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FOOD ADDICTION (E SCHULTE)

Defining Risky Use in the Context of Food Addiction

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Abstract

Purpose of Review This narrative review examined literature on the risky use diagnostic criteria for substance use disorders as applied to ultra-processed food addiction. Empirical research on the rates of risky use in humans and evidence from animal models are reviewed. Theoretical considerations for conceptualizing the risky use criteria in food addiction and areas for future research are also discussed.

Recent Findings Rates of risky use, based on the Yale Food Addiction Scale, are heterogenous across studies, though elevated in clinical samples with disordered eating. Issues regarding operational definitions of risky use may lead to elevated rates, and variability in interpretation of the hazardous use criteria. Animal models suggest that under highly controlled conditions, behaviors indicative of risky use can be observed, yet may lack generalizability to humans.

Summary Future work, which examines the clinical utility and diagnostic value of the risky use criterion for ultra-processed food addiction, is warranted.

Keywords Food addiction · Eating disorders · Obesity · DSM-5

Introduction

Overconsumption of food, like drugs and alcohol, is linked to medical disease, functional impairment, and psychological distress [1, 2]. Research indicates that overconsumption of food can present in several clinically distinct ways, including food addiction. The construct of food addiction proposes that some people may experience addictive-like eating, particularly when consuming ultra-processed food (i.e., foods with added fats and/or refined carbohydrates) [3]. Food addiction is most often conceptualized as a type of substance-related and other addictive disorders (SRAD) [4], and involves symptoms observed in substance use disorders including risky use.

Risky use refers to recurrent use of the substance in situations that are physically hazardous or continued use of the substance despite having physical and psychological consequences because of the substance. Risky use has been well characterized in disorders such as alcohol use disorder, where driving under the influence and continued use despite alcohol-associated medical comorbidities (e.g., cirrhosis, pancreatitis) is prominent [5]. National data indicate that 6.1% of people who drink alcohol report use that is physically hazardous and 2.8% report continued use despite the psychological and physical consequences [6]. The same study showed that these criteria, particularly continued use despite consequences, were effective at discriminating between those who do and do not have an alcohol use disorder.

Risky use is less well characterized and understood in food addiction. In fact, some have argued that the "use in physically hazardous situations" criteria in particular may not apply to food consumption and might be unique to drug and alcohol use [7], particularly as eating food does not involve intoxication as with alcohol and most, but not all (i.e., tobacco), drugs of abuse [4, 8]. Those critical of the food addiction diagnosis argue that utilizing the identical criteria for SRAD and translating specifically for ultra-processed foods is inappropriate [9]. Research on clinical comparisons including human and animal model research has widely been reviewed with respect to diagnostic criteria such as tolerance and withdrawal. Importantly, the prevalence,

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clinical features, and outcomes associated with risky use among people with food addiction and animal models have not been evaluated.

Aims

In the following narrative review, we aimed to review the recent (i.e., primarily within the past five years) and relevant literature on the risky use diagnostic criteria for substance use disorders as applied to ultra-processed food addiction. We conducted a search of peer-reviewed publications in PubMed and PsyINFO focusing on recent papers published within the past 5 years. Papers were included if they were written in English; books were excluded from search results. With regard to specific aims, first, we will review empirical research evaluating the rates of risky use criteria using the Yale Food Addiction Scale (YFAS) [10] and associated features in humans. Next, we will discuss evidence of the risky use criterion based on animal models. Finally, we will highlight theoretical considerations for the risky use criteria as applied to ultra-processed food addiction and discuss potential future directions for study.

Human Literature

Food addiction among humans has primarily been examined using the YFAS [10, 11], which is a standardized self-report measure assessing symptoms of addictive-like eating, with respect to ultra-processed foods. The most recent version of the YFAS (i.e., YFAS 2.0) [10] is based on the criteria for SRAD from the Diagnostic and Statistical Manual for Mental Disorders Fifth Edition (*DSM-5*); however, food addiction is not a formally recognized diagnosis within any diagnostic classification system. Other measures of food addiction using alternative models have more recently been developed, such as the Addiction-like Eating Behaviour Scale [12]; however, the YFAS 2.0 is the most widely used. Several meta-analyses have identified that the prevalence of food addiction in the general population based on the YFAS 2.0 is approximately 20% [13, 14].

The YFAS 2.0 is composed of 35 items, five of which assess the risky use criterion, consistent with the *DSM-5* definition for SRAD, within the following two domains: (1) use continues despite knowledge of adverse consequences (e.g., emotional problems, physical problems) and (2) use in physically hazardous situations. The specific items from the YFAS 2.0 evaluating these domains are included in Table 1. Risky use despite adverse consequences is defined by the behavior of eating ultra-processed foods despite emotional and/or physical problems caused or made worse by the consumption. Risky use in physically hazardous situations is defined by the consumption of ultra-processed foods despite having health-related complications such as diabetes, or heart disease, in addition to the possibility of experiencing injury while distracted by eating (e.g., driving a car), or while distracted by thoughts about food. Each item on the YFAS has a unique frequency threshold to determine whether the item is considered positive, which were developed using receiver operator characteristic curves. An individual is thought to be experiencing a specific symptom if one or more of the items is positively endorsed at the threshold frequency and the clinical threshold for each domain is met if one or more of the items are endorsed. In the original validation study of the YFAS 2.0, both risky use criterion had factor loadings above 0.71 [10].

Rates of endorsement for risky use symptoms, based on the YFAS 2.0, are highly heterogenous across studies. Table 2 includes a representative sample of studies examining both risky use criteria. The majority of studies have evaluated the risky use within non-clinical/population or convenience samples [10, 15–17, 18•, 19–26]. Rates of endorsement within these studies range from 5 to 24% for physical/emotional consequences and 4 to 25% for physically hazardous situations, with the highest rates documented in the original validation paper [10]. While few

Table 1 Items assessing risky use from the Yale Food Addiction Scale 2.0

	Use Continues Despite knowledge of adverse consequences
Item 22	*"I kept eating in the same way even though my eating caused emotional problems"*
Item 23	*"I kept eating the same way even though my eating caused physical problems"*
	Use in physically hazardous situations
Item 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"*
Item 33	*"I was so distracted by eating that I could have been hurt (e.g., when driving a car, crossing the street, operating heavy machinery)"*
Item 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 heavy machinery"*

Original table with information included in the table obtained from the Yale Food Addiction Scale 2.0 [12]. Thresholds for each items: item 22 = at least once per week, item 23 = at least 2–3 times per week; item 28 = at least once per week; item 33 = at least once per month; item 34 = at least 2–3 times per month

Table 2 Endorsement of risky use on the Yale Food Addiction Scale 2.0

Author	Sample	Use despite physical/emotional consequences (% yes)	Use in physically hazardous situations (% yes)
Nonclinical, population representative samples			
Aloi et al. 2017 [15]	Undergraduate students ($N=574$)	5.2%	4%
Brunault et al. 2020 [16]	Non-clinical sample from the community ($N=250$)	8.0%	7.6%
Gonçalves et al. 2022 [17]	Female college students in Portugal ($N=302$)	8.6%	10.9%
Gearhardt et al. 2016 [10]	Amazon Mechanical Turk ($N=536$)	23.5%	24.8%
Granero et al. 2018 [18•]	Healthy controls from the general population ($n=152$)	5.3%	7.2%
Hauck et al. 2017 [19]	General population from Germany ($N=1,034$)	12.7%	18.3%
	Participants from total sample with FA ($n=82$)	76.9%	68.3%
	Participants from total sample without FA ($n=52$)	7.1%	14%
Horsager et al. 2020 [20]	Community sample of people in Denmark ($N=1,436$)	8.9%	8.5%
Khine et al. 2019 [21]	Undergraduate students in Japan ($N=752$)	6.2%	5.7%
Manzoni et al. 2021 [22]	General population in Italy ($N=304$)	9.54%	6.91%
Meule et al. 2017 [23]	Online recruited sample ($N=617$)	13.8%	5.1%
Romero-Blanco et al. 2021 [24]	University students ($N=536$)		
	No food addiction	5%	6.6%
	Mild food addiction	22.2%	0%
	Moderate food addiction	40%	10%
	Severe food addiction	71.5%	57.1%
Rostanzo et al. 2022 [25]	Online recruited sample in Italy ($N=156$)	17.6%	13.5%
	Males ($n=46$)	10.9%	8.7%
	Females ($n=102$)	20.6%	15.7%
Swarna Nantha et al. 2020 [26]	Primary care patients in Malaysia ($N=358$)	9.2%	13.7%
Eating disorder samples			
Granero et al. 2018 [18•]	Patients with eating disorders ($n=135$)	66.7%	58.5%
	Patients with gambling disorder ($n=166$)	12%	7.8%
Linardon et al. 2019 [27]	Online recruited sample with probable BED ($N=302$)	50%	19.5%
Tran et al. 2020 [28]	Patients with AN	50%	Not reported
Obesity and bariatric samples			
Manzoni et al. 2021 [22]	Individuals with obesity receiving inpatient treatment ($N=400$)	30.75%	28.75%
Meule et al. 2017 [23]	Bariatric surgery candidates ($N=138$)	37.6%	28.6%

studies have conducted statistical comparisons, endorsement of risky use appears higher among individuals meeting the clinical threshold, or food addiction "diagnosis," and those with greater severity of food addiction [19], than those without food addiction [19, 24]. Similarly, consistent with the greater literature on food addiction, one study documented that women appear to endorse risky use at double the rate of men [25].

Fewer studies have specifically evaluated risky use within clinical samples, such as patients with eating disorders [18•, 27, 28], bariatric surgery candidates [23], or those with obesity [22]. Endorsement of risky use appears consistently higher in the few studies that have evaluated symptoms of food addiction in patients with eating disorders, which aligns with the overall literature on food addiction and eating disorders [29]. For instance, 50% of patients with anorexia nervosa [28] and binge-eating disorder [27] endorsed use despite physical/emotional consequences, and approximately 59% of patients treated for an eating disorders reported use within hazardous situation [18•]. Notably, Granero and colleagues (2018) compared patients receiving inpatient treatment for eating disorders, patients treated for gambling disorder, and a non-clinical sample, and found significant differences in use within physically hazardous situations [18•]. Patients with eating disorders were significantly more likely to report use in physically hazardous situations as compared to the non-clinical sample and the gambling sample. There were no differences when comparing the gambling sample and the non-clinical group. Significant differences between all groups were found when evaluating use despite physical/emotional consequences, with the highest endorsement found in those treated for eating disorders (approximately 67%). We are unaware of any other studies

evaluating differences in symptom endorsement among clinical subgroups. Rates of risky use appear relatively higher among patients with obesity [22], and bariatric surgery candidates [23], than the general population, though lower than those with eating disorders (see Table 2).

Taken together, the majority of data on clinical presentations of risky use within humans has been primarily been examined using the YFAS. Although the rate of endorsement for risky use is heterogeneous, it is certainly higher for ultra-processed food addiction (i.e., approximately 4–59% for hazardous use, and 5–67% for continued use despite consequences), in comparison of the national data on alcohol use (i.e., 6.1% and 2.8% for hazardous use, and continued use despite consequences, respectively) [6]. Rates of endorsement are indeed higher within clinical samples, including patients diagnosed with eating disorders, obesity, and bariatric surgery candidates than non-clinical samples, which is consistent with the broader literature on food addiction within clinical samples.

Animal Literature

Several paradigms have been used with animal models to study "risky use," defined in these studies as use despite negative consequences (i.e., use that has become punishment resistant). The most widely used of these has been a shock paradigm, which tests whether an animal will continue to seek a substance if doing so yields an electric shock that causes physical discomfort; other work has tested bitter tastes or gastrointestinal discomfort as punishers associated with the addictive substance. Consistently, studies have shown that, provided the reward from the substance is high enough and the physical discomfort is low enough, drug-seeking behavior can become punishment resistant among animal models bred for addiction-proneness [30].

Studies of addictive behavior with highly palatable food have similarly shown that animal models bred for "binge-proneness" will endure greater physical discomfort to retrieve highly palatable foods compared to those without binge-proneness. Recent studies have observed that rats with greater binge-proneness endure greater shocks [31] and ingest more of a highly palatable food that caused gastrointestinal discomfort compared to rats with lower binge proneness [32]. The latter of these paradigms mirrors what many patients experience during binge-eating (e.g., eating until uncomfortably full) or during other maladaptive eating episodes. Reviews of the preclinical data have suggested that prolonged exposure to highly palatable foods in susceptible animals may lead to overactivation of reward pathways and a weakening in top-down regulatory control pathways, yielding punishment resistance to highly palatable foods similar to what is observed in drug use [33]. However, equally important to note are the differences in food environment during these tightly controlled trials compared to the (often) overabundance of highly palatable foods that humans experience. It has been noted that many studies which breed and induce "binge-proneness" in rodents do so, in part, by offering high-fat and sugar foods only intermittently, and only under such conditions are the putative neurobiological mechanisms of addiction activated [34]. Given that human environments rarely have the same intermittent availability that precedes the observed risky use in animal models, translating these results to humans is complicated.

Clinically, some patients describe consuming foods that cause discomfort (e.g., individuals with Celiac disease consuming gluten, individuals who have undergone Roux-en-Y surgery and consuming sugar causing dumping syndrome) or that otherwise induce a disgust response (e.g., retrieving foods previously thrown away) during binge-eating episodes. Whether such behaviors and associated consequences mirror the persistent use observed in animal studies is unclear. Moreover, because food does not cause the same perceptual changes and associated danger as some substances do, nor does it have many of the same inherent punishers (e.g., legal problems stemming from the substance itself or engaging in substance use during certain activities), "risky use" may be observably different in humans when discussing food versus substances. However, evidence from animal models suggests that the reward obtained from highly palatable foods is strong enough to elicit continued use despite punishment just as substances might.

Theoretical Considerations and Future Directions

Although the validity of the food addiction construct has been keenly debated, often with specific attention directed to criteria such as tolerance and withdrawal as applied to ultra-processed food, there is relatively little focus on the specific risky use criteria. We will next highlight some of the theoretical considerations based on human and animal data reviewed, highlighting alternative theoretical models of food addiction, and areas for future research.

The development of Non-Substance-Related Disorders within the category of SRAD, as well as the addition of the term "addictive disorder," represented a significant paradigm shift within the *DSM-5*. During the development of the *DSM-5*, the SRAD workgroup examined data on behavioral, or non-substance addictions including eating, Internet gaming, Internet use broadly, shopping, sex, exercise, tanning, and gambling. The workgroup concluded gambling should be conceptualized in the *DSM-5* as an addiction as there was sufficient evidence based on neurobiological and genetic data [35] leading to the reclassification of problematic

gambling from the Impulsive-Control Disorders section of the *DSM-IV-TR* to the SRAD section. Thus, gambling disorder was characterized as the first non-substance addiction within the *DSM-5*. Ultimately, the SRAD workgroup determined there was insufficient evidence for the inclusion of eating as a behavioral or non-substance addiction, which may be due to the controversial nature of food addiction and the relatively limited neurobiological data available at that time [35]. Moreover, the workgroup concluded that "eating" as an addiction may share more similarities to eating disorders, than substance addiction [35].

As previously discussed, the assessment of food addiction based on the YFAS directly parallel the criteria of substance use disorders; advocates for the food addiction (as opposed to the "eating addiction") orientation argue that food is best conceptualized using the criteria for substance use, rather than the criteria for a feeding and eating disorder. However, the nuanced differences in diagnostic criteria for certain SRADs, including gambling disorder, are worth highlighting. Some SRAD symptoms are less salient with respect to certain substances, and in other cases do not apply at all (e.g., withdrawal symptoms for inhalant use disorder) [36]. In the case of gambling disorder, several of the diagnostic criteria for Gambling Disorder differ significantly from the 11 substance use criteria in the *DSM-5*, for instance, the inclusion "chasing losses" and "bailout behavior," or turning to friends and family members for financial help caused by gambling [36]. Caffeine-related disorders are the only substance-related addictive disorder that do not include either of the risky use criterion, perhaps due to the lack of relevancy of this criterion in these conditions. Further, the assessment of use in physically hazardous situations with respect to tobacco use (i.e., smoking in bed, increasing the risk of a fire) differs significantly from the assessment of other substance use disorders which require intoxication from the substance (e.g., driving an automobile or swimming while intoxicated), given that tobacco intoxication is rare [36]. These examples highlight that the 11 SRAD criteria are not universally applied across several current *DSM-5* diagnoses. It is possible that the syndrome model of addiction [37], which is a theoretical approach that highlights shared manifestations across different expressions of addictions and unique manifestations and sequelae with respect to the type of addiction (e.g., liver cirrhosis in alcohol use, significant debt in gambling), may provide a useful alternative conceptualization to the continued narrow focus on the "addictive" nature of specific chemicals in the context of food.

Ultra-processed foods do not cause intoxication and in fact the concept of food addiction has previously been criticized for the inherent lack of an established "addictive" chemical or substance [38••]. Like the assessment of tobacco use, items on the YFAS assessing hazardous use do not directly parallel criteria from most SRADs as no proxy of intoxication is drawn. Instead, items on the YFAS emphasize the role of thoughts related to ultra-processed foods, or the act of eating itself as causing a distraction, and thus increasing the risk of harm (e.g., eating while driving a car), or the physically dangerous effects of eating ultra-processed foods while having certain medical conditions (e.g., diabetes, heart disease). Meule et al. (2014) highlight that eating while driving has been documented to impair driving and increase risk for accidents [8], yet thus far and to our knowledge, no studies have examined whether those with a food addiction diagnosis actually engage more often in such behaviors like eating while driving. Further, research has not examined whether individuals who eat while driving are also more likely to engage in other risky or unsafe behavior such as texting while driving or use of substances while driving that could also contribute to increasing accident risk.

The argument in favor of the hazardous use criteria could be considered plausible with respect to certain health conditions [8]. It has been suggested that eating ultra-processed foods in certain contexts might be considered physically dangerous (e.g., eating sugary foods despite having diabetes, fatty foods despite having heart disease), which may lend support for the inclusion of the hazardous use criteria [8]. On the other hand, several researchers have strongly argued that the hazardous use criterion does not apply to food [7, 9]. Chronic conditions, such as diabetes and heart disease, are the typical examples used to describe how the hazardous use criterion can be applied to food addiction; however, the timeframe and context of these health conditions is an important consideration. In terms of substance use, there is a relatively acute and reliably consistent onset of substance intoxication that can occur very rapidly; thus, recurrent use of a substance in situations that are physically hazardous (e.g., using alcohol while driving) carry greater mortality and morbidity risk towards self and others. In contrast, the clinical presentation of chronic health conditions when assessing food addiction (e.g., diabetes, heart disease) varies considerably and is multidetermined [9], with more severe complications often taking years to present, and importantly is not solely influenced by the presence or absence of ultra-processed foods in one's diet. For example, an individual with poorly managed cardiac disease could feasibly continue to consume ultra-processed foods and suffer from addictive-like eating without experiencing cardiac complications. In fact, a recent study documented that food addiction among those with obesity was not associated with obesity-related complications (e.g., type 2 diabetes, hypertension, metabolic syndrome) [39]. We are unaware of any studies to date which have examined whether those with chronic health conditions who experience food addiction endorse higher rates of the risky use criteria as compared to those without.

Similarly, the operational definition for continued use of ultra-palatable foods or continued eating in the same

way despite emotional and physical adverse consequences using the YFAS has several limitations. The items from the YFAS assessing these features do not provide examples of emotional and physical consequences, and thus are open to interpretation. Some may interpret these items in a way that more closely parallels the feelings of disgust, depression, or guilt and marked distress associated with binge-eating disorder rather than food addiction [36]. Others may interpret these items as reflecting the consequences of weight gain as opposed to an acute hazardous effect, as with drugs and alcohol (e.g., severe mood changes associated with substance use). Subjectivity in interpreting items on the YFAS has been theorized as possibly leading to elevated rates of the food addiction diagnosis [40], and elevated rates have been documented across certain weight categories including underweight participants [41], and those diagnosed with anorexia nervosa [18•]. Overall, it remains unclear if the risk level for the SRAD criterion aligns with food addiction in a clinically meaningful way.

There are several limitations worth highlighting based on the available data. First, few studies have reported the rates of risky use, and statistical comparisons between groups are rarely conducted. Second, most studies which do report rates of risky use are obtained from convenience samples, such as undergraduate students or online recruited samples, which limit generalizability. Animal models may lack generalizability to humans, and have been developed based on paradigms of scarcity, whereas the food environment for humans is rich and abundant in the availability of ultra-processed foods. Finally, to date, the YFAS remains the primary method of assessing food addiction, relies on self-report data, and offers limited guidance for the operational definition of the physical or emotional consequences of eating, possibility leading to variability in interpretation of the hazardous use items.

To address these limitations, we propose the following avenues for further research. To date, there are no validated structured or semi-structured clinical interviews assessing food addiction [40]. Development of a rigorous structured or semi-structured clinical interview to assess food addiction via clinician informed diagnosis, rather than solely relying on self-report questionnaires, would likely mitigate the potential for misinterpretation and elevated rates of food addiction, or false positive diagnosis. Data from other established self-report measures of eating pathology, such as the Eating Disorder Examination, suggest inflated rates of reporting on self-report when comparing clinician interview, and low agreement between these assessment methods [42].

Qualitative methodology could also help ascertain how SRAD criterion may map on the experience of patient-reported food addiction and the incremental clinical utility of such criteria beyond already-established eating disorders. Some qualitative reports suggest the addiction-based approach may be beneficial for those participating in Overeaters Anonymous, in contrast to the focus on specific eating disorders [43]. However, little is known regarding the clinical utility of the risky use criteria, specifically. One recent study used qualitative analysis and interviewed participants meeting criteria for food addiction on the YFAS 2.0 and found support for endorsement of the risky use criterion [44••]; however, participants were directly primed to reflect on how the specific items might relate to their experience, and in terms of hazardous use only one person indicated that preoccupation with food might have resulted in an accident (but did not have direct experience with it). In other qualitative studies, risky use was not a theme endorsed among participants. Ruddock and colleagues (2017) developed the Addiction-like Eating Behavior Scale (AEBS) and their approach to item development included use of qualitative thematic analysis to establish the six domains identified those endorsing self-perceived food addiction [12]; notably, risky use was not among the domains identified [12], and similar qualitative work have not identified hazardous use in definitions of addictive-like eating described among patients [45]. Contrary to the substance use conceptualization of food addiction (or food as the substance) is the argument that food addiction should be conceptualized as a behavioral addiction, or "eating addiction" [9]. This perspective suggests that an addiction to eating may occur due to an increased responsibility to reward-related cues, and a diminished ability to exert inhibitory control [12], rather than the assumption that certain food have addictive-like properties. Relatively fewer studies, however, have investigated alternative measures, such as the AEBS, when compared to the rapid increase in publications on the YFAS during the past two decades.

Additionally, studies using ecological momentary assessment could examine behavioral patterns and emotional and physical consequences related to addictive eating as captured with in the moment assessment. This innovative methodology has been utilized in the study of both addiction and binge-eating disorder, and may have utility in understanding temporal associations between distal and proximal factors of emotional problems caused by eating ultra-processed foods and hazardous use (e.g., driving a car, crossing the street, operating heavy machinery while eating).

Conclusions

Based on literature reviewed, future research is warranted to examine the clinical utility and the diagnostic value of the risky use SRAD criterion, as applied to ultra-processed food addiction. Within human studies, heterogenous rates of risky use have been found, with elevated rates of risky use found in those with disordered eating. Studies of rodent models support that under tightly controlled conditions, behavior

mirroring risky substance use can be observed; however, it is difficult to extrapolate these results to humans whose food-rich environment is anything but tightly controlled. Many questions regarding the clinical utility of risky use criteria remain, including whether the SRAD YFAS-defined risky use criteria effectively discriminate those with and without food addiction. Future work which aids in resolving the continued controversy of whether food addiction warrants a clinical diagnosis is warranted.

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Declarations

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

Conflict of Interest The authors declare no competing interests.

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• Of importance
•• Of major importance

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