between food addiction and obesity/lifestyle-related diseases is indeed predominantly representing an effect of food addiction on obesity/lifestyle-related diseases (and not vice versa), we plan to employ the directed acyclic graphs approach (Pearl, 1995; Wouk *et al.*, 2018). Furthermore, the directed acyclic graphs can also be employed in the analysis of familial transmission of food addiction.

Discussion

The FADK Project is the first investigation of food addiction conducted in a Scandinavian country, where access to comprehensive national register data on socio-economics and health care is available. This provides a unique opportunity to generate new knowledge on food addiction. Specifically, the FADK Project was designed to address four gaps in the literature on food addiction:

The representativeness of populations used for prevalence estimates of food addiction

Prior prevalence estimates of food addiction in different populations are predominantly based on nonprobability sampling, which calls the validity of the prevalence estimates into question. In the FADK Project, the random samples from both the general population and the population with mental disorders – in addition to the availability of extensive register data on both participants and nonparticipants – will enable us to conduct comprehensive attrition analyses to evaluate and quantify potential selection bias and hence the validity of the food addiction prevalence estimates.

In addition, in order to minimise selection bias, all invitees – irrespective of which cohort they belonged to – received the same information material. Importantly, the invitation consignee was the university hospital and not the psychiatric department. This choice was made deliberately to avoid low response rates and selective nonresponse due to stigma related to mental disorders (Carrozzino *et al.*, 2016). To encourage invitees with lower socio-economic statuses to participate, the respondents were entered into a lottery for iPads. Competitions and lotteries in surveys have been documented to heighten response rates among lower socio-economic groups (Edwards *et al.*, 2009).

Finally, a Danish study comparing response rates from paper based and web-based questionnaire invitations (sent via eBoks) found a difference around 10% in the favour of the paper-based version. However, no significant difference in socio-demographic variables in the nonresponding groups was found, indicating that the level of selection bias was not different between the paper-invited and the web-invited group (Ebert *et al.*, 2018).

Comorbidity of food addiction and (other) mental disorders

Several studies have suggested that there is a strong association between food addiction and (other) mental health problems (Goluza *et al.*, 2017; Kucukerdonmez *et al.*, 2017; Burrows *et al.*, 2018; Mills *et al.*, 2018). The majority of these studies, however, are based on self-reported mental health problems/mental disorders (Burrows *et al.*, 2018). Data from the FADK Project allow us to investigate food addiction as a comorbid condition to clinically verified mental disorders diagnosed at psychiatric hospitals (derived from the DPCRR). In addition, food addiction symptoms will be examined in relation to the self-reported psychiatric symptoms from the included SCL-92 subscales, the EDE-Q, and the AUDIT. We expect to find that food addiction (like other types of addiction) is prevalent among individuals with mental disorders and that this association may be on the path that leads some individuals with mental disorders via obesity/metabolic syndrome to excess mortality (mental disorder → food addiction → obesity/metabolic syndrome → increased morbidity → excess mortality). If this is indeed the case, interventions aimed at preventing and treating food addiction may provide a means of reducing the excess mortality among individuals with mental disorders.

Familial transmission of food addiction

Most addiction disorders have a strong hereditary component that interacts with environmental factors (Merikangas *et al.*, 1998; Wang *et al.*, 2012; Yu & McClellan, 2016). It is therefore of importance to investigate whether food addiction resembles other addiction disorders in terms of genetic susceptibility and environmental risk factors, that is, the familial transmission of the condition. To our knowledge, only one prior study has investigated this aspect and found a positive association between the YFAS scores of children ($n = 150$) and their parents ($n = 150$) (Burrows *et al.*, 2017). Due to our collection of data on food addiction from both children and their parents, the FADK Project will allow extensive analyses of familial transmission among children both with and without mental disorder. First, the direct correlation between food addiction symptoms in adolescents and food addiction symptoms in their parents can be investigated. Second, retrospective register data allow us to examine the environmental component of the upbringing and maybe find potential patterns in socio-demographic factors characterising families with high burden of food addiction symptoms. Moreover, in the future, we can conduct a follow-up study and investigate outcomes in families with food addiction symptoms. Also, we can use directed acyclic graphs to do more advanced examinations of the familial transmission of food addiction. Finally, the establishment of the parent-offspring cohort will provide us with an opportunity to collect DNA from the cohort members in the future. The possibility of combining cross-generational genetic data with information on psychosocial factors from the Danish registers will be a very powerful tool to disentangle the genetic and environmental contributions to the development of food addiction (Pedersen *et al.*, 2018).

Trajectories of food addiction

There is a paucity of longitudinal studies on food addiction. Most studies with (relatively short) follow-up have focused on the stability of the food addiction construct (Chen *et al.*, 2015; Torres *et al.*, 2017). Thus, longitudinal studies focusing on risk factors and outcomes of food addiction are needed. The linkage of register data with the survey data from the FADK Project provides a unique opportunity to conduct longitudinal studies of food addiction. Such studies are likely to identify risk factors for food addiction that may enable the targeting of preventive interventions. Future follow-up studies of the FADK cohort will have the potential to cast light upon the long-term consequences of food addiction (e.g. medical morbidity, psychiatric morbidity, and mortality) and clarify whether it is necessary to intervene with treatment.

Limitations

Although the FADK Project has been carefully designed, it has some important limitations.

First and foremost, we used a self-report web-based questionnaire to obtain information about food addiction and mental health, and self-report measures are less valid than information

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obtained from an objective clinical interview (Fairburn & Beglin, 1994; Eaton *et al*., 2000). However, sensitive information regarding mental health and eating concerns may be more accurately conveyed when it is anonymously self-reported (in this study, de-identified), potentially reducing the risk of information bias (Joinson, 1999).

Second, the study uses self-reported weight and height. Self-reported anthropometrics such as weight and height tend to be misreported, leading to systematically lower BMI values in the high BMI range and an overestimation of BMI values at the low end of the BMI range (Stommel & Schoenborn, 2009). However, when compared to objectively measured BMI, self-reported BMI measures nevertheless seem to have acceptable validity (Pursey *et al*., 2014b).

Third, our measurements of food addiction, eating pathology, psychopathology, and well-being were cross-sectional, and the symptoms may represent only a snapshot of the continuum of severity. However, the included rating scales ask for symptoms within a time horizon of at least 1 week, some up to 1 year.

The differences in the time frame considered by the included measures/scales (YFAS 2.0/YFAS-C = 1 year, AUDIT = 1 year for items #9 and #10; the other measures = significantly shorter time frames) could potentially be a problem. However, like other substance use disorders (e.g. alcohol addiction), food addiction is considered to be a fairly constant phenotype (Chen *et al*., 2015; Pursey *et al*., 2016; Torres *et al*., 2017; Volkow *et al*., 2017; Lindgren *et al*., 2018). Consequently, the scores obtained with YFAS 2.0/YFAS-C are expected to be representative of the current eating and food-seeking behaviour. Therefore, comparing YFAS 2.0/YFAS-C scores to scores from measures considering shorter time frames should be a valid approach – and is in line with prior validation studies (Aloi *et al*., 2017; Meule *et al*., 2017; Granero *et al*., 2018).

Fourth, to ensure that all invitees were able to understand the Danish language, only Danish-born citizens with Danish-born parents were invited. Consequently, the samples are not directly generalisable to the Danish population. However, as the Danish population in itself is quite ethnically homogeneous (in 2019, 86% of the population is of Danish origin) (Statistics Denmark, 2019), the results of the FADK Project will be representative for a large fraction of the general population. In addition, as only individuals with a current valid postal address were included, homeless individuals were not invited. Adolescents who were institutionalised (e.g. in orphanages) or otherwise in care of the authorities were also ineligible to be invited. Knowing that mental disorders or problems are prevalent among the homeless (Nielsen *et al*., 2011) and in adolescents in the care of the authorities, this could contribute to selection bias. Homelessness is, however, rare in Denmark, and in 2017, there were 6600 homeless individuals in Denmark – corresponding to a prevalence of 0.11% (VIVE – the Danish Center for Social Science Research, 2017; Statistics Denmark, 2019). In 2015, around 13.500 (0.86%) children and adolescents were in the care of the authorities (the National Board of Social Services, 2015), and in 2017, 6200 (0.12%) adults were institutionalised (Statistics Denmark, 2019).

Furthermore, as some individuals invited to the survey will likely be unable to participate because of, for example, dementia, mental retardation, dyslexia, a response bias may be expected. Alternative approaches (e.g. personal interviews and measures/scales developed for use in specific groups) are necessary to recruit individuals from these groups, but this is beyond the scope of this study.

We deliberately oversampled (stratified probability sampling) less common mental disorders, resulting in subsamples that are not representative for the prevalence of these conditions in the source population (Aday & Cornelius, 2006). Thus, knowing that individuals with some of the more rare and severe mental disorders (e.g. psychotic disorders) will probably be less able/willing to participate in the study, the oversampling strategy was chosen to mitigate this problem. Therefore, when analysing the data stemming from the psychiatric populations, we will add weights to adjust for the relative oversampling/undersampling of the different diagnostic groups (inverse-probability weighting Rothman *et al*., 2008). This will provide a weighted prevalence estimate of food addiction in the psychiatric population across the diagnostic groups, which should mirror the prevalence in the source population – when taking selection bias into account via the attrition analyses.

Finally, the invitees were allowed to continue answering questions even if they skipped one or more questions. The use of this strategy in web-based surveys imitates those used in pen-and-paper questionnaires and is known to encourage participants to continue answering, even if they find some questions hard to answer or if they do not want to answer one or more questions. Consequently, some of the responses have missing items, and when relevant for the analysis, those with 5–10% of missing items will be handled with multiple imputations.

Conclusion

The FADK Project is among the largest studies of food addiction to date. We believe that the very rich dataset established with the FADK Project will allow for analyses that will provide important new knowledge regarding food addiction, to the benefit of those struggling with this problem.

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Conflict of Interest. The authors declare no conflicts of interest.

Ethical Standards. The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration.

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3.1. ADDITIONAL METHODOLOGICAL CONSIDERATIONS

In this section, some of the methodological aspects described in Paper I is further elaborated. In addition, some changes were made in the methodology compared to that presented in Paper I, and these changes are also described in this section.

3.1.1. PARTICIPANTS

The extraction of participants included in the adult and adolescent populations with a mental disorder is more thoroughly described below.

3.1.1.1 Adults with mental disorder

The algorithm for the sampling procedure included the individuals on the basis of the following criteria: I) a contact (inpatient or outpatient) at a Danish psychiatric hospital facility in the period 2013-2017,II) the diagnosis was the primary reason for the contact (i.e. the main diagnosis), III) emergency department contacts were not included, IV) the sampling from each of the eight categories was random, and V) the sampling procedure was executed hierarchically, thereby extracting the most severe diagnostic categories first. The hierarchical sampling strategy ensured that the invitees were most likely included in the category with the most severe diagnosis. The same person could only be included once, even if the person was registered with more than one diagnosis.

3.1.1.2 Adolescents with mental disorder

The same sampling algorithm was used as described above. However, only six diagnostic categories of mental disorders were included for the adolescent population (see Table 1 in Paper I above).

3.1.2. THE DANISH REGISTERS

Denmark has a wide range of comprehensive nationwide registers containing individual-level data on health care and socioeconomic issues. Data from the different registers are available to researchers following an approval process. The application process includes an extensive research protocol, with a detailed exposition on how the data will be used, and arguments on why this data are needed.[153,154] The application for register data needs approval from the Danish Health Data Authority and/or Statistics Denmark. Furthermore, studies using register data must be registered at the Danish Data Protection Agency.
The two registers that were used for sampling of the study publication in this project (the Danish Civil Registration System and the Danish Psychiatric Central Research

Register) are described below. For a more thorough description of the other registers used for the attrition analyses, please see the cited articles in Paper I (Chapter 3).

3.1.2.1 The Danish Civil Registration System (DCRS)

All citizens in Denmark are assigned a unique personal identification number at birth or immigration; this personal civil registration (CPR) number is recorded in the DCRS.[155] The DCRS was established in 1968 and contains daily updated information on migration and vital status, name and address, date and place of birth, civil status, and information on children.[155] The latter gives the opportunity for linking parents and children by the CPR number. The CPR number also allows linkage of data from the different Danish registers on an individual level.

3.1.2.2 The Danish Psychiatric Central Research Register (DPCRR)

The DPCRR[153,156] contains information regarding all inpatient and outpatient contacts at psychiatric departments in Denmark since 1969. It contains all assigned diagnoses, onset and end time of any treatment and admission, and type and place of admission. All the recorded diagnoses in the DPCRR are assigned as a part of everyday clinical practice by physicians who are trained in the psychiatry field. The DPCRR includes only contacts with the psychiatric hospital system. Contacts at private practicing psychiatrist or general practitioners are not recorded in the DPCRR.[153,156] It is important to note that all Danish citizens have equal access to diagnostics and treatment in the health care system, which is tax-financed. This includes both general practitioners and inpatient/outpatient hospital facilities.
All information in the register is linked by the CPR number, which also provides the opportunity to link information from the DPCRR to other nationwide Danish registers.

3.1.3. EBOKS (DIGITAL MAIL)

eBoks (digital post) is a secure electronic mail system that Danish public authorities use to communicate with Danish citizens regarding important subjects like pension, tax, and information related to health care, e.g., hospital appointments.[157] All Danish citizens with a CPR number have an eBoks online digital mailbox; it is mandatory and is used by approximately 91.7% of Danish citizens. However, citizens that are unable to use digital communication may be exempted from using eBoks.[157]

3.1.4. INVITATION AND REMINDER

The invitation letter was prepared to ensure that the study purpose and the rights of the invitees were clearly stated and easily readable. In addition, there was

information on anonymization (responses would be de-identified) and informed consent. Furthermore, invitees were informed of the opportunity to redraw, at any time, their informed consent to participate. In addition, a simple and concise instruction was included on how to open the personal link to the web-based survey via www.surveyexact.dk[158] and how to fill in the questionnaire. Lastly, the letter included name and contact information on the main investigator, so invitees could get further information on the study or actively notify if they did not want to participate. If the invitees did not respond to the invitation within 6 weeks, they were sent a polite reminder by surface mail. The reminder included the same information as the initial invitation. In the adolescent populations, the invitation letter was sent to the eBoks account(s) of cohabiting parents. Therefore, the parents decided whether the adolescent should have the invitation to participate in the survey.

3.1.5. MEASURES

Additional information on each of the included measures in the compiled FADK questionnaire is provided below. This includes a description of the variables used in the psychometric analyses of the construct validity.

3.1.5.1 The Yale Food Addiction Scale version 2.0

The YFAS 2.0 is a 35-item self-report questionnaire with a Likert-type format that evaluates food addiction. The YFAS 2.0 has two scoring options. One is a categorical option based on severity; no food addiction, mild food addiction (2-3 SRAD symptoms), moderate food addiction (4-5 SRAD symptoms), and severe food addiction ($\geq$6 SRAD symptoms). Another is a dimensional scoring option, which reflects the number of endorsed SRAD symptoms (0-11 SRAD symptoms). Each SRAD criterion is represented by two to five items focusing on symptoms related to this criterion, e.g., withdrawal. For each item, a cut-off value is set; if one item reaches this cut-off, the SRAD criteria (that the item represents) is considered endorsed and adds one to the total SRAD symptom score. Therefore, the total score ranges from zero to 11. To meet the diagnosis of food addiction, the criterion of significant impairment and/or distress should be endorsed.

3.1.5.2 The dimensional Yale Food Addiction Scale for Children version 2.0

The 16-item dimensional Yale Food Addiction Scale for Children (dYFAS-C 2.0)[59] was developed in 2018; it includes only items reflecting criteria related to dependence, excluding criteria on problem-focused symptoms. Symptoms are reported for the past year, and each item can be rated on a Likert-type scale from zero to four. The dYFAS-C 2.0 allows only for a dimensional scoring option, which is calculated by

adding each item score (ranging from zero to four) up to the dYFAS-C 2.0 total score (ranging from zero to 64).

3.1.5.3 Translation of the YFAS 2.0/YFAS-C 2.0 into Danish

The translation of the YFAS 2.0 and the YFAS-C 2.0 into Danish was performed in accordance with the World Health Organization (WHO) guideline for back-translation of psychometric instruments.[159,160]
Two bilingual clinical physicians with experience in the field of psychiatry each translated the two original English scales (YFAS-C 2.0/YFAS 2.0) into Danish. The two physicians discussed their respective versions, e.g., wording and discrepancies, and produced one combined translated version of each of the two scales. A bilingual English-speaking translator, who had no knowledge of the original questionnaire, translated the Danish versions back into English. Dr. Ashley N. Gearhardt then approved the back-translated version of the YFAS-C 2.0 and the YFAS 2.0 to ensure that the content of the translated scales corresponded with the original version of the two scales.[1,36] Any differences between the forward- and the back-translated versions were discussed and resolved by consensus.
The Danish YFAS 2.0 and YFAS-C 2.0 were included in a small pilot study (covering the age span 13-60 years), and few corrections were made to optimize the wording.
The 5-item World Health Organization well-being index (WHO-5)
The WHO-5[161] was not included in the analyses for this PhD dissertation, but it will be included in future publications examining the association between food addiction and well-being.

3.1.5.4 The Hopkins Symptom Checklist-92 (SCL-92)

The full version of the SCL-92 consists of several subscales. The ADHD subscale[162] was the only one included in the psychometric analysis of the convergent validity. The subscale was used as a measure of ADHD symptomatology and impulsivity, which both have shown to correlate with food addiction.[66,84,86]
The remaining SCL-92 subscales were not included in analyses for this PhD dissertation, but they will be included in future publications on the FADK Project.

3.1.5.5 The Eating Disorder Examination Questionnaire (EDE-Q)

All four EDE-Q[163] subscales and the global score were included in the evaluation of the construct validity. The total global score and the subscales on eating, weight, and shape concern were used in the analysis of the convergent validity.[50,53] Restrained eating[1,59] was used in the analysis of the discriminant validity, whereas binge eating frequency was used in the analysis of the incremental validity.[1,50,53]

3.1.5.6 The Alcohol Use Disorder Test (AUDIT)

The AUDIT[164] was used as a discriminant measure in the construct validity analyses, as previous studies found no or a negative association between alcohol use disorder and food addiction.[63,70] Additionally, obesity and substance use disorders (including alcohol dependence disorder) are often negatively correlated.[12]

3.1.5.7 Body Mass Index (BMI) and BMI z-score

Weight and height were reported as a part of the EDE-Q questionnaire. BMI was categorized according to the definitions by the WHO: *underweight*: BMI<18.5; *normal weight*: BMI=18.5-24.9; *overweight* (pre-obese): BMI=25.0-29.9; *obese*: BMI≥30. Reported height under 100 centimeters or weight under 30 kilograms were considered biologically implausible and were excluded from the analyses.

For the adolescent population aged 13-17 years, the BMI-z score was computed. In growing children and adolescents, the Body Mass Index (BMI) varies with sex and age. The BMI z-score[165] takes into account the common growth according to both sex and age.[166] The BMI z-score was categorized according to definitions by the WHO[166]: *underweight/thinness*: <-2 SD; *normal weight*: -2 SD > +1 SD; *overweight*: +1 SD < +2 SD; and *obese* > +2 SD. For adolescents, BMI z-scores of >+5.5 and <-4.5 were considered biologically implausible and were excluded from the analyses.

3.1.6. CHANGES IN METHODOLOGY

Few changes have been made in the methodology compared to that described in Paper I.[152] The changes concern statistical aspects, namely the handling of missing data (described section 3.1.7.2) and attrition from the survey. Instead of using wave analysis to evaluate the impact of selection bias, we used augmented inverse propensity weighting (AIPW).[167,168] AIPW has the advantage of providing weighted prevalence estimates, which account for attrition. This was only possible due to the availability of register data on all invitees. Wave analysis only gives an indication of whether the crude estimate may be affected by selection bias, but it does not provide a weighted estimate prevalence estimate. Therefore, AIPW was preferred over wave analysis (the AIPW model is further described in section 3.1.7.6).

A more extensive section on the statistical analyses is found below.

3.1.7. STATISTICAL ANALYSES

The underlying model assumptions were checked prior to all statistical analyses, and alternative non-parametric analyses were chosen if assumptions were not met.

The specific details on each analysis are provided below. All analyses were conducted using Stata statistical software version 15.1.

3.1.7.1 Definition of partial and complete respondents

Adult populations

Complete response to the YFAS 2.0 was defined as having answered all 35 questions. A partial response to the YFAS 2.0 was defined as having answered a minimum of one question per SRAD criterion, which enabled the scoring of each criterion (including that on impairment/distress). This made it possible to compute the YFAS 2.0 continuous symptom score and categorical score (no food addiction, mild food addiction, moderate food addiction, or severe food addiction) for partial responses. Hence, the prevalence estimation of food addiction was based on data from both complete and partial responses to the YFAS 2.0.

Adolescent populations

As described previously, the total score of dYFAS-C 2.0 is based on all 16 questions. Therefore, only invitees with complete responses to all 16 questions were considered as respondents, and partial responses were not relevant for the adolescent population.

3.1.7.2 Missing data

For the confirmatory factor analysis, we deliberately chose solely to include complete responses of the YFAS 2.0/dYFAS-C 2.0. This choice was made to ensure that the validity analyses were based on raw data. Imputation of missing values was, therefore, not necessary. The same applied for the analyses of the construct validity (Pearson's correlations, ANOVA, and hierarchical linear regression analyses), which included other measures than the dYFAS-C 2.0. Here, both the dYFAS-C 2.0 and the other scale/subscale of interest should be complete in order to qualify for inclusion. Thus, the sample size differs, and the N for a given analysis is always provided.

Furthermore, the inspection of missing values in the data set revealed a quite clear trend; more values were missing at the end of the FADK questionnaire. Typically, respondents answered most items of a given subscale in the questionnaire and then stopped when a new scale was presented in the compiled questionnaire. This also resulted in values that were "missing not at random". Together, this complicated the use of multiple imputation.[169,170]

3.1.7.3 Psychometric analyses

Confirmatory factor analysis

The YFAS 2.0: The confirmatory factor analysis tested the fit for a single-factor model and a two-factor model, using the maximum likelihood and robust estimation. The confirmatory factor analysis for the single-factor model was based on the eleven DSM-5 SRAD criteria (and not at item level), excluding the criteria for distress and impairment. In the analysis testing the two-factor model, the first factor included the eight SRAD dependence criteria plus "craving", and the second factor included the three SRAD abuse criteria ("use despite interpersonal/social consequences", "failure in role obligation", and "use in physically hazardous situations"). It is widely discussed which fit indexes are relevant to include in the assessment of model fit in a confirmatory factor analysis, and when a model fit is to be considered adequate.[171,172] Based on the previous validation studies of the YFAS 2.0, [50,53,137] we included the following fit indexes: the confirmatory fit index (CFI), the Tucker Lewis Index (TLI), the root-mean-square error of approximation (RMSEA), and the Chi² test. The internal consistency was examined by the Kuder-Richardsons alpha.[173]

The dYFAS-C 2.0: The confirmatory factor analysis was only conducted for a single-factor model (based on the 16 items), using the maximum likelihood and robust estimation. The following fit indexes, which were also used in the original study,[59] were included: CFI, TLI, RMSEA, and standardized root mean square residual (SRMR). The internal consistency was examined through Cronbach's alpha.

The assumptions of multivariate normality for the CFA analyses (for both the YFAS 2.0 and the dYFAS-C 2.0) were assessed by Q-Q plots only, as tests for normality. For example, conducting the Shapiro-Wilk test in large samples are likely to reject the hypothesis of normality due to negligible deviations from the normal distribution. In case of non-normal distributions, the robust maximum likelihood was applied in the CFA model.[174]

The goodness-of-fit was considered adequate according to Barrett, Hu & Bentler, and Kline[172,175,176]: RMSEA $\leq$0.06-0.08; CFI $\geq$0.90-0.95; TLI $\geq$0.90-0.95, and Kuder-Richardsons alpha >0.8, and Cronbach's alpha >0.8.[177] However, the model fit indexes were also compared with other psychometric validation studies on the YFAS 2.0/dYFAS-C 2.0.

Construct validity, convergent validity, and discriminant validity

The YFAS 2.0: The convergent and discriminant validity was tested through Pearson's correlations between the YFAS 2.0 total scores versus total scores on the external validators (more details under Measures); the EDE-Q (all subscales and the total score), binge eating frequency, the SCL-92 ADHD subscale, the AUDIT, age, and BMI. Correlation coefficients at ($|r|$) $\geq$0.30 were considered to represent a relevant

association[178,179] with the significance level set at $p<0.05$. The assumptions for the Pearson's correlation analysis were ensured in the following way: i) all variables were continuous, II) the included variables had related pairs for each correlation analysis (e.g., food addiction and BMI data was only included in the analysis of the correlation if neither of the variables were missing for the individual), III) absence of outliers (only the case for BMI, where outliers were excluded from the analysis), and IV) linearity, inspected by scatter plots.

For the categorical YFAS 2.0 scoring option, ANOVA was used to test the difference in mean score for the external validators (mentioned above) between the different food addiction severity levels (from no food addiction to severe food addiction). For sex, the Chi^2 test was used. Post-hoc comparison with a hierarchical approach was used to examine whether differences in mean scores for the external validators were of statistical significance across the categories of food addiction. First, the mean scores for respondents without and with mild food addiction were compared. Second, respondents with severe and mild food addiction were compared, then severe and moderate food addiction, and finally respondents with mild and moderate food addiction were compared. The following step was only initiated if all analyses in the previous steps had provided evidence of statistically significant differences between the groups examined. This hierarchical approach was preferred over adjustment for multiple comparisons (Bonferroni correction). Effect sizes were estimated as partial eta squared (partial η^2) and Cohen's definitions of small (0.01), medium (0.06), and large (0.14) effect sizes were applied. [179–181]
The assumptions for ANOVA, i.e. I) normally distributed data (due to the large sample size, this assumption was not important), II) homogeneity of variance, and III) independence of observations, were checked prior to the analyses, and no obvious violations were found.

The dYFAS-C 2.0: Because of the dimensional scoring option, the convergent validity and the discriminant validity[1,36,37,59] were examined by Pearson's correlations only. This procedure was identical with that used for the convergent validation and the discriminant validation of the adult YFAS 2.0.

Incremental validity
The incremental validity was assessed through hierarchical linear regression analysis in order to examine whether the YFAS 2.0 score/dYFAS-C 2.0 score did predict the BMI/BMI z-score over and above binge-eating frequency. In model one, binge-eating frequency was entered as the only explanatory variable for BMI/BMI z-score. In model two, the YFAS 2.0/dYFAS-C 2.0 score was entered together with binge-eating frequency; this enabled an evaluation of the percentage of variance in BMI/BMI z-score that the YFAS 2.0/dYFAS-C 2.0 uniquely accounted for.
The assumption of independence was met, normality and variance homogeneity were assessed visually by inspection of residual plots. Linearity was evaluated with visual inspection of scatterplots. However, due to a relatively large N, this

assumption was not a concern. Generally, no obvious violations of the assumptions were found.

3.1.7.4 Attrition analyses

The attrition analyses comparing respondents (complete and partial responses) with non-respondents were analyzed using descriptive statistics, with means and standard deviations (SDs) for continuous variables and relative frequencies for categorical variables. Chi^2 test/Fischer's exact test and student's simple t-test were used to compare differences between respondents and non-respondents.
In cases of non-normality and violated model assumptions, bootstrapping with 1000 replications was used to estimate the 95%CI.

3.1.7.5 Food addiction prevalence estimation and dYFAS-C score estimation

The prevalence of food addiction and the mean dYFAS-C 2.0 score were estimated using both partial and complete responses to the YFAS 2.0/dYFAS-C 2.0.
The crude prevalence of food addiction/mean dYFAS-C 2.0 score with 95%CI were calculated. Further, the prevalence/mean dYFAS-C 2.0 score were stratified on sex, and the difference between sex was tested using student's simple t-test. In cases of non-normality or violated model assumptions, bootstrapping with 1000 replications was used to estimate the 95%CI.

3.1.7.6 Weighting of estimates

We used augmented inverse probability weighting (AIPW) to account for the missing survey data (YFAS 2.0/dYFAS-C 2.0) from non-respondents, who could not be included in the crude estimation of the prevalence/the mean dYFAS-C 2.0 score.[182] With the availability of sociodemographic, economic, and health-related data on all invitees, we were able to estimate the probability that food addiction status could be indicated by another conglomerate of individual data (the sociodemographic, economic, and health profile). The AIPW model was used to inflate the weights for respondents who were under-represented (according to their sociodemographic, economic, and health profile) among all respondents.[168,183]
In the AIPW model, "exposure" was equal to respondent status (respondent vs. non-respondent) and we used the same variables as in the attrition analyses for the weights. These variables were used as they have shown to have impact on the respondent status (respondent/non-respondent).[184] The "outcome" in the AIPW model was defined as food addiction status (dichotomous: yes/no), and the continuous mean dYFAS-C 2.0 score was used for the adolescent populations. Again, the same variables were employed for the outcome weights. This choice was made due to the known association between food addiction and obesity,[61] and the

association between obesity and the sociodemographic, economic, and health profile.[185,186]

The variables were included in the model in the following order: age, sex, (parental) marital status, (parental) socioeconomic factors, (parental) educational level, (parental) occupational status, and personal income/equivalized disposal income, degree of urbanization, geography/region (region of home address), lifetime somatic illness (the Charlson Comorbidity Index), lifetime mental disorders, and lifetime use of psychotropic medication. Whenever relevant, the estimate was stratified by sex due to known preponderance of females with food addiction.

The main assumptions for the AIPW model were considered to be fulfilled. These includes the "the stable unit treatment value assumption", which assumes that the potential outcome (food addiction Yes/No) for a given individual was completely independent of the assigned "treatment" (respondent/non-respondent) of another individual. In addition, "the strong ignorability assumption", which assumes that the potential outcome is completely independent of the assigned "treatment" given a set of observed control variables (sociodemographic, economic, and health profile), and that the propensity score is greater than zero and less than one based on the control variable.[168] For some of the stratified analyses, the model assumption was violated from one or more variables. In such cases, the variable(s) produced "nonsense" weights/propensity scores (very close to zero) due to small strata (e.g., in the eating disorder category stratified on sex, as eating disorders are rare among males, which caused too small strata, resulting in very small "nonsense" weights). Thus, the violating variable was excluded from the analyses. It is clearly stated in the footnotes of a table which variables were excluded for each analysis.

It should be noted that it was not possible to stratify on specific diagnoses in the adolescent population, as strata would have been too small (and become personally identifiable). Further, it was not possible to weight the sex-stratified mean dYFAS-C 2.0 scores, as this would have caused too small weights, which would have violated the model. Therefore, all the sex-stratified estimates are crude in the adolescent population.

3.1. ETHICS

An approval from the Committee on Health Research Ethics is not required in Denmark for survey and register-based studies if they do not include biological material or intervention.[187] The questionnaire and survey methodology was approved by the Danish Health Data Authority, and approval of the use of data from the Danish registers was granted by Statistics Denmark and the Danish Health Data Authority. Data obtained from the survey and data from the Danish registers were

de-identified by Statistics Denmark. The project was registered at the Danish Data Protection Agency (file no. 2008-58-0028).

When research studies include children and adolescents, the legal guardian(s) must consent on participation on behalf of the child/adolescent. In Denmark, the legal age of consent is 18 years. Therefore, the invitation was sent to the legal guardian(s) in the adolescent populations. This ensured that the legal guardian(s) were informed of the study purpose and able to evaluate whether their child should have the opportunity to participate in the survey (informed consent).
All invitees (adult and adolescent) were informed that survey participation was voluntary and that their consent to participate could be withdrawn at any time.

The FADK project was conducted and reported in accordance with the Strengthening The Reporting of Observational Studies in Epidemiology (STROBE) guideline [188].

The ethical considerations in relation to the design and conduct of the study are discussed in Chapter 5.

CHAPTER 4. RESULTS

Chapter 4 gives a compiled presentation of the main results of the PhD project. A more comprehensive description of the results, including several additional tables and figures, are given in the four articles included in the Appendix A to D. Here, the results will be presented for the adult and the adolescent populations combined, allowing for a more direct comparison between the populations. When tables and figures are replications from the articles, this is clearly stated in the legends.

4.1. ATTRITION

The survey response rate in the adult populations (based on both partial and complete responses) was 27.9% (n=1,394) in the population with mental disorder and 34.0% (n=1,699) in the general population, respectively. The response rate in the adolescent populations (including only complete responses to the dYFAS-C 2.0) was considerably lower; 12.0% (n=423) in the population with mental disorder and 15.4% (n=576) in the general population, respectively. In all four populations, respondents were more likely to be female, to have higher education, to be in the labor force, and to have higher income. The only exception was among adolescents with mental disorder, where the parental occupational level did not differ between respondents and non-respondents.
In both adults and adolescents from the general populations, non-respondents were more likely to be registered with a lifetime mental disorder and with lifetime use of psychotropic medication. In the adolescent population with mental disorder, this applied for the parents of the non-respondents. The detailed attrition analyses are presented in each of the four articles (found in Appendix A-D).
In both adults and adolescents with mental disorder, large differences were seen in the response rates across the different diagnostic groups. Please see Figure 2 and Figure 3.

4.2. PSYCHOMETRIC VALIDITY

4.2.1. PSYCHOMETRIC VALIDITY OF THE YFAS 2.0

4.2.1.1 Factor structure and internal consistency

For the general population, the average number of symptoms endorsed was 0.9 (SD=2.0); 1.1 (SD=2.2) for females and 0.6 (SD=1.6) for males, respectively. The fit indexes are presented in Table 1. Factor loadings for the one-factor model were in the range 0.43 to 0.77 and did not improve notably in the two-factor model.

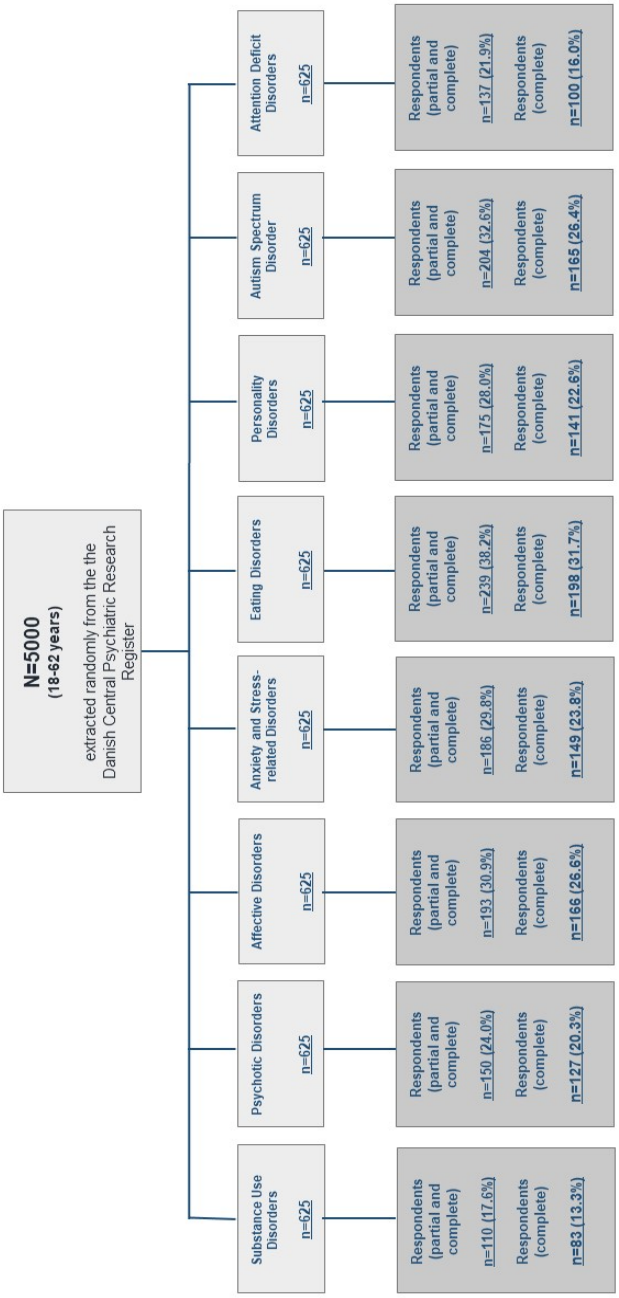


Figure 2. Flow chart for the adult population with mental disorder. Replicated from Horsager et al. Food addiction comorbid to mental disorder: A nationwide survey and register-based study. Under review.

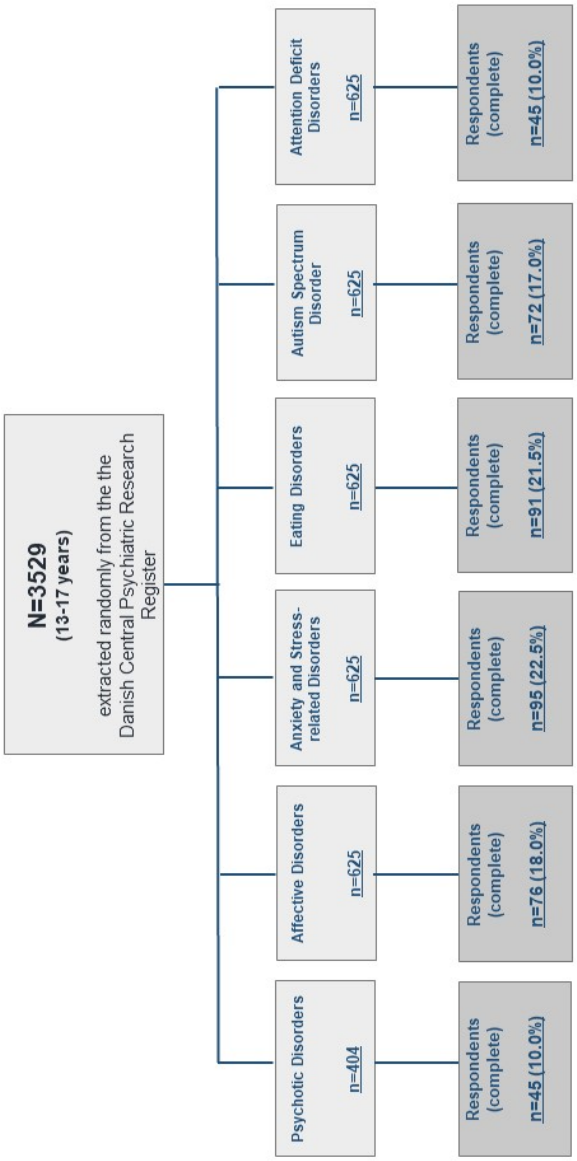


Figure 3. Flow chart for the adolescent population with mental disorder. From Horsager et al. Food addiction in adolescents with mental disorder – a nationwide combined survey and register-based study. In preparation.

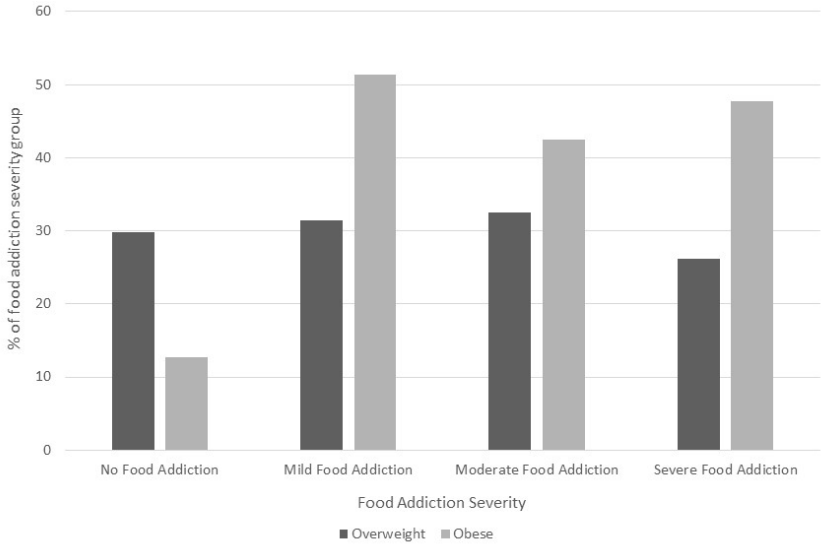
Among the adults with mental disorder, the average number of symptoms endorsed was 2.4 (SD=3.2); 2.7 (SD=3.4) for females and 1.8 (SD=2.6) for males. Factor loadings (see Table 1) for the one-factor model were in the range 0.55 to 0.77 and did not improve notably in the two-factor model in this population.

	General population		Population with mental disorder	
	One-factor model	Two-factor model	One-factor model	Two-factor model
Confirmatory fit index	0.909	0.909	0.907	0.907
Tucker Lewis Index	0.886	0.884	0.884	0.881
Root-mean-square error of approximation	0.089	0.090	0.105	0.107
Chi²	p<0.001	p<0.001	p<0.001	p<0.001
Kuder-Richardson alpha	0.87	-	0.91	-
Covariance between factor one and two	r=0.99		r=0.99	

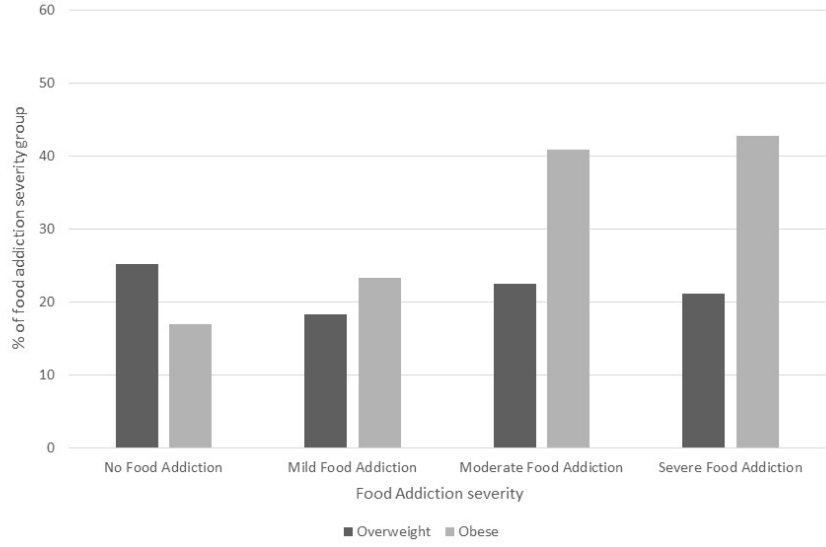
Table 1. Fit indexes and internal consistency for the YFAS 2.0 in the adult populations.

4.2.1.2 Convergent validity and discriminant validity of the YFAS 2.0

General population: The correlation matrix illustrating the convergent validity and discriminant validity of the YFAS 2.0 in the general population is provided in Table 2. All EDE-Q subscales of eating pathology were moderately to strongly correlated with the YFAS 2.0 total score (in the range *r*=0.50 to *r*=0.61 with p-values<0.05); restrained eating was less, albeit still significantly, correlated with the YFAS 2.0 total score (*r*=0.35, p<0.05). BMI and the SCL-92 ADHD subscale also correlated positively with the YFAS 2.0 total score, *r*=0.30, p<0.05, and *r*=0.44, p<0.05, respectively. The AUDIT score did not correlate with the YFAS 2.0 total score (*r*=- 0,001). When comparing the mean BMI between the different food addiction severity levels,[189] the BMI was significantly higher for those with food addiction (mean BMI for mild: 29.9 (SD=6.0), moderate: 30.3 (SD=8.3), and severe: 30.2 (SD=7.2) food addiction, respectively), compared to those without (mean BMI: 25.4 (SD=4.6), p<0.001). However, BMI did not differ between food addiction severity levels. In Figure 4 it is illustrated that a larger proportion had obesity among those with food addiction compared to those without.



General population



Body Mass Index (BMI) categorized according to the WHO definition of weight classes: Overweight (pre-obese): BMI=25.0 – 29.9, Obese: BMI≥30

Population with mental disorder

Figure 4. The proportion of individuals with overweight or obesity across food addiction severity levels in the adult general population and in the population with mental disorder. Replicated from Horsager et al. Validation of the Yale Food Addiction Scale 2.0 and estimation of the population prevalence of food addiction. Clinical Nutrition (2020) and Horsager et al. Food addiction comorbid to mental disorder: A nationwide survey and register-based study. Under review.

Adults with mental disorder: The correlation matrix illustrating the convergent and discriminant validity of the YFAS 2.0 is provided in Table 3. All measures of eating pathology were moderately to strongly correlated with the YFAS 2.0 total score (ranging from r=0. 57 to r=0. 66, p-values<0.05); restrained eating was also the less correlated eating pathology measure among adults with mental disorder (r=0.45, p<0.05). BMI and the ADHD subscale correlated moderately with the YFAS 2.0 total score, r=0.32, p<0.05 and r=0.47, p<0.05, respectively. As seen in the general population, alcohol dependence (AUDIT score) did not correlate with the YFAS 2.0 score (r=0,05). When comparing the mean BMI between the different food addiction severity levels, those having moderate food addiction (mean BMI=28.7, SD=7.1) and severe food addiction (mean BMI=30.1, SD=9.9) had a mean BMI that was significantly higher than the mean BMI of those without food addiction (mean BMI=25.1, SD=5.1). Thus, there was no difference in mean BMI between no food addiction and mild food addiction. This is also evident from Figure 4.

4.2.1.3 Incremental validity

General population: In model one (n=1369) with binge-eating frequency as the only explanatory variable, binge-eating frequency was a significant predictor of BMI (t=5.30, coeff.=1.15 [0.73;1.58], p<0.001), explaining 2.0% of the variance in BMI. In model two (n=1369) with addition of the YFAS 2.0 total score as explanatory variable, binge-eating frequency was no longer associated with BMI (t=0.59, coeff.=0.14 [-0.34;0.63], p=0.554), but the YFAS 2.0 total score was (t=8.30, coeff.=0.74 [0.56;0.91], p<0.001), accounting for an additional 4.7% of the unique variance in BMI.

Adults with mental disorder: In model one (n=1037), binge-eating frequency was a significant predictor of BMI (t=9.94, coeff.=1.59 [1.28;1.91], p<0.001), explaining 8.7% of the variance in BMI. In model two (n=1037), where the YFAS 2.0 total score was entered as explanatory variable, binge-eating frequency became less associated with BMI (t=3.67, coeff.=0.77 [0.36;1.18], p<0.001); the YFAS 2.0 total score was also associated with BMI (t=5.91, coeff.=0.49 [0.33;0.65], p<0.001), accounting for additional 3.0% of the unique variance in BMI.

4.2.2. PSYCHOMETRIC VALIDITY OF THE DYFAS-C 2.0

4.2.2.1 Factor structure and internal consistency

General population: The confirmatory factor analysis for a single-factor model showed factor loadings in the range from 0.38 to 0.83 (all with p-values <0.001). The fit indices were as follows: the CFI=0.86, the TLI=0.84, the RMSEA=0.099, and the SRMR=0.06. The internal consistency was 0.92 measured by Cronbach's alpha.

Adolescents with mental disorder: Factor loadings for a single-factor model was in the range from 0.38 to 0.87, and the fit indices were: the CFI= 0.85, the TLI= 0.82, the RMSEA= 0.12, and the SRMR= 0.06. The internal consistency was 0.94 measured by Cronbach's alpha.

Table 2 (next page, p.64). *Correlation matrix illustrating the convergent validity and discriminant validity for the YFAS 2.0 symptom score in the general adult population. Replicated from Horsager et al. Validation of the Yale Food Addiction Scale 2.0 and estimation of the population prevalence of food addiction. Clinical Nutrition (2020).*

	YFAS 2.0 symptom count (n)	Age (n)	ADHD (SCL-92) (n)	Restraint eating (EDE-Q) (n)	Eating concern (EDE-Q) (n)	Shape concern (EDE-Q) (n)	Weight concern (EDE-Q) (n)	Binge eating frequency (EDE-Q) (n)	Eating pathology (Global EDE-Q score) (n)	BMI (n)	Alcohol dependence (AUDIT) (n)
YFAS 2.0 symptom count	1 (1436)										
Age	-0.11* (1436)	1 (1436)									
ADHD (SCL-92)	0.44* (1366)	-0.23* (1366)	1 (1366)								
Restraint eating (EDE-Q)	0.35* (1400)	-0.02 (1400)	0.24* (1350)	1 (1400)							
Eating concern (EDE-Q)	0.61* (1339)	-0.20* (1339)	0.45* (1309)	0.43* (1325)	1 (1339)						
Shape concern (EDE-Q)	0.54* (1359)	-0.15* (1359)	0.50* (1333)	0.58* (1346)	0.63* (1303)	1 (1359)					
Weight concern (EDE-Q)	0.54* (1383)	-0.14* (1383)	0.45* (1356)	0.58* (1367)	0.63* (1325)	0.91* (1354)	1 (1383)				
Binge eating frequency (EDE-Q)	0.50* (1387)	-0.07* (1387)	0.32* (1351)	0.25* (1370)	0.55* (1327)	0.40* (1344)	0.39* (1368)	1 (1387)			
Eating pathology (Global EDE-Q score)	0.54* (1286)	-0.13* (1286)	0.45* (1262)	0.78* (1286)	0.73* (1286)	0.93* (1286)	0.93* (1286)	0.40* (1274)	1 (1286)		
BMI[a]	0.30* (1381)	0.13 (1381)	0.15* (1355)	0.23* (1365)	0.24* (1323)	0.40* (1347)	0.45* (1370)	0.20* (1366)	0.40* (1276)	1 (1381)	
Alcohol dependence (AUDIT)	-0.001 (1297)	-0.17* (1297)	0.15* (1285)	0.01 (1282)	0.04 (1243)	0.03 (1264)	0.02 (1289)	0.06* (1283)	0.03 (1198)	-0.04 (1288)	1 (1297)

YFAS 2.0: Yale Food Addiction Scale 2.0
EDE-Q: Eating disorder Examination Questionnaire
SCL-92: The Symptom Checklist-92
AUDIT: The Alcohol Use Disorder Test
* Significance level: $p<0.05$
[a] Not including data from four individuals with a reported height under 100 centimeters or weight under 30 kilograms

	YFAS 2.0 symptom count (n)	Age (n)	ADHD (SCL-92) (n)	Restraint eating (EDE-Q) (n)	Eating concern (EDE-Q) (n)	Shape concern (EDE-Q) (n)	Weight concern (EDE-Q) (n)	Binge eating frequency (EDE-Q) (n)	Eating pathology (Global EDE-Q score) (n)	BMI (n)	Alcohol dependence (AUDIT) (n)
YFAS 2.0 symptom count	1 (1129)										
Age	-0.01 (1129)	1 (1129)									
ADHD (SCL-92)	0.47* (1047)	-0.05 (1047)	1 (1047)								
Restraint eating (EDE-Q)	0.45* (1100)	0.01 (1100)	0.32* (1040)	1 (1100)							
Eating concern (EDE-Q)	0.65* (935)	-0.11* (935)	0.43* (906)	0.52* (927)	1 (935)						
Shape concern (EDE-Q)	0.60* (1049)	-0.08* (1049)	0.50* (1027)	0.67* (1043)	0.69* (910)	1 (1049)					
Weight concern (EDE-Q)	0.60* (1057)	-0.09* (1057)	0.48* (1036)	0.67* (1051)	0.69* (918)	0.93* (1040)	1 (1057)				
Binge eating frequency (EDE-Q)	0.66* (1064)	-0.001 (1064)	0.36* (1027)	0.36* (1056)	0.61* (925)	0.48* (1029)	0.49* (1037)	1 (1064)			
Eating pathology (Global EDE-Q score)	0.57* (897)	-0.07* (897)	0.41* (878)	0.79* (897)	0.81* (897)	0.94* (897)	0.94* (897)	0.50* (887)	1 (897)		
BMI[a]	0.32* (1057)	0.21* (1057)	0.19* (1039)	0.13* (1049)	0.20* (917)	0.34* (1036)	0.36* (1034)	0.30* (1037)	0.31* (886)	1 (1057)	
Alcohol dependence (AUDIT)	0.05 (916)	0.03 (916)	0.15* (906)	0.03 (909)	0.04 (797)	0.01 (898)	0.001 (904)	0.03 (898)	0.03 (771)	-0.05 (909)	1 (916)

YFAS 2.0: Yale Food Addiction Scale 2.0
EDE-Q: Eating disorder Examination Questionnaire
SCL-92: The Symptom Checklist-92
AUDIT: The Alcohol Use Disorder Test
* Significance level: $p<0.05$
[a] Not including data from four individuals with a reported height under 100 centimeters or weight under 30 kilograms

Table 3 (previous page, p. 65). Correlation matrix illustrating the convergent validity and discriminant validity for the YFAS 2.0 symptom score in the adult population with mental disorder. Replicated from Horsager et al. Food addiction comorbid to mental disorder – a nationwide combined survey and register-based study. Under review.

4.2.2.2 Convergent validity and discriminant validity of the dYFAS-C 2.0

General population: The correlation matrix illustrating the convergent validity and discriminant validity of the dYFAS-C 2.0 in the general population is provided in Table 4. All sub-scales on eating pathology correlated moderately to strongly with the dYFAS-C 2.0 total score (all in the range from r=0.43 to r=0.56 with p-values<0.05). Similarly to the adult version of the YFAS 2.0, the subscale on restrained eating was the less correlated eating pathology measure (r=0.41, p<0.05). The SCL-92 ADHD subscale correlated moderately with the dYFAS-C 2.0 total score (r=0.47, p<0.05) and the BMI z-score (r=0.29, p<0.05). Alcohol dependence (AUDIT score) correlated poorly with the dYFAS-C 2.0 score (r=0.14, p<0.05).

Adolescents with mental disorder: The correlation matrix illustrating the convergent validity and discriminant validity of the dYFAS-C 2.0 in the population with mental disorder is provided in Table 5. In the population with mental disorder, all measures of eating pathology were moderately to strongly correlated with the dYFAS-C 2.0 total score. Binge-eating frequency was the best correlated measure (r=0.60, p<0.05); the remaining subscales were in the range r=0.41, p<0.05 to r=0.46, p<0.05. Again, restrained eating was the least correlated among eating-related measure (r=0.32, p<0.05). The BMI z-score was moderately correlated with the dYFAS-C 2.0 total score (r=0.33, p<0.05); the same applied for the SCL-92 ADHD subscale (r=0.43, p<0.05) and alcohol dependence (AUDIT score) (r=0.33, p<0.05).

4.2.2.3 Incremental validity of the dYFAS-C 2.0

General population: Binge-eating frequency was a significant predictor of the BMI z-score (t=5.01, coeff.=0.36 [0.22;0.50], p<0.001) in the first model, explaining 4.4% of the variance. In the second model, adding the dYFAS-C 2.0 total score to the model implied that binge-eating frequency became less associated with the BMI z-score (t=2.11, coeff.=0.17 [0.01;0.32], p=0.036). The dYFAS-C 2.0 total score was also associated with BMI (t=5.35, coeff.=0.027 [0.02;0.04], p<0.001), accounting for an additional 4.8% of the unique variance in the BMI z-score.

Adolescents with mental disorder: In model one (n=395), binge-eating frequency was a significant predictor of the BMI z-score (t=3.91, coeff.=0.25 [0.12;0.38], p<0.001), explaining 3.7% of the variance. When adding the dYFAS-C 2.0 total score to the model, binge-eating frequency was no longer significantly associated with the BMI z-score (t=0.04, coeff.=0.003 [-0.15;0.15], p=0.968). Thus, the dYFAS-C 2.0 total score was (t=5.33, coeff.=0.033 [0.02;0.05], p<0.001), accounting for an additional 6.5% of the unique variance in the BMI-z score.

General population	dYFAS-C 2.0 symptom count (n)	Age (n)	ADHD (SCL-92) (n)	Restraint eating (EDE-Q) (n)	Eating concern (EDE-Q) (n)	Shape concern (EDE-Q) (n)	Weight concern (EDE-Q) (n)	Binge eating frequency (EDE-Q) (n)	Eating pathology (Global EDE-Q score) (n)	BMI z-score (n)	Alcohol dependence (AUDIT) (n)
dYFAS-C 2.0 symptom count	1 (576)										
Age	0.16* (576)	1 (576)									
ADHD (SCL-92)	0.47* (539)	0.19* (555)	1 (555)								
Restraint eating (EDE-Q)	0.41* (564)	0.09* (579)	0.32* (552)	1 (579)							
Eating concern (EDE-Q)	0.55* (529)	0.04 (544)	0.47* (529)	0.54* (542)	1 (544)						
Shape concern (EDE-Q)	0.56* (541)	0.12* (557)	0.52* (542)	0.65* (555)	0.69* (536)	1 (557)					
Weight concern (EDE-Q)	0.54* (546)	0.13* (561)	0.51* (545)	0.62* (559)	0.68* (537)	0.92* (553)	1 (561)				
Binge eating frequency (EDE-Q)	0.46* (551)	0.06 (567)	0.27* (548)	0.31* (565)	0.39* (538)	0.41* (538)	0.39* (555)	1 (567)			
Eating pathology (Global EDE-Q score)	0.56* (517)	0.11* (530)	0.49* (516)	0.79* (530)	0.79* (530)	0.95* (530)	0.93* (530)	0.40* (525)	1 (530)		
BMI z-score	0.29* (549)	0.16* (565)	0.16* (551)	0.28* (562)	0.24* (538)	0.34* (552)	0.35* (555)	0.22* (558)	0.33* (525)	1 (565)	
Alcohol dependence (AUDIT)[a]	0.14* (372)	0.56* (384)	0.24* (378)	0.12* (383)	0.08 (363)	0.16* (374)	0.17* (376)	0.15* (379)	0.14* (354)	0.08 (382)	1 (384)

EDE-Q: Eating disorder Examination Questionnaire
SCL-92: The Symptom Checklist-92
AUDIT: The Alcohol Use Disorder Test
* p<0.05

[a] The sex-stratified correlation: males: 0.19* (n=163), females: 0.12 (n=209).

Psychiatric population	dYFAS-C 2.0 symptom count (n)	Age (n)	ADHD (SCL-92) (n)	Restraint eating (EDE-Q) (n)	Eating concern (EDE-Q) (n)	Shape concern (EDE-Q) (n)	Weight concern (EDE-Q) (n)	Binge eating frequency (EDE-Q) (n)	Eating pathology (Global EDE-Q score) (n)	BMI z-score (n)	Alcohol dependence (AUDIT) (n)
dYFAS-C 2.0 symptom count	1 (423)										
Age	0.17* (423)	1 (423)									
ADHD (SCL-92)	0.43* (393)	0.14* (411)	1 (411)								
Restraint eating (EDE-Q)	0.32* (415)	0.21* (433)	0.41* (406)	1 (433)							
Eating concern (EDE-Q)	0.43* (376)	0.21* (393)	0.40* (379)	0.70* (388)	1 (393)						
Shape concern (EDE-Q)	0.41* (390)	0.23* (407)	0.49* (397)	0.77* (402)	0.72* (376)	1 (407)					
Weight concern (EDE-Q)	0.46* (399)	0.22* (416)	0.51* (406)	0.74* (412)	0.71* (383)	0.94* (404)	1 (416)				
Binge eating frequency (EDE-Q)	0.60* (408)	0.13* (426)	0.28* (409)	0.33* (421)	0.48* (391)	0.33* (405)	0.33* (414)	1 (426)			
Eating pathology (Global EDE-Q score)	0.43* (355)	0.24* (369)	0.45* (360)	0.86* (369)	0.83* (369)	0.96* (369)	0.94* (369)	0.38* (367)	1 (369)		
BMI z-score	0.33* (398)	0.13* (418)	0.10* (407)	0.07 (412)	0.03 (382)	0.13* (401)	0.16* (410)	0.19* (413)	0.09 (363)	1 (418)	
Alcohol dependence (AUDIT)[a]	0.33* (283)	0.41* (295)	0.13* (288)	0.25* (292)	0.23* (268)	0.30* (284)	0.27* (290)	0.11 (292)	0.31* (255)	0.09 (292)	1 (295)

EDE-Q: Eating disorder Examination Questionnaire
SCL-92: The Symptom Checklist-92
AUDIT: The Alcohol Use Disorder Test
* Significance level: p<0.05

[a] The sex-stratified correlation: males: 0.08 (n=92), females: 0.30* (n=191).

Table 4 (page 67). Correlation matrix illustrating the convergent validity and discriminant validity for the dimensional dYFAS-C 2.0 symptom score in the general adolescent population. Replicated from Horsager et al. Validation of the dimensional Yale Food Addiction Scale for Children 2.0 and estimation of the dimensional food addiction score in a sample of adolescents from the general population. Under review.

Table 5 (page 68). Correlation matrix illustrating the convergent validity and discriminant validity for the dimensional dYFAS-C 2.0 symptom score in the adolescent population with mental disorder. From Horsager et al. Food addiction comorbid to mental disorders in adolescents: A nationwide survey and register-based study. In preparation.

4.3. FOOD ADDICTON PREVALENCE AND SYMPTOM SCORE

4.3.1. PREVALENCE OF FOOD ADDICTION IN THE ADULT POPULATIONS

General population: The crude food addiction prevalence was 9.0% (CI 95%: 7.6-10.4) (n=153/1,699). The distribution was 2.5% mild, 2.6% moderate, and 3.9% severe food addiction cases. Stratified on sex, 119 (77.8%) of those with food addiction were female, corresponding to 11.9% of the female respondents, and 34 (22.2%) were male, corresponding to 4.8% of the male respondents; the difference between sex was significant (p<0.001). The weighted prevalence was 9.4% (CI 95%: 7.9;10.9); 6.1% (CI 95%: 4.2;8.0) for males and 13.4% (CI 95%: 11.1;15.7) for females when stratified on sex.

Adults with mental disorder: Across all diagnoses, the crude food addiction prevalence was 26.5% (n=369/1,394). The distribution was 5.0% mild, 5.9% moderate, and 15.6% severe food addiction cases. Stratified on sex, 303 (82.2%) of those with food addiction were female, corresponding to 32.0% of the female respondents, and 66 (13.4%) were male, corresponding to 14.2% of the male respondents. In Table 6, both the crude and weighted prevalence estimates of food addiction across the diagnostic categories are presented. The weighted food addiction prevalence estimate across all diagnoses was 23.7% (95%CI: 21.5;25.9). Between diagnostic categories, the weighted prevalence varied substantially in the range from 8.3% (95%CI: 3.8;12.9) for substance use disorders to 47.7% (95%CI: 41.2;54.2) for eating disorders. The second highest prevalence was found for affective disorders, 29.4% (95%CI: 22.9;36.0), and personality disorders, 29.0% (95%CI: 22.2;35.9). When the data were stratified on sex, food addiction was more prevalent in females in all diagnostic categories and across all specific mental disorders. The highest prevalence was found in females with the diagnosis of schizophrenia 51.9% (95%CI: 39.7;64.2) in females vs. 12.8% (95%CI: 2.6;23.0) in males. The only exception from the rule of female predominance was found for

bipolar disorder, where the crude food addiction prevalence was higher for males, 54.5% (95%CI: 25.1;84.0), compared to females, 31.8% (95%CI: 12.4;51.3). However, these estimates are based on few cases (7 females and 6 males; this is also reflected in the wide confidence intervals).

4.3.1.1 Comparison of food addiction prevalence estimates between the general population and adults with mental disorder

The difference in the weighted prevalence was significant between the general population (9.4% (CI 95%: 7.9;10.9)) and the population with mental disorder (23.7% (95%CI: 21.5;25.9)), p<0.001.
The food addiction prevalence in the diagnostic categories of substance use disorders, 8.3% (CI 95%: 3.8;12.9), and attention deficit disorders, 12.3% (CI 95%: 6.7;17.9), did not differ significantly from the prevalence in the general population.

4.3.2. THE MEAN DYFAS-C SCORE IN THE ADOLESCENT POPULATIONS

General population: The crude dYFAS-C 2.0 total score was 11.9 (95% CI: 11.1;12.7) and, when stratified on sex, 14.2 (95%CI: 13.1;15.3) for females vs. 9.1 (95%CI: 8.1;10.1) for males, p<0.001.
The weighted mean dYFAS-C 2.0 total score was 12.0 (95% CI: 11.2;12.9); 9.5 (95% CI: 8.3;10.6) for males vs. 15.0 (95% CI: 13.9;16.2) for females, p<0.001.
The mean dYFAS-C 2.0 score increased, going from one BMI z-score weight category to the next, as illustrated in Figure 5.

Adolescents with mental disorder: The crude mean dYFAS-C 2.0 total score was 13.8 (95% CI: 12.6;14.9), and, when stratified on sex, 9.9 (95% CI: 8.3;11.4) for males vs. 16.0 (95% CI: 14.5;17.5) for females, p<0.001.
The weighted mean dYFAS-C 2.0 total score was 13.8 (95% CI: 12.6;14.9); 10.3 (95% CI: 8.7;11.9) for males vs. 16.1 (95% CI: 14.6;17.6) for females, p<0.001.
Similar to the general population, the mean dYFAS-C 2.0 score increased, going from one BMI z-score weight-category to the next, as illustrated in Figure 6.
The mean dYFAS-C score estimates for the six diagnostic categories of mental disorders, as well as the sex-stratified crude estimates, are presented in Table 7. Females had higher mean dYFAS-C 2.0 scores compared to males for all diagnostic categories of mental disorder, but the difference was only significant for psychotic disorders (p=0.006) and anxiety disorders (p=0.031). For females, the dYFAS-C 2.0 score was lowest in attention deficit disorders, 11.4 (95%CI: 5.7;17.1), and autism spectrum disorders, 12.1 (95%CI: 7.6;16.6), and highest in affective disorders and psychotic disorders, 19.6 (95%CI: 16.1;23.0) and 23.2 (95%CI: 17.4;29.0), respectively. The distribution was slightly different for males, where the lowest mean dYFAS-C 2.0 scores were found in autism spectrum disorders, 8.3 (95%CI: 6.1;10.5), and eating disorders, 9.0 (95%CI: 1.6;16.4]), and the highest scores were

seen in affective disorders, 15.7 (95%CI: 8.3;23.1), and psychotic disorders, 11.5 (95%CI: 5.7;17.4).

4.3.2.1 Comparison of mean dYFAS-C 2.0 estimates between the general population and adolescents with mental disorder

A significant difference was seen in the crude dYFAS-C 2.0 score between the general population and adolescents with mental disorder (p=0.009). However, when stratified on sex, this difference became statistically insignificant for both males (p=0.387) and females (p=0.053).

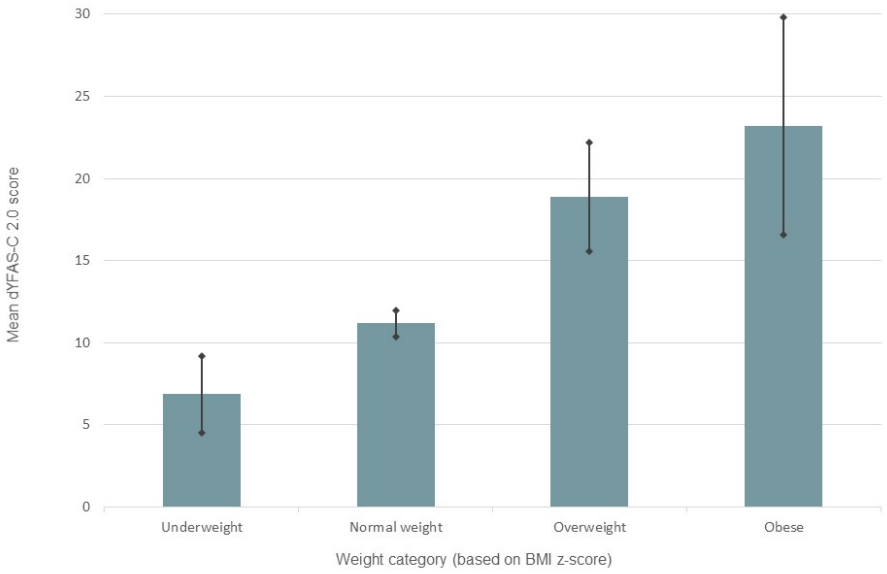
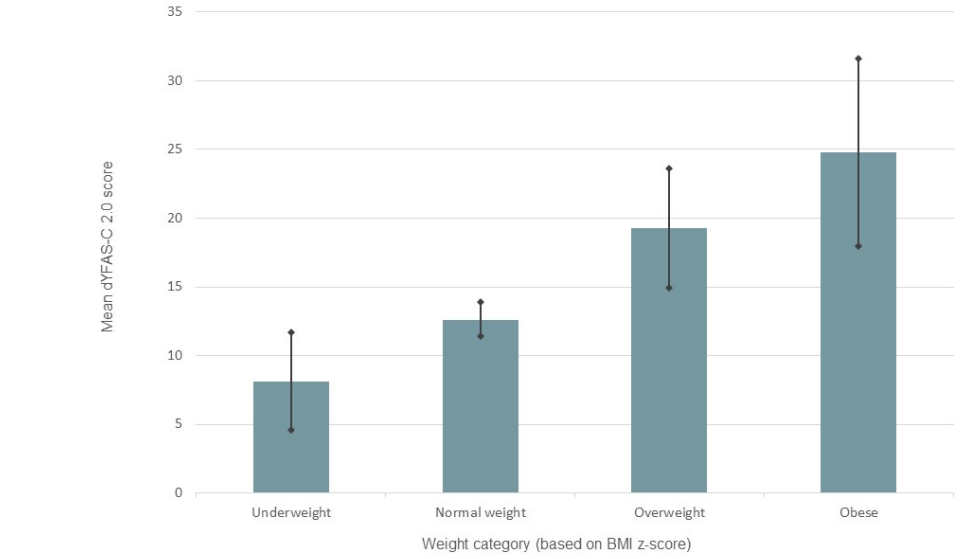


Figure 5. Mean dYFAS-C 2.0 scores divided into BMI z-score weight categories in the general adolescent population. The 95% Cis are shown for each BMI z-score category. Replicated from Horsager et al. Validation of the dimensional Yale Food Addiction Scale for Children 2.0 and estimation of the dimensional food addiction score in a sample of adolescents from the general population. Under review.



BMI z-score categorized according to the WHO; underweight/thinness < -2 SD, normal weight -2 SD > +1 SD, overweight +1 SD < +2 SD, and obese > +2 SD.

Figure 6. Mean dYFAS-C 2.0 scores divided into BMI z-score weight categories in the adolescent population with mental disorder. The 95% CIs are shown for each BMI z-score category. From Horsager et al. Food addiction comorbid to mental disorders in adolescents: A nationwide survey and register-based study. In preparation.

Table 6 (next page, p. 73). The crude and weighted prevalence of food addiction across diagnostic categories in the adult population with mental disorder. Replicated from Horsager et al. Food addiction comorbid to mental disorder: A nationwide survey and register-based study. Under review.

Adult population with mental disorder	Individuals with food addiction (N)	Crude food addiction prevalence estimate % [95% CI]	Weighted food addiction prevalence estimate[a] % [95% CI]	Female food addiction prevalence estimate[a] % [95% CI]	Male food addiction prevalence estimate[a] % [95% CI]
Overall prevalence across all diagnostic groups[b]	369	26.5 [24.2;28.8]	23.7 [21.5;25.9]	32.0 [29.0;35.0][a] (n=303/929)	13.4 [10.2;16.5][a] (n=66/465)
Categories of mental disorders (responders)[c]					
Substance use disorders (n=110)	13	11.8 [5.8;17.9]	8.3 [3.8;12.9]	14.3 [-0.7;29.3][a,d] (n=8/38)	6.9 [1.4;12.5][a,e] (n=5/72)
Psychotic disorders (n=150)	39	26.0 [19.0;33.0]	22.7 [16.1;29.3]	40.0 [30.1;49.9][a,e] (n=30/86)	12.6 [4.7;20.6][a,f] (n=9/64)
Schizophrenia (n=85)	27	31.8 [21.9;41.7]	27.3 [19.0;35.5]	51.9 [39.7;64.2][a,e] (n=22/45)	12.8 [2.6;23.0][a,f] (n=5/40)
Affective disorders (n=193)	54	28.0 [21.6;34.3]	29.4 [22.9;36.0]	33.0 [25.3;40.7][a] (n=43/141)	24.0 [10.7;37.3][a,f] (n=11/52)
Bipolar disorder (n=33)	13	39.4 [22.7;56.1]	43.4 [15.4;71.4]	31.8 [12.4;51.3][b] (n=7/22)	54.5 [25.1;84.0][b] (n=6/11)
Unipolar depression (n=160)	41	25.6 [18.9;32.4]	25.3 [18.6;32.0]	30.7 [22.6;38.8][a] (n=36/119)	13.9 [3.1;24.8][a,f] (n=5/41)
Anxiety and stress-related disorders (n=186)	44	23.7 [17.5;29.8]	22.8 [16.5;29.2]	26.3 [18.4;34.1][a] (n=32/122)	18.6 [8.3;28.9][a,f] (n=12/64)
Anxiety (n=121)	23	19.0 [12.0;26.0]	19.7 [12.6;26.9]	22.6 [14.2;31.0][a] (n=17/79)	13.9 [1.6;26.1][a,f,j] (n=6/42)
Obsessive-compulsive disorder (n=36)	13	36.1 [20.4;51.8]	42.9 [19.3;66.4][f]	37.5 [18.1;56.9][b] (n=9/24)	33.3 [6.7;60.0][b] (n[g]/12)
Post-traumatic stress disorder (n=29)	8	27.6 [11.3;43.9]	19.9 [7.8;32.1][h]	31.6 [10.7;52.5][b] (n=6/19)	(n[h]/10)
Eating disorders (n=239)	109	45.6 [39.3;52.0]	47.7 [41.2;54.2][i]	45.1 [38.5;51.7][j] (n=107/236)	[h]
Anorexia nervosa (n=109)	42	38.5 [29.4;47.7]	42.5 [32.3;52.7][i]	42.2 [32.0;52.5] (n=42/109)	-
Bulimia nervosa (n=83)	38	45.8 [35.1;56.5]	51.8 [39.6;64.0][k]	51.0 [38.7;63.2][i] (n=37/82)	[h]
Personality Disorder (n=175)	53	30.3 [23.5;37.1]	29.0 [22.2;35.9]	32.4 [24.7;40.2][a] (n=49/146)	(n[h]/29)
Borderline personality disorder (n=48)	21	43.8 [29.7;57.8]	36.3 [20.5;52.2]	29.3 [10.8;47.8][a] (n=19/44)	[h]
Autism spectrum disorder (n=204)	35	17.2 [12.0;22.3]	16.3 [11.4;21.2]	21.1 [13.6;28.6][a,j] (n=21/92)	11.9 [5.8;17.9][a] (n=14/112)
Attention deficit disorders (ADHD/ADD) (n=137)	22	16.1 [9.9;22.2]	12.3 [6.7;17.9]	18.3 [8.5;28.0][a,j] (n=14/68)	9.3 [2.0;16.6][a,j] (n=8/69)

[a] Based on augmented inverse probability weighted (AIPW) estimation
[b] n=5,000
[c] n=625 for each of the eight diagnostic categories
[d] The variable "autism spectrum disorder" violated the AIPW-model and was therefore not included.
[e] The variable "eating disorder" violated the AIPW-model and was therefore not included.
[f] The variable "substance use disorders" violated the AIPW-model and was therefore not included.
[g] Numbers are too small to be shown according to rules enforced by Statistics Denmark (due to risk of identification of individuals).
[h] The last step in the AIWP-model including "Use of psychotropic medication" was not performed due to the small number of respondents and food addiction cases in this sub-group.
[i] The variable "lithium" violated the AIPW-model and was therefore not included.
[j] The variable "sex" violated the AIPW-model and was therefore not included.
[k] The variable "medication for addiction disorders" violated the AIPW-model and was therefore not included.

	Mean dYFAS-C 2.0 total score				
Diagnostic categories mean, [95%CI]	**Total crude dYFAS-C 2.0 score estimate**	**Total weighted dYFAS-C 2.0 score estimate [i,ii]**	**Female crude dYFAS-C 2.0 score estimate**	**Male crude dYFAS-C 2.0 score estimate**	**Comparison between sexes (P-value[iii])**
Total population	13.8 [12.6;14.9]	13.8 [12.6;14.9]	16.0 [14.5;17.5] (n=270)	9.9 [8.3;11.4] (n=153)	<0.001
Psychotic disorders	18.8 [14.4;23.3]	18.4 [14.6;22.1]	23.2 [17.4;29.0] (n=28)	11.5 [5.7;17.4] (n=17)	0.006
Affective disorders	18.8 [15.7;21.9]	19.4 [16.3;22.5]	19.6 [16.1;23.0] (n=61)	15.7 [8.3;23.1] (n=15)	0.296
Anxiety disorders	13.1 [11.0;15.2]	13.0 [10.7;15.3]	14.6 [12.0;17.2] (n=65)	9.8 [6.4;13.2] (n=30)	0.031
Eating disorders	13.4 [10.8;15.9]	13.2 [10.7;15.8][iv]	13.7 [11.0;16.4] (n=85)	9.0 [1.6;16.4] (n=6)	0.140
Autism spectrum disorders	9.4 [7.4;11.4]	9.3 [7.3;11.3]	12.1 [7.6;16.6] (n=20)	8.3 [6.1;10.5] (n=52)	0.099
Attention deficit disorders (ADHD/ADD)	9.7 [6.8;12.5]	10.0 [8.2;11.9][v]	11.4 [5.7;17.1] (n=11)	9.1 [5.7;12.5] (n=33)	0.473

[i] Based on augmented inverse probability weighted (AIPW) estimation, n=625 (n=403 for psychotic disorders).
[ii] The variables "medication for addiction disorders" and "lithium" violated the AIPW-model and were therefore not included.
[iii] Simple t-test. Testing the difference in dYFAS-C 2.0 score between sexes. Because of violated model assumptions (outcome was not normally distributed), bootstrapping with 1000 replications was used to estimate SE.
[iv] The variable "ADHD medication" violated the AIPW-model and was therefore not included.
[v] The variables "psychotic disorders" and "eating disorders" violated the AIPW-model and were therefore not included.

Table 7. The crude and weighted prevalence of food addiction across diagnostic categories in the adolescent population with mental disorder. From Horsager et al. Food addiction comorbid to mental disorders in adolescents: A nationwide survey and register-based study. In preparation.

CHAPTER 5. DISCUSSION OF RESULTS

5.1. SUMMARY OF MAIN RESULTS

The FADK Project survey was completed successfully with response rates at an acceptable level, especially in the adult populations. Furthermore, the merging of data from the Danish registers was complete. This allowed for comprehensive attrition analyses and weighting of the food addiction prevalence estimates and the mean dYFAS-C 2.0 score in the adult and adolescent populations, respectively. The nearly identical crude and weighted estimates indicated that attrition from the study did not seem to affect the prevalence or the mean dYFAS-C 2.0 estimates.

The psychometric properties of the YFAS 2.0 were sound and were comparable to those described both in the original validation study[1] and validation studies conducted in other languages.[49,53,137,190] Food addiction was far more prevalent in individuals with mental disorder (23.7%) compared to the general population (9.4%). The prevalence was particularly high in respondents with psychotic disorders, affective disorders, personality disorders, and eating disorders.

Among the adolescents, we found the dYFAS-C 2.0 to be a valid measure of food addiction symptomatology in the general population as well as in the population with mental disorder. Further, among the adolescents, the symptom load was found to be lower than previously reported in the original study by Schiestl et al.,[59] which was based on populations in the United States (US). Moreover, food addiction symptomatology seemed to be more prevalent in the group with psychotic and affective disorders.

The results confirmed that food addiction appears to be more prevalent in females, and that food addiction symptoms are positively correlated with BMI/obesity.

5.2. PSYCHOMETRIC VALIDITY

5.2.1. CONFIRMATORY FACTOR ANALYSIS OF THE YFAS 2.0 AND DYFAS-C 2.0

As noted in the section on statistics, the evaluation of the confirmatory factor analysis is based on the theoretically established cut-off values for adequate model fit indexes. However, as both the merit and the choice of model fit indexes is debated,[172] the results are mainly discussed in relation to previous psychometric validation studies on the YFAS 2.0/dYFAS-C 2.0 in order to confirm the hypothesized one-factor structure of the scale.

5.2.1.1 The YFAS 2.0

The Danish YFAS 2.0 showed good internal consistency in both adult populations. Further, the one-factor structure was supported in both populations, with acceptable factor loadings in the range from 0.43 to 0.77 in the general population and 0.58 to 0.77 in the adults with mental disorder. In both populations, the two-factor model did not provide significantly better fit indexes. Additionally, the correlation between the two factors was high in both populations, providing further support for the one-factor model. Evidence in favor of a one-factor model was also found in several other validation studies of the YFAS 2.0 across different countries and languages.[1,49,50,53,137,190–192] However, the fit indexes and factor loadings were markedly better in the original US study by Gearhardt et al. and validation studies performed in translated versions of the YFAS 2.0.[1,50,53,137] Still, the Japanese and French validation studies[49,190] both found fit indexes and factor loadings that were comparable to those obtained in this project (both in the general population and in the adults with mental disorder). An explanation for the less optimal factor loadings and fit indexes could be that the present project relied on random sampling from both the general population and adults with mental disorder, and the validation was performed across diagnostic categories. Therefore, the two samples in this study were more diverse and less homogeneous than the samples used in other validation studies of the YFAS 2.0 (often highly selected population or included by self-selection). This could result in more variance in the dataset and resulting lower fit indices and factor loadings. In summary, the findings support that the food addiction construct is best described as having an underlying single latent structure, and that the Danish YFAS 2.0 has good psychometric properties in the general population and among the adults with mental disorder; thus, it may be used as a valid measure of food addiction in these populations.

5.2.1.2 The dYFAS-C 2.0

Adolescence is a period of life with a high incidence of addiction disorders and related conditions.[113–116] The dYFAS-C 2.0 was developed to detect indicators of emerging food addiction in this young group. So far, only one study by Schiestl et al. has validated the dYFAS-C 2.0; they found its psychometric properties promising.[59] The factor loadings for a one-factor latent structure were comparable to those found in the study by Schiestl et al., and this applied for both adolescent populations. Interestingly, the factor loadings were improved for almost all items in the population of adolescents with mental disorder (range 0.38 to 0.87) compared to the general adolescent population (range 0.38 to 0.83). This is probably explained by the higher food addiction symptom load in the population of adolescents with mental disorder. The same applied for the internal consistency (a Cronbach's alpha of 0.92 in the general population and of 0.94 in the population of adolescents with mental disorder) and the fit indices for the one-factor model. For the latter, all indexes (except for the RMSEA) were slightly better in both populations compared to the

original study. Altogether, these findings expand the validity and applicability of the dYFAS-C 2.0 across cultures and languages.

5.2.2. THE CONSTRUCT VALIDITY OF THE YFAS 2.0 AND DYFAS-C 2.0

The construct validity will be discussed across both the YFAS 2.0 and dYFAS-C 2.0 and the four populations in order to get a more consolidated picture of the food addiction construct. This was possible because the same measures were used for the validation analyses in all populations. To examine the construct validity of the YFAS 2.0 and the dYFAS-C 2.0, we applied hypothesis testing with convergent and discriminant measures that were believed to be theoretically correlated or non-correlated with the food addiction construct. In general, the correlation patterns were comparable to those in numerous validation studies conducted on the YFAS 2.0.[1,49,53,59]

Eating pathology was hypothesized to be convergent with food addiction. Accordingly, both the YFAS 2.0 score and the dYFAS-C 2.0 score did correlate moderately to strongly with all eating pathology measures. In the general populations (both adult and adolescent), the most correlated measures were eating and shape concern and the global EDE-Q score (measure of total eating pathology). In both of the populations with mental disorder, the most strongly correlated measure was binge-eating frequency followed by the same measures as in the general populations. This difference could be explained by a potentially more intense binge-eating pattern in this population, which could be caused by, e.g., the primary mental disorder or psychotropic medication. In summary, these findings are in line with other validation studies on the YFAS 2.0,[1,49,137,190] and with the high prevalence of food addiction in populations with eating disorders[131,193]. The association between food addiction and eating disorders will be discussed further in the section 5.4.5. Food addiction and eating disorders.

Food addiction is associated with binge eating (frequency), which was also found in this study. Therefore, in the context of food addiction, restrained eating has often been hypothesized as a discriminant construct.[1,50,194] However, across all four populations, we found a moderate to strong positive correlation between restrained eating and food addiction. Yet, restrained eating was the less correlated eating-related measure. In support of this quite counterintuitive correlation, a growing body of studies have found the same positive correlation between restrained eating and food addiction, also in adolescents.[49,53,59,190] Some authors have explained the correlation by subjective overeating because consumption of objectively small meal portions can be associated with a subjective feeling of control loss, as seen in disorders with restrained eating.[61,110] This could then reflect in a “falsely” high score on YFAS-items like “Consumed more than planned” and “Unable to cut down or stop”. Another possibility is that restrained behavior is a mechanism that could

contribute to the food addiction pathophysiology, for example in the emergence and/or in the maintenance of the condition. This theory is supported by a study by Price et al., who found dietary restriction to be a positive and independent predictor of elevated BMI.[195] The authors suggested the association to be explained by cycles of unsuccessful attempts to maintain weight. This is further supported by two studies by Gearhardt et al., who found that weight cycling and food addiction were associated.[1,75] An important step in the future understanding of the food addiction phenotype and pathophysiology would be to study this potential association between food addiction and restrained eating in more detail. This could potentially promote the understanding of some underlying mechanisms in the emergence and maintenance of food addiction. This issue is further discussed in the section 5.4.5. Food addiction and eating disorders.

The close association between food addiction and binge eating (frequency) also reflects in the BMI. Both the YFAS 2.0 symptom count and the dYFAS-C 2.0 score correlated weakly to moderately with the BMI/BMI z-score. Furthermore, in the adult general population, the BMI was substantially higher (and more had obesity) among those fulfilling the criteria for mild to severe food addiction compared to those without food addiction. In the population of adults with mental disorder, only individuals with moderate and severe food addiction had a substantially higher BMI, and a corresponding higher proportion had obesity. The fairly close association between food addiction and BMI was further supported by the incremental validity analyses, where the YFAS 2.0 and dYFAS-C 2.0 were able to predict the BMI or the BMI z-score over and above binge eating frequency in all populations. The dYFAS-C 2.0 accounted for 4.8% (general adolescent population) and 6.5% (adolescents with mental disorder) of the unique variance in the BMI z-score, and the YFAS 2.0 for 4.7% (general adult population) and 3.0% (adults with mental disorder) of the unique variance in the BMI in the adult populations. These findings fit well with the findings from the original studies on dYFAS-C 2.0 (3.4% of the variance in the BMI z-score)[59] and the YFAS 2.0 (3.5% of the variance in the BMI),[1] and the French validation of YFAS 2.0 (6.0% of the variance in BMI).[49] However, it is important to note that some studies do not find associations between food addiction and BMI, or they find only weak associations. It is likely that the YFAS can discriminate between normal weight and obesity, but not necessarily between degrees of obesity. Inclusion of subjects with a wider range of BMI is likely to counteract ceiling effects, which could be present in the samples including only overweight and obese subjects. Hence, the findings from this project support that the YFAS 2.0 and the dYFAS-C 2.0 are also sensitive in capturing food addiction symptomatology in more lean populations. Together, the association between food addiction and BMI was quite evident and consistent for all four populations; this implies that the relationship was found for both adults and adolescents, as well as in the general and the populations with mental disorder.

Another construct considered to be convergent to food addiction is impulsivity and ADHD symptomatology in general. In all four populations, we found a moderate to strong positive correlation between the SCL-92 ADHD-subscale and the YFAS 2.0/dYFAS-C 2.0 score. These findings are in agreement with other studies, which found food addiction to correlate positively with impulsive personality traits,[66,84,86] and this fits well with the well-known positive association between conventional addiction disorders and impulsivity.[196] The association between food addiction and ADHD symptomatology will be discussed further in the section 5.4.8. Food addiction and attention deficit disorders.

As hypothesized, alcohol use disorder (the AUDIT score) and the YFAS 2.0 score did not correlate in the two adult populations. This implies that alcohol misuse/dependence did represent a discriminant construct in relation to food addiction. This is in line with other studies, which found either a negative or no association between food addiction and alcohol use disorder.[63,70] Interestingly, we found positive correlations between the AUDIT score and the dYFAS-C 2.0 score in both of the adolescent populations. The correlation was only week in the general adolescent population, but it was moderate in the population of adolescents with mental disorder. This co-occurrence of food addiction and alcohol-related problems that seems to be present in adolescents could be explained from a developmental perspective; having an addiction risk profile[197] could lead to more problematic intake of both alcohol and highly rewarding foods in adolescents, and “the drug of choice” may not have been consolidated at this early stage. A recent Dutch study also found food addiction and substance use disorder to be associated in adolescents.[111] These diverging findings in adults and adolescents may provide some important information on the trajectories of food addiction and substance use disorders.

The correlation between food addiction and age was weak in all four populations. However, in both adult populations, the correlation was negative (although only statistically significant in the population of adults with mental disorder), whereas the correlation was positive and significant in both adolescent populations. This could indicate that symptoms of food addiction could be more prevalent in younger/middle-aged adults, with the symptom load increasing throughout adolescence until a certain age, where the symptomatology maybe dampens. This could explain the negative correlation in the adult populations. A negative correlation between age and food addiction symptom score has also been found in a study by Hauck.[69]

5.3. FOOD ADDICTION IN THE GENERAL POPULATION

In the general adult Danish population, the crude food addiction prevalence was estimated at 9.0%, with an overrepresentation of severe food addiction compared to moderate and mild food addiction. This is consistent with several other studies,

which found the category of severe food addiction to be most prevalent.[1,42,50,53,137] There was a preponderance of females with food addiction, which has also been reported in two other studies,[41,61] and it is also in accordance with the sex-ratio in other eating-related disorders.[198] The female predominance in food addiction will be discussed further in a later section (5.5. Sex differences in food addiction). The weighted prevalence was estimated at 9.4%, which did not differ markedly from the crude estimate. This finding may suggest that attrition has only limited impact on the prevalence estimation of food addiction. Indirectly, this could imply that socioeconomic status and food addition are not closely associated, as could otherwise have been hypothesized based on the known negative association between socioeconomic status and overweight/ obesity.[199–201]
The weighted prevalence of 9.4% is comparable to the prevalence of 7.9% found in another European study from Germany,[69] although the estimate was not as high as the estimate at 15% from the US.[71] Both studies used quota-based sampling in order to improve the generalizability to the general population. The difference in prevalence estimates between general populations obtained in Europe and the US, respectively, echoes with the difference in overweight and obesity rates seen between the US and most European countries.[202,203]

In the general adolescent population, the weighted mean dYFAS-C 2.0 total scores of 15.0 for females and 9.5 for males, respectively, did not differ substantially from the crude estimates. This parallels with the general adult population, where attrition and selection bias did not seem to influence the prevalence estimate markedly. As for the adult population, the weighted dYFAS-C 2.0 total scores obtained in this study were markedly lower compared to the (only) other study on the dYFAS-C 2.0 by Schiestl et al. from the US.[59] This is likely to be explained by the difference in the proportion of participants with overweight and obesity between the two studies. The US study deliberately sampled overweight and obese individuals, whereas the present study had a randomly drawn sample from the general population. This is also supported by the difference in mean BMI z-score between the two studies; 0.95, SD=0.89 in the US study compared to -0.20, SD=1.07 in this study. Even though the US study oversampled individuals with overweight and obesity, the rates of both overweight and obesity in adolescents are considerable higher in the US compared to Denmark. A total of 20.6% in the age group 14-19 years have obesity in the US,[204] whereas 4% in the age group 13-16 years[205] and 6,6% of males and 8,8% of females in the age group 16-24 years have obesity in Denmark[206].

Taken together, the rather large differences in the food addiction symptom load between US studies and the general Danish adult and adolescent populations may be explained by the more obesogenic food environment in the US, where highly processed foods are more easily accessible at lower cost compared to Denmark.[18] These findings could have important implications. The difference in food addiction symptom load found across countries and food cultures could potentially help identify potential socioeconomic and environmental factors that may put the

population in some countries/areas at greater risk of evolving food addiction. However, even though the Danish food environment is less obesogenic than that of the US, we found a fairly high population prevalence of food addiction (9.4%). This indicates that addictive-like eating could be a significant problem in Denmark, which warrants more attention in the future.

5.4. FOOD ADDICTION COMORBID TO MENTAL DISORDER

5.4.1. FOOD ADDICTION COMORBID TO MENTAL DISORDER

Food addiction symptomatology was more prevalent in those with mental disorder (both adults and adolescents) compared to the general population. In the adult population, the weighted prevalence was estimated at 23.7%, which was not substantially different from the crude estimate at 26.5%. The same applied for the weighted and crude dYFAS-C 2.0 estimates, which were almost identical. As suggested above, this could indicate that selection bias does not affect the food addiction estimate substantially. When stratified on sex, the prevalence of food addiction in the adult population with mental disorder remained significant higher for both sexes compared to the general population. For the adolescent populations, when stratified on sex, there was no difference in dYFAS-C 2.0 score between adolescents with mental disorder and adolescents from the general population. This may be explained from the relatively low mean BMI z-score (-0.11, SD=1.2) found in the adolescent population with mental disorder, which was lower than one would expect for a population with mental disorder (based on the correlation between mental disorder and obesity). In addition, there was a relatively large proportion of females with eating disorder among the adolescent respondents with mental disorder, and a large proportion was diagnosed with anorexia nervosa. Based on this, it is likely that the dYFAS-C 2.0 score was biased and underestimated – this is discussed further in the section on limitations.

Large differences were seen in the food addiction prevalence as measured by the dYFAS-C 2.0 score across the diagnostic groups of mental disorders. This was evident in both the adult and adolescent populations. Therefore, the results are discussed for each diagnostic group of mental disorders separately below.

5.4.2. FOOD ADDICTION AND PSYCHOTIC DISORDERS

Psychotic disorders, schizophrenia in particular, are severe and often chronic conditions. In addition to psychotic symptoms, they are characterized by impaired executive function and negative symptoms.[207] This combination of symptoms can result in a less healthy and sedentary lifestyle, which may lead to obesity.[208–210] Furthermore, psychotic disorders have a high frequency of comorbid addiction disorder.[211]

In the FADK project, we found food addiction to be prevalent among participants with psychotic disorders (weighted prevalence of 22.7% and a dYFAS-C 2.0 score at 18.4 among adults and adolescents, respectively). Stratified on sex, females had a significantly higher prevalence/symptom load of food addiction at 40.0% and a dYFAS-C 2.0 score at 23.2. In males, the prevalence and dYFAS-C 2.0 score were considerably lower, but the score remained one of the highest for males across all diagnostic categories. The highest prevalence of food addiction was found in adult females with schizophrenia (51.9%). Thus the prevalence in males remained unchanged from the male estimate for psychotic disorders (12.8%). It is possible that the known female dominance in food addiction becomes so evident due the equal distribution of sex found for psychotic disorders.

A potential underlying mechanism that could explain the high comorbidity between food addiction (and obesity) and psychotic disorders is the presumed high proportion of individuals in treatment with antipsychotics. Antipsychotic medication has a known appetite-stimulating effect, which often results in weight gain.[210,212] Also, treatment with D2 antagonists (most antipsychotics) diminishes dopamine-signaling in the reward systems.[213] This could potentially drive the (compensatory) overconsumption and compulsive use of addictive substances and highly rewarding foods.[211] Kucukerdonmez et al. found no difference in the proportion treated with antipsychotic medication between those with and without food addiction. It would be relevant to examine drug naïve patients with schizophrenia to investigate whether the food addiction prevalence differs from the prevalence found in patients treated with antipsychotics.

The high prevalence of food addiction and high dYFAS-C 2.0 symptom scores among adults and adolescents with psychotic disorder found in this study is in agreement with results from other studies. Specifically, Goluza et al.[148] and Kucukerdonmez et al.[149] investigated food addiction in adult outpatients with schizophrenia and found high, although diverging, prevalence rates at 26.9% and 62.9%, respectively. Neither of the studies found a difference in the prevalence between the sexes. Among adolescents with a psychotic disorder, Teasdale and colleagues[150] found a prevalence of 50% among adolescents with a first-episode psychosis. Interestingly, they also found adolescents with a first-episode psychosis (and ultra-high risk of psychosis) to have a poorer diet quality and higher daily energy intake compared to adolescents from the general population. Additionally, they found that adolescents in treatment with antipsychotics had a higher energy intake compared to their drug naïve peers.

In conclusion, there is a quite consistent high degree of comorbidity between food addiction and psychotic disorders across studies. Further research should be undertaken to investigate the implications of food addiction in individuals with psychotic disorder, as obesity is a considerable problem in this group.

5.4.3. FOOD ADDICTION AND AFFECTIVE DISORDERS

Affective disorders, particularly depression, are maybe the most investigated mental disorders when it comes to obesity.[128,214,215] Most often, a bidirectional association between obesity and depression is proposed [215,216]. However, Mendelian randomization study designs suggest that the association is unidirectional, going from obesity to depression.[127,217,218] Speed and colluegues[127] found that this association was likely to be mediated by body fat and suggested it explained from biological and psychological mechanisms.[128] Biologically, excess body fat causes hormonal (e.g., leptin and ghrelin) and inflammatory imbalances, which are suggested to mediate neurodegenerative processes[126,219], which could potentially contribute to impairment of, e.g., the executive functioning and emotional dysregulation.[126] Psychologically, excess body fat can result in body dissatisfaction, obesity-shaming from society, and low self-esteem.[126,127,219] Maybe, for these reasons, symptoms of depression are among the most investigated psychiatric symptoms in relation to food addiction. A positive association is generally found between food addiction and depression,[35,63,131] also in adolescent populations.[58,121]

In this study, we confirmed the close association between food addiction and depressive disorder as we found a prevalence of 25.3% in adult participants with depression. This also applied for the adolescent population, where the dYFAS-C 2.0 score was higher for affective disorders compared to other mental disorders. In fact, the prevalence rate in the adult population was nearly identical with those found by Mills et al.[133,220] In individuals with a clinically verified diagnosis of depression, they found a prevalence of food addiction in the range from 24% to 29%, and higher in females. Likewise, in the present study, a clear sex difference in the prevalence of food addiction was found. Females were more likely to have both depression and food addiction compared to males, 30.7% vs. 13.9%. Among adolescents, there was no substantial difference in dYFAS.C 2.0 score between the sexes. A possible explanation for the sex difference among adults could be the atypical presentation of a depressive disorder that is often seen in females.[221] The atypical presentation is characterized by hyperphagia and hypersomnia, which is thought to be mediated by, e.g., emotional dysregulation and impaired executive functioning.[126,219] Furthermore, in females only, Mills et. al. found high leptin levels (as proxy for leptin resistance)[133,222] and peripheral dopamine[220] to correlate with eating pathology (emotional and restrained eating) as well as increased appetite and/or weight. They also found that individuals with both food addiction and depressive disorder demonstrated more eating pathology and depressive symptomatology compared to individuals with depressive disorder only.[133,220]

In adult respondents with bipolar disorder, the prevalence of food addiction was very high (43.4%), although based on a limited number of individuals (n=13). Only two other studies have examined self-reported symptoms of bipolar disorder and food addiction, and they found a positive association between the two.[63,223] This is in

accordance with previous findings that substance use disorders are very prevalent comorbid conditions to bipolar disorder.[224,225] As with depressive disorder, obesity is also a major problem in individuals with bipolar disorder.[226,227] This relatively strong association is suggested to be explained by the phenotype of the bipolar disorder itself. Bipolar disorder is characterized by periods of depression (mechanisms described in the section above) and periods with hypomania or mania with increased impulsivity and affect lability/emotional dysregulation. This is likely to result in a greater susceptibility to addictive-like and compulsive use of rewarding substances, including consumption of hyperpalatable foods.[126] Another potential explanation is that the treatment with antipsychotics and lithium and other psychotropic medications is known to have metabolic side effects. However, one study found a positive association between bipolar disorder and obesity among drug naïve patients[228], which could indicate that other mechanisms than side effects from psychotropic medications are involved.

Interestingly, in our study, males with bipolar disorder had a markedly higher prevalence of food addiction than females. This was the only condition in which females did not have a higher prevalence than males. However, due to a limited number of individuals, the present findings for participants with bipolar disorder should be interpreted with caution and need confirmation in larger studies.

5.4.4. FOOD ADDICTION AND ANXIETY DISORDERS

Anxiety is characterized by both psychological and physiological symptoms, and it often co-occurs with other mental disorders.[2] Moreover, anxiety seems to be an important contributing and maintaining factor in substance use disorders.[229] Food addiction has also been widely investigated in relation to anxiety, mostly through self-reported anxiety symptoms. Quite consistently, a positive association between food addiction and anxiety has been found in both adults[230–232] and adolescents.[44,120]

In the present study, we found a relatively high weighted prevalence of food addiction (22.8%) in the adult population with anxiety disorders. However, among adolescents, the weighted dYFAS-C 2.0 score at 13.0 did not differ substantially from the weighted dYFAS-C 2.0 score in the general population.

When stratified on the specific anxiety diagnoses, the prevalence of food addiction in anxiety disorder did not change substantially (19.7%). Interestingly, the total prevalence for PTSD was 19.9% and 31.6% for females. This resonates well with the findings from other studies linking food addiction with PTSD.[91,146] A large-scale study by Mason et al.[147] found a clear association between food addiction and PTSD symptoms in women. This corresponds with the association found between food addiction and lifetime traumas.[63,72,102,103] However, the results on PTSD relied on a limited number of individuals (n=8) and should be interpreted with caution.

To the best of our knowledge, obsessive-compulsive disorder (OCD) has not previously been investigated in relation to food addiction. In this diagnostic subgroup, we found a very high prevalence of food addiction (42.9%). This resonates well with the previous finding that 25% of individuals seeking treatment for OCD also fulfill the criteria for an addiction disorder.[233] Again, due to the few cases of food addiction in OCD (n=13), the results should be interpreted with caution. Nevertheless, the results would seem to suggest that it could be of relevance to examine food addiction in larger samples of individuals with OCD.

5.4.5. FOOD ADDICTION AND EATING DISORDERS

Eating disorders are characterized by abnormal eating patterns and weight control to an extent causing significant distress and/or impairment.[2] Food addiction is also characterized by abnormal (addictive-like) eating and has been widely studied in patients with eating disorders. As described in the introduction, quite large overlaps in symptomatology and comorbidity between food addiction and eating disorders (of bingeing subtype) have been identified. This includes the high comorbidity with obesity; nearly 30% of individuals with eating disorders have been obese at some point during their lifetime.[234]

Among the mental disorders studied in the FADK project, we found the highest weighted prevalence of food addiction in participants with eating disorders (45.1%). In this diagnostic category, it was not possible to stratify on sex, as there were too few males with food addiction. Individuals with bulimia nervosa had the highest prevalence of food addiction (51.8%). However, food addiction was also prevalent in those with anorexia nervosa (42.5%). This distribution of food addiction prevalence between bingeing[51,61,86,137,139] and restrained[67,135,137] eating disorder subtypes has also been reported in several other studies.

Most studies on bulimia nervosa report high prevalence rates of food addiction of up to 100% (review by Meule and Gearhardt[42] and other papers[67,135,137,235]). Thus, the prevalence of food addiction in bulimia nervosa in the present study (51.8%) was relatively low. This could indicate that food addiction and bulimia nervosa are not fully overlapping constructs. Another explanation could be that some participants had remitted from their bulimia nervosa at the time of the survey. Similarly, a study by Meule and colleagues[235] found that food addiction symptomatology dampened together with remission of bulimia nervosa symptoms. Additionally, a study by Hilker et al.[136] examined food addiction symptomatology in patients with bulimia nervosa before and after a short-term psychoeducational intervention. Interestingly, they also found that food addiction symptoms reduced parallel with the symptoms of bulimia nervosa.

Due to the high comorbidity and symptom overlap in BED and food addiction, it would have been relevant to examine the prevalence of food addiction in individuals with BED.[51,62,139] Unfortunately, it was not possible as BED is not included as a diagnosis in the ICD-10.

The somewhat counterintuitive overlap between food addiction and anorexia nervosa has also been reported in several other studies. For example, the review by Burrows et al. reported a prevalence of food addiction in individuals with anorexia nervosa between 6% and 56%.[131] Potential explanations for the association have been discussed by other authors, including Wolz et al.[89] and Schulte et al.[110] It is possible that the YFAS 2.0 provides a false positive "diagnosis" of food addiction when used in individuals with restrained eating (like anorexia nervosa). Individuals with such eating patterns would tend to get higher scores on items like desire to "stop eating" and "cut down" on certain foods, as these symptoms also represent key features of restrained eating (e.g., anorexia nervosa).[2] Therefore, the higher scores are likely to reflect a subjective experience of overeating and control loss, rather than actual addiction-like consumption.[110,143] Another explanation could be that restrained eating and addictive-like eating have several overlapping mechanisms that potentially feed off each other. This corresponds with the increased sensitivity toward addictive substances that results from chronic food restriction, which has been associated with both drug addiction and binge eating.[236]

The association between food addiction and eating disorders has also been found in adolescents.[237–239] Interestingly, we did not find a high weighted dYFAS-C 2.0 score in the eating disorder category (13.2), and the score did not differ substantially from the weighted dYFAS-C 2.0 score in the general population (12.0). In fact, when stratified on sex, the crude dYFAS-C 2.0 score for both females and males were among the lowest scores across all diagnostic categories. This may be explained by a large fraction of participants in the eating disorder category having the diagnosis anorexia nervosa (n=59/91) and therefore a more restrained eating pathology. In the eating disorder spectrum, a diagnostic crossover is commonly seen from one eating disorder to another; often from anorexia nervosa to a bingeing eating disorder subtype.[240,241] Potentially, the adolescent participants with anorexia nervosa have not yet experienced such crossover to a more bingeing eating pattern and therefore score lower on the dYFAS-C 2.0. In fact, Cinelli et al.[239] have speculated that food addiction symptomatology in adolescents with anorexia nervosa could predict a diagnostic cross over to a bingeing eating disorder subtype.

Irrespective of how the correlation between food addiction and eating disorders is interpreted, the current evidence on food addiction and eating disorder suggests that food addiction appears to predict more severe eating pathology, more severe psychopathology, and higher degree of obesity in individuals with eating disorders.[135,138,142,143,242] This has led researchers to suggest that the food addiction

framework may be useful in conceptualizing new treatment strategies for eating disorders.[143,242,243]

5.4.6. FOOD ADDICTION AND PERSONALITY DISORDERS

Food addiction has not previously been studied in individuals with clinically diagnosed personality disorders. However, a disrupted personality structure has been associated with food addiction and the severity of such food addiction.[138] Another study found self-reported borderline-personality traits to correlate with food addiction symptomatology.[235] Moreover, addiction disorders[244] and obesity are prevalent in people with personality disorders.[245,246]

In the present study, food addiction in personality disorders was examined only in the adult population due to the low prevalence of personality disorders in adolescents.

We found a weighted prevalence of food addiction of 29.0% in those with a personality disorder and of 36.3% in those with borderline personality disorder. The high prevalence in this subgroup of personality disorders resonates well with the shared personality traits found in both food addiction[94,95] and borderline personality disorder.[244,247] These include neuroticism, impulsivity (including negative urgency), and emotional dysregulation (including alexithymia).[94,95] In some individuals with borderline personality disorder, addictive-like eating (food addiction) may be used instead of self-harm or other substance use disorders to manage emotional dysregulation. This is in line with the study by Carlson and collegues[248], who found an association between lifetime self-injury (non-suicidal) and food addiction in individuals with eating disorders. They suggested this association to be mediated by the emotional dysregulation. Hence, the high prevalence of food addiction in individuals with clinically verified personality disorders, which was found in the FADK project, fits well with the findings from other studies and seems worthy of further research.

5.4.7. FOOD ADDICTION AND AUTISM SPECTRUM DISORDERS

In adults and adolescents with autism spectrum disorders, food addiction symptomatology was not prevalent when compared to other mental disorders. In fact, the third lowest prevalence (16.3%) was seen for adults and the lowest dYFAS-C 2.0 score (9.3) was seen for adolescents. The food addiction “load” seems to be in the same range as that seen for the general population, and even lower in the adolescent population. In general, addiction disorders are not very common in people with autism spectrum disorders, at least not compared to other mental disorders. In a study examining addiction in treatment-seeking adolescents with autism spectrum disorder, addiction was only present in those with a co-occurring ADHD diagnosis. Furthermore, the prevalence of addiction disorders was markedly lower for adolescents with autism spectrum disorder compared to other mental

disorders (3% vs. 17%).[249] Another study found that adolescents with developmental disorders were 1.5 times more likely to be overweight or obese. However, they were also at the same risk (1.5) of being underweight.[250] Additionally, autism spectrum disorders are more often associated with restrictive and picky eating (avoidant-restrictive food intake disorder in the DSM-5), which is associated with low weight or underweight.[251]

5.4.8. FOOD ADDICTION AND ATTENTION DEFICIT DISORDERS

Recently, there has been renewed interest in the link between attention deficit disorders and obesity. In a review by Hanć et al.[252], potential factors contributing to obesity in ADHD were examined. These included genetics, fetal programming, neurobiology, metabolism (hormones, etc.), executive functioning, and sleep patterns. The authors concluded that the etiology is multifaceted and complex and that different models of explanation probably should be combined. In addition to the well-known link between attention deficit disorders and obesity, it is also well-known that addiction disorders are prevalent comorbidities to attention deficit disorders.[253] The strong correlation between the two is not fully understood. A study by Davis et al. found that a "high-risk personality profile" defined as sensation-seeking tendencies, anxiety sensitivity, and impulsivity partly accounted for the correlation between ADHD symptomatology and addiction disorders.[254]
All of this indicate that food addiction could be prevalent in individuals with attention deficit disorders. Few studies on food addiction and ADHD have actually indicated a positive association.[86,144,145] Therefore, it was somewhat surprising that the weighted prevalence of food addiction (12.3%) and the weighted dYFAS-C 2.0 score (10.0) were in the very low end in participants with attention deficit disorder (including both ADHD and attention-deficit disorder (ADD)) compared to the other mental disorders. There was no difference in the prevalence of food addiction between the sexes among participants with attention deficit disorder. This resonates well with a large Danish cohort study on ADHD, which found both sexes to have an equally increased risk of substance use disorder.[255]

There are various explanations for the unanticipated finding of a low prevalence of food addiction and low dYFAC-C 2.0 scores among participants with attention deficit disorder. First, the male preponderance in ADHD[256] and the female preponderance in food addiction may account for the relatively low food addiction symptom load in ADHD. Second, individuals with attention deficit disorder were less likely to respond to the survey (adults: 21.9% for attention deficit disorder vs. 27.9% for the survey in total, adolescents: 10% for attention deficit disorder vs. 12% for the survey in total). This could have introduced selection bias; those managing to respond could represent a less ill fraction of the sampled attention deficit disorder population. Third, attention deficit disorder often co-occurs with (other) comorbid substance use disorders, which could theoretically "compete"[25] with the less potent high palatable

foods as the "drug of choice". Also, appetite suppression from ADHD medication[126,257] could contribute to the relatively low food addiction prevalence. Although controversial, these findings could be key in identifying potential successful medical treatments of food addiction. Stimulant medication is already approved and used in the treatment of BED in the US,[143] and Poulton et. al.[258] has suggested it in the treatment of hedonic eating.

A contradictory finding to the low food addiction symptom load in participants with attention deficit disorder was the moderate and positive correlation between the self-reported SCL-92 ADHD subscale and the YFAS 2.0 symptom score/dYFAS-C 2.0 score. This was found across all diagnostic categories of mental disorders in both adults and adolescents. A potential explanation for this somehow counterintuitive finding could be that the SCL-92 ADHD subscale may reflect impulsivity as a trait (known to associate with food addiction) in other mental disorders. In addition, the association between impulsivity and food addiction in other mental disorders may not necessarily be affected (and reduced) by the same potential mechanisms as described for participants with ADHD (described in the section above).
Further research should be undertaken to clarify the association between food addiction and ADHD.

5.4.9. FOOD ADDICTION AND SUBSTANCE USE DISORDERS

Food addiction in individuals with substance use disorders is only examined in the adult population due to the low prevalence of clinically diagnosed substance use disorders in adolescents.[259]

The lowest weighted prevalence of food addiction was found in adults with substance use disorders (8.3%) and was comparable to the prevalence in the Danish general population (9.4%). Likewise, the self-reported measure of alcohol dependence and abuse (AUDIT) did not correlate with food addiction in the adult population. This resonates well with the lower risk of obesity in individuals with substance use disorder.[12] As described in previous sections, it is likely that more potent substances like alcohol and cocaine could compete with the less potent hyperpalatable foods on the same reward circuits in the brain.[25] This theory also resonates with the so-called "addiction shift", which has been described for bariatric surgery patients. Addiction shift refers to a shift from food addiction to another addiction (e.g., alcohol) following bariatric surgery.[104,260]

Findings from previous research on food addiction and substance use disorder are, however, somewhat mixed. Benzerouk et al. found no association between food addiction and substance use disorder in bariatric surgery patients (prior to surgery).[261] In contrast, a study in males with heroin use disorder found that both binge eating disorder and food addiction were highly frequent in this group

compared to the general population.[262] Among adolescents, a large-scale study also found a positive association between substance use and food addiction.[111] In accordance with this, we found that problematic alcohol consumption (AUDIT) correlated with the dYFAS-C 2.0 score in adolescents. In adolescents with mental disorder, this correlation was moderate. The positive correlation found for adolescents, but not for adults, could suggest an emerging addiction tendency in some adolescents;[197] an attraction towards addictive and rewarding substances, where the "drug of choice" has not yet been determined. Future longitudinal studies should investigate the trajectory of food addiction symptomatology from adolescence to adulthood and clarify the association between food addiction and other substance use disorders during this transition,

5.5. SEX DIFFERENCES IN FOOD ADDICTION

A clear female preponderance in food addiction was evident for both adults and adolescents in all four populations (excluding bipolar disorder). This supports previous evidence on the sex difference in food addiction[42,61] and resonates well with the conclusions from a very recent review on sex disparity in obesity by Kroll and collegues.[263] They found some apparent differences in the mechanisms that are involved in the development of obesity between the two sexes. Reward regions appear to be of greater importance in females, whereas it seems to be linked to changes in the somatosensory regions in males.[263]

Sex differences are also well described for substance use disorders and are known to be present in all phases of the evolving addiction disorder. Specifically, females go more rapidly from casual drug consumption to addictive use, and they exhibit greater withdrawal response and greater vulnerability for relapse compared to males.[264] Furthermore, across the majority of substance use disorders, there is a clear male dominance. This is interesting in light of food addiction. Future research could probably benefit from investigating the sex difference in food addiction more comprehensively. Studies on sex-specific neurobiological and hormonal as well as sociocultural aspects could presumably be beneficial in widening our understanding of the food addiction construct.

5.6. THE FOOD ADDICTION CONSTRUCT

Our present understanding of the food addiction phenotype is not complete. Consequently, we are not able to confirm nor reject whether food addiction is a valid psychiatric syndrome. This has been the center of an ongoing – sometimes heated – debate on whether or not food addiction is truly a single entity, or whether it does exist at all.[107,265] Some authors argue that food addiction should be seen as a behavioral addiction ("eating addiction").[266] Others argue that food addiction is

embedded in the eating disorder spectrum, and that it represents the most pathological extreme when it accompanies a disorder in this spectrum.[267] In 2018, Fletcher and Kenny[109] presented arguments against and in favor of the validity of food addiction as a single entity. They concluded that – although the present evidence-base for food addiction is insufficient – important knowledge is likely to be lost on the overconsumption of both food and drugs if the work on establishing and investigating the food addiction construct is not continued. The food addiction framework may contribute with valuable and important information to the addiction field and vice versa.

As noted above, the field of food addiction is still in its emergence phase, and many questions are still to be answered in order to confirm the "validity" of the food addiction construct as a new diagnostic entity. However, Kendell and Jablensky (2003)[268] argue that the assumption of "valid" psychiatric diagnoses being discrete entities as suggested by Robins and Guze[269] (who defined five criteria that had to be fulfilled to confirm the validity of a new psychiatric construct) is questioned by both clinical and genetic findings. Over the past decades, research has established that substantial overlaps exist between the diagnostic categories in psychiatry, and that the same genes and environmental factors contribute to different syndromes. Most clinicians and researchers now accept a dimensional understanding of psychiatric concepts and the utility of a diagnosis rather than a strict focus on the definite validity of it. Kendell and Jablensky point toward two factors that are crucial for determining the utility (not the validity) of psychiatric syndromes. First, the construct should be well documented and described in the literature with regard to both quantity and quality. Second, the implications of existing research, in particular in terms of etiology, prognosis, and treatment, should be different from those existing on related constructs. In other words, the new construct must add new information and must have relevant clinical implications.[268]
With food addiction in mind, this perspective is indeed interesting. It would seem unrealistic to find evidence of food addiction as a discrete diagnostic entity in line with physical disorders, as none of the existing psychiatric diagnostic categories are (except for the organic mental disorders). Instead, researchers may benefit from keeping the utility and dimensionality of the construct in mind when investigating and examining the food addiction construct. This approach has already been applied by Tresure et al.[143] and Wiss et al.[243], who describe the potential utility of the food addiction framework in widening and refining our current understanding and treatment of eating disorders. They suggest that food addiction occurs as a comorbid condition to the primary eating disorder, which should be taken into consideration when treating the condition.

5.7. METHODS AND LIMITATIONS

This section addresses the strengths and limitations of the project. The section includes a discussion and an evaluation of how the methodology of the project might have affected the results of the studies.

5.7.1. STUDY DESIGN

The FADK study was designed as a cross-sectional study combined with retrospective register data; the latter were used to perform attrition analyses. Thus, the most important limitation was the cross-sectional design, which hinders the possibility for temporal interpretations of the estimates obtained in the study. It was, therefore, not possible to determine whether individuals with a mental disorder were more prone to develop food addiction, or if food addiction was present before the diagnosis of the mental disorder, which could potentially have increased the risk of mental disorder. Only longitudinal studies could help clarify these questions.

5.7.2. INTERNAL VALIDITY

5.7.2.1 Selection bias

Methods to reduce the impact of selection bias

Participation in surveys has declined considerably over the past decades.[270,271] This development is likely to be a consequence of the quite steep increase in the number of surveys, which is related to the new possibilities offered by the internet, and strategies to improve the response rate have been studied widely.[112,272] With this in mind, we implemented some strategies into the design to heighten the response rate and thereby reduce selection bias:

I) By using eBoks for the invitations, we ensured that invitees were contacted from a highly trustable mailing system, which is used only by public authorities. An invitation received through another electronic mailing system would most likely have been interpreted as “spam” or advertising material.

II) Personal guidance on filling the questionnaire was offered via telephone or mail.

III) Invitees exempted from using eBoks (digital post) (n=560) received the initial invitation by surface mail; they also had the opportunity to request a paper version of the questionnaire with a pre-stamped return envelope.

IV) Participants who completed the full questionnaire entered a lottery for three iPads. It has been documented that lotteries for money or gifts increase the motivation to participate in surveys. This tends to be more pronounced in groups

with lower socioeconomic status, who are usually the less likely to participate in surveys.[272]

V) All invitees received the same information material, irrespective of population. Importantly, the invitation consignee was the university hospital, even though the project was based in a psychiatric research department. We deliberately made this choice to avoid selection bias due to stigma related to mental disorders.[162]

VI) The focus of the survey was described as "general mental health and eating habits", and it was a deliberate choice not to mention "food addiction". This choice was made to reduce selection bias related to interest; individuals who identified with the concept of food addiction could be more likely to respond to the survey and more likely to score higher on the YFAS 2.0. This could have artificially inflated the prevalence of food addiction.

VII) We deliberately oversampled (stratified probability sampling) less common mental disorders, resulting in subsamples that were not representative for the prevalence of these conditions in the source population (the "natural" distribution of the different mental disorders).[112] This approach was taken because individuals with rare and severe mental disorders (e.g., psychotic disorders) would probably be less able or less willing to participate in the study. The oversampling strategy was chosen to mitigate this problem.

VIII) Invitees were allowed to skip questions in the compiled questionnaire and proceed. It is known to cause attrition from a survey if one is forced to answer all questions to proceed.[272] The method used in the present study imitates pen-and-paper questionnaires and encourages participants to continue answering.

Statistical methods to reduce the impact of selection bias

Even though the study was designed to reduce selection bias, we were aware that not all invitees would participate. Therefore, the AIPW model (instead of wave analyses) was used to calculate the weighted outcome estimates. The weighted prevalence takes attrition from the study into account, thereby "mirroring" the prevalence in the source population. It is, however, important to bear in mind that the AIPW model has limitations. The model is limited by the variables included, or rather the variables not included. The impact from variables that are not included in the model on the food addiction estimate remains unknown. As discussed below, BMI is probably one of the most important unknown variables (for non-respondents). In addition, the higher the number of respondents who can add information on the included variables and their association with food addiction, the better prediction of the weighted estimate.

A more thorough description of the augmented weighted probability weighting is available in section 3.1.7.6.

Limitations with regard to selection bias

The response rates were acceptable for the adult populations. The overlap between the crude and weighted prevalence estimates showed that attrition, with regard to the included variables, did not change the estimates markedly. However, the response rates were low in the two populations of adolescents. A possible explanation could be that the adolescents were invited through their parents. We did so to ensure that the parents were informed and able to decide whether their child should have the opportunity to participate in the survey. It is likely that some parents would decline participation on behalf of their child in order to protect them from questions of a sensitive nature. This tendency could perhaps be more pronounced if the adolescent had problems related to eating or mental health. The close association between food addiction and eating pathology and between food addiction and psychopathology may help explain the relatively low dYFAS-C 2.0 scores found in these studies. Furthermore, the weighted dYFAS-C 2.0 score estimates were based on relatively few respondents; therefore, the propensity weights were not as accurately calibrated as the ones for the adult population.

The participants from both the adolescent and the adult populations were less overweight and obese compared to the general population in Denmark (as discussed in section 5.3). Because the BMI/BMI z-score was not available for non-participants, the weighted estimates did not take into account attrition coupled to BMI/BMI z-score. Therefore, the food addiction prevalence as measured by the dYFAS-C 2.0 score obtained in these studies are likely to be lower than in a more representative sample (with regard to BMI/BMI z-score). Furthermore, there was an overrepresentation of respondents with higher socioeconomic status compared to non-respondents; this applied to all four populations. Based on the known association between lower socioeconomic status, poor eating habits, and resulting overweight/obesity,[199–201] this skewness in socioeconomic status between participants and non-participants would likely have contributed to an underestimation of the food addiction prevalence/symptomatology as well.

In the populations with mental disorder, we cannot preclude that those with sufficient mental resources to answer represented a less ill fraction. If this was the case, based on the close association between food addiction and mental disorder, the food addiction load was likely to be underestimated. Therefore, it would be relevant to investigate whether food addiction symptomatology fluctuates with the severity of the primary mental disorder. However, due to the cross-sectional design, this was not possible.

Lastly, due to their condition (e.g., mental retardation, dementia, and dyslexia), some individuals were not able to participate. Therefore, the results cannot be generalized to these groups. To investigate food addiction in such populations, alternative approaches like personal interviews should be applied.

5.7.2.2 Response bias

Conducting surveys using self-report measures inherently introduces a risk of information bias. Personal clinical interviews with trained clinicians may provide more valid information.[273,274] However, it would be costly and hard to complete a study of this size, and a structural clinical interview assessing food addiction is not available. Furthermore, there is a tendency that self-reported weight and height are misreported (mostly underestimated).[275] However, it has also been found that self-reported BMI does not differ substantially from objective BMI measurements obtained by clinicians.[276] Lastly, as the samples for the two populations with mental disorder were drawn from the DPCRR, the results may be affected by limitations related to this register. The most important potential limitation is that all recorded diagnoses are assigned as part of everyday clinical practice. Therefore, some diagnostic heterogeneity may be expected.

There are also advantages from using anonymized self-reported measures. When self-reported measures are used in a survey, some invitees may be more likely to participate due to convenience. In addition, some participants may be even more likely to report information of a sensitive nature, like eating concerns and mental health problems. Additionally, the reported information could be more accurate and correct when not confronted by an interviewer (e.g., underreporting of symptoms that one might find shameful).[277]

Misclassification bias

Misclassification of exposure (mental disorder)

The populations with mental disorder included individuals who were assigned a primary diagnosis within one of the eight/six defined categories of mental disorders in the period from January 1, 2013 to December 31, 2017. The period of five years ensured that a sufficient number of cases was available to draw random samples from each defined diagnostic category (this was, however, not possible for adolescents with psychotic disorders). As consequence, the invitees did not necessarily belong to the diagnostic category from which they were initially drawn. At the time when the survey was conducted, the mental disorder could have remitted in some invitees. Also, it is likely that some of the invitees fulfilled the criteria for another diagnostic category than the one they were drawn from originally. However, this probable diagnostic drift is most likely to be relevant for the less severely ill. As food addiction seems to be more prevalent in individuals with mental disorder, the food addiction prevalence/symptom load was possibly underestimated due to a drift from ill to remission. In addition, this was probably most evident for diagnostic categories like anxiety and depression. Another aspect is that different mental disorders often co-occur at the same time. Therefore, at the time of the survey, the main diagnosis could have changed.

Lastly, the reader should note that the general populations were randomly sampled. Therefore, individuals with mental disorder were also included. We deliberately included all to obtain a representative sample from the general population. The exceptions will be discussed under generalization of the results (5.7.3. External validity).

Misclassification of outcome (food addiction)
Even though the survey was announced as a survey on "general mental health and eating habits" and did not mention "food addiction", it cannot be precluded that individuals identifying with eating and disordered eating were more likely to participate. In such case, the food addiction prevalence and the dYFAS-C 2.0 scores would likely have been overestimated.

5.7.3. EXTERNAL VALIDITY

Random sampling strategies in general ensure that the generalizability to the source population is maintained. However, in the FADK Project, exclusion criteria were applied to ensure that those invited were able to understand the Danish language (Danish born and Danish born parents). In addition, it was required that invitees had a valid Danish postal address, and that they were not legally incapacitated. Hence, the results from this project are not generalizable to the complete Danish population, although to the majority (around 86% are of Danish ethnicity).[278]
Overall, the population prevalence obtained in the present studies is likely to be comparable to that in other countries with similar distribution of overweight/obesity and a similar food environment as in Denmark.

In the populations with mental disorder, it is important to note that the DPCRR (from where the samples were drawn) includes only inpatient and outpatient hospital contacts. Less severe mental disorders diagnosed and treated by general practitioners and private practicing psychiatrists are not included. Consequently, the prevalence estimates/dYFAS-C 2.0 scores obtained in the present studies generalize only to the more severe spectrum of mental disorders.

5.7.4. ETHICAL ASPECTS

Conducting a survey by inviting a large number of individuals via a personal electronic mail may potentially cause discontent among the invitees. They are contacted without having expressed an a priori interest in participating in research. This approach may thus give rise to some opposition, perhaps even suspiciousness about why one is contacted, and how the institution contacting them got the information about them. We were very much aware of this potential problem and implemented the following strategies to ensure transparency:

I) The invitation was kept short, and it included concise and easily understandable information on the study purpose.

II) Name and contact information on the main investigator was included. The invitees were advised to reach out by telephone or email if they had any questions regarding the project, their rights, and ethical concerns, or if they needed help.

III) The invitees were given the opportunity to get information on which register their name had been drawn from (CPR register or the DPCRR), and through this information get to know which study population they belonged to. However, invitees requesting the latter were informed that limitations are inherent to the DPCRR (e.g., misclassification of diagnoses) and that the Danish Health Data Authority could be contacted if they disagreed on the information obtained from the register.

IV) Lastly, the invitees could actively indicate (by telephone or email) if they did not want to participate. However, they indirectly stated the same by not filling in the questionnaire. Importantly, it was clearly stated that participation was voluntary, and that their consent to participate could be withdrawn at any time. Only few invitees used this possibility after having begun to fill in the questionnaire.

During the period when the survey was open, several invitees contacted the main investigator by telephone or email with questions regarding the project and ethical concerns. Rather few requested information on which register they were drawn from, and relatively few actively declined participation.

As described in section 3.1, there are specific concerns that must be considered when including adolescents in a survey. In Denmark, the legal age of consent is 18 years. Until this age, the legal guardians must consent if their child is to participate in research studies. Therefore, the invitation was sent to the parents to ensure that the legal guardian(s) was informed on the study purpose and able to consent on behalf of their child, or reject the invitation in case they believed that participation would be too stressful for the adolescent. It is possible that parents of adolescents with a mental disorder would be more likely to reject the invitation on behalf of their child, which could have introduced a risk of selection bias (discussed further in section 5.7.2.1 “Limitations with regard to selection bias”).

CHAPTER 6. MAIN CONCLUSIONS

This combined survey and register-based study was the first to investigate food addiction as a comorbid condition to the major mental disorders. Based on sociodemographic and health-related register data on all invitees, comprehensive attrition analyses were conducted, and the weighted food addiction prevalence/dYFAS-C 2.0 scores were estimated.

The studies confirmed that food addiction is highly prevalent in individuals with a clinically verified mental disorder compared to the general population; and it seems that food addiction, like other addiction disorders, often co-occur with mental disorders; this may lead to obesity and potentially worsen the severity of the primary mental disorder.

Despite the exploratory and descriptive nature of the studies included in this PhD dissertation, the findings add to our current understanding of food addiction and may lay the groundwork for future research on food addiction and mental disorders. Specifically, five key findings were uncovered.

First, both the Danish YFAS 2.0 and the Danish dYFAS-C 2.0 showed to be psychometric valid measures of food addiction in both the general population and in individuals with clinically verified mental disorder. This applied for both adults and adolescents. The overlapping crude and weighted prevalence estimates measured by the dYFAS-C 2.0 scores indicated that selection bias might not be a significant problem when measuring food addition.

Second, food addiction was found to be relatively prevalent (9.4%) in the general adult population. This finding indicates that food addiction could be a potential obesogenic mechanism contributing to overweight and obesity in the general Danish population, and potentially add knowledge on alternative treatment and prevention strategies.

Third, the food addiction symptom load (dYFAS-C 2.0 score) was relatively low among adolescents; this was partly caused by a low mean BMI z-score among the respondents. This could also indicate that food addiction symptomatology has not yet fully emerged in adolescents. Future investigations of food addiction symptomatology in the transition from adolescence to adulthood could help elucidate the underlying etiological mechanisms in food addiction and investigate specific risk factors for developing fulminant food addiction.

Fourth, the association between food addiction symptomatology and increasing BMI (especially obesity) was confirmed, also among individuals with mental disorder.

Further investigations of this association may help disentangle the complex pathway to obesity in individuals with mental disorders.

Finally, the most important finding was that food addiction is indeed more prevalent in individuals with mental disorder compared to the general population. This was particularly evident for eating disorders, affective disorders, personality disorders, and psychotic disorders (in females). These findings suggest that food addiction, akin to other addiction disorders, often co-occur with mental disorder and may lead to obesity and potentially worsen the severity of the primary mental disorder. These are important avenues for further investigation, which may inform prevention and treatment strategies in the future.

CHAPTER 7. PERSPECTIVES

This project is the first comprehensive study to investigate food addiction comorbid to a wide range of clinically verified mental disorders. In the process of establishing evidence for food addiction as a common comorbidity to major mental disorders, a range of new questions has been raised. Suggestions for future research that could address some of these new questions are presented below.

7.1.1.1 Psychometric refinement of the YFAS

A psychometric refinement of the YFAS 2.0 and the dYFAS-C 2.0/YFAS-C 2.0 is highly warranted to further validate the construct of food addiction.
The full version of YFAS 2.0 has already been modified into a briefer (and validated) version, the Modified Yale Food Addiction Scale 2.0 (mYFAS 2.0).[279] Thus, it would be an important next step to conduct item response theory based psychometric analyses on the mYFAS 2.0. This could further refine the construct validity and add information on whether each item is truly representative of the underlying construct; such knowledge would add unique information on the severity (unidimensionality). In addition, it would provide knowledge on whether the current way of scoring by adding together the number of endorsed SRAD criteria into a total score is a valid measure of the severity of the syndrome.

Future studies should also investigate the possibility of dichotomizing the YFAS-C 2.0. A diagnostic scoring option for the YFAS 2.0 would be important to allow detection of more pathological states of food addiction in adolescents, including impairment and distress. The full version based on all eleven SRAD criteria (as in the adult YFAS 2.0) should be examined. However, it would also be important to examine the validity of a briefer version (dYFAS-C 2.0) based on the seven SRAD criteria (plus the criteria regarding impairment/distress), while excluding the problem-focused SRAD symptoms. We plan to conduct such analyses on data from the FADK project.

Finally, studies have so far relied strictly on the YFAS diagnosis of food addiction. Therefore, it would be highly relevant to develop a corresponding semi-structured interview. Such semi-structured interview could be helpful in capturing details on the symptomatology that may be lost in self-reported questionnaires. In combination with qualitative research, this could help to further consolidate the construct of food addiction. This specific gap has also been acknowledged by Schulte et al. based on a review of the literature.[110]

7.1.1.2 Food addiction comorbid to mental disorders

The high comorbidity between food addiction and mental disorder, in addition to the association between food addiction and obesity, have important implications. Future studies need to gain insights into these complex associations.

Specifically, identifying the outcomes of food addiction co-occurring with mental disorders is highly warranted. It could be hypothesized that the close association between obesity and mental disorder could (partly) be mediated by food addiction in some cases. Results from this study partly support this notion. Nevertheless, longitudinal studies are needed to investigate the temporal and causal aspects of this association. Another important aspect would be to investigate the interaction between food addiction symptomology and the symptomatology of the primary mental disorder, and whether the severity of the primary mental disorder may fluctuate with food addiction severity. Ideally, the temporal and causal aspects of such associations should also be explored. Data from the SCL-92 subscales on depression and anxiety, which formed part of the FADK survey, may help disentangle this association; these measures represent a snapshot of the depression and anxiety symptoms at the time when food addiction was assessed. Furthermore, follow-up studies using the Danish registers could help investigate whether individuals with food addiction have a higher incidence of mental disorders compared to individuals without food addiction. Finally, the identification of unique risk factors for developing food addiction comorbid to mental disorder could help inform strategies aimed at preventing and treating food addiction in this population.

In section 7.1.1.3. “Trajectories of food addiction”, different research strategies for investigating both risk factors and outcomes of food addiction are described further (both alone and when comorbid to mental disorder).

Psychotropic medication and food addiction

The well-known appetite-related side effects of psychotropic medication make it highly relevant to further investigate the impact from psychotropic medication on food addiction symptomatology. For instance, it could be hypothesized that ADHD medication (partly explained by appetite suppression)[257] may reduce symptoms of food addiction. In contrast, it could be hypothesized that treatment with medications that are known to have appetite-enhancing side effects (e.g., antipsychotics)[126]may result in more symptoms of food addiction. Based on data from the FADK study, we plan to conduct extensive analyses on the potential association between psychotropic medication and food addiction.

7.1.1.3 Trajectories of food addiction

In order to obtain more knowledge on food addiction, it is important to identify risk factors as well as long-term consequences of the condition (also described above).

To obtain such information, longitudinal studies are needed. A major limitation of existing research is, however, the paucity of longitudinal studies with a sufficient follow-up period.[42] Based on data from the FADK project, it is possible to investigate both risk factors and outcomes of food addiction. We plan to carry out these studies in the near future with particular emphasis on the following aspects.

Characteristics of food addiction

The finding of nearly identical crude and weighted estimates of food addiction suggests that the food addiction "diagnosis" may not be that sensitive to selection bias. Indirectly, this could indicate that food addiction is not as closely associated with specific sociodemographic groups as one would expect. Therefore, a natural next step is to make a thorough characterization of those fulfilling the criteria for food addiction compared to those who do not. It could be hypothesized that food addiction – due to the close association with obesity – would be more prevalent in lower sociodemographic groups.[199–201] Data from the FADK project allow for a comprehensive characterization of individuals with food addition (using the same variables as for the attrition analyses); this could allow us to explore whether there are different characteristics for individuals with food addiction alone compared to individuals with food addiction comorbid to mental disorder. Such knowledge could help identify potential high-risk groups and thereby target prevention strategies.

Furthermore, the potential association between food addiction and the subjective experience of wellbeing/quality of life could be examined with data from the WHO-5 wellbeing index. It is likely that there is a negative association between food addiction symptomatology and wellbeing. When characterizing a potential new diagnosis, it is of high importance to investigate the subjective experience of and distress related to the illness to fully understand the need for intervention.

Retrospective studies

Most of the Danish registers used in the FADK Project contain data dating back to the 1970s. Besides the registers used for the studies described in this PhD dissertation, registers on several other sociodemographic and economic aspects, including previous psychiatric and physical illness, are available. These data allow for a comprehensive retrospective investigation of the characteristics of the participants in the FADK project, including a comparison between those with and without food addiction, and those with food addiction comorbid to mental disorder. With the use of more advanced analytical prediction models and machine learning models, potential risk factors for food addiction may be identified.

Prospective follow-up

Register-based data

The Danish registers also provide the possibility of conducting prospective follow-up studies, where new register data (e.g., on physical illness or mental disorder) are coupled to the participants from the FADK project. This would allow for an

investigation of potential outcomes of food addiction, including life-style related metabolic diseases (e.g., cardiovascular disease and type 2 diabetes) and mental disorders (please see section 7.1.1.2).
Few studies have already investigated the association between food addiction and different biochemical parameters and physical conditions related to obesity. For instance, Nelder et al. found that food addiction correlated with insulin resistance and dyslipidemia in a sample from the general population.[280] The association between food addiction and type 2 diabetes has also been investigated, and a positive association has generally been found.[77–81] An important avenue for future research would be to investigate the direction of these associations and identify other potential outcomes of food addiction. Future follow-up studies based on data from the FADK project and data from the Danish registers would allow for such investigations.

Follow-up survey
There is a lack of long-term follow-up studies on food addiction, which means that the existing knowledge is sparse on the stability of the food addiction construct[281,282] and on the incidence of food addiction. Follow-up surveys among participants from the FADK project will provide us with the opportunity to investigate these aspects.
Furthermore, as previously discussed, food addiction symptomatology is likely to increase the risk of obesity over time. Even though obesity seems to be an obvious outcome of food addiction, it would be important to document BMI over longer time periods. The trajectories of BMI in relation to food addiction could be further investigated through follow-up surveys with intervals from two to five years.

Another important aspect is to examine adolescents and food addiction symptomatology in the transition from adolescence into adulthood. Trajectories of food addiction alongside other addictive behaviors would be of great relevance to investigate specific risk factors for developing fulminant food addiction. Future follow-up surveys among the adolescents from the FADK project combined with register data would allow such investigations.

This dissertation was written alongside the COVID-19 pandemic. This has given rise to some thoughts on how the COVID-19 pandemic may affect food addiction symptomatology and the incidence of food addiction. A well-known risk factor for substance use disorders is loneliness,[283,284] which several people experienced during "lock-down" all over the world. Furthermore, food addiction and symptoms of anxiety and depression are highly associated; the two latter have also shown to elevate in many people during this period.[285,286] In addition, one previous study did find an association between food addiction and loneliness in adolescents.[121] Thus, the COVID-19 pandemic might turn out to be the ideal incubator for food addiction. A new survey could help answer this question. Specifically, the present FADK study could provide a benchmark from before the pandemic. Ideally, a new survey should be conducted during the pandemic and again when the pandemic is over. This would

provide three measures of the food addiction symptomatology, with numerous possibilities to explore how it has fluctuated during the pandemic.

7.1.1.4 Family transmission

Studies investigating food addiction in families[76] and studies on potential genetic mechanisms in food addiction are generally sparse.[26] Nevertheless, there are some major advantages from investigating food addiction in families. Such studies could provide knowledge on cross-generational genetic and environmental factors (from the Danish register). Furthermore, the investigation of eating patterns (food addiction) in families and the potential association with, e.g., sociodemographic factors, mental disorder, and physical illness, could help identify families at greater risk of developing food addiction.[152]

Epidemiological studies have indicated that maternal obesity in pregnancy may increase the risk of several mental disorders, including ADHD, depression, and eating disorders in the child.[287] As the FADK project includes data on maternal (e.g., BMI, physical disorders, and mental disorders), prenatal (maternal BMI, complications during pregnancy, etc.), and postnatal (e.g., birth weight) characteristics of the adolescent participants, such associations could be explored in relation to food addiction. The comparison of adolescents with high dYFAS-C 2.0 scores vs. low dYFAS-C 2.0 scores may help identify potential maternal and perinatal risk factors for food addiction symptomatology.

7.1.1.5 Intervention studies

A potential advantage of the food addiction framework applied to overeating is identification of effective intervention strategies. Therefore, a very important aspect of future research is intervention studies. Several researchers have suggested that relevant interventions should be based on treatment strategies from the addiction field.[288,289] Such strategies could include help to reduce cue reactivity, craving, and withdrawal symptoms via psychoeducation, cognitive behavioral therapy, and pharmacotherapy. However, before such studies can be properly conducted, more knowledge on both risk factors and outcomes of food addiction is needed to ensure well-designed studies with regard to outcome measures and confounding factors. Ideally, future studies based on the FADK project could provide such knowledge (described above in section 7.1.1.2 and 7.1.1.3).
Finally, even though individual treatment (e.g., cognitive behavioral therapy, pharmacotherapy) seems feasible (including the potential motivation from pharmaceutical companies to engage in development of new pharmacotherapies), a great challenge in preventing and treating food addiction is the obesogenic food environment.[289] It can be difficult to overcome an addiction disorder if one is constantly exposed to cues that trigger the addictive behavior. Therefore, the food

addiction framework also points to a need for more structural changes with regard to health policies, e.g., food production, availability of hyperpalatable foods, and advertisement/commercials of hyperpalatable foods.[289–291]
Another perspective is that of weight stigma related to obesity. Several studies have suggested that weight stigma, rather than self-devaluation related to weight and shape, could be an important predictor of overeating.[292,293] Weight stigma has also been investigated in relation to food addiction. Some studies find food addiction to be less associated with weight stigma compared to an alternative diet and exercise explanation model (as a proxy for obesity as solely related to personal control).[293–295] This suggests that the food addiction framework may also help de-stigmatize individuals suffering from obesity, which may in itself reduce overeating.

In conclusion, the FADK study has several implications for both researchers and clinicians. Future studies based on data from the FADK study may help provide knowledge on risk factors and outcomes of food addiction; establishing such new knowledge is a critical step to identify targets for future interventions aimed at preventing and treating food addiction.

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APPENDICES

Appendix A. Paper II

Horsager C, Færk E, Lauritsen MB, Østergaard SD

Validation of the Yale Food Addiction Scale 2.0 and estimation of the population prevalence of food addiction

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Original article

Validation of the Yale Food Addiction Scale 2.0 and estimation of the population prevalence of food addiction

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SUMMARY

Background & aims: Food addiction (FA) is likely to contribute to the global obesity epidemic. Most studies of FA have been conducted within clinical and/or highly selected populations, suggesting that prevalence estimates of FA may be biased. This is problematic as valid estimates of the population prevalence of FA is a requirement for informing and designing public health initiatives focusing on this phenotype. Therefore, we aimed to estimate the weighted prevalence of food addiction in the adult general population of Denmark.

Methods: A random sample of 5000 individuals aged 18 to 62 from the Danish population was invited to participate in a survey, which included the Yale Food Addiction Scale (YFAS 2.0) and several rating scales measuring eating pathology and other psychopathology. Health, demographic and socioeconomic data from the Danish registers were linked to all invitees to allow for attrition analysis. The analysis had three steps: I) Psychometric validation of the Danish version of YFAS 2.0 II) Attrition analysis to examine selection bias, and III) Estimation of the weighted prevalence of FA taking attrition into account.

Results: The confirmatory factor analysis of the YFAS 2.0 supported a one-factor model, and the scale had good internal consistency. The YFAS 2.0 score correlated with eating pathology including binge eating frequency, impulsivity and body mass index (BMI). The survey response rate was 34.0% (n = 1699) with a slight overrepresentation of respondents with higher socioeconomic status. The crude prevalence of FA was 9.0%. When taking attrition into account, the weighted prevalence of FA was 9.4% CI 95% [7.9–10.9].

Conclusions: The psychometric properties of the Danish version of the YFAS 2.0 were good. The weighted prevalence of FA was very similar to the crude prevalence estimate. This suggests that attrition may not be a large problem when estimating the prevalence of FA with the YFAS 2.0.

1. Introduction

The food environment in developed countries has changed dramatically since the 1960s [1]. Specifically, the virtually unlimited access to calorie-dense and hyper-palatable food has turned many societies into so-called "obesogenic environments" [1]. This represents a stark contrast to the hunter-gatherer lifestyle of our ancestors where the drive for energy seeking and consumption was a prerequisite for survival [2]. Due to this uncoupling of energy need and intake, the obesogenic environment is considered to be among the most important contributors to the global obesity epidemic [3]. In fact, prior research has suggested that the obesogenic environment has led to development of outright addiction to hyper-palatable, calorie-dense foods (so-called food addiction) – a phenotype with psychological, behavioral and neurobiological characteristics equivalent to those seen in (other) substance use disorders, namely impaired control over - and preoccupation with - the substance, risky use (despite knowledge of harming effect), symptoms of withdrawal and tolerance, and resulting social impairment [4–8].

Food addiction was operationalized by the self-reported Yale Food Addiction Scale (YFAS) in 2009 [9]. The updated version of the

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YFAS - YFAS 2.0 [10] - is based on the DSM-5 criteria for substance-related and addictive disorders [7]. The YFAS and the YFAS 2.0 have demonstrated robust psychometric properties across different languages and settings [11]. However, most validation and prevalence studies have been performed in clinical populations or community samples defined by self-inclusion, and not in random representative samples (for a review, see Penzenstadler et al. [12]). Consequently, both prevalence estimates and characterizations of individuals with food addiction vary with the sampling strategy and the study setting, which complicate our understanding of this phenotype.

To our knowledge, only two studies have aimed at overcoming this sampling problem by using quota-based methods in order to obtain representative samples from general populations [13,14]. However, quota sampling is non-probability based and may therefore introduce selection bias [15]. Furthermore, lack of background data on those not participating in these studies makes it difficult to determine the generalizability of the results – and hence to estimate the true prevalence of food addiction in the general population. Having valid population estimates of the prevalence of food addiction is a requirement for informing and designing potential public health initiatives focusing on this phenotype – and establishing these estimates is therefore of interest and importance.

Denmark is likely to represent an ideal setting for a study aiming at obtaining valid population estimates of food addiction. This is due to the fact that there is a longstanding Danish tradition for coupling survey data with demographic, socioeconomic and health data from nationwide registers [16]. This tradition allows for both random sampling from the entire population and for obtaining demographic, socioeconomic and health data from both survey respondents and non-respondents, enabling attrition analyses and weighted estimation of the prevalence of food addiction in the general population. For these reasons, we designed a study to be conducted in Denmark, which had three sequential aims:

I) To perform a psychometric validation of the YFAS 2.0 in a random sample of the adult general population in Denmark (a requirement for meeting aim III).

II) To assess the representativeness of the respondents based on attrition analysis using demographic, socioeconomic and health data on both respondents and non-respondents extracted from the Danish registers.

III) To estimate the weighted prevalence of food addiction in the adult general population in Denmark based on the results of the attrition analysis.

2. Materials and methods

2.1. Study design and setting

This study is based on data from the Food Addiction Denmark (FADK) project – a web-based survey conducted in 2018, which includes linkage to register-based demographic, socioeconomic and health-related data for all invitees [17].

2.2. Invitees

A total of 5000 individuals aged 18–62 years from the general population were extracted randomly from the Danish Civil Registration System (DCRS) [18]. The DCRS has all individuals residing in Denmark registered by a unique 10-digit personal identifier, which enables linkage of information from all Danish registers at the level of the individual [19]. To be eligible for extraction for this survey, individuals had to i) be registered in the DCRS, ii) be born in Denmark, iii) have Danish born parents, and iv) have a valid Danish postal address. Individuals who were legally incapacitated or individuals with a protected personal address were not eligible.

2.3. Survey procedure

The invitation to the web-based survey was sent to invitees via a secure electronic mail system (eBoks) [20] used by the Danish public authorities [21]. The invitation, in which information and instructions regarding the study was described, included a personal link to the web-based survey on www.surveyexact.dk [22]. A reminder was sent by surface mail to those who had not responded to the first invitation within 6 weeks. A more comprehensive description of the survey procedure and specific details on the FADK Project are provided in Horsager et al., 2019 [17].

2.4. Ethics

Invitees were informed that survey participation was voluntary, and that they could withdraw their consent to participate at any time. All data from the survey as well as from the registers (see "Data used for the attrition analysis" below) was de-identified by Statistics Denmark. The project was registered with the Danish Data Protection Agency (record number 2008-58-0028) and the use of register data was approved by the Danish Health Data Authority and Statistics Denmark. In Denmark, Ethical Review Board approval is not required for surveys and studies based on register data that do not involve biomedical intervention.

2.5. The survey questionnaire

As the first aim of this study was to validate the Danish version of YFAS 2.0, the survey questionnaire, in addition to the YFAS 2.0, contained external validators (questionnaires) comparable to those used in the original validation studies of the YFAS and YFAS 2.0 by Gearhardt et al. [9,10]. Furthermore, external validators used in recent studies of the German, Italian, and Spanish versions of the YFAS 2.0 [23–25] were also included. Specifically, the following self-report measures were included in the FADK questionnaire:

2.5.1. The Yale Food Addiction Scale 2.0 (YFAS 2.0)

The YFAS 2.0 was translated into Danish in accordance with the WHO-guideline for translation of psychometric instruments [26]. A.N. Gearhardt approved the back-translated version in order to ensure that the content corresponds to that of the original. The YFAS 2.0 contains 35 items covering the 11 DSM-5 criteria for substance-related and addiction disorders (SRAD criteria); I) Consumption of more than planned, II) unable to cut down or stop, III) much time spent, IV) important activities given up, V) use despite physical/emotional consequences, VI) tolerance, VII) withdrawal, VIII) craving, IX) failure in role obligation, X) use despite interpersonal consequences, and XI) use in physically hazardous situations, as well as two items covering the criterion regarding distress/impairment. There are two ways of scoring the YFAS 2.0, categorically or continuous. In the categorical scoring it is determined whether the criteria for the food addiction "diagnosis" are met or not. The diagnosis can be further divided into mild (two to three symptoms present), moderate (four to five symptoms present), and severe food addiction (six or more criteria present). To meet the criteria for the diagnosis, significant impairment or distress should be present as well. The continuous scoring simply sums all the symptoms that are endorsed, yielding a total score between zero and 11.

2.5.2. The eating disorder Examination Questionnaire (EDE-Q)

The EDE-Q is a questionnaire based on the clinical interview Eating Disorder Examination (EDE) [27,28]. The EDE-Q has been used in the Italian [23] and German [24] psychometric validation of the YFAS 2.0. In this study, EDE-Q item #15 regarding binge eating frequency was used in the analyses of incremental and convergent validity, while the subscale on dietary restraint was used in the analysis of discriminant validity [10,23,24]. Finally, the subscales on eating concern and the total score were used in the analysis of convergent validity [23,24]. Item #13-#18 were categorized into seven categories ranging from zero days/times to more than 27 times/every day (like the remaining items in the EDE-Q).

2.5.3. The ADHD subscale of the symptom Checklist-92 (SCL-92)

The SCL-92 examines a broad range of psychopathology [29]. In this study, data on the ADHD subscale of the SCL-92 [29] was used in the analysis of convergent validity as impulsivity has been found to associate with food addiction [30–37].

2.5.4. The Alcohol Use Disorder Test (AUDIT)

The AUDIT is commonly used to detect alcohol dependence and problematic use of alcohol [38]. In the validation study of the original YFAS, alcohol dependence was used as a discriminant construct [9]. Since then, other studies have confirmed that alcohol use disorder is negatively associated with food addiction [39,40]. Therefore, we included alcohol dependence (as operationalized by the AUDIT) in the analysis of the discriminant validity of YFAS 2.0.

2.5.5. Weight and height

Weight and height were self-reported, and the BMI was computed based on this information.

2.6. Definition of complete/partial response to the YFAS 2.0

Complete response to the YFAS 2.0 was defined as having answered all of its 35 questions. In agreement with prior studies [9,10], the analysis of the psychometric validity was based only on data from those with complete response to the YFAS 2.0.

Partial response was defined as having answered at least one question per SRAD criterion – thereby enabling scoring of each criterion (including that on impairment/distress). Hence, for the partial respondents we were also able to compute the YFAS 2.0 continuous symptom score and categorical score (no food addiction, mild food addiction, moderate food addiction or severe food addiction). Therefore, our estimation of the prevalence of food addiction in Denmark was based on data from those with complete-as well as partial response to the YFAS 2.0.

2.7. Data used for the attrition analysis

Data from the Danish registers regarding demographics, socioeconomics and health was used for the attrition analysis (available for both respondents and non-respondents). The following information was extracted for all invitees: age, sex and marital status from the Danish Civil Registration System [18], education level from the Register on Personal Level of Education [41], occupation status from the Registers on Personal Labor Market Affiliation [41], personal income from the Income Statistics Register [41], degree of urbanization (population density in the area of home address) and geography (province of home address) from the Danish Civil Registration System [18], prior mental disorder from the Psychiatric Central Research Register [42,43], use of psychotropic medication from the National Prescription Register [44], and somatic/medical comorbidity as measured by the Charlson Comorbitity Index [45] from the National Patient Register [46]. The categorization of the included demographic, socioeconomic and health parameters are specified in supplement S1.

2.8. Statistics

2.8.1. Validation of the YFAS 2.0

The validation was performed in accordance with the original work [10], and included an examination of the internal reliability (Kuder-Richardsons alpha), and a confirmatory factor analysis testing the fit for a single factor model and a two-factor model. The confirmatory factor analysis for the single factor model was conducted using the items representing the eleven DSM 5 SRAD criteria, except the criteria for distress and impairment. In the two factor model, the first factor represented the eight SRAD dependence criteria plus “craving”, and the second factor the three SRAD criteria representing “abuse” (“failure in role obligation”, “use despite interpersonal/social consequences”, and “use in physically hazardous situations”). The goodness of fit of the two models was evaluated with the confirmatory fit index, the Tucker Lewis Index, the root-mean-square error of approximation and the Chi^2-test.

The convergent, the discriminant, and incremental validity [9,10,47,48] was tested by calculating Pearson's correlation coefficient between the YFAS 2.0 total scores versus total scores on the SCL-92 ADHD subscale, the AUDIT and the EDE-Q (all subscales as well as the total score), age and BMI, respectively. Only complete responses on the validation measures were included in the correlation analyses. Pearson's correlation coefficients ($|r|$) $\geq$0.30 were considered as evidence of a relevant association [49,50] with the significance level set at $p < 0.05$.

For the YFAS 2.0 categorical scoring option, ANOVA was performed to test for difference in total scores on the SCL-92 ADHD subscale, the AUDIT and the EDE-Q subscales and total score, age and BMI, respectively, across the no food addiction, mild food addiction, moderate food addiction, and severe food addiction categories. For sex, the Chi^2-test was used. Afterwards, a post hoc comparison with a hierarchical approach was used. Specifically, if a statistically significant difference was found between individuals with and without food addiction, the next step was to evaluate whether there was a difference between the three severity levels of food addiction. First, the difference between respondents with severe and mild food addiction were compared, then severe and moderate food addiction, and finally respondents with mild and moderate food addiction, but only if all of the before-mentioned analyses had provided evidence of statistically significant differences across and between groups. This hierarchical method was preferred over adjustment for multiple comparisons. The effect sizes were estimated as partial eta squared (partial η^2), and Cohens definition of small (0.01), medium (0.06) and large (0.14) effect sizes was applied [50–52].

The incremental validity was examined with multiple hierarchical regression analysis to estimate the predictive effect of binge eating frequency and YFAS 2.0 score on the BMI, respectively. Binge eating frequency was entered in the first model as the only explanatory variable for BMI and subsequently the YFAS 2.0 total score was entered as well (model two) enabling an evaluation of the variance in BMI accounted for by the YFAS 2.0.

2.8.2. Attrition analysis

The attrition comparing respondents (complete and partial responses) with non-respondents is predominantly analyzed using descriptive statistics. Means and standard deviations (SDs) for continuous variables and relative frequencies for categorical

variables are reported and comparisons between respondents and non-respondents are analyzed with Chi^2-test/Fischers exact test and students simple t-test.

2.8.3. Estimation of the weighted prevalence of food addiction

The weighted prevalence estimation taking attrition into account was performed in nine steps using augmented inverse propensity weighted estimation [53,54]. The estimate was weighted by the attrition divided on the following factors, which were included in the model in the following order: age, sex, marital status, socioeconomic factors (educational level, occupation status and personal income), urbanization, geography/region, somatic illness (the Charlson Comorbidity Index), prior mental disorders and finally prior use of psychotropic medication.

Prior to all statistical analyses, the underlying assumptions were checked and alternative non-parametric analyses were chosen if assumptions were not met. All analyses were conducted using STATA version 15.1.

3. Results

3.1. Survey response rate

A flow chart illustrating the survey participation is shown in Fig. 1. The overall response rate (complete plus partial response to the YFAS 2.0) was 34.0% and 28.7% only including complete responses of the YFAS 2.0. The mean age of the respondents was 43.5 years and 58.7% were female. The demographic, socioeconomic and health-related characteristics of the respondents (and non-respondents) are listed in relation to the attrition analysis (see below).

3.2. Psychometric validation of the YFAS 2.0

3.2.1. Factor structure and reliability

Prevalence and factor loadings of the SRAD-criteria are provided in Table 1. The average number of symptoms endorsed was 0.9

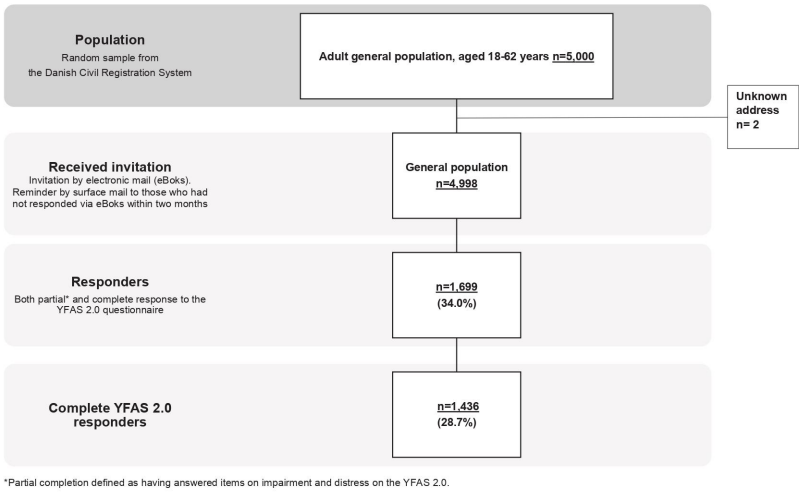

Fig. 1. Flowchart of the survey.

Table 1
Prevalence and factor loadings of the substance-related and addiction disorders (SRAD) diagnostic indicators of the Yale Food Addiction Scale 2.0 (n = 1436).

	Met criterion N (%)	Did not meet criterion N (%)	Factor loadings 1-factor model	Factor loadings 2-factor model
Food addiction symptoms (SRAD diagnostic indicators)				
Consumed more than planned	190 (13.2)	1246 (86.8)	0.56	–
Unable to cut down or stop	229 (16.0)	1207 (84.1)	0.67	–
Great deal of time spent	156 (10.9)	1280 (89.1)	0.66	–
Important activities given up	41 (2.9)	1395 (97.1)	0.43	–
Use despite physical/emotional consequences	128 (8.9)	1308 (91.1)	0.77	–
Tolerance	65 (4.5)	1371 (95.5)	0.68	–
Withdrawal	151 (10.5)	1285 (89.5)	0.71	–
Craving	84 (5.9)	1352 (94.2)	0.67	0.68
Failure in role obligation	46 (3.2)	1390 (96.8)	0.55	0.55
Use despite interpersonal/social consequences	79 (5.5)	1357 (94.5)	0.51	–
Use in physically hazardous situations	122 (8.5)	1314 (91.5)	0.62	0.63
Impairment or distress	162 (11.3)	1274 (88.7)	–	–

(SD = 2.0), 1.1 (SD = 2.2) for females), and 0.6 (SD = 1.6) for males. The most commonly endorsed SRAD criteria were "inability to cut down or stop" (16.0%) followed by "consumed more than planned" (13.2%). The less endorsed criteria were "important activities given up" (2.9%) and "failure in role obligation" (3.2%).

The confirmatory factor analysis for a single factor model found factor loadings ranging from 0.43 to 0.77 (all with p-values <0.001), confirmatory fit index = 0.909, Tucker Lewis Index = 0.886, root-mean-square error of approximation = 0.089 and Chi^2 ($F = 549.59$, $df = 44$, $p < 0.001$). The internal consistency measured by Kuder-Richardson alpha (KR-20) was 0.8683. For the two factor model, the following values were obtained: confirmatory fit index = 0.909, and the Tucker Lewis Index = 0.884, and root-mean-square error of approximation = 0.090. The covariance between the two factors was $r = 0.99$ [0.95; 1.02] $p < 0.001$.

3.2.2. Convergent and discriminant validity

A correlation matrix illustrating convergent and discriminant validity of the YFAS 2.0 is provided in Table 2. All measures of eating pathology were moderately/strongly positively correlated with the YFAS 2.0 total score (all in the range from $r = 0.50$ to $r = 0.61$, with p-values<0.05) apart from restrained eating, which correlated less strongly, albeit significantly, with the YFAS 2.0 total score ($r = 0.35$, $p < 0.05$). The ADHD subscale ($r = 0.44$, $p < 0.05$) and BMI were also positively correlated with the YFAS 2.0 total score ($r = 0.30$, $p < 0.05$). Alcohol dependence (AUDIT score) did not correlate with the YFAS 2.0 score ($r = -0{,}001$).

The results of the comparison of clinical characteristics between groups of individuals with different levels of food addiction are presented in Table 3. Measures on eating pathology were all able to discriminate between individuals with and without food addiction. The most noteworthy findings were i) that both binge eating frequency ($F = 105.30$, $p < 0.001$ and partial-$\eta^2 = 0.19$) and eating concern ($F = 188.52$, $p < 0.001$ and partial-$\eta^2 = 0.30$) were able to discriminate all levels of food addiction from each other; ii) that restrained eating was more prevalent in individuals with food addiction ($F = 59.45$, $p < 0.001$), however among all constructs related to eating pathology it had the lowest effect size (partial-$\eta^2 = 0.11$); iii) that individuals with food addiction had significant higher BMI than those without ($p < 0.001$), but there was no difference in BMI between the food addiction severity levels (see also Fig. 2); iv) that individuals with food addiction had higher scores on the ADHD-subscale of the SCL-92 compared to those without food addiction ($F = 76.85$, $p < 0.001$); and finally that alcohol dependence (AUDIT) was not able to discriminate between those with- and without food addiction ($F = 0.92$, $p = 0.43$).

3.2.3. Incremental validity

In model one (n = 1369) with binge eating frequency as the only explanatory variable for BMI, binge eating frequency was a significant predictor of BMI (t = 5.30, coeff. = 1.15 [0.73; 1.58], $p < 0.001$) explaining 2.0% of the variance in the model. In model two (n = 1369) where the YFAS 2.0 total score was added to model one, binge eating frequency was no longer significantly associated with BMI (t = 0.59, coeff. = 0.14 [-0.34; 0.63], p = 0.554), but the YFAS 2.0 total score was (t = 8.30, coeff. = 0.74 [0.56; 0.91], $p < 0.001$), and accounted for additional 4.7% of the variance in the model.

3.3. Attrition analysis

The results of the attrition analysis are shown in Table 4.

Compared to non-respondents, the respondents were older (mean age = 43.5 years (SD = 0.3) versus 39.5 years (SD = 0.2), $p < 0.001$), more likely to be female (58.7% vs. 44.7%, $p < 0.001$) and more likely to be married or cohabiting (71.2% vs. 65.2%, $p < 0.001$). There were also significant group differences ($p < 0.001$ for all analyses) with regard to educational level (a larger proportion of the respondents had medium-cycle or long-cycle higher education compared to the non-respondents), occupation status (a larger proportion of the respondents were in the labor force compared to the non-respondents) and income (a larger proportion of the respondents were in the highest income quintile). There were no differences between respondents and non-respondents with regard to region/urbanization of residence (p = 0.223 and p = 0.429, respectively). While the somatic illness load (operationalized as the Charlson Comorbidity Index) was comparable between respondents and non-respondents (p = 0.790), prior and/or present users of antipsychotics (5.2% vs. 7.7%, p = 0.001) and ADHD medication (0.5% vs. 2.6%, p = 0.018) as well as those with prior diagnoses of mental disorders (8.5% vs. 11.3%, p = 0.002) were underrepresented among the respondents. The only exception to this tendency was individuals with eating disorders, who were overrepresented among the respondents (1.4% vs. 0.6%, p = 0.010).

3.4. Food addiction prevalence estimate (crude and weighted)

A total of 9.0% CI 95% [7.6–10.4] (n = 153) met the criteria for food addiction, including both complete and partial responses (n = 1699), with 2.5% being mild, 2.6% moderate 3.9% severe, respectively. Of the 153 individuals with food addiction, 119 were females, corresponding to 77.8% of all food addiction cases and 11.9% of all female respondents. The 34 males with food addiction corresponded to 4.8% of the male respondents, the difference in prevalence between sex was statistical significant ($p < 0.001$).

Individuals with mild (38.8 years, SD = 12.2) and moderate (39.8 years, SD = 13.6) food addiction were statistical significantly younger than individuals without (43.9 years, SD = 12.6) food addiction (mild vs. no food addiction p = 0.026; moderate vs. no food addiction p = 0.048). The same tendency was seen for severe food addiction (40.9 years, SD = 12.2), without reaching statistical significance (p = 0.067).

The results from the weighted prevalence model are outlined in Fig. 3. It shows how the estimate of the prevalence of food addiction decreased slightly with the introduction of demographic variables to the model varying from 9.5% when only age is introduced to the model to 8.8%, when attrition according to sex was also taken into account. The prevalence estimate increased slightly with the inclusion of socioeconomic and health related variables, and reached a plateau around 9.4% CI 95% [7.9; 10.9]. As evident from Fig. 3, all confidence intervals of the estimates obtained in the stepwise weighing procedure overlapped with the crude prevalence at 9.0%. Hence the change in the estimated prevalence of food addiction due to adjustment for attrition was not statistically significant.

4. Discussion

In this study using data from the FADK project [17], we examined the psychometric properties of the Danish version of YFAS 2.0 in a sample from the general adult population. Subsequently, via comprehensive attrition analyses using data from both respondents and non-respondents, the generalizability of the results was evaluated. Finally, based on the results from the attrition analyses, we estimated the weighted prevalence of food addiction in the adult Danish population. The results showed that the Danish version of the YFAS 2.0 has good psychometric properties that are comparable to those obtained in the validation of the English original. The survey response rate was 34.0% (n = 1699) with a slightly over-representation of respondents with higher education, employment and higher income. The crude prevalence of food addiction was 9.0% CI 95% [7.6–10.4], higher among females than among males

Table 2
Correlation matrix showing data regarding convergent and discriminant validity.

	YFAS 2.0 total score (n)	Age (n)	ADHD (SCL-92) (n)	Restraint eating (EDE-Q) (n)	Eating concern (EDE-Q) (n)	Shape concern (EDE-Q) (n)	Weight concern (EDE-Q) (n)	Binge eating frequency (EDE-Q) (n)	Eating pathology (Global EDE-Q score) (n)	BMI[a] (n)	Alcohol dependence (AUDIT) (n)
YFAS 2.0 total score (n)	1 (1436)										
Age (n)	−0.11* (1436)	1 (1436)									
ADHD (SCL-92) (n)	0.44* (1366)	−0.23* (1366)	1 (1366)								
Restraint eating (EDE-Q) (n)	0.35* (1400)	−0.02 (1400)	0.24* (1350)	1 (1400)							
Eating concern (EDE-Q) (n)	0.61* (1339)	−0.20* (1339)	0.45* (1309)	0.43* (1325)	1 (1339)						
Shape concern (EDE-Q) (n)	0.54* (1359)	−0.15* (1359)	0.50* (1333)	0.58* (1346)	0.63* (1303)	1 (1359)					
Weight concern (EDE-Q) (n)	0.54* (1383)	−0.14* (1383)	0.45* (1356)	0.58* (1367)	0.63* (1325)	0.91* (1354)	1 (1383)				
Binge eating frequency (EDE-Q) (n)	0.50* (1387)	−0.07* (1387)	0.32* (1351)	0.25* (1370)	0.55* (1327)	0.40* (1344)	0.39* (1368)	1 (1387)			
Eating pathology (Global EDE-Q score) (n)	0.54* (1286)	−0.13* (1286)	0.45* (1262)	0.78* (1286)	0.73* (1286)	0.93* (1286)	0.93* (1286)	0.40* (1274)	1 (1286)		
BMI[a] (n)	0.30* (1381)	0.13 (1381)	0.15* (1355)	0.23* (1365)	0.24* (1323)	0.40* (1347)	0.45* (1370)	0.20* (1366)	0.40* (1276)	1 (1381)	
Alcohol dependence (AUDIT) (n)	−0.001 (1297)	−0.17* (1297)	0.15* (1285)	0.01 (1282)	0.04 (1243)	0.03 (1264)	0.02 (1289)	0.06* (1283)	0.03 (1198)	−0.04 (1288)	1 (1297)

EDE-Q: Eating disorder Examination Questionnaire.
SCL-92: The Symptom Checklist-92.
AUDIT: The Alcohol Use Disorder Test.
*Significance level: $p < 0.05$.
[a] Not including data from four individuals with a reported height under 100 centimeters or weight under 30 kilograms.

Table 3
Comparison of clinical characteristics between groups of individuals with different levels of food addiction (no, mild, moderate and severe).

	1. No food addiction	2. Mild food addiction	3. Moderate food addiction	4. Severe food addiction	ANOVA Test stat (F)	P-value	Effect size (partial η^2)	Pairwise comparisons (unadjusted p < 0.05)
Food Addiction prevalence, N (%) (n = 1436)	1308 (91.09%)	31 (2.16%)	37 (2.58%)	60 (4.18%)	–	–	–	–
Sex (females), N (%)* (n = 1436)	734 (56.12%)	24 (77.42%)	27 (72.97%)	49 (81.67%)	–	<0.000	–	–
Age, Mean (SD) (n = 1436)	43.94 (12.59)	38.84 (12.19)	39.78 (13.63)	40.88 (12.21)	3.85	0.009	0.01	[a]
ADHD (SCL-92), Mean (SD) (n = 1366)	4.06 (3.98)	8.39 (5.10)	9.39 (5.01)	10.88 (5.95)	76.85	<0.000	0.14	1<2,3,4 4>2
Restrained eating**, Mean (SD) (n = 1400)	1.06 (1.24)	2.32 (1.03)	2.82 (1.63)	2.69 (1.43)	59.45	<0.000	0.11	1 < 2,3,4
Eating concern**, Mean (SD) (n = 1339)	0.22 (0.47)	1.07 (0.90)	1.52 (1.00)	1.90 (1.41)	188.52	<0.000	0.30	1< 2,3,4 4>3 > 2
Shape concern**, Mean (SD) (n = 1359)	1.38 (1.32)	3.69 (1.04)	4.08 (0.98)	4.06 (1.45)	145.55	<0.000	0.24	1 < 2,3,4
Weight concern**, Mean (SD) (n = 1383)	1.18 (1.19)	3.35 (0.94)	3.53 (0.87)	3.73 (1.33)	155.77	<0.000	0.25	1 < 2,3,4
Binge eating freq.**, Mean (SD) (n = 1387)	0.16 (0.50)	0.42 (0.92)	0.75 (1.18)	1.61 (1.74)	105.30	<0.000	0.19	1<2,3,4 4>3 > 2
Eating pathology**, Mean (SD) (Global EDE-Q score) (n = 1286)	0.94 (0.87)	2.54 (0.72)	3.01 (0.81)	2.95 (1.27)	140.29	<0.000	0.25	1 < 2,3,4
BMI[b] (n = 1381)	25.38 (4.59)	29.91 (5.96)	30.27 (8.29)	30.16 (7.19)	35.63	<0.000	0.07	1 < 2,3,4
Alcohol dependence (AUDIT) (n = 1297)	5.67 (4.16)	6.21 (5.09)	5.97 (6.11)	4.84 (4.28)	0.92	0.43	0.002	–

ANOVA and post hoc comparisons.*Chi^2-test. ** Derived from the Eating Disorder Examination Questionnaire (EDE-Q).
For the pairwise comparisons: 1: no food addiction, 2: mild food addiction, 3: moderate food addiction, 4: severe food addiction.
[a] 1 and 4 not different at the p < 0.05 level.
[b] Not including data from four individuals with a reported height under 100 centimeters or weight under 30 kilograms.

(11.9% vs. 4.8%), while the prevalence in the fully adjusted model taking attrition into account, was 9.4% CI 95% [7.9–10.9].

The Danish YFAS 2.0 had good internal reliability and a single factor model was supported [55]. Additionally, the two-factor model did not provide any better fit indices and the correlation between the two factors was 0.9, also supporting a single factor model, which is in concordance with the results from validation studies of other language versions of the YFAS 2.0 [10,23–25,56,57]. However, the original US validation study as well as validation studies of other language versions of the YFAS 2.0 [10,23–25] showed markedly better fit indices than those obtained in the present study, which are similar to those reported in the validation studies of the Japanese and French YFAS 2.0 [56,57]. The same was the case for the factor loadings, which were all acceptable and also comparable with the validation studies of the Japanese and French YFAS 2.0 and all larger than 0.30 [58], but markedly lower than the validation studies of the original, the Italian, the German, and the Spanish YFAS 2.0. It seems likely, that the random sample of Danish adults is more diverse than other samples used for validation of the YFAS 2.0, which will have

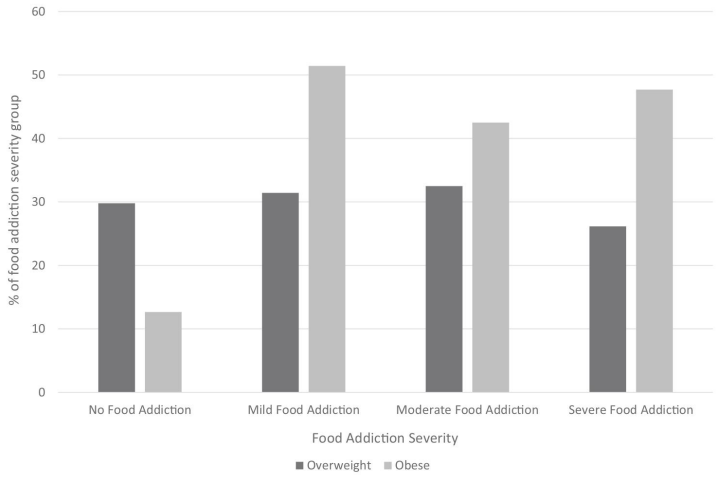

Fig. 2. Food addiction severity and BMI group.

Table 4
Demographic, socioeconomic and health-related characteristics of the respondents and non-respondents.

	Respondents (n = 1699)	Non-respondents (n = 3301)	P-value[a]
Characteristics			
Age in years (SD)	43.5 (0.3)	39.5 (0.2)	<0.001
Female sex (%)	997 (58.7)	1475 (44.7)	<0.001
Civil status (%)			
Married or cohabiting	1210 (71.2)	2154 (65.2)	
Single	489 (28.8)	1147 (34.8)	
			<0.001
Educational level (%)			
Lower secondary school	297 (17.5)	847 (25.7)	
High school	199 (11.7)	385 (11.7)	
Vocational or short-cycle higher education	612 (36.0)	1256 (38.1)	
Medium-cycle higher education including bachelor	376 (22.1)	501 (15.2)	
Long-cycle higher education	212 (12.5)	294 (8.9)	
Missing n = 212			
			<0.001
Occupation status (%)			
In the labor force	1290 (75.9)	2338 (70.8)	
Unemployment, sick pay, leave of absence	42 (2.5)	74 (2.2)	
Disability pension, social security benefit	121 (7.1)	340 (10.3)	
Enrolled in education	210 (12.4)	444 (13.5)	
Missing n = 141[b]	36 (2.1)	105 (3.2)	
			<0.001
Personal income (%)			
Quintiles			
< 21,906 euro	299 (17.6)	695 (21.1)	
21,906 euro – 38,145 euro	283 (16.7)	721 (21.8)	
38,146 euro – 48,914 euro	338 (19.9)	658 (19.9)	
48,915 euro – 63,329 euro	376 (22.1)	621 (18.8)	
> 63,329 euro	401 (23.6)	597 (18.1)	
Missing n = 11[b]			
			<0.001
Degree of urbanization[c] (%)			
Densely populated	537 (31.6)	1026 (31.1)	
Intermediate populated, largest town with ≥40,000 inhabitants	281 (16.5)	488 (14.8)	
Intermediate populated, largest town with <40,000 inhabitants	300 (17.7)	581 (17.6)	
Intermediate populated, largest town with <15,000 inhabitants	37 (2.2)	87 (2.6)	
Thinly populated, largest town with ≥15,000 inhabitants	205 (12.1)	440 (13.3)	
Thinly populated, largest town with <15,000 inhabitants	339 (20.0)	679 (20.6)	
			0.429
Region (%)			
Capital	483 (28.4)	977 (29.6)	
Central Jutland	409 (24.1)	776 (23.5)	
Northern Jutland	204 (12.0)	329 (10.0)	
Zealand	250 (14.7)	507 (15.4)	
Southern Denmark	353 (20.8)	712 (21.6)	
			0.223
Prior mental disorder [d,e] (%)			
Any mental disorder (binary y/n) n = 5000	144 (8.5)	372 (11.3)	0.002
Psychoactive substance use (F10–F19)	26 (1.5)	88 (2.7)	0.010
Psychotic disorders (F20–F29)	14 (0.8)	74 (2.2)	<0.001
Mood disorders (F30–F33)	77 (4.5)	171 (5.2)	0.317
Anxiety disorders (F40–F42, F431)	34 (2.0)	106 (3.2)	0.014
Eating disorders (F50)	23 (1.4)	21 (0.6)	0.010
Personality Disorders (F60–F62.1)	47 (2.8)	90 (2.7)	0.935
Pervasive developmental disorders incl. autism (F84.0, F84.1, F84.5, F84.8)	5 (0.3)	21 (0.6)	0.111
Behavioral and emotional disorders incl. ADHD (F90, F90.1, F90.8, F98.8)	13 (0.8)	68 (2.1)	0.001
Any other mental disorder (not included in the defined diagnostic groups).	52 (3.1)	103 (3.1)	0.908
Use of psychotropic medication [d] (%)			
Any psychotropic medication (binary y/n) -all categories together (n = 5000)	529 (31.1)	995 (30.1)	0.470
Antipsychotics	89 (5.2)	253 (7.7)	0.001
Lithium	11 (0.7)	12 (0.4)	0.160
Anxiolytics	272 (16.0)	464 (14.1)	0.065
Antidepressants	407 (24.0)	734 (22.2)	0.170
ADHD medication	26 (1.5)	85 (2.6)	0.018
Medication for addiction disorders	45 (2.7)	118 (3.6)	0.081

Table 4 (*continued*)

	Respondents (n = 1699)	Non-respondents (n = 3301)	P-value[a]
Somatic illness (%)			
(Charlson Comorbitity Index)			
No/Low	1445 (85.19	2785 (84.4)	
Moderate	229 (13.5)	462 (14.0)	
Severe/High	25 (1.5)	54 (1.6)	
			0.790

[a] Comparing respondents with non-respondents. All tests are performed as Chi^2 tests except for the comparison of age between groups where the two-sample t-test was used.
[b] Numbers cannot be shown according to rules enforced by Statistics Denmark (due to risk of identification of individuals).
[c] Based on EUROSTAT's DEGURBA categorization.[87].
[d] according to the ICD-10.
[e] Individuals are allowed to be in more than one category, for each analysis n = 5000.

increased the variance in the data set and resulted in lower fit indices and factor loadings.

The results from the convergent and discriminant validity analyses were in line with those obtained in other validation studies. Specifically, food addiction correlated strongly with all eating pathology symptoms, indicating that food addiction shares core features with eating disorders, as theoretically expected and supported by several other studies [11,59]. Restrained eating correlated less strongly, albeit significantly, with food addiction, this somewhat counterintuitive association has also been reported in prior studies, and may be an indicator of a persistent feeling of control loss among individuals with a restrictive eating pattern, even when eating objectively small portions [59,60].

Impulsivity is a known risk factor of addiction [61], and our results supported the previously reported association between food addiction and impulsivity [24,32,34,37] as well as the association of ADHD-symptoms and food addiction [62–65]. As expected, food addiction did however not correlate with alcohol dependence. This is in line with the results from prior studies [39,40], and fits with the theory of addiction-shift found in bariatric surgery patients, who occasionally shift from food addiction to e.g. alcohol dependence in the post-surgery period [66–68].

The results of the incremental validity analysis showed that food addiction accounted for additional 5.6% of the variance in BMI when entered with binge eating frequency into the model, and binge eating frequency was then no longer a significant predictor of BMI. Similar results were reported from the French YFAS 2.0 validation study [56]. Taken together, this suggests that food addiction is likely to associate stronger with BMI than binge eating frequency, indicating that food addiction may "precede" binge eating on the complex etiological path that leads to obesity. Also, the BMI was significantly higher among individuals with food addiction compared to those without food addiction, which is in agreement with the results from the majority of studies on food addiction – for instance the systematic review by Penzenstadler et al. [12] as well as the recent study by Najem et al. [69].

Over the course of the past three decades there has been a clear decline in response rates to surveys [70,71]. With the expanded use of web-based surveys, which are more cost-beneficial and easy to conduct, there has been a steep increase in the number of survey

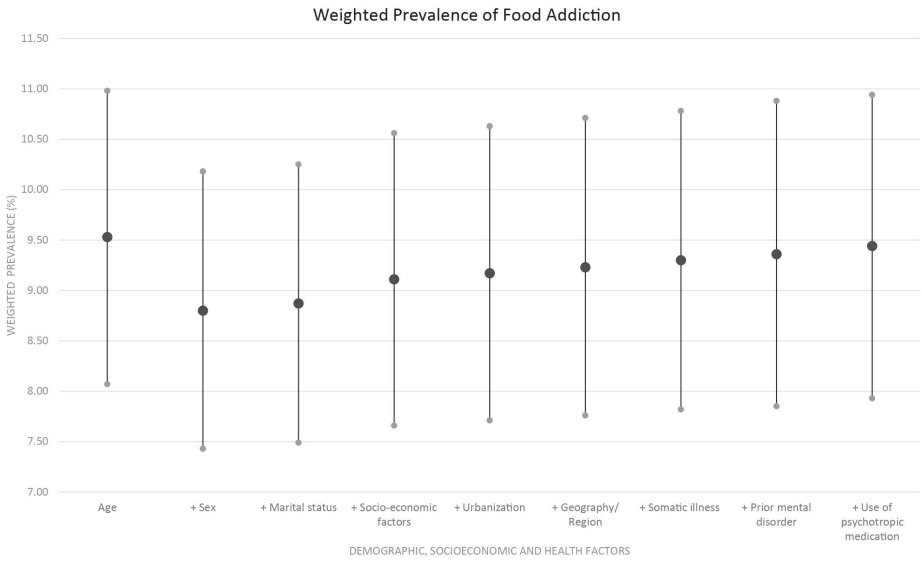

Fig. 3. Weighted prevalence of food addiction with 95% confidence intervals based on demographic, socioeconomic and health related factors.

invitations and a resulting decline in the willingness to participate in surveys [21,72]. In the present study, the overall response rate of 34.0% was satisfactory and comparable to another recent Danish nationwide survey using eBoks for invitation [21]. When compared to the non-respondents, the respondents were i) older, ii) more often females, and represented in higher iii) educational-, iv) occupational-, and v) income groups. This is in line with a wide body of literature on the impact of demographics and socioeconomic status on survey participation [73–77]. A Danish population-based study from 2015 found survey respondents less likely to have an unhealthy lifestyle compared to non-respondents and therefore a lower morbidity caused by e.g. addiction disorders than non-respondents [78]. As lower socioeconomic status correlates with poor eating habits (and resulting overweight/obesity) [79–81], the overrepresentation of individuals with higher socioeconomic status in this survey has likely resulted in an underestimation of the true prevalence of food addiction. Therefore, we calculated weighted prevalence estimates taking the attrition into account.

The crude prevalence rate of food addiction in the general Danish population was estimated at 9.0%. Consistent with findings from other studies [10,23–25], severe food addiction was more prevalent than both moderate and mild food addiction. The prevalence of food addiction was significantly higher among females compared to males – a result that is in accordance with those from the vast majority, but not all [69], other studies on food addiction [82], and also in agreement with the sex-ratio for eating disorders in general [83].

Based on the results from the attrition analysis, a weighted prevalence of food addiction was estimated using a stepwise procedure (see Fig. 3). Somewhat surprisingly, the weighted estimate (9.4%, 95% CI: 7.9–10.9) was not markedly different from the crude estimate (9.0%, 95% CI: 7.6–10.4). The two most notable changes in the estimate were observed when taking age and sex into account since food addiction is more prevalent in the young (who were underrepresented among respondents) and less prevalent in males (also underrepresented among the respondents). The subsequent adjustments for various demographic, socioeconomic and health-related factors had only little impact on the prevalence estimates, due to the fact that the respondents were either quite balanced with respect to these characteristics (e.g. demographics) and/or that these characteristics were not strongly associated with food addiction (e.g. socioeconomics). While the seemingly limited impact of attrition observed here is not necessarily representative of other settings, it does suggest that attrition may not be a large problem with regard to estimating the prevalence of food addiction based on the YFAS 2.0. Indeed, the weighted prevalence of 9.4% in the general Danish population is comparable with estimates from neighboring Germany where crude prevalence rates of 7.9–9.7% were found in non-clinical samples [13,24], but not nearly as high as the 15% estimate stemming from a study of a general population sample from the US [14]. This European-US difference in the prevalence of food addiction resonates well with the fact that overweight and obesity is markedly more common in the US compared to most European countries [84].

4.1. Limitations

The limitations of the FADK project, which provides data for this study, are covered extensively by Horsager et al., 2019 [17] and are summarized briefly in the following. First and foremost, we used a self-report questionnaire for data collection, which introduces a risk for report bias. Determining the direction and magnitude of this potential bias is not possible based on the data at hand. However, as e.g. self-reported weight tends to be underestimated and height tends to be overestimated, resulting in underestimations of the BMI [85], the same seems likely to be the case for behavior related to the BMI (e.g. food addiction). Thus, the prevalence of food addiction reported here (and in other studies) may be underestimated. Second, since the assessment of food addiction, eating pathology, and general psychopathology was cross-sectional, this study does not provide evidence for the stability of these traits over time. We plan to address this aspect in future follow-up studies of this sample. Third, to ensure that all participants were able to understand the Danish questionnaire, only Danish born citizens with Danish born parents were invited to participate. Consequently, the sample is not fully representative of the Danish population. However, as the population of Denmark is quite homogeneous (according to Statistics Denmark, approximately 86% of the inhabitants of Denmark are of Danish origin [86]), our findings should be representative of the vast majority of the Danes.

5. Conclusion

To our knowledge, this validation of the YFAS 2.0 is the largest to date, and the first to validate the YFAS 2.0 in a random sample from a general population. We found that the Danish version of the YFAS 2.0 had sound psychometric properties, and – based on results from extensive attrition analyses – we estimated the weighted prevalence of food addiction to be 9.4%. As the crude prevalence estimate was 9.0%, these results suggest that attrition may not be a large problem when estimating the prevalence of food addiction based on the YFAS 2.0.

Statement of authorship

The study was designed by CH, MBL and SDØ. The data was analyzed by CH and EF. The first version of this manuscript was drafted by CH and revised critically for important intellectual content by EF, MBL and SDØ. The final version of the manuscript was approved by all authors prior to submission.

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Conflict of interest

The authors declare no conflicts of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.clnu.2019.12.030.

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Appendix B. Paper III

Horsager C, Færk E, Lauritsen MB, Østergaard SD

Food addiction comorbid to mental disorders: A nationwide survey and register-based study

The manuscript is under review

Appendix C. Paper IV

Horsager C, Færk E, Gearhardt AN, Østergaard SD, Lauritsen MB

Validation of the dimensional Yale Food Addiction Scale for Children 2.0 and estimation of the dimensional food addiction score in a sample of adolescents from the general population.

The manuscript is under review

Appendix D. Paper V

Horsager C, Færk E, Gearhardt AN, Lauritsen MB, Østergaard SD

Food addiction comorbid to mental disorders in adolescents: A nationwide survey and register-based study

Manuscript in preparation

Appendix E. Categorization of variables included in the attrition analyses

The following sociodemographic- and health-related data obtained from the Danish registers[1-5] are included in the attrition analysis and categorized as follows:

Age and sex (The Danish Civil Registration System): Assessed at the time the first invitation for the survey was sent.

Marital status (The Danish Civil Registration System): Categorized categorically as married/cohabiting or single.

Educational level (Registers on personal level of education): Lower secondary school, Upper secondary school, Vocational or short-cycle higher education, Medium-cycle higher education including bachelor degrees (refers to e.g. nurses, teachers, physiotherapists, midwifes), Long-cycle higher education (research-based undergraduate and postgraduate programs and PhD programs obtained at universities), and Missing.

Occupation status (Registers on personal labor market affiliation): In the labor force; Unemployment, Sick leave or leave of absence; Disability pension or social security benefit; Retirement pension, early retirement (due to the defined max. age of 62 years, no one was registered in this category), Enrolled in education, and Missing.

Personal income (The Income Statistics Register): This categorization is based on the general population's income ultimo 2017 divided into quintiles: <21,906 euro; 21,906 euro – 38,145 euro; 38,146 euro – 48,914 euro; 48,915 euro – 63,329 euro; >63,329 euro. Missing.

The equivalated disposable income (The Income Statistics Register): Used for the adolescent population. The purpose of using this variable is to ensure comparability in income by taking both the size- and total income of a family into account.
The categorizing will be based on the equivalated disposable income for the general population divided into quintiles.

Degree of urbanization (The Danish Civil Registration System): Densely populated, Intermediately populated (largest town ≥ 40,000 inhabitants), Intermediately populated with largest town < 40,000 inhabitants), Intermediately populated with largest town < 15,000 inhabitants, Thinly populated, (largest town ≥ 15,000 inhabitants), Thinly populated (largest town < 15,000 inhabitants).
The categorization is based on Eurostat's definition of "Degree of Urbanization" (DEGURBA).

Geography/region (The Danish Civil Registration System): Capital, Central part of Jutland, Northern part of Jutland, Zealand, Southern part of Denmark.

Lifetime mental disorder (The Psychiatric Central Research Register): Defined as any inpatient or outpatient contact with a psychiatric hospital registered in the Psychiatric Central Research Register[5] in the period from 1969 and onwards. The listed ICD-10 diagnoses (Classification of Mental and Behavioural Disorders)[6] were used (before 1994 the corresponding ICD-8 diagnoses were used): Mental and behavioral disorders due to psychoactive substance use (F10-F19); Psychotic disorders (F20-F29); Affective disorders (F30-F33); Anxiety disorders incl. Obsessive-compulsive disorder and Post-traumatic stress disorder (F40-F42, F431); Eating disorders (F50); Personality Disorders (F60-F62.1); Pervasive developmental disorders incl. autism (F84.0, F84.1, F84.5, F84.8); ADHD and ADD (F90, F90.1, F90.8, F98.8); Any other mental disorder (not included in the defined diagnostic groups). Each individual may be present in more than one category – if he or she has been assigned diagnosis from different categories.

Lifetime use of psychotropic medication (The National Prescription Register): As registered in the National Prescription Register[3], which contains data from 1995 and onwards on all prescriptions redeemed at pharmacies in Denmark. The following groups of medication were used (Anatomical Therapeutic Chemical (ATC) codes in parentheses): Antipsychotics (N05A - N05AX17 excl. N05AN); Lithium (N05AN); Anxiolytics (N05BA, N05CD02, N05CD05, N05CD06, N03AX16); Antidepressants (N06A - N06AX26); Medication for ADHD/ADD (N06BA09, N06BA04, N06BA12, N06BA02, C02AC02, N06BA07); Medication for addiction disorders (N07BB, N07BC). Each individual may be present in more than one category – if he or she has redeemed prescriptions from more than one category of psychotropic medication.

Lifetime physical illness (The National Patient Register): As operationalized by the Charlson Comorbitity Index[7] based on hospital inpatient and outpatient contacts registered in the Danish National Patient Register[2] since 1977.
The total Charlson Comorbidity Index score was categorized in: 0 no comorbidity; 1-2 moderate comorbidity; and 3 or more as high/severe comorbidity.

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Appendix F. The full FADK questionnaire

Reproduced from: Horsager C, Østergaard SD, Lauritsen MB. The Food Addiction Denmark (FADK) Project: A combined survey- And register-based study. Acta Neuropsychiatrica. 2019;31(6):325-336. doi:10.1017/neu.2019.34

Supplementary material S1. The full FADK questionnaire in the English and the Danish language.

QUESTIONNAIRE ON EATING HABITS, ADULTS (Yale Food Addiction Scale 2.0)

This survey asks about your eating habits in the past year. People sometimes have difficulty controlling how much they eat of certain foods such as:

- Sweets like ice cream, chocolate, doughnuts, cookies, cake, candy
- Starches like white bread, rolls, pasta, and rice
- Salty snacks like chips, pretzels, and crackers
- Fatty foods like steak, bacon, hamburgers, cheeseburgers, pizza, and French fries
- Sugary drinks like soda pop, lemonade, sports drinks, and energy drinks

When the following questions ask about "CERTAIN FOODS" please think of ANY foods or beverages similar to those listed in the food or beverage groups above or ANY OTHER foods you have had difficulty with in the past year

IN THE PAST 12 MONTHS:		**Never**	**Less than monthly**	**Once a month**	**2-3 times a month**	**Once a week**	**2-3 times a week**	**4-6 times a week**	**Every Day**
1.	When I started to eat certain foods, I ate much more than planned.	0	1	2	3	4	5	6	7
2.	I continued to eat certain foods even though I was no longer hungry.	0	1	2	3	4	5	6	7
3.	I ate to the point where I felt physically ill	0	1	2	3	4	5	6	7
4.	I worried a lot about cutting down on certain types of food, but I ate them anyways.	0	1	2	3	4	5	6	7
5.	I spent a lot of time feeling sluggish or tired from overeating.	0	1	2	3	4	5	6	7
6.	I spent a lot of time eating certain foods throughout the day.	0	1	2	3	4	5	6	7
7.	When certain foods were not available, I went out of my way to get them. For example, I went to the store to get certain foods even though I had other things to eat at home.	0	1	2	3	4	5	6	7
8.	I ate certain foods so often or in such large amounts that I stopped doing other important things. These things may have been working or spending time with family or friends.	0	1	2	3	4	5	6	7
9.	I had problems with my family or friends because of how much I overate.	0	1	2	3	4	5	6	7
10.	I avoided work, school or social activities because I was afraid I would overeat there.	0	1	2	3	4	5	6	7
11.	When I cut down on or stopped eating certain foods, I felt	0	1	2	3	4	5	6	7

	irritable, nervous or sad.								
12.	If I had physical symptoms because I hadn't eaten certain foods, I would eat those foods to feel better.	0	1	2	3	4	5	6	7
13.	If I had emotional problems because I hadn't eaten certain foods, I would eat those foods to feel better.	0	1	2	3	4	5	6	7
14.	When I cut down on or stopped eating certain foods, I had physical symptoms. For example, I had headaches or fatigue.	0	1	2	3	4	5	6	7
15.	When I cut down or stopped eating certain foods, I had strong cravings for them.	0	1	2	3	4	5	6	7
16.	My eating behavior caused me a lot of distress.	0	1	2	3	4	5	6	7
17.	I had significant problems in my life because of food and eating. These may have been problems with my daily routine, work, school, friends, family, or health.	0	1	2	3	4	5	6	7
18.	I felt so bad about overeating that I didn't do other important things. These things may have been working or spending time with family or friends.	0	1	2	3	4	5	6	7
19.	My overeating got in the way of me taking care of my family or doing household chores.	0	1	2	3	4	5	6	7
20.	I avoided work, school or social functions because I could not eat certain foods there.	0	1	2	3	4	5	6	7
21.	I avoided social situations because people wouldn't approve of how much I ate.	0	1	2	3	4	5	6	7
22.	I kept eating in the same way even though my eating caused emotional problems.	0	1	2	3	4	5	6	7
23.	I kept eating the same way even though my eating caused physical problems.	0	1	2	3	4	5	6	7
24.	Eating the same amount of food did not give me as much enjoyment as it used to.	0	1	2	3	4	5	6	7
25.	I really wanted to cut down on or stop eating certain kinds of foods, but I just couldn't.	0	1	2	3	4	5	6	7
26.	I needed to eat more and more to get the feelings I wanted from eating. This included reducing negative emotions like sadness or increasing pleasure.	0	1	2	3	4	5	6	7
27.	I didn't do well at work or school because I was eating too much.	0	1	2	3	4	5	6	7
28.	I kept eating certain foods even though I knew it was physically dangerous. For example, I kept eating sweets even though I had diabetes. Or I kept eating fatty foods despite having heart disease.	0	1	2	3	4	5	6	7
29.	I had such strong urges to eat certain foods that I couldn't think of anything else.	0	1	2	3	4	5	6	7

30.	I had such intense cravings for certain foods that I felt like I had to eat them right away.	0	1	2	3	4	5	6	7
31.	I tried to cut down on or not eat certain kinds of food, but I wasn't successful.	0	1	2	3	4	5	6	7
32.	I tried and failed to cut down on or stop eating certain foods.	0	1	2	3	4	5	6	7
33.	I was so distracted by eating that I could have been hurt (e.g., when driving a car, crossing the street, operating machinery).	0	1	2	3	4	5	6	7
34.	I was so distracted by thinking about food that I could have been hurt (e.g., when driving a car, crossing the street, operating machinery).	0	1	2	3	4	5	6	7
35.	My friends or family were worried about how much I overate.	0	1	2	3	4	5	6	7

QUESTIONNAIRE ON WELL-BEING (WHO-5)

Please indicate for each of the five statements which is closest to how you have been feeling over the last two weeks.
Notice that higher numbers mean better well-being.
Example: If you have felt cheerful and in good spirits more than half of the time during the last two weeks, put a tick in the box with the number 3 in the upper right corner.

Over the last two weeks…	**All of the time**	**Most of the time**	**More than half of the time**	**Less than half of the time**	**Some of the time**	**At no time**
1. I have felt cheerful and in good spirits	5	4	3	2	1	0
2. I have felt calm and relaxed	5	4	3	2	1	0
3. I have felt active and vigorous	5	4	3	2	1	0
4. I woke up feeling fresh and rested	5	4	3	2	1	0
5. My daily life has been filled with things that interest me	5	4	3	2	1	0

QUESTIONNAIRE ON EATING (EDE-Q)

Instructions: The following questions are concerned with the past four weeks (28 days) only. Please read each question carefully. Please answer all the questions. Thank you.

Questions 1 to 12: Please circle the appropriate number on the right. Remember that the questions only refer to the past four weeks (28 days) only.

ON HOW MANY OF THE PAST 28 DAYS ...	**0 days**	**1-5 days**	**6-12 days**	**13-15 days**	**16-22 days**	**23-27 days**	**Every day**
1. Have you been deliberately trying to limit the amount of food you eat to influence your shape or weight (whether or not you have succeeded)?	0	1	2	3	4	5	6
2. Have you gone for long periods of time (8 waking hours or more) without eating anything at all in order to influence your shape or weight?	0	1	2	3	4	5	6
3. Have you tried to exclude from your diet any foods that you like in order to influence your shape or weight (whether or not you have succeeded)?	0	1	2	3	4	5	6
4. Have you tried to follow definite rules regarding your eating (for example, a calorie limit) in order to influence your shape or weight (whether or not you have succeeded)?	0	1	2	3	4	5	6
5. Have you had a definite desire to have an empty stomach with the aim of influencing your shape or weight?	0	1	2	3	4	5	6
6. Have you had a definite desire to have a totally flat stomach?	0	1	2	3	4	5	6
7. Has thinking about food, eating or calories made it very difficult to concentrate on things you are interested in (for example, working, following a conversation, or reading)?	0	1	2	3	4	5	6
8. Has thinking about shape or weight made it very difficult to concentrate on things you are interested in (for example, working, following a conversation, or reading)?	0	1	2	3	4	5	6
9. Have you had a definite fear of losing control over eating?	0	1	2	3	4	5	6
10. Have you had a definite fear that you might gain weight?	0	1	2	3	4	5	6
11. Have you felt fat?	0	1	2	3	4	5	6
12. Have you had a strong desire to lose weight?	0	1	2	3	4	5	6

Questions 13-18: Please fill in the appropriate number in the boxes on the right. Remember that the questions only refer to the past four weeks (28 days).

Over the past four weeks (28 days)….	**0 day/ times**	**1-5 days/ times**	**6-12 days/ times**	**13-15 days/ times**	**16-22 days/ times**	**23-27 days/ times**	**Every day**
13. Over the past 28 days, how many TIMES have you eaten what other people would regards as an unusually large amount of food (given the circumstances)?	0	1	2	3	4	5	6
14. … On how many of these TIMES did you have a sense of having lost control over your eating (at the time you were eating)?	0	1	2	3	4	5	6
15. Over the past 28 days, on how many DAYS have such episodes of overeating occurred (i.e. you have eaten an unusually large amount of food and have had a sense of loss of control at the time)?	0	1	2	3	4	5	6
16. Over the past 28 days, how many TIMES have you made yourself sick (vomit) as a means of controlling your shape or weight?	0	1	2	3	4	5	6
17. Over the past 28 days, how many TIMES have you taken laxatives as a means of controlling your shape or weight?	0	1	2	3	4	5	6
18. Over the past 28 days, how many TIMES have you exercised in a "driven" or "compulsive" way as a means of controlling your weight, shape or amount of fat, or to burn off calories?	0	1	2	3	4	5	6

Questions 19 to 21: Please circle the appropriate number. Please note that for these questions the term "binge eating" means eating what others would regard as an unusually large amount of food for the circumstances, accompanied by a sense of having lost control over eating.

Over the past four weeks (28 days)….	**0 days**	**1-5 days**	**6-12 days**	**13-15 days**	**16-22 days**	**23-27 days**	**Every day**
19. Over the past 28 days, on how many days have you eaten in secret (ie, furtively)? … Do not count episodes of binge eating.	0	1	2	3	4	5	6
	None of the times	**A few of the times**	**Less than half**	**Half of the times**	**More than half**	**Most of the time**	**Every time**
20. On what proportion of the times that you have eaten have you felt guilty (felt that you've done wrong) because of its effect on your shape or weight? … Do not count episodes of binge eating.	0	1	2	3	4	5	6

	Not at all	**Slightly**		**Moderately**		**Markedly**	
21. Over the past 28 days, how concerned have you been about other people seeing you eat? … Do not count episodes of binge eating.	0	1	2	3	4	5	6

Questions 22 to 28: Please circle the appropriate number on the right. Remember that the questions only refer to the past four weeks (28 days).

Over the past four weeks (28 days)….	**Not at all**	**Slightly**		**Moderately**		**Markedly**	
22. Has your weight influenced how you think about (judge) yourself as a person?	0	1	2	3	4	5	6
23. Has your shape influenced how you think about (judge) yourself as a person?	0	1	2	3	4	5	6
24. How much would it have upset you if you had been asked to weigh yourself once a week (no more, or less, often) for the next four weeks?	0	1	2	3	4	5	6
25. How dissatisfied have you been with your weight?	0	1	2	3	4	5	6
26. How dissatisfied have you been with your shape?	0	1	2	3	4	5	6
27. How uncomfortable have you felt seeing your body (for example, seeing your shape in the mirror, in a shop window reflection, while undressing or taking a bath or shower)?	0	1	2	3	4	5	6
28. How uncomfortable have you felt about others seeing your shape or figure (for example, in communal changing rooms, when swimming, or wearing tight clothes)?	0	1	2	3	4	5	6

What is your weight at present? (Please give your best estimate.)**:**.....

What is your height? (Please give your best estimate.)**:** .....

Age: .....

If female:
Have you missed any menstrual periods over the past three to four months? .....

If so, how many? .....
Have you been taking the "pill"? .....
Are you pregnant? .....
If so, which week of pregnancy are you in? .....

QUESTIONNAIRE ON MENTAL HEALTH (SCL-92)

Below is a list of problems and complaints that people sometimes have. Please read each one carefully and **enter the number** that best describes how much you were bothered by that problem during the past week.

Please enter only ONE.

FOR THE *PAST WEEK*, HOW MUCH WERE YOU BOTHERED BY:

		Not At All	A Little Bit	Moderately	Quite A Bit	Extremely
1	Nervousness or shakiness inside (#2)	0	1	2	3	4
2	Feeling critical of others (#6)	0	1	2	3	4
3	Trouble remembering things (#9)	0	1	2	3	4
4	Feeling easily annoyed or irritated (#11)	0	1	2	3	4
5	Feeling low in energy or slowed down (#14)	0	1	2	3	4
6	Poor appetite (#19)	0	1	2	3	4
7	Feeling shy or uneasy with the opposite sex (#21)	0	1	2	3	4
8	Suddenly scared for no reason (#23)	0	1	2	3	4
9	Temper outbursts that you could not control (#24)	0	1	2	3	4
10	Blaming yourself for things (#26)	0	1	2	3	4
11	Feeling blocked in getting things done (#28)	0	1	2	3	4
12	Feeling blue (#30)	0	1	2	3	4
13	Worrying too much about things (#31)	0	1	2	3	4
14	Feeling no interest in things (#32)	0	1	2	3	4
15	Your feelings being easily hurt (#34)	0	1	2	3	4

FOR THE *PAST WEEK*, HOW MUCH WERE YOU BOTHERED BY:

		Not At All	A Little Bit	Moderately	Quite A Bit	Extremely
16	Feeling others do not understand you or are unsympathetic (#36)	0	1	2	3	4
17	Feeling that people are unfriendly or dislike you (#37)	0	1	2	3	4
18	Feeling inferior to others (#41)	0	1	2	3	4
19	Having to check and double-check what you do (#45)	0	1	2	3	4
20	Having to avoid certain things, places, or activities because they frighten you (#50)	0	1	2	3	4
21	Trouble concentrating (#55)	0	1	2	3	4
22	Overeating (#60)	0	1	2	3	4
23	Feeling uneasy when people are watching or talking about you (#61)	0	1	2	3	4
24	Having to repeat the same actions such as touching, counting, washing (#65)	0	1	2	3	4
25	Sleep that is restless or disturbed (#66)	0	1	2	3	4
26	Feeling very self-conscious with others (#69)	0	1	2	3	4
27	Feeling everything is an effort (#71)	0	1	2	3	4
28	Spells of terror or panic (#72)	0	1	2	3	4
29	Feeling uncomfortable about eating or drinking in public (#73)	0	1	2	3	4
30	Feeling so restless you couldn't sit still (#78)	0	1	2	3	4

ALCOHOL HABITS (AUDIT)

Please circle the answer that is correct for you. If you do not drink alcohol, just circle *Never* in the first question.

	Never	**Monthly or less**	**2-4 times a month**	**2-3 times a week**	**4 or more times a week**
1. How often do you have a drink containing alcohol?	0	1	2	3	4

	1 or 2	**3 or 4**	**5 or 6**	**7 or 9**	**10 or more**
2. How many standard drinks containing alcohol do you have on a typical day when drinking?	0	1	2	3	4

	Never	**Less than monthly**	**Monthly**	**Weekly**	**Daily or almost daily**
3. How often do you have six or more drinks on one occasion?	0	1	2	3	4
4. During the past year, how often have you found that you were not able to stop drinking once you had started?	0	1	2	3	4
5. During the past year, how often have you failed to do what was normally expected of you because of drinking?	0	1	2	3	4
6. During the past year, how often have you needed a drink in the morning to get yourself going after a heavy drinking session?	0	1	2	3	4
7. During the past year, how often have you had a feeling of guilt or remorse after drinking?	0	1	2	3	4
8. During the past year, have you been unable to remember what happened the night before because you had been drinking?	0	1	2	3	4

	No	**Yes, but not in the past year**	**Yes, during the past year**
9. Have you or someone else been injured as a result of your drinking?	0	2	4
10. Has a relative or friend, doctor or other health worker been concerned about your drinking or suggested you cut down?	0	2	4

If you have any comments regarding the questionnaires, please write them here:

Thank you so much for participating!

Danish version of the full FADK questionnaire

SPØRGESKEMA OM SPISEVANER (Yale Food Addiction Scale 2.0)

Dette spørgeskema omhandler dine spisevaner gennem det seneste år. Folk har sommetider vanskeligt ved at kontrollere, hvor meget de spiser af bestemte madvarer som f.eks.:

-Søde sager som is, chokolade, doughnuts/wienerbrød, småkager, kage, slik
-Kulhydrater som hvidt brød, rundstykker/boller, pasta og ris
-Saltede snacks som chips, saltstænger og saltkiks
-Fed mad som bøf, bacon, hamburgere, cheeseburgere, pizza og pomfritter
-Sukkerholdige drikkevarer som sodavand, saftevand, sportsdrikke og energidrikke

Når de følgende spørgsmål spørger til "BESTEMTE MADVARER", bedes du tænke på HVILKEN SOM HELST type madvarer eller drikkevarer svarende til dem fra ovennævnte mad- og drikkevare grupper - eller HVILKEN SOM HELST ANDEN type mad, som du har haft problemer med gennem det seneste år.

I DE SENESTE 12 MÅNEDER	**Aldrig**	**Mindre end en gang om måneden**	**En gang om måneden**	**2-3 gange om måneden**	**En gang om ugen**	**2-3 gange om ugen**	**4-6 gange om ugen**	**Hver dag**
1. Når jeg begyndte at spise bestemte madvarer, spiste jeg meget mere end planlagt.	0	1	2	3	4	5	6	7
2. Jeg fortsatte med at spise bestemte madvarer, selvom jeg ikke længere var sulten.	0	1	2	3	4	5	6	7
3. Jeg spiste, indtil jeg blev fysisk dårlig.	0	1	2	3	4	5	6	7
4. Jeg tænkte meget på at skære ned på bestemte madvarer, men jeg spiste dem alligevel.	0	1	2	3	4	5	6	7
5. Jeg brugte meget tid på at føle mig sløv eller træt på grund af overspisningen.	0	1	2	3	4	5	6	7
6. Jeg brugte meget tid på at spise bestemte madvarer i løbet af dagen.	0	1	2	3	4	5	6	7
7. Når bestemte madvarer ikke var tilgængelige, gjorde jeg alt, hvad jeg kunne for at skaffe dem (for eksempel tog jeg på indkøb for at få bestemte madvarer, selvom jeg havde andet at spise derhjemme).	0	1	2	3	4	5	6	7
8. Jeg spiste bestemte madvarer så ofte eller i så store mængder, at jeg holdt op med at gøre andre vigtige ting (f.eks. at arbejde eller tilbringe tid med min familie eller mine venner).	0	1	2	3	4	5	6	7

I DE SENESTE 12 MÅNEDER	**Aldrig**	**Mindre end en gang om måneden**	**En gang om måneden**	**2-3 gange om måneden**	**En gang om ugen**	**2-3 gange om ugen**	**4-6 gange om ugen**	**Hver dag**
9. Jeg havde problemer med min familie eller mine venner på grund af overspisningen.	0	1	2	3	4	5	6	7
10. Jeg undgik arbejde, skole eller sociale aktiviteter, fordi jeg var bange for, at jeg ville overspise der.	0	1	2	3	4	5	6	7
11. Når jeg skar ned på eller holdt op med at spise bestemte madvarer, blev jeg irritabel, nervøs eller trist.	0	1	2	3	4	5	6	7
12. Hvis jeg havde fysiske symptomer, fordi jeg ikke havde spist bestemte madvarer, spiste jeg denne slags mad for at få det bedre.	0	1	2	3	4	5	6	7
13. Hvis jeg havde følelsesmæssige problemer, fordi jeg ikke havde spist bestemte madvarer, spiste jeg denne slags mad for at få det bedre.	0	1	2	3	4	5	6	7
14. Når jeg skar ned på eller holdt op med at spise bestemte madvarer, fik jeg fysiske symptomer (f.eks. hovedpine eller træthed).	0	1	2	3	4	5	6	7
15. Når jeg skar ned på eller holdt op med at spise bestemte madvarer, fik jeg en stærk trang til dem ("craving").	0	1	2	3	4	5	6	7
16. Mine spisevaner har givet mig mange bekymringer.	0	1	2	3	4	5	6	7
17. Jeg havde betydelige problemer i mit liv på grund af mad og spisning (f.eks. problemer med mine daglige gøremål, arbejde, skole, venner, familie eller helbred).	0	1	2	3	4	5	6	7
18. Jeg havde det så dårligt med overspisningen, at jeg ikke fik gjort andre vigtige ting (f.eks. at gå på arbejde eller tilbringe tid med min familie eller mine venner).	0	1	2	3	4	5	6	7
19. Min overspisning forhindrede mig i at tage mig af min familie eller udføre huslige pligter.	0	1	2	3	4	5	6	7

I DE SENESTE 12 MÅNEDER	**Aldrig**	**Mindre end en gang om måneden**	**En gang om måneden**	**2-3 gange om måneden**	**En gang om ugen**	**2-3 gange om ugen**	**4-6 gange om ugen**	**Hver dag**
20. Jeg undgik arbejde, skole eller sociale	0	1	2	3	4	5	6	7

arrangementer, fordi jeg ikke kunne spise bestemte madvarer der.								
21. Jeg undgik sociale situationer, fordi folk ikke ville synes om, at jeg spiste så meget.	0	1	2	3	4	5	6	7
22. Jeg fortsatte med at spise på samme måde, selvom min spisning gav mig følelsesmæssige problemer.	0	1	2	3	4	5	6	7
23. Jeg fortsatte med at spise på samme måde, selvom min spisning gav mig fysiske problemer.	0	1	2	3	4	5	6	7
24. Jeg opnåede ikke lige så stor nydelse ved at spise den samme mængde mad, som jeg plejede.	0	1	2	3	4	5	6	7
25. Jeg ville virkelig gerne skære ned på eller holde op med at spise bestemte madvarer, men jeg kunne bare ikke.	0	1	2	3	4	5	6	7
26. Jeg var nødt til at spise mere og mere for at få de følelser frem, som jeg ville opnå med spisningen (f.eks. at mindske negative følelser som tristhed eller øge følelsen af nydelse/velvære).	0	1	2	3	4	5	6	7
27. Jeg klarede mig ikke så godt på arbejdet eller i skolen, fordi jeg spiste for meget.	0	1	2	3	4	5	6	7
28. Jeg fortsatte med at spise bestemte madvarer, selvom jeg vidste, at det var fysisk skadelig (for eksempel fortsatte jeg med at spise søde sager, selvom jeg havde sukkersyge, eller jeg fortsatte med at spise fed mad, selvom jeg havde hjerte-kar-sygdom).	0	1	2	3	4	5	6	7
29. Jeg havde så stærk trang til at spise bestemte madvarer, at jeg ikke kunne tænke på noget andet.	0	1	2	3	4	5	6	7

I DE SENESTE 12 MÅNEDER	**Aldrig**	**Mindre end en gang om måneden**	**En gang om måneden**	**2-3 gange om måneden**	**En gang om ugen**	**2-3 gange om ugen**	**4-6 gange om ugen**	**Hver dag**
30. Jeg havde så intens trang (”craving”) til bestemte madvarer, at jeg følte, at jeg måtte spise dem med det samme.	0	1	2	3	4	5	6	7
31. Jeg forsøgte at skære ned på eller holde op med at spise bestemte madvarer, men det lykkedes ikke for mig.	0	1	2	3	4	5	6	7

32. Jeg forsøgte at skære ned på eller holde op med at spise bestemte madvarer, men jeg kunne ikke.	0	1	2	3	4	5	6	7
33. Jeg var så distraheret af at spise, at jeg kunne være kommet til skade (f.eks. når jeg kørte bil, gik over vejen, betjente maskiner).	0	1	2	3	4	5	6	7
34. Jeg var så distraheret af at tænke på mad, at jeg kunne være kommet til skade (f.eks. når jeg kørte bil, gik over vejen, betjente maskiner).	0	1	2	3	4	5	6	7
35. Mine venner eller min familie var bekymrede over, hvor meget jeg overspiste.	0	1	2	3	4	5	6	7

TRIVSEL (WHO-5)

Sæt venligst ved hvert af de 5 udsagn et kryds i det felt der kommer tættest på hvordan **du har følt dig i de seneste to uger.** Bemærk at et højere tal står for bedre trivsel.
Eksempel: Hvis du har følt dig glad og i godt humør i lidt mere end halvdelen af tiden i **de sidste to uger,** så sæt krydset i feltet med 3-tallet i øverste højre hjørne.

I DE SIDSTE 2 UGER…	**Hele tiden**	**Det meste af tiden**	**Lidt mere end halvdelen af tiden**	**Lidt mindre end halvdelen af tiden**	**Lidt af tiden**	**På intet tidspunkt**
1. .. har jeg været glad og i godt humør	5	4	3	2	1	0
2. .. har jeg følt mig rolig og afslappet	5	4	3	2	1	0
3. .. har jeg følt mig aktiv og energisk	5	4	3	2	1	0
4. .. er jeg vågnet frisk og udhvilet	5	4	3	2	1	0
5. .. har min dagligdag været fyldt med ting der interesserer mig	5	4	3	2	1	0

SPØRGESKEMA OM SPISNING (EDE-Q)

Vejledning: Nedenstående spørgsmål drejer sig kun om de sidste fire uger (28 dage). Læs venligst hvert spørgsmål omhyggeligt og vær venlig at besvare alle spørgsmål, tak.
Spørgsmål 1-12: Sæt venligst en cirkel om det nummer til højre, der passer. Husk at spørgsmålene kun drejer sig om **de sidste fire uger (28 dage)**

I hvor mange af de **sidste 28 dage**	**0 dage**	**1-5 dage**	**6-12 dage**	**13-15 dage**	**16-22 dage**	**23-27 dage**	**Hver dag**

I hvor mange af de **sidste 28 dage**	**0 dage**	**1-5 dage**	**6-12 dage**	**13-15 dage**	**16-22 dage**	**23-27 dage**	**Hver dag**
1. Har du bevidst forsøgt på at begrænse den mængde mad, du spiser, for at påvirke din figur eller vægt (uanset om det er lykkedes)?	0	1	2	3	4	5	6
2. Har du gået i lang tid (8 timer eller mere i vågen tilstand) uden at spise noget overhovedet for at påvirke din figur eller vægt?	0	1	2	3	4	5	6
3. Har du forsøgt at udelade nogle former for mad, som du kan lide, fra din kost for at påvirke din figur eller vægt (uanset om det er lykkedes)?	0	1	2	3	4	5	6
4. Har du forsøgt at følge klare regler med hensyn til din spisning (for eksempel en kaloriegrænse) for at påvirke din figur eller vægt (uanset om det er lykkedes)?	0	1	2	3	4	5	6
5. Har du haft et klart ønske om at have en tom mave med det formål at påvirke din figur eller vægt?	0	1	2	3	4	5	6
6. Har du haft et klart ønske om at have en fuldstændig flad mave?	0	1	2	3	4	5	6
7. Har det at tænke på mad, spisning eller kalorier gjort det meget vanskeligt at koncentrere dig om ting, du er interesseret i (for eksempel arbejde, at følge med i en samtale eller at læse)?	0	1	2	3	4	5	6
8. Har det at tænke på figur og vægt gjort det meget vanskeligt at koncentrere dig om ting, du er interesseret i (for eksempel arbejde, at følge med i en samtale eller at læse)?	0	1	2	3	4	5	6
9. Har du haft en klar frygt for at miste kontrol over at spise?	0	1	2	3	4	5	6
10. Har du haft en klar frygt for, at du kunne tage på i vægt?	0	1	2	3	4	5	6
11. Har du følt dig tyk?	0	1	2	3	4	5	6
12. Har du haft et stærkt ønske om at tabe dig?	0	1	2	3	4	5	6

Spørgsmål 13-18: Sæt venligst en cirkel om det nummer til højre, der passer. Husk at spørgsmålene kun drejer sig om de **sidste fire uger (28 dage).**

I hvor mange af de **sidste 28 dage**	**0 dage**	**1-5 dage**	**6-12 dage**	**13-15 dage**	**16-22 dage**	**23-27 dage**	**Hver dag**
13. Hvor mange gange i løbet af de sidste 28 dage har du spist hvad andre mennesker (efter omstændighederne) ville betragte som en usædvanlig stor mængde mad?	0	1	2	3	4	5	6

I hvor mange af de **sidste 28 dage**	**0 dage**	**1-5 dage**	**6-12 dage**	**13-15 dage**	**16-22 dage**	**23-27 dage**	**Hver dag**
14. ..... Hvor mange af disse gange har du haft en følelse af at have mistet kontrol over din spisning (på det tidspunkt, hvor du spiste)?	0	1	2	3	4	5	6
15. Hvor mange DAGE inden for de sidste 28 dage har der været sådanne episoder med overspisning (d.v.s. hvor du har spist en usædvanlig stor mængde mad og har haft en følelse af, at du på dette tidspunkt havde mistet kontrollen)	0	1	2	3	4	5	6
16. Hvor mange gange inden for de sidste 28 dage har du fremkaldt opkastning for at kontrollere din figur eller vægt?	0	1	2	3	4	5	6
17. Hvor mange gange inden for de sidste 28 dage har du taget afførringsmidler for at kontrollere din figur og vægt?	0	1	2	3	4	5	6
18. Hvor mange gange inden for de sidste 28 dage har du motioneret på en "tvangsmæssig" måde for at kontrollere din vægt, figur eller fedtmængde eller for at brænde kalorier af?	0	1	2	3	4	5	6

Spørgsmål 19-21: Sæt venligst en cirkel om det nummer til højre, der passer. Læg mærke til, at i disse spørgsmål betyder udtrykket "overspisning" at spise, hvad andre efter omstændighederne ville anse for en usædvanlig stor mængde mad, ledsaget af en følelse af at have tabt kontrollen over spisningen.

I hvor mange af de **sidste 28 dage**	**0 dage**	**1-5 dage**	**6-12 dage**	**13-15 dage**	**16-22 dage**	**23-27 dage**	**Hver dag**
19. Hvor mange dage har du inden for de sidste 28 dage spist i hemmelighed (d.v.s. i smug)? .... Overspisninger skal ikke tælles med	0	1	2	3	4	5	6
	Ingen af gangene	**Få af gangene**	**Mindre end halvdelen**	**Halvdelen af gangene**	**Mere end halvdelen**	**De fleste gange**	**Hver gang**
20. Hvor stor en del af de gange du har spist, har du følt dig skyldig (følt du har gjort noget forkert) på grund af virkningen heraf på din figur eller vægt .... Overspisninger skal ikke tælles med	0	1	2	3	4	5	6
	Slet ikke		**Kun lidt**		**Noget**		**Udpræget**
21. Hvor bekymret har du været inden for de sidste 28 dage over, at andre mennesker kunne se dig spise ... Overspisninger skal ikke tælles med	0	1	2	3	4	5	6

Spørgsmål 22-28: Sæt venligst en cirkel om det nummer til højre, der passer. Husk at spørgsmålene kun drejer sig om **de sidste fire uger (28 dage).**

I hvor mange af de **sidste 28 dage .....**	**Slet ikke**		**Kun lidt**		**Noget**		**Udpræget**
22. Har din vægt haft indflydelse på, hvordan du tænker på (bedømmer) dig selv som menneske?	0	1	2	3	4	5	6
23. Har din figur haft indflydelse på hvordan du tænker på (bedømmer) dig selv som menneske?	0	1	2	3	4	5	6
24. Hvor ubehageligt ville det have været for dig, hvis du var blevet bedt om at veje dig en gang om ugen (hverken mere eller mindre) i løbet af de næste 4 uger?	0	1	2	3	4	5	6
25. Hvor utilfreds har du været med din vægt?	0	1	2	3	4	5	6
26. Hvor utilfreds har du været med din figur?	0	1	2	3	4	5	6
27. Hvor utilpas har du følt dig, når du har set din krop (for eksempel når du har set din figur i spejlet, spejlet dig i en vinduesrude, mens du har klædt dig af, eller har taget et bad eller et styrtebad)?	0	1	2	3	4	5	6
28. Hvor utilpas har du følt dig ved, at andre ser din skikkelse eller figur (for eksempel i fælles omklædningsrum, til svømning, eller når du har haft tætsiddende tøj på)?	0	1	2	3	4	5	6

Hvad er din nuværende vægt? (angiv det venligst så tæt på som muligt) ……...

Hvad er din højde? (angiv det venligst så tæt på som muligt) ……

Alder: ……

Hvis du er af hunkøn:
Er der nogle menstruationer,
du ikke har haft i løbet af de sidste 3 til 4 måneder? ……
Hvis ja, hvor mange? ……

Har du taget p-piller? ……
Er du gravid? ……
Hvis ja, hvilken uge? ……

SPØRGESKEMA OM MENTAL OG FYSISK SUNDHED (SCL-92)

INSTRUKTION

Nedenfor er anført en række problemer og gener, som man undertiden kan have. Læs venligst hver enkelt grundigt. Når du har gjort det, bedes du venligst lave en cirkel om det nummer til højre, der bedst beskriver, **i hvor høj grad det pågældende problem har voldt dig ubehag i løbet af den sidste uge inklusiv i dag.** Lav kun én cirkel for hvert problem. Hvis du skifter mening, bedes du slette din første markering tydeligt.Det er af stor betydning, at du besvarer **alle** spørgsmålene.

I hvilken grad har du været plaget af:

		Slet ikke	**Lidt**	**Noget**	**En hel del**	**Særdeles meget**
1	Nervøsitet eller indre uro (#2)	0	1	2	3	4
2	At føle dig kritisk over for andre (#6)	0	1	2	3	4
3	Besvær med at huske (#9)	0	1	2	3	4
4	En følelse af, at du let bliver ærgerlig eller irriteret (#11)	0	1	2	3	4
5	En følelse af manglende energi eller af at være langsom (#14)	0	1	2	3	4
6	Manglende appetit (#19)	0	1	2	3	4
7	At føle dig generet eller usikker over for det modsatte køn (#21)	0	1	2	3	4
8	At du pludselig bliver bange uden grund (#23)	0	1	2	3	4
9	Vredesudbrud, som du ikke kan kontrollere (#24)	0	1	2	3	4
10	Selvbebrejdelser (#26)	0	1	2	3	4
11	En følelse af ikke at kunne overkomme noget (#28)	0	1	2	3	4
12	At føle dig nedtrykt (#30)	0	1	2	3	4
13	At bekymre dig for meget (#31)	0	1	2	3	4
14	At du ikke føler dig interesseret i noget (#32)	0	1	2	3	4
15	At du let bliver såret (#34)	0	1	2	3	4

I hvilken grad har du været plaget af:		**Slet ikke**	**Lidt**	**Noget**	**En hel del**	**Særdeles meget**
16	En følelse af, at andre ikke forstår dig eller er ufølsomme (#36)	0	1	2	3	4
17	En følelse af, at folk er uvenlige eller ikke kan lide dig (#37)	0	1	2	3	4
18	En følelse af mindreværd (#41)	0	1	2	3	4
19	At være nødt til at kontrollere alt, hvad du gør, igen og igen (#45)	0	1	2	3	4
20	At være nødt til at undgå visse ting, steder eller aktiviteter, fordi de skræmmer dig (#50)	0	1	2	3	4
21	At du har svært ved at koncentrere dig (#55)	0	1	2	3	4
22	At du spiser for meget (#60)	0	1	2	3	4
23	At du føler dig usikker, når folk iagttager dig eller taler om dig (#61)	0	1	2	3	4
24	At du er nødt til at gentage de samme handlinger, f.eks. vaske eller tælle (#65)	0	1	2	3	4
25	Hvileløs eller urolig søvn (#66)	0	1	2	3	4
26	At være meget genert over for andre (#69)	0	1	2	3	4
27	En følelse af, at alting er anstrengende (#71)	0	1	2	3	4
28	Anfald af rædsel eller panik (#72)	0	1	2	3	4
29	En følelse af ubehag ved at spise eller drikke i andres påsyn (#73)	0	1	2	3	4
30	At du føler dig rastløs, at du ikke kan sidde stille (#78)	0	1	2	3	4

ALKOHOLVANER (AUDIT)
I det følgende spørges der ind til dine alkoholvaner. Sæt venligst cirkel om det svar, som passer bedst.
Hvis du slet ikke drikker alkohol, svarer du bare aldrig til første spørgsmål.

	Aldrig	**Højest én gang om måneden**	**2-4 gange om måneden**	**2-3 gange om ugen**	**4 gange om ugen eller oftere**
1. Hvor tit drikker du noget, der indeholder alkohol?	0	1	2	3	4

	1-2 genstande	**3-4 genstande**	**5-6 genstande**	**7-9 genstande**	**10 eller flere genstande**
2. Hvor mange genstande drikker du almindeligvis, når du drikker noget?	0	1	2	3	4

	Aldrig	**Sjældent**	**Månedligt**	**Ugentligt**	**Dagligt eller næsten dagligt**
3. Hvor tit drikker du fem genstande eller flere ved samme lejlighed?	0	1	2	3	4
4. Har du inden for det seneste år oplevet, at du ikke kunne stoppe, når du først var begyndt at drikke?	0	1	2	3	4
5. Har du inden for det seneste år oplevet, at du ikke kunne gøre det, du skulle, fordi du havde drukket?	0	1	2	3	4
6. Har du inden for det seneste år måttet have en lille én om morgenen, efter at du havde drukket meget dagen før?	0	1	2	3	4
7. Har du inden for det seneste år haft dårlig samvittighed eller fortrudt, efter du har drukket?	0	1	2	3	4
8. Har du inden for det seneste år oplevet, at du ikke kunne huske, hvad der skete aftenen før, fordi du havde drukket?	0	1	2	3	4

	Nej	Ja, men ikke inden for det seneste år	Ja, inden for det seneste år
9. Er du selv eller andre nogensinde kommet til skade ved en ulykke, fordi du havde drukket?	0	2	4
10. Har nogen i familien, en ven, en læge eller andre været bekymret over dine alkoholvaner eller foreslået dig at sætte forbruget ned?	0	2	4

Hvis du har kommentarer til undersøgelsen eller noget du gerne vil uddybe, er du meget velkommen til at gøre det her:

_____

_____

_____

_____

_____

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Tusind tak for din besvarelse!

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