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Food Perceptions in Adults with and without ADHD

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Abstract
Introduction: Adults with attention-deficit/hyperactivity disorder (ADHD) have unhealthy eating habits, associated with overweight/obesity. We explored whether they present with different food-related benefit/risk perceptions, compared to those without ADHD. ***Methods:*** One hundred five university students with (n = 36) and without (n = 69) ADHD, aged 22–30, participated in the study. They rated the level of frequency and likelihood of food consumption, as well as the perceived attractiveness, convenience, and risk of 32 healthy and unhealthy food items. ***Results:*** The findings revealed significantly lower healthy/unhealthy food frequency consumption ratios for the ADHD group compared with the non-ADHD one but no differences in the ratios of estimated likelihood of food consumption and perceptions (attractiveness, convenience, and risk). ***Conclusion:*** The results of this study demonstrated a discrepancy between the eating behavior (more unhealthy eating patterns in adults with ADHD compared with controls) and their food-related perceptions (same perceptions regarding the benefit and risk of foods in both groups).

Introduction

Attention-deficit/hyperactivity disorder (ADHD) is the most prevalent neurodevelopmental disorder, characterized by developmentally inappropriate inattention and/or hyperactive-impulsive behaviors, interfering with educational, social, occupational, and health-related functioning [1]. Community surveys suggest that ADHD occurrence in most cultures is about 5.3–7.2% in childhood [2, 3] and about 2.5% in adults [4]. Pharmacologic [5] and nonpharmacologic treatments [6] are available for individuals with ADHD.

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ADHD has received much attention in the last decade of research, recognized as being strongly connected to adverse life outcomes [1, 7, 8]. Whereas ADHD-related impairments in academic, occupational, and social domains are well established, the impact of ADHD on health impairments as sleep difficulties, physical injuries, hypertension, and obesity/abnormal eating patterns has started being explored only recently [9–11].

In regard, more specifically, to obesity, two recent meta-analyses have shown that adults with ADHD have significantly higher body mass index(BMI) and a higher prevalence of obesity than controls [12, 13]. Indeed, the pooled prevalence of obesity was increased by about 70% in adults with ADHD compared with subjects without ADHD [12, 13]. The association between ADHD and obesity is pertinent from a clinical and public health standpoint as enormous personal, family, and social burden is associated with both obesity and ADHD [14].

Excessive weight is a major risk factor for a range of preventable diseases, such as cardiovascular disease, cancer, osteoarthritis, and diabetes [15]. Moreover, the health risks associated with an unbalanced diet have become the leading factor contributing to the global burden of disease as 11 of the top 20 risk factors for the burden of disease are related to diet or physical inactivity [16]. A recent study [17] among adults from 195 countries between the years 1990 and 2017 found that 11 million deaths were attributable to dietary risk factors.

Abnormal eating patterns may contribute to a higher prevalence of obesity in adults with ADHD compared with those without the disorder. Indeed, individuals with ADHD are more likely to suffer from eating disorders: anorexia nervosa, bulimia nervosa, and binge eating disorder (OR = 3.82) [18]. It has also been reported that ADHD is associated with unhealthy dietary patterns, which may directly lead to excess weight gain [19]. A large-sample study revealed associations between ADHD and both the number of overeating episodes and unhealthy food consumption in children [20]. A recent systematic review and meta-analysis revealed that healthy dietary patterns decreased the odds of ADHD and adherence to "junk food" patterns increased it [21]. Iranian children with ADHD adhered more often to the sweet and fast-food diet [22]. Korean children with higher odds of having ADHD endorsed the traditional Western pattern [23]. Another study [24] found that children with ADHD consumed a lower proportion of dairy, calcium, and vitamin B-2. Regarding adolescents with ADHD, it was found they consume less of vegetables, fruits, and nutrient density and more total fat, sugar, candies, soft drinks, and fast food [25, 26]. University students with ADHD reported eating similar amounts of calories and food servings to controls, yet the composition of those calories included more unhealthy food for ADHD [27]. In another study on students with ADHD at the university cafeteria, it was found that they bought more unhealthy foods compared with students without ADHD (almost three times higher) [28]. Adults with ADHD symptoms (18–65 years) reported poor diets with high consumption of sweets [29].

Improvement of diet could potentially prevent one in every five deaths globally. Moreover, the suboptimal diet is responsible for more deaths than any other risk globally, including tobacco smoking. Unlike many other risk factors, dietary risks affected people regardless of age, sex, and sociodemographic development of their place of residence [17]. Therefore, the Youth Risk Behavior Surveillance System (YRBSS) has considered unhealthy dietary behaviors as health-risk behavior [30]. Risk-taking behavior is defined as an intentional engagement in behaviors that may lead to undesirable results in some likelihood [31]. Unhealthy eating joins other risk-taking behaviors that often co-occur with ADHD, including smoking, substance abuse, dangerous driving, and unprotected sex [32–37].

A large body of evidence has focused on what influences an individual to take this risk and choose unhealthy food items. Decision-making theories suggest that individuals make decisions based on their perceptions of the risks and benefits of the alternatives, which are inherently subjective [38]. Several review studies have presented a long list of individual and situational variables that are relevant for food choices [39–41]. The current study focuses on three major factors: (a) attractiveness: more the attractive appearance of the food, comparatively or absolutely or, relative to other what else is available foods [39], (b) convenience: relate to the way food is offered – such as whether it is convenient to see, select, and consume [39], and (c) risk: how unhealthy the food is. Regarding benefit perception, foods that are perceived as more attractive or convenient (less effortful) to select and consume are more frequently chosen. On the other hand, as for risk perception, foods that are perceived as having a detrimental impact on health are less frequently selected.

Previous studies found decreased risk perception in individuals with ADHD [42], but others found that they endorse exaggerated views regarding the benefit of the outcome of risk-taking behaviors [43]. To the best of our knowledge, the benefit and risk perceptions of food

have never been examined in people with ADHD; therefore, the extent at which their food choices can be influenced by their perceptions remains elusive. To fill this gap, the aim of the current study was to explore food perceptions (attractiveness, convenience, and risk) as a potential explanation for unhealthy eating patterns of adults with ADHD. We examined university students because their lifestyle includes making independent food choices [44].

Materials and Methods

Participants and Protocol

The Hebrew University of Jerusalem Institutional Review Board approved the study protocol (approval number: 0410I2016) and all participants provided written informed consent. One hundred seventy-seven university undergraduate students, recruited through a student's social media (email addresses) in the Faculty of Agriculture, Food and Environment of the Hebrew University of Jerusalem, completed the questionnaires that were sent to their emails. They were asked to fill out a short questionnaire (voluntarily). Four of them were excluded because of a specific diet. Three of them were excluded because of a high score (above 51) in the ASRS questionnaire (Adult ADHD Self-Reported Scale, a scaling of ADHD symptoms) which means they have reported multiple symptoms of ADHD: inattention, impulsivity, or hyperactivity [45].

Sixty-five students from the control group were excluded as they did not fit the age criterion (they were under 22 years old). Although the instructions for the assignment that was conveyed through emails indicated the age range of the participants in the study, they did not notice it and filled out the questionnaire even though they should not have to. It should be noted that the results of the study were unaffected by this exclusion. The remained sample consisted of 36 and 69 students, in the ADHD and control groups, respectively. The two groups were similar in terms of demographic characteristics, including age, gender, religion, family status, and residence (living alone or not).

Exclusion criteria were age 22–30 (the acceptable age range for BA students in Israel) and any specific dietary pattern (e.g., vegetarian, vegan, as well as chronic diseases influencing food choice patterns, such as diabetes, or any other health condition reported by participants). Another exclusion criterion was a high score (above 51) in the Adult ADHD Self-Report [46] for the non-ADHD students.

Non-ADHD control participants included students with no history of ADHD diagnosis. Also, they did not meet the screening criterion of the Adult ADHD Self-Report [46].

For the study group, participants diagnosed with ADHD were recruited. All of these students were diagnosed at the MATAL Diagnostic Center of the Hebrew University when they began university studies (before the study was conducted). MATAL is a system of standard tests and questionnaires developed for diagnosing learning disabilities – dyslexia, dyscalculia, and dysgraphia – and for assessing the likelihood of ADHD in adults. MATAL was developed at the Israeli National Center for Testing and Evaluation with the assistance of learning disability experts and is based on up-to-date theoretical knowledge. MATAL includes a background interview and a systematic information gathering, two questionnaires, and 20 tests that examine cognitive functions in the following areas: language (reading and writing), mathematical abilities, attention, memory, perception, and general processing speed. Based on the interview, the documentation, the questionnaires, and the tests, the existence of ADHD is determined by a trained diagnostician. The effectiveness of the tools in the diagnosis of learning disabilities was examined in a large-scale study of students with various learning disabilities, and national performance norms were collected for all tools (National Institute for Testing and Evaluation – NITE). For more details, see, e.g., reference [47]. In addition, the final diagnosis was confirmed by a neurologist or a psychiatrist.

Regarding the use of medication to treat ADHD, 16 out of the 35 participants from the ADHD group that answered this question reported not using medication at all, 17 participants used medication occasionally, and 2 used it daily; 9 participants reported using medication to treat ADHD during the 24 h before participating in the study.

Clinical Measures

Standard diagnostic scales were used to assess participants' characteristics. The Demographic and Background Questionnaire was used for collecting information about age, gender, family status (single/in a relationship/married/divorce), type of residence (living alone, with partners, or family), religiosity, intake of medication (use or not/daily or not/last time of taking the medication), healthy lifestyle (physical activity and sleeping habits), and maintenance of special dietary patterns.

Food-related benefit and risk (FRBR) questionnaire: For the purpose of the study, we developed a questionnaire that included 32 food items, 16 of which were healthy (like fruits and vegetables) and the other 16 unhealthy (like pizza and fries). We asked four questions about each item of food (regarding the attractiveness, convenience, risk, and the likelihood of consumption this food if it was offered to you right now), using a 7-point scale (1 very low degree to 7 very high degree): (1) How tasty/pleasurable is this item to you? (2) How convenient, available, and affordable is this item to you? (3) What is your "gut feeling" about the risk of the following food? (4) What is the likelihood that you would eat this food if it was presented to you right now? The internal consistency of the items was found to be satisfactory for attractiveness, convenience, risk, and the likelihood of consumption (Cronbach's alpha for healthy food items = 0.82, 0.85, 0.80, 0.81, respectively, and for unhealthy food items = 0.88, 0.92, 0.82, 0.94, respectively).

The Food Frequency Questionnaire (FFQ) is a semiquantitative scale with a standard portion size provided for each food item, presenting nine frequency options [48]. The Hebrew version of FFQ employed in the National Health and Nutrition Survey was used for this study. Based on the World Health Organization guidelines [49], we selected and examined 16 healthy and 16 unhealthy items. The internal consistency of the scale in the study was 0.63 and 0.70, for healthy and unhealthy items, respectively.

The Hebrew version of the ASRS-v1.1 [46] was filled out for a continuous scaling of ADHD symptoms. The scale contains 18 items corresponding to the DSM diagnostic criteria of ADHD, 9 items for inattention, and 9 items for hyperactivity/impulsivity, of which frequency is rated from 1 (never) to 5 (very often). The questionnaire has high internal consistency (Cronbach's alpha = 0.88)

Table 1. Demographic and clinical characteristics by diagnostic group

	Controls (n = 69)	ADHD (n = 36)	Group comparison
Age, M (SD)	25.86 (1.63)	25.55 (2.20)	t (96) = 0.76 (p = 0.45)
Gender, %	38 males	36 males	χ^2 (1) = 0.02 (p = 0.90)
Religiosity, %	75 secular	73 secular	χ^2 (2) = 4.82 (p = 0.09)
Family status, %	44.1 single	53 single	χ^2 (2) = 1.31 (p = 0.52)
Residence, %	31 roommate	32 roommate	χ^2 (4) = 3.30 (p = 0.50)
Physical activity, %	17 never	19 never	χ^2 (6) = 9.50 (p = 0.15)
Hours of sleep, M (SD)	6.94 (0.87)	6.59 (1.03)	t (100) = 1.81 (p = 0.07)
BMI,[1] M (SD)	22.10 (2.53)	22.33 (7.07)	t (100) = −0.24 (p = 0.85)
GHQ,[2] M (SD)	2.97 (0.47)	2.59 (0.51)	t (103) = 3.78 (p < 0.001)
ASRS,[3] M (SD)	42.42 (8.77)	58.17 (10.08)	t (103) = −8.29 (p < 0.001)

[1] BMI, body mass index. [2] GHQ, General Health Questionnaire. [3] ASRS, Adult ADHD Self-Report Scale.

Table 2. Medians and interquartile ranges of the frequency, risk, attractiveness, convenience, and likelihood healthy/unhealthy ratios

Scale	Frequency		Risk		Attractiveness		Convenience		Likelihood	
	ADHD	control	ADHD	control	ADHD	control	ADHD	control	ADHD	control
Median	1.10	1.58	0.59	0.56	0.93	0.92	0.96	1.00	1.09	1.04
Interquartile range	0.97–1.23	1.28–2.19	0.38–0.76	0.38–0.85	0.84–1.04	0.80–1.11	0.84–1.25	0.90–1.24	0.94–1.39	0.90–1.39

Table 3. Spearman's correlations between the scales of FRBR questionnaire

Scale	Frequency	Risk	Attractiveness	Convenience
Frequency	–			
Risk	−0.16			
Attractiveness	−0.21*	−0.03		
Convenience	0.26*	−0.19*	0.29**	
Likelihood	0.33**	−0.10	0.72**	0.29**

* p < 0.05. ** p < 0.01.

assessing ADHD in adults. Its sensitivity is 68.4% and specificity 99.6% [50]. The internal consistency of the ASRS in the study was found to be satisfactory (Cronbach's alpha = 0.91). According to the validation study of the Hebrew version of the ASRS [45], the sum of the raw scores on all 18 items (Part A and Part B) together is the best indication for further clarification of ADHD, and the suggested cutoff is 51.

The brief version of the General Health Questionnaire (GHQ-12), a reliable and valid screening tool for measuring psychiatric symptoms [51], was used to determine mental health status. Participant Gureje rated the extent to which they have presented 12 psychiatric symptoms. The test provided one score as suggested by Gureje and Obikoya [52]. The internal consistency of the GHQ in the study was found to be good (Cronbach's alpha = 0.87). BMI was calculated by dividing weight by height squared (kg/m^2) using self-reported weight and height.

Statistical Analysis

The reliability of the food perceptions task was confirmed by Cronbach's alpha test. The normality of distribution of the scales was tested using skewness and kurtosis parameters, for the control and the ADHD groups separately. As normality was not confirmed, nonparametric testing was further employed. The main effects of the diagnostic group on the ratios of perceptions (attractiveness, convenience, risk), frequency, and likelihood of food consumption were tested using a Mann-Whitney test. As further post hoc analyses, we examined the effect of ADHD on frequency and likelihood of food consumption, so as perceptions, this time separately for healthy and unhealthy items. Regression analyses were used to examine the contribution of attractiveness, convenience, and risk to the prediction of the frequency and the likelihood of healthy eating. The significance of coefficients was tested via bootstrap analysis, which is commonly performed given its advantage of greater statistical power without assuming multivariate normality in the sampling distribution, assuming only that the sample is representative of the population. Significance was demonstrated if the 95% bias-corrected confidence interval for the parameter estimate did not contain zero. SPSS v.22.0 and PROCESS model 6 was used for analysis.

Results

Demographic and Clinical Characteristics

The comparison between the characteristics of the control and ADHD groups, presented in Table 1, con-

Table 4. Regression analyses for the scales of FRBR questionnaire

Frequency					Likelihood			
Scale	B	SE B	b	CI 95%	B	SE B	b	CI 95%
Risk	−0.13	0.17	−0.06	−0.52 to 0.27	−0.12	0.13	−0.07	−0.36 to 0.78
Attractiveness	0.74	0.21	0.30	**0.22–1.17**	1.21	0.17	0.52	**0.77–1.59**
Convenience	0.40	0.09	0.40	**0.11–0.59**	0.29	0.30	0.29	−0.03 to 0.60
R^2		0.34				0.47		
F		15.79*				30.53*		

Values in bold represent CI not containing zero. CI, confidence interval. * $p < 0.001$.

firmed no significant differences in age, gender, BMI, religiosity, family status, residence, hours of sleep, and physical activity (Table 1). Significant differences between groups were found in ASRS (significantly higher rates for the ADHD group), as well as in general mental health (significantly lower rates for the ADHD group).

Variables of the FRBR Questionnaire

The questionnaire used for the research (food-related benefit and risk) consisted of five different scales of 16 healthy and 16 unhealthy food items (attractiveness, convenience, risk, likelihood, and frequency of food consumption). We calculated the results as ratios, meaning that each scale reflected the ratio between the corresponding healthy and unhealthy food items (e.g., the mean frequency of eating healthy servings divided by the mean frequency of eating unhealthy servings, the mean perceived risk of healthy items divided by the mean perceived risk of unhealthy items). Means and SDs are presented in Table 2. Skewness and kurtosis for some of the food-related benefit and risk scales were not in the acceptable range. Therefore, for further analyses, we used nonparametric tests.

We found correlations between the scales as expected. The frequency and the likelihood of food consumption were correlated with all scales except the risk scale. Attractiveness and convenience were also correlated with each other (Table 3).

Regression analyses examined the concurrent contribution of attractiveness, convenience, and risk to the prediction of the frequency and the likelihood of healthy eating. Attractiveness and convenience, but not risk, predicted the level of food frequency consumption scores. Attractiveness predicted the level of likelihood of food consumption scores (Table 4).

Effect of ADHD on the FRBR Scales

The Mann-Whitney test revealed differences between the groups in frequency of food consumption ($Z = -5.86$, $p < 0.001$), but no differences in the attractiveness, convenience, and risk perceptions of the food ($Z = -0.11$, $p = 0.91$, $Z = -0.84$, $p = 0.40$, $Z = -0.20$, $p = 0.84$), or the likelihood of food consuming ($Z = -0.32$, $p = 0.75$). Excluding the participants that used medication in the 24 h prior to the completion of the questionnaire did not significantly affect the results.

Post hoc analyses revealed that the ADHD group reported eating significantly less healthy food and more unhealthy food, compared with the control group. No differences were observed in the likelihood of food consumption and perception scales (Fig. 1).

Additional Analyses

Spearman's test (see Table 3) revealed significant correlations between the ratio frequency of food consumption and the ASRS, inattention, hyperactivity, physical activity, and mental health status (GHQ); between risk perception ratio and sleeping habits; between likelihood ratio and physical activity; between ASRS and inattention, hyperactivity, and mental health status; and finally between physical activity and mental health status.

Discussion

Previous studies have found high obesity rates in individuals with ADHD, which may be caused (among others) by unhealthy eating patterns [10, 53]. As unhealthy eating increases the probability of health problems, it may be defined as a risky behavior [30], similarly to other risk-taking behaviors that often co-occur with ADHD [10]. Decision theories suggested that individuals make decisions based on their subjective benefit and risk percep-

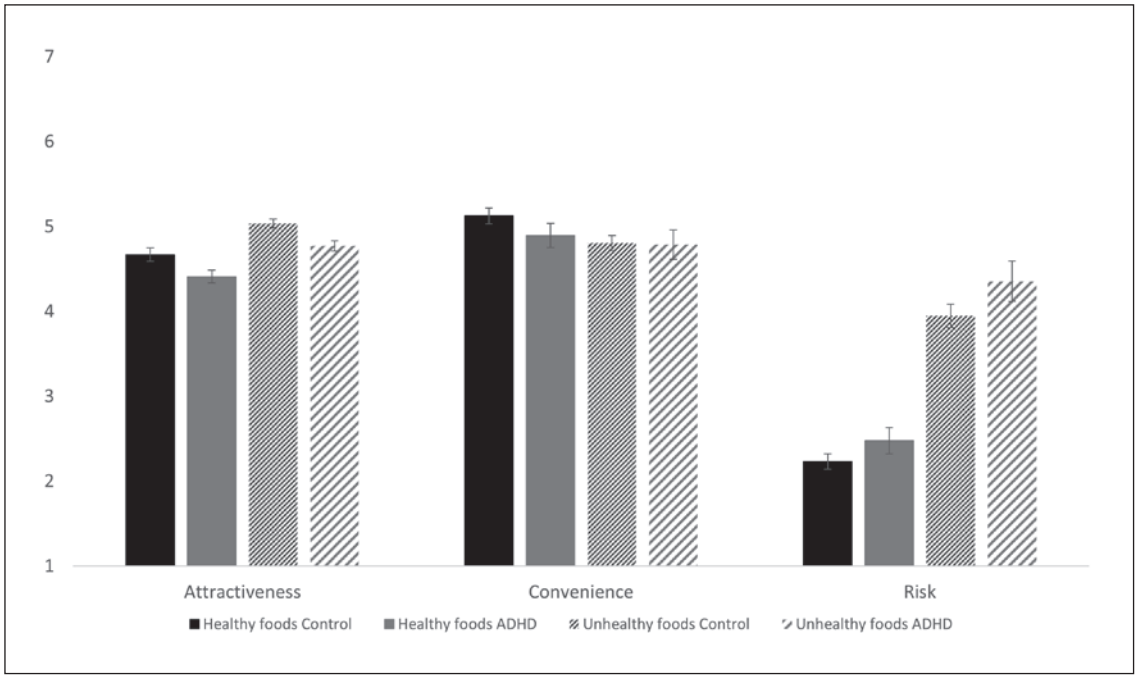

Fig. 1. Perception ratings of attractiveness, convenience, and risk, by diagnostic group.

tions [38]. Food-choices studies have presented the role of benefit variables (attractiveness and convenience) in food choices [41]. Therefore, the current study aimed to explore for the first time whether there is an association between ADHD, food perceptions (benefit and risk), and unhealthy eating patterns.

Following previous studies [27], the results revealed unhealthy eating patterns of the ADHD group, reporting a higher frequency of unhealthy foods and a lower frequency of healthy foods, compared with the control group. However, we found no differences in likelihood of food consumption, as well as in benefit and risk perceptions, between these groups. In addition, no significant correlation was found between food perceptions and the level of inattention and the level of hyperactivity/impulsivity. Indeed, the ADHD group rated the level of likelihood, attractiveness, convenience, and risk similarly to the control group. Previous work on benefit and risk perceptions of other risky behaviors [42, 43] was inconclusive regarding the differences between individuals with and without ADHD. There is little empirical evidence of how individuals with ADHD assess benefit and risk, and if the assessment differs from individuals without ADHD, hence, further research is needed [54].

The lack of differences between participants with and without ADHD in the self-rated likelihood of eating as to risk and benefit perceptions may relate to the distinction between "the cold and hot states" (the aroused and non-aroused states). "Hot" state is when experiencing an elevated visceral factor (like hunger, fatigue, or emotions), and "cold" state is when one is not experiencing an elevated visceral factor [55]. An individual's behavior, including food choices, is based on his current state (hot or cold state) [55]. For example, it has been found that when people embrace colder state reasoning, they are more likely to choose healthily. Impulsive behavior has been linked to the impact of the hot state [55]. Hence, it is necessary to examine food choices within a "hot" state, when an individual can see, smell, and touch the food (like in a restaurant). The "hot" state may lead to a different behavior, especially for ADHD individuals (more impulsive), compared with a "cold" state, when an individual is asked about food items in a questionnaire.

We did not find any significant difference between the groups regarding benefit and risk food perceptions, although we did find interesting results regarding the whole sample. Benefit perceptions predicted the frequency and likelihood of healthy eating. These findings are in accordance with previous work, demonstrating that consumer attitudes and beliefs regarding the potential risks and benefits associated with specific foods are likely to represent potentially influential determinants of consumer

food choices [56]. Other studies have also found out that attitudes relevant to specific food choices are likely to be informed by benefit and risk perceptions [57].

Moreover, we found that attractiveness and convenience, but not risk, predicted the frequency of healthy eating, and only attractiveness predicted the likelihood of healthy eating. These findings are in line with food-related risk perceptions studies, which demonstrated a gap between the risk perceptions and the behavior of an individual. Similarly, McIntosh and his colleges [58] found that individuals did not associate their knowledge of risks with their practice. For instance, they found that awareness of the danger of improperly cooked hamburger did not necessarily affect willingness to change behavior.

The novelty of the current study is the investigation of food perceptions in the ADHD population that has not been examined so far. Nowadays, dietary patterns continue to evolve, and obesity levels are rising both among children and adults, causing morbidity and mortality, as well as significant economic and social costs [59–61]. Hence, the awareness of the disorders that are strongly associated with obesity (ADHD) is important to allow early diagnosis and treatment of these conditions [62]. Additionally, studies that have examined food cues tested attractiveness and convenience as one variable (e.g., [63, 64]), while in this study we separated them to examine whether there was a differentiable effect.

This study has several limitations. As noted, samples were recruited from one university faculty, which enhances control over many demographic variables but at the same time weakens the ability to generalize the conclusions to other populations. Accordingly, the groups were similar in terms of gender, academic level, residence, religion, family status, and GHQ scores (psychiatric symptoms), which implicates that the ADHD group consisted of high functioning participants (university diagnosed and treated students), that may not represent the whole ADHD population. Additionally, the fact that the study was conducted in the Faculty of Agriculture, Food and Environment may have affected the knowledge and the awareness of the participants concerning healthy/unhealthy eating. Another limitation regards the study questionnaire. We designed a new questionnaire that has not been tested before. Future studies should further validate the food perception measures and replicate the findings of this procedure, and make other convergent validity analyses, within other populations as well, and may test the correlations between ADHD symptoms, food perceptions, and with eating disorders or symptoms.

Conclusions

The research findings revealed that ADHD was associated with higher self-reported frequency of unhealthy food choices. On the other hand, individuals with and without ADHD rated similarly the likelihood of eating the food items that were presented to them and had the same benefit and risk perceptions for them. This gap should be addressed in future studies. For instance, further studies should compare the behavior of individuals with ADHD (their food choices) in "hot" states (cafeteria or restaurant) and examine what influences their behavior.

Statement of Ethics

The Hebrew University of Jerusalem Institutional Review Board approved the study protocol (approval number: 0410I2016). All participants provided written informed consent.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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Author Contributions

All the authors have the same contribution to the article, have written, conducted the research, and analyzed the results.

Data Availability Statement

Data are available in the lab of corresponded author.

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