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Calorie intake and gambling: is fat and sugar consumption 'impulsive'?

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Abstract

Background: Excessive calorie intake constitutes a global public health concern, due to its associated range of untoward outcomes. Gambling is commonplace and gambling disorder is now considered a behavioral addiction in DSM-5. The relationships between calorie intake, gambling, and other types of putatively addictive and impulsive behaviors have received virtually no research attention.

Methods: Two-hundred twenty-five young adults who gamble were recruited from two Mid-Western university communities in the United States using media advertisements. Dietary intake over the preceding year was quantified using the Dietary Fat and Free Sugar Short questionnaire (DFS). Clinician rating scales, questionnaires, and cognitive tests germane to impulsivity were completed. Relationships between dietary fat/sugar intake and gambling behaviors, as well as other measures of psychopathology and cognition germane to addiction, were evaluated using correlational analyses controlling for multiple comparisons.

Results: Greater dietary fat and sugar intake were associated with lower educational levels and with male gender. Controlling for these variables, higher dietary fat and sugar intake were correlated significantly with worse gambling pathology and anxiety scores. Dietary sugar intake was also significantly associated with higher depressive scores, more alcohol intake, lower self-esteem, and with greater risk of having one or more mental disorders in general. Dietary intake did not correlate significantly with ADHD symptoms, presence of one or more impulse control disorders, Barratt impulsiveness, or cognitive functioning.

Conclusions: These data suggest a particularly strong relationship between fat/sugar intake and symptoms of gambling pathology, but not most other forms of impulsivity and behavioral addiction (excepting alcohol intake). Providing education about healthy diet may be especially valuable in gamblers and in community settings where gambling advertisements feature prominently. Future work should explore the mediating mechanisms between calorie intake and gambling symptoms, such as whether this could be driven by environmental factors (e.g. advertising) or common dysfunction of brain reward pathways.

Key words: impulsivity, compulsivity, gambling, fat, sugar, diet, nutrition, calorie, calories.

Introduction

Young adulthood is a developmental period frequently associated with occurrence of impulsive behaviors including gambling, alcohol abuse, illegal drug use, and risky sexual behavior (Chambers & Potenza, 2003; Scott et al., 2011; Stone et al., 2012; Casey, 2015). Gambling behaviors exist along a continuum, from occasional recreational gambling with minimal negative functional consequences; through to formal gambling disorder, recognized in the Diagnostic and Statistical Manual (DSM-5, APA, 2013) as a Substance-Related and Addictive Disorder, which is associated with a range of deleterious outcomes (Grant et al., 2016). Research indicates that up to 9% of young people experience problems related to gambling, a rate that is considerably higher than that observed in older adults (Barnes et al., 2010). Peer group influences, genetics, brain development, and life transitions have all been studied as elements contributing to the elevated rates of gambling and other impulsive behaviors in this age group (Chambers & Potenza, 2003; Quinn et al., 2011).

Broadly speaking, impulsivity refers to behaviors or acts that are inappropriate, unduly hasty, or risky, often leading to untoward longer-term outcomes (Daruna & Barnes, 1993). While high calorie intake has been linked with untoward outcomes such as high rates of psychiatric disorders and decreased perceived quality of life (World Health Organization, 2012; Baskin et al., 2015; Rasheed & Woods, 2013; Imamora et al., 2016; Rouhani et al., 2016; Zhao et al., 2016; Gallagher et al., 2016), the interplay between diet and gambling behaviors has received next to no research attention. In previous work in 511 young adults, we found that obese people (10.8% of the sample) exhibited higher rates of problem gambling, and more impulsive neuropsychological performance on cognitive tasks (worse response inhibition and decision-making) as compared to normal weight individuals (Chamberlain et al., 2015). Calorie intake was not assessed.

There is some other research to suggest that poor diet and/or high calorie intake is associated with other types of impulsive behaviors besides gambling. Impulsive individuals tend to consume more fast foods, takeaways, convenience meals, salted snacks and use of ready-made sauces and mixes than healthy eaters (Sarmugam and Worsley, 2015). Disinhibition, measured using a child report version of the Temperament in Middle Childhood Questionnaire, was associated with unhealthy snack consumption but not with BMI in 1377 children (Scholten et al., 2014). In twenty women with weight concerns, higher levels of impulsivity – as measured by a subscale from the Barratt Impulsiveness Scale and by a delay discounting measure – correlated with greater brain striatal activation for high energy food stimuli (van der Laan et al., 2016). One study found that attention-deficit hyperactivity disorder (ADHD; an archetypal disorder of impulsivity), was associated with increased consumption of sugar and disruptive patterns of eating behavior compared to controls (sample size 100 per group) (Ptacek et al., 2014).

In view of the evident paucity of data examining whether calorie intake is related to gambling and other impulsive/potentially addictive behaviors, the current study sought to examine the nutritional status of young adults and the relationship of their nutrition to a range of impulsive domains, problematic behaviors, and mental health issues. We hypothesized that high calorie intake would be associated with higher rates of gambling, and with higher impulsivity (particularly personality- and cognitive-related measures).

Methods

Two-hundred twenty-five participants were recruited from the surrounding communities near two large Midwestern universities for a study on impulsive behavior in young adults. Inclusion criteria were age 18-29 years, being non-treatment seeking, and having gambled at least five times in the preceding year (this was used as a proxy for some baseline level of impulsive behavior). Our reason for recruiting people who gambled at least five times in the preceding year was because the study was conducted as part of a larger programme of research funded by the US National Center for Responsible Gaming, hence the focus on gambling related behaviors.

Subjects were excluded if they were unable to give informed consent or were unable understand/undertake the study procedures. All study procedures were carried out in accordance with the Declaration of Helsinki. The Institutional Review Board of the University of Chicago approved the study and the consent statement. Participants were compensated with a $50 gift card for a local department store.

Assessments

Participants attended the research center to complete standard diagnostic interviews, basic demographic information, self-report impulsivity inventories, and a computerized cognitive battery focusing on impulsivity.

The Dietary Fat and Free Sugar Short questionnaire (DFS) was used to quantify intake of saturated fat and free sugars over the preceding year (Francis & Stevenson, 2013). In a previous validation study, this instrument demonstrated good-excellent reliability and performed well when compared to more detailed and time-consuming questionnaires of dietary intake (Francis & Stevenson, 2013).

Psychiatric morbidity was assessed using the Mini International Neuropsychiatric Inventory (MINI) (Sheehan et al., 1998) and the Minnesota Impulsive Disorders Interview (MIDI) (Grant, 2008) by trained raters. Problem gambling severity was evaluated using the Yale Brown Obsessive Compulsive Scale Modified for Pathological Gambling (PG-YBOCS) (Pallanti et al., 2005). State anxiety and depression were measured using the Hamilton Anxiety and Depression scales (Hamilton, 1959; Hamilton, 1960), and ADHD symptoms were measured using the World Health Organization's Adult ADHD Rating Scale (ASRS v1.1 Part A; Kessler et al., 2005).

Participants completed the Barratt Impulsiveness Scale, Version 11 (BIS) (Patton et al., 1995) to assess impulsivity. The BIS is a self-report measure of impulsivity across attentional, motor, and non-planning dimensions. The measure consists of 30 questions, with each rated on a scale of 1 ("Rarely/Never") to 4 ("Almost Always/Always"). Self-esteem was measured using the Rosenberg Self-Esteem Scale (Rosenberg, 1965).

Neurocognitive variables were assessed using the Cambridge Neuropsychological Test Automated Battery (CANTAB) system. The following assessments were included in this analysis:

Stop Signal Task (SST): The SST assesses facets of motor inhibition, which is reflective of motor impulsivity. During the task, the computer displays sequences of arrows that face either left or right. The subject is asked to press one of two buttons corresponding with the left and right arrows displayed on the screen. After a training phase, audible "beeps" are introduced after certain arrows, and participants are instructed to not press a button for arrows after which there is a "beep" until the next arrow is displayed. The length of time between the arrow and sound varies over the course of the trial, depending on the participant's success in inhibiting the initial motor response. The target measure for the task is the Stop-Signal Reaction Time (SSRT). This variable reflects the gap between initial arrow presentation and sound at which the participant is able to inhibit their motor response for approximately 50% of the No-Go trials.

Cambridge Gambling Task (CGT): The CGT examines different aspects of decision-making by asking participants to gamble a proportion of their cumulative points on the task. On each trial participants are presented with a row of ten colored boxes, some of which are red, and the rest blue. They are invited to choose the color of box (red or blue) a token is hidden behind, and then choose the proportion of points that they wish to gamble on whether they have made the correct choice. By varying the proportion of red and blue boxes, the task explores proportion of points gambled, extent of rational decision-making (choosing the colored box that is in the majority), and risk adjustment.

Intra-/Extra-dimensional Set Shift (IED): The IED assesses cognitive flexibility. During the task, participants are presented with four boxes, two of which contain pink shapes. Participants are told that one shape has been chosen as “correct”, and the remaining is “incorrect”. They are then informed that their goal is to select the correct shape as many times as possible. After a set number of correct choices, the correct answer is changed to the other shape, a process which is then repeated several times. Upon reaching a set point in the task, the computer adds a second set of white shapes on top of the existing pink shapes. During this phase, the computer begins to identify the white shapes as the correct and incorrect variables, rather than the pink shapes. The target variable for this analysis was the total number of errors made during the task, adjusted for the level of difficulty that the subject was able to reach.

Statistical Analysis

Relationships between total calorie intake of fat/sugar and demographic variables (age, gender, education level, and body mass index [BMI]) were first explored using regression analysis (Spearman's rho). Relationships between total calorie intake of fat/sugar and other types of measures were then explored using partial correlation coefficients, controlling for potential demographic confounds that were identified in the initial analysis. For partial correlation analyses, the variables of interest were classified as follows:

1. Measures of psychopathology: frequency of alcohol intake per week, total amount lost to gambling in the past year, problem gambling severity according to the PG-YBOCS sub-score for thoughts and behaviors, HAM-D total score, HAM-A total score, ADHD total score, presence/absence of current MINI mental disorder, and presence/absence of current MIDI mental disorder.
2. Personality-related: Barratt second order factors of non-planning, cognitive, and motor impulsiveness; Rosenberg self-esteem score.
3. Cognitive: SST stop-signal reaction times, CGT proportion of points gambled, CGT proportion of rational decisions, CGT risk adjustment, and IED total errors adjusted.

For demographic characteristics, and each class of variable, multiplicity was controlled for using Bonferroni correction, with p values reported multiplied by the number of comparisons undertaken within each category. For example, the class of variable 'measures of psychopathology' had 9 measures within it, hence the p values from each statistical test were multiplied by 9 to determine whether it remained significant at $p<0.05$ with Bonferroni correction. This is mathematically equivalent to using a statistical threshold of 0.05 divided by the number of multiple comparisons within each class of variable.

Results

In the 225 participants, total fat and sugar intake were mean 29.0 (standard deviation 8.0) units and 11.2 (4.1) units respectively. An overview of other characteristics of the sample is provided in Table 1. Higher total dietary fat correlated significantly with male gender (r=0.189, p=0.012), and lower levels of education (r=-0.195, p=0.009), but not with age or BMI (both p>0.1). Higher total dietary sugar also correlated significantly with male gender (r=0.177, p=0.024), and with lower levels of education (r=-0.168, p=0.033), but not with age or BMI (both p>0.10). Therefore, educational levels and gender were included as covariates in subsequent analyses.

Table 1. Characteristics of the Sample (N=225)

	Mean	Std. Deviation	N [%]
Age, years	22.76	3.69	
Gender, male			135 [60.0%]
Education level	3.28	0.80	
Body mass index (BMI)	25.65	10.26	
Alcohol consumption, times per week	1.37	1.30	
Dollars lost to gambling in the past year	1979.06	5291.18	
PG-YBOCS urge score	3.00	3.74	
PG-YBOCS behavioral score	3.18	3.89	
HAM-D score	4.26	5.74	
HAM-A score	4.15	4.89	
ADHD symptom score	8.44	4.52	
Occurrence of one or more MINI mental disorders			87 [38.7%]
Occurrence of oe or more MIDI mental disorders			25 [11.1%]
Barratt Impulsivity score, attentional	16.37	4.02	
	23.55	4.87	
Barratt Impulsivity score, non-planning	23.95	5.64	
Rosenberg Self-Esteem score	21.45	6.48	
SST SSRT	182.47	63.43	
CGT Overall proportion bet	0.54	0.15	
CGT Risk adjustment	1.46	1.27	
CGT Quality of decision making	0.95	0.08	
IED Total errors (adjusted)	27.46	26.56	

PG-YBOCS: Yale-Brown Obsessive-Compulsive Scale for Pathological Gambling; HAM-D: Hamilton Depression Scale; HAM-A: Hamilton Anxiety Scale; MINI: Mini International Neuropsychiatric Inventory; MIDI: Minnesota Impulse Disorder Intervew; SST: Stop-Signal Task; SSRT: stop-signal reaction time; CGT: Cambridge Gamble Test; IED: Intra-Dimensional/Extra-Dimensional Set-shift test. Education level: 0=less than high school, 1=high school graduate, 2=some college, 3=college graduate, 4=post-graduate.

Calorie intake and measures of psychopathology

Higher total fat intake was significantly correlated with higher PG-YBOCS urge scores (r=0.222, p=0.018 Bonferroni corrected [note: all subsequent p values are reported Bonferroni corrected]), higher PG-YBOCS behavior scores (r=0.307, p<0.001), and with higher HAM-A scores (r=0.208, p=0.036). Partial correlation plots are provided in Figure 1. Total fat intake did not correlate significantly with dollars lost to gambling in the past year, alcohol consumption per week, presence of mental disorders (MIDI or MINI), ADHD symptoms, or HAM-D scores (all p>0.05).

Higher total sugar intake correlated significantly with more alcohol drinks per week (r=0.244, p=0.009), higher PG-YBOCS urge scores (r=0.37, p<0.001), higher PG-YBOCS behavior scores (r=0.36, p<0.001), higher HAM-D scores (r=0.303, p<0.001), higher HAM-A scores (r=0.303, p<0.001), and occurrence of one or more MINI mental disorders (r=0.276, p<0.001). Partial correlation plots are provided in Figure 2. Total sugar intake did not correlate significantly with ADHD symptoms or presence of MIDI mental disorders (both p>0.05).

Calorie intake and personality-related measures

Neither total fat nor total sugar intake correlated significantly with Barratt Impulsivity Questionnaire measures of motor, non-planning, and cognitive impulsivity (all p>0.05). Higher total sugar intake correlated significantly with lower self-esteem (r=-0.173, p=0.03) but higher total fat intake did not (p>0.05). The partial correlation plot for the significant result is provided in Figure 3.

Calorie intake and cognitive performance

Neither total fat nor total sugar intake correlated significantly with the cognitive measures that were considered (all p>0.05).

Figure 1. Partial regression plots showing significant correlations between total fat calorie intake and measures of psychopathology. (Note: x and y values are normalized and corrected for gender and education levels, hence do not reflect raw values).

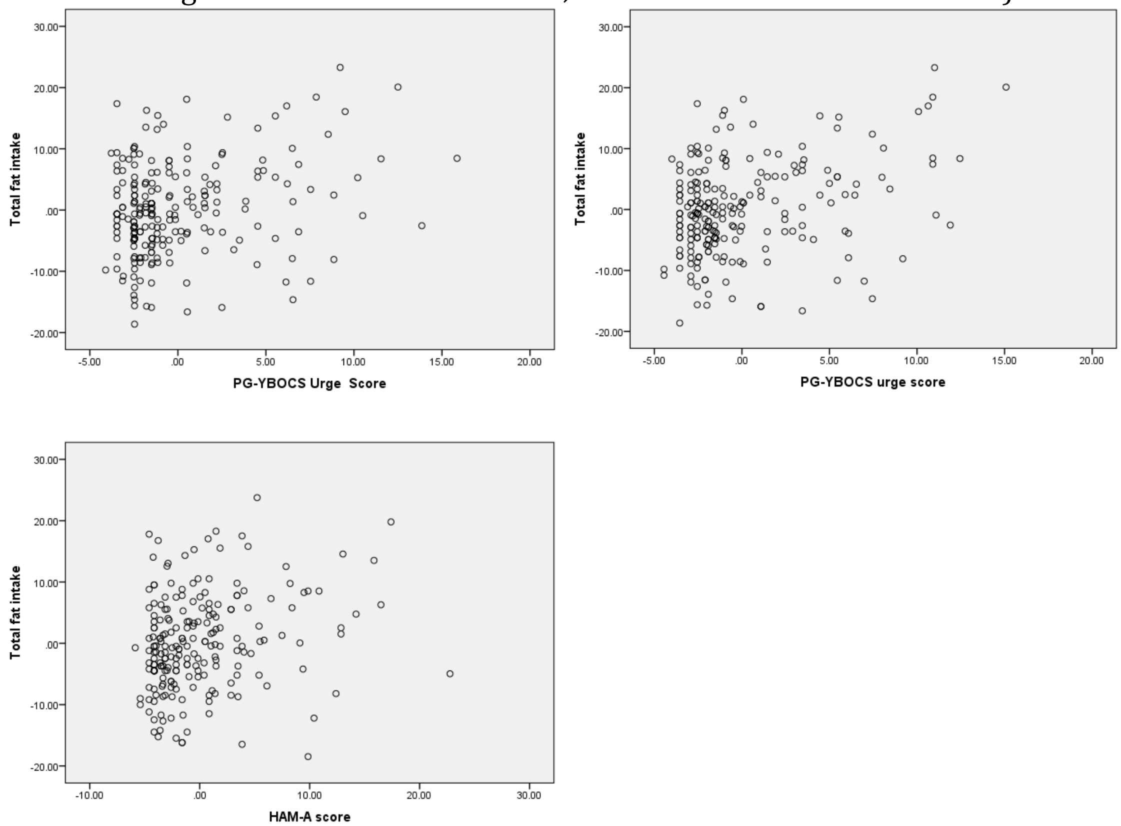


Figure 2. Partial regression plots showing significant correlations between total sugar calorie intake and measures of psychopathology. (Note: x and y values are normalized and corrected for gender and education levels, hence do not reflect raw values).

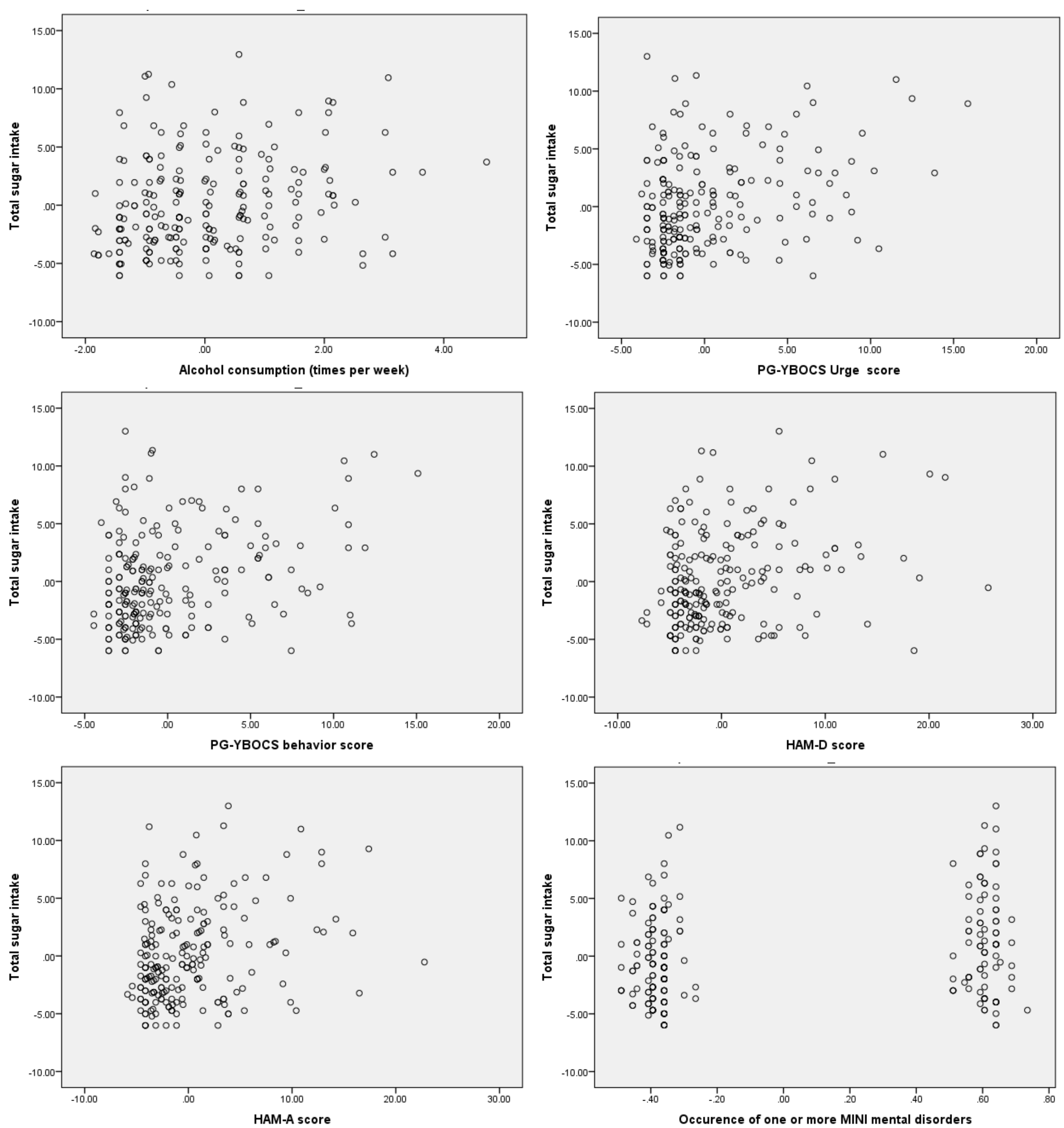
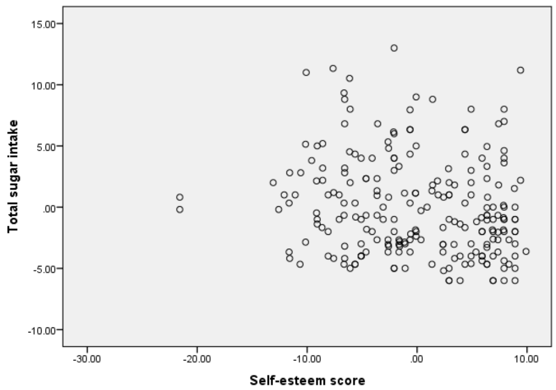


Figure 3. Partial regression plot showing significant correlations between total sugar calorie intake and self-esteem. (Note: x and y values are normalized and corrected for gender and education levels, hence do not reflect raw values).



Discussion

Despite food and drink intake representing a fundamental behavior in daily existence, little is known about whether calorie intake relates to gambling, and other manifestations of impulsivity. Excessive calorie intake itself might be due to problems suppressing behavior (e.g. Sarmugam and Worsley, 2015), and has been associated with non-food related measures of impulsivity (Scholten et al., 2014). The key finding in the current study was that greater past-year calorie intake (fat and sugar) was associated with more severe gambling symptoms and worse state anxiety, while sugar intake was also associated with higher state depression, occurrence of mental disorders, alcohol use, and worse self-esteem. These relationships were not mediated by body mass index, because this did not correlate significantly with calorie intake in our sample. Calorie intake was not related with other aspects of impulsivity, notably personality measures, cognitive measures, or presence of one or more impulse control disorders.

The association between male gender and higher sugar plus fat intake is consistent with the established higher calorie requirements in men (United States Department of Agriculture, Center for Nutrition Policy and Promotion, 2015). The association between lower levels of education and higher calorie intake is also as expected, bearing in mind the previous literature. Lower levels of maternal education have been linked with high calorie snack and/or high sugar drink consumption in offspring (Wijtzes et al., 2015). Lower educational levels in adults have similar associations within individuals in terms of higher calorie intake (Keihner et al., 2012). Importantly, we controlled for educational levels and gender when investigating other measures.

The issue of nutrition in people who gamble has received limited attention. In a Danish study conducted in around 19,000 people aged 16 years and older, problem gambling was associated with unhealthy behavior (alcohol intake, illicit drug use) and obesity, but also with unhealthy dietary patterns – albeit the latter finding did not withstand statistical correction for all confounds (Algren et al., 2015). One possible mediator for the relationship between gambling and poor diet (plus higher alcohol use) could be advertising: advertisements for these themes are commonplace across the globe and are often shown in the same settings (e.g. Lindsay et al., 2013). Another explanation might be gambling environments – casinos sell alcohol and provide buffets of often high calorie inexpensive foods. It would be interesting in future work to include questionnaires relating to advertisement exposure.

Another explanation for our finding that higher calorie intake was associated with higher consumption of alcohol and worse gambling symptoms, could be that common neural circuitry, i.e. the striatum, may be dysregulated in response to fat/sugar rich foodstuffs, gambling and addictive substance exposure. Decreased striatal activation during reward processing has been found in gambling disorder, binge-eating, and alcohol dependence (Potenza, 2014). Militating against this explanation, we did not find any significant relationships between calorie intake and Barratt impulsiveness nor with neuropsychological measures in our study, including those measures related to impulse control (stop-signal task), and reward processing/discounting (decision-making task). In the absence of neuroimaging, however, we cannot refute common neural substrates mediating the link between calorie intake and gambling/alcohol use.

It has long been suggested that people might crave unhealthy footstuffs due to anxious or low mood states (Morris and Reilly, 1987). Most research in this area has focused on obesity (for detailed discussion see Singh, 2014). In the current study, we were able to demonstrate that greater sugar intake correlated with higher anxiety and depressive scores, while higher fat intake correlated only with higher anxiety scores. These findings were not driven by body mass index variation. Our data are consistent with the notion that preference for palatable but unhealthy foodstuffs can develop as a means of temporarily providing relief from negative emotional states of anxiety and low mood (Macht, 2008).

There are several limitations that should be considered in relation to this study. We focused on young adults who gamble at least five times per year, and so the findings may not generalize to other populations, such as people who very rarely gamble, or the population at large. Our study, being cross-sectional in nature, cannot show causality, only correlation/association. We controlled for the impact of gender and education levels on calorie intake, but the possibility exists that other unmeasured variables could have mediated the statistically significant relationships that were observed between calorie intake and the measures of interest such as problem gambling symptom severity. We corrected our analyses for multiple comparisons, so some of the negative findings could be due to conservative statistical analysis; but this approach does have the advantage of reducing the risk of false positives (type I error). Lastly, the study did not collect information on medication (such as ADHD medication for those with high ADHD scores). As such, the impact of medication status on the findings cannot be evaluated.

In conclusion, in young adults who gamble, calorie intake was positively associated with more gambling symptoms, state anxiety/depression, and alcohol use. Further research is needed to clarify the mechanisms mediating these relationships (e.g. advertising, environmental, neurobiological factors), and to explore the public health implications. One such consideration is whether dietary and alcohol consumption advice should be made more available for people who gamble, even in non-obese individuals. The findings suggest that calorie intake is not overtly associated with other aspects of impulsivity, specifically personality- and cognitive-related parameters, and occurrence of impulse control disorders, mitigating against this conceptualization of food intake.

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