Associations between attention-deficit/hyperactivity disorder symptoms and dietary habits in elementary school children

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ABSTRACT

Objective: The aim of the present study was to investigate the associations between dietary habits and attention deficit/hyperactivity disorder (ADHD) symptoms in elementary school children.
Methods: The parents of 16,831 participating children assessed the ADHD symptoms of their children by responding to the Korean version of the ADHD rating scale (K-ARS). Parents also responded to the food habit questionnaire, which consists of 8 items regarding the eating pace, the frequency of overeating, and patterns of eating six types of food: fast food, soft drinks, instant noodles, fruit and vegetables, and milk.
Results: K-ARS scores were positively associated with higher consumption of foods categorized as unhealthy, including fast food, soft drinks, and instant noodles, and negatively associated with higher consumption of fruit and vegetables categorized as healthy foods. K-ARS scores were also higher in the groups who overate more frequently and ate faster or slower compared to other family members.
Conclusion: Our findings may provide useful clinical information for dietary interventions in children with ADHD.

1. Introduction

Attention deficit/hyperactivity disorder (ADHD) is a major neurodevelopmental disorder studied in the field of child and adolescent psychiatry, which affects approximately 5% of children and 2.5% of the adult population (American Psychiatric Association, 2013). ADHD is characterized by three major symptoms: attention-deficit, hyperactivity, and impulsivity (American Psychiatric Association, 2013). ADHD has a negative impact on academic achievement (Barry, Lyman, & Klinger, 2002) and delinquent behavior in childhood, as well as on functional impairment during adulthood, including decreased occupational productivity (Küpper et al., 2012), marital problems, substance abuse, and involvement in criminal activity (Mannuzza, Klein, & Moulton, 2008; Murphy & Barkley, 1996). Although ADHD is a highly heritable disorder, gene-environment interactions, including diet, play an important role in the occurrence of ADHD (Arnold, Lofthouse, & Hurt, 2012).

Previous studies on the dietary habits of patients with ADHD have

reported that there is a positive association between ADHD and uncontrolled eating. For instance, in a review, Nazar et al. (2008) reported that adult women with ADHD are at higher risk of bulimia nervosa, ranging from 1% to 12% compared to 0%–2% in control groups. Cortese, Bernardina, and Mouren (2007) also reported increasing evidence that subjects with ADHD show more binge-eating behaviors than is reported in the general population and examined impulsivity as an underlying mechanism of the high comorbidity between ADHD and binge eating.

Another finding of the previous studies regarding the association between ADHD and dietary habits is consumption of unhealthy food such as fast food, snacks, and sweetened beverages. In a study using the food frequency questionnaire, Howard et al. (2011) divided food categories into "Healthy" and "Western" dietary patterns and reported that the "Western" dietary pattern was associated with an increased odds ratio for ADHD. Although there is no clear definition of fast food, it is associated with higher calorie, fat, sodium, sugar, and food additive intake, such as those contained in burgers, French fries, fried chicken,

mass-produced pizza, and sweetened beverages (Bahadoran, Mirmiran, & Azizi, 2015; Dunn, Mohr, Wilson, & Wittert, 2011; Fleischhacker, Evenson, Rodriguez, & Ammerman, 2011). Ptacek et al. (2014) reported that boys with ADHD consume more sweetened beverages and less fruit and vegetables compared to controls. Woo et al. (2014) also reported that a diet pattern including more snacks, processed meat, and bread was associated with an increased odds ratio for ADHD. A high consumption of unhealthy foods, such as sweetened beverages, was associated with increased risk of behavioral problems. In contrast, high fruit consumption was associated with decreased risk of behavioral problems (Øverby & Høigaard, 2012).

However, previous studies have reported some inconsistent findings regarding the association between dietary habits and ADHD. For instance, greater rates of bulimia nervosa comorbid with ADHD were only found in women (Biederman et al., 1992, 1994). Moreover, Wiles, Northstone, Emmett, and Lewis (2009) reported that increased consumption of 'junk food' was associated only with hyperactivity, not with conduct problems or behavioral difficulties, contrary to the findings of the study by Øverby and Høigaard (2012).

Additionally, to our knowledge, in spite of multiple studies on the dietary habits of patients with ADHD, there have been few studies on the association between ADHD symptoms and dietary habits, including types of food, overeating, and eating pace in the general population. Notably, there has been no study on these associations with a large sample of Korean elementary school children. Thus, this study aimed to investigate the association between ADHD symptoms and dietary habits, including types of food, overeating, and eating pace.

2. Methods

2.1. Participants

The participants of the present study consisted of the parents of elementary school children aged 6–12 years who participated in screening for neurodevelopmental disorders in Cheonan, a medium-sized city in Korea between 2007 and 2010. Among a total of 30,552 parents who agreed to participate and responded to the ADHD Rating Scale (K-ARS), 16,831 parents who completed both questionnaires assessing ADHD symptoms and the dietary habits of their children were enrolled in this study.

2.2. Measures

2.2.1. ADHD symptom severity

The ADHD rating scale is an assessment tool measuring ADHD symptom severity in children, which was developed by Dupaul, Power, Anastopoulos, and Reid (1998). To assess the ADHD symptom severity of the children of the participants in this study, the Korean version of the ADHD rating scale (K-ARS) was used, which was validated by So, Noh, Kim, Ko, and Koh (2002). The K-ARS consists of 18 items and is rated on a 4-point Likert scale ranging from 0 to 3 points with "never or rarely," "sometimes," "often," and "very often" as responses, and the score ranges from 0 to 54. The nine odd-numbered items of the K-ARS assess hyperactivity-impulsivity symptoms, and the nine even-numbered items assess inattention symptoms. The Cronbach's α value in the present study for the total K-ARS score was 0.909.

2.2.2. Dietary habits

The dietary habits of the children were rated by the parents using the questionnaire used in the Youth Risk Behavior Web-based Survey in Korea. The questionnaire included items for consumption frequencies of food groups including Westernized fast food (i.e., hamburgers, pizza, fried chicken), soft drinks, and instant noodles (i.e., ramen and cup ramen). Instant noodles are a very popular food in Korea. However, they contain high amounts of salt and food additives and are recognized as an unhealthy food. The questionnaire also included items for

consumption frequencies of fruit and vegetables. The consumption frequency of each food group was assessed using seven frequency categories (never, 1 to 2, 3 to 4, and 5 to 6 times per week, and 1, 2, and more than 3 times per day). The items for overeating (never, 1 to 2, 3 to 6 times per week, and every day) and eating pace compared with those of other family members (slower, similar, and faster) were also included in the questionnaire. Demographic variables including sex, age, parental education, and household income were also collected from the questionnaire.

2.3. Statistical analysis

Demographic variables and characteristics of dietary habits were analyzed using frequency analysis and descriptive statistics. K-ARS scores according to the score groups of dietary habits were compared with Welch's variance-weighted analysis of variance (ANOVA) because the variance of K-ARS scores in each score group was not equal. Post-hoc analysis was performed using Dunnett's T3 test. Logistic regression analysis was performed to assess the association between dietary habits and ADHD risk. Sex, age, parental education level, and household income level were included in the analysis as covariates. The ADHD high-risk group was defined as a K-ARS score greater than 18. Statistical analyses were conducted using the software package SPSS 18.0 for windows (SPSS Inc., Chicago, IL).

2.4. Ethics statement

The study protocol was approved by the Institutional Review Board for Human Subjects of a university hospital in Cheonan, South Korea. All participants and their parents were provided with information on the study and signed informed consent before enrollment.

3. Results

3.1. Demographic characteristics

The average age of the children of the participants was 9.29 (SD = 1.71) years. Among 16,831 participating children, 8352 (49.8%) were boys and 1515 (9.0%) were included in the ADHD high-risk group. Most parents (97.8%) had graduated from high school. The demographic characteristics are presented in Table 1.

3.2. The number and mean K-ARS score of each response group for the frequency of consuming fast food, soft drinks, and instant noodles

Table 2 shows the K-ARS total scores for the subgroups of each response score for fast food, soft drinks, and instant noodles. K-ARS scores differed significantly among the subgroups. In the post-hoc comparisons, the children who consumed these foods more frequently had higher K-ARS scores than the children who consumed these foods less frequently.

3.3. The number and mean K-ARS score of each response group for the frequency of consuming vegetables, fruit, and milk

The K-ARS scores of the subgroups of each response score for the frequency of consuming vegetables, fruit, and milk are presented in Table 3. K-ARS scores differed significantly among the subgroups for fruit and vegetable consumption. The K-ARS scores of the children who consumed fruit and vegetables more frequently were significantly lower in the post-hoc analysis than those of the children who consumed these foods less frequently. In contrast, the differences in K-ARS scores among children who consumed milk more or less frequently were less remarkable, albeit significant, compared to the other food types.