Nutritional and environmental factors in attention-deficit hyperactivity disorder (ADHD): A cross-sectional study

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Objectives: Attention-deficit hyperactivity disorder (ADHD) has been related to nutrient deficiencies and ‘unhealthy’ diets, and to date there is only one study that examined the relationship between the Mediterranean diet and ADHD. The aim was to determine the association between those environmental, nutritional, and body composition factors that may affect the pathogenesis and symptomatology of patients with ADHD in Spain.

Methods: A total of 89 children and adolescents (41 with diagnosed ADHD and 48 controls) were studied in an observation case–control study. Anthropometry, nutritional status, adherence to a Mediterranean diet, sedentary behaviour, and sleep were measured.

Results: Lower adherence to a Mediterranean diet was associated with ADHD diagnosis. Individuals with ADHD more often missed having a second serving of vegetables daily and showed reduced intakes of fish, pulses, and pasta or rice almost every day when compared with controls. Statistically significant differences (P < 0.05) were found for fish, cereal, no breakfast and commercially baked goods consumption. There were also statistically significant differences between ADHD individuals and controls when analysing sedentary behaviours and BMI (P < 0.05).

Conclusion: Low adherence to a Mediterranean diet might play a role in ADHD development. Not only specific nutrients but also the whole diet should be considered in ADHD. No clear association was found for anthropometry and sedentary behaviours.

Keywords: Attention-deficit hyperactivity disorder, Mediterranean diet, Sedentary behaviour, Body mass index

Introduction
Attention-deficit hyperactivity disorder (ADHD) is one of the most commonly diagnosed neurobehavioural disorders in childhood, and it often lasts into adulthood. It is characterized by a difficulty in maintaining voluntary attention to activities, both academic and in daily tasks, coupled with lack of impulse control. According to the DSM-V-TM, it is divided into three subtypes attending symptomatology: inattentive; hyperactive-impulsive and combined.¹

ADHD prevalence rates vary by age, gender, and ethnicity. Boys are more likely to have ADHD than girls, and higher rates of ADHD in younger age groups have been observed in studies of children and adolescents.² The worldwide pooled prevalence of ADHD is reported to be 3.4% (95% confidence interval [CI]: 2.6–4.5) in children and adolescents,³ whereas in Spain it is reported to be 5–8% in children and 2.5–4% in adolescents.⁴

The etiology of ADHD is multifactorial, and both genetic and environmental factors may be involved in ADHD.⁵ Genetic studies suggest that ADHD is familiar and that genetic influences can contribute to its etiology from moderate to high phenotypic expression.⁶

The inheritance and behaviour of the parents seem to be important, for all components of nutritional programming, metabolic and epigenetic changes. Breastfeeding is one of the factors that could be related to ADHD.⁷–⁹ Thus, the prevalence of ADHD among patients not fed with breast milk, but
with artificial formula, was significantly higher than in children fed with breast milk. Other factors associated with ADHD are the inadequate lifestyle of parents, such as alcohol, tobacco, and drugs, especially during the gestation period\textsuperscript{10}; or pathological alterations, such as hypothyroidism during pregnancy.\textsuperscript{11}

Proposed ADHD environmental risk factors include heavy metal and chemical exposures such as lead, mercury, organochlorine, organophosphates, and phthalates, as well as nutritional and lifestyle/psychosocial factors.\textsuperscript{3} The effect of diet and dietary supplements is unclear, but considerable evidence suggests that dietary factors are associated with childhood behavioural disorders such as ADHD. Low levels of copper, iron, zinc, magnesium, and omega-3 fatty acids have been reported in children with ADHD and sugar, artificial food colourants, and preservatives are associated with an increased risk of ADHD.\textsuperscript{12,13}

A possible comorbidity between ADHD and obesity has been suggested by recent studies.\textsuperscript{14} Research indicates that individuals with ADHD may have an elevated risk for obesity in adults and youths.\textsuperscript{15} From a behavioural perspective, ADHD is individually associated with lifestyle-related behaviours such as screen time, and physical activity, apart from eating behaviours.\textsuperscript{16}

We hypothesized that a low adherence to the Mediterranean diet would be associated with an increase in the prevalence of ADHD diagnosis.

**Aim**

The purpose of this study was to determine the association, through the observation, between those environmental, nutritional, and body composition factors that may affect the pathogenesis and symptomatology of patients with ADHD in a sample of children and adolescents from Madrid.

Secondary/specific objectives were as follows:

- **Diet and physical activity:** to assess the role of specific nutrients, eating patterns, exercise, physical inactivity, type of leisure, and intellectual entertainment in the development of ADHD.
- **Body composition:** to assess the accumulation of body fat and muscle mass, compromised aspects in the metabolism of people with ADHD.

**Methods**

**Design**

Cross-sectional, observational, descriptive, and comparative cohort study.

**Sample size**

Initial sample: $n = 92$. Cases were recruited at the ADHD specialized unit of Hospital El Escorial in Madrid, Spain. Controls who did not have severe chronic diseases, a history of ADHD diagnosis, or any related disease, such as mental disorder and tic disorder were recruited at school. All children belonged to the same socio-economic status, attended same school, and were from the same geographical area.

After excluding two participants who did not complete the questionnaire and one participant from group 1 who did not present ADHD, a total of 89 participants were finally selected. The mean age of controls and participants with ADHD was $9.5 \pm 1.6$ and $10.4 \pm 2.4$ years, respectively.

Volunteer participants were divided into two study groups: Group (1) cases (ADHD) and Group (2) controls (healthy without ADHD), of the same age range.

**Inclusion criteria (Fig. 1) were as follows:**

- Men and women with ages between 8 and 16 years old
- Diagnosed ADHD, according to the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision*,\textsuperscript{17} by experienced psychiatrists in group 1 (cases)
- Controls with no ADHD diagnosis or severe chronic diseases
- Sufficient level of understanding to allow their participation in the study
- Acceptance and voluntary participation

**Exclusion criteria were as follows (Fig. 1):**

- Autism spectrum disorder, psychosis, developmental disorders, and any ADHD drug treatment.
- Participants who did not complete the study correctly.

**Data collection**

Demographic and clinical data were obtained from both subjects and parents. The whole evaluation, from the first to the last visit, lasted at most 4 weeks.

The study variables were established in order to find possible correlations that could help elucidate and achieve the objectives.

- **Anthropometry:** The following body measures were taken: height (m), body weight (kg), body mass...
index (BMI), and waist circumference (cm). Height was measured with portable height rod SECA with the precision of 1 mm, following the established procedure by the World Health Organization.\textsuperscript{18} Body weight was measured with a tetrapolar, monofrequency (20–100 Hz), digital bioimpedance InBody M230. BMI was calculated from body weight and height with the Quetelet index.\textsuperscript{19} In order to establish overweight and obesity cut-offs, the BMI values were compared with the curves and growth tables published by the Institute for Research of Growth and Development of Orbeogozo Foundation\textsuperscript{20} which consider overweight, in children, if BMI is higher than percentile 85 and lower than percentile 97 of the population of the same age and sex and obese if BMI is higher than percentile 97. Waist circumference was measured with an inelastic body measuring tape (range 0–150 cm), in the intermediate abdominal region between the last rib and the crest of the ilium.\textsuperscript{21}

- **Nutritional status**: The Mediterranean Diet Quality Test for Children and Adolescents (KIDMED Index)\textsuperscript{22} was used to measure quality and adherence to the Mediterranean diet by the child and adolescent population. Items denoting lower adherence were assigned a value of −1 and those related to higher adherence were scored +1. Scores range from −4 to 12, with higher scores indicating greater adherence to the Mediterranean diet. It allows classifying diet quality into three groups: ≤3, poor quality diet; 4–7, need to improve eating pattern to match Mediterranean model; and ≥8, optimal Mediterranean diet. For our statistical purposes, we grouped the first two results (0–7) as ‘not adherent or value not optimal’ and ≥8 value as ‘optimal or adherent’. A 72-hour recording and a nutritional diary were also used.

- **Physical activity**: Regular physical activity was assessed using an adapted version of the IPAQ questionnaire that classifies subjects into groups doing intense, moderate, and light physical exercise, both during their main activity and in their free time over the last 7 days. A minimum of 60 minutes of exercise a day was established, as reflected by the physical activity levels recommended by the WHO for healthy 5- to 17-year-olds.\textsuperscript{23}

- **Sedentary behaviour**: The participants were asked, ‘How much time did you spend watching TV, using electric devices and reading’. The response options included: less than 30 minutes, 30–60 minutes, 1–2 hours, 2–3 hours, 3–4 hours, and more than 4 hours. This measure was based on a scale originally developed by Robinson.\textsuperscript{24}

- **Sleep**: Sleep quality was assessed by compiling hours of sleep on week days, including naps, as well as hours of sleep on weekends. The resulting average of total weekly hours was compared with the recommendations in the Clinical Guidelines for Sleep Disorders,\textsuperscript{25} which establishes that students should sleep 10 hours a day. An adapted version of the Short Form Health Survey (SF-36)\textsuperscript{26} was also used to assess quality-of-life measures.

Each participant and their legal guardian were provided with an informed consent form. The content and procedure of this study was approved by the Ethical Committee Season of Clinical Research of Hospital Universitario Severo Ochoa on 27 January 2016.

**Data analysis**

Analyses were performed using the Statistical Package for the Social Sciences (SPSS) version 21.0. Frequency, percentage, and other descriptive statistics were used to describe and summarize data. Data are presented either as means and 95% confidence intervals (CI) for continuous variables, or as numbers and percentages for dichotomous variables. We compared the distribution of the selected characteristics between groups using $\chi^2$ tests for categorical variables or Student’s $t$-tests or analysis of variance, as appropriate, for continuous variables. $P$ values <0.05 were considered statistically significant.

**Results**

Baseline characteristics of the study population are shown in Table 1. There were no statistically differences in age and gender between children in ADHD and controls.

The Student’s $t$-test between cases–controls on the one hand, and the variables related to physical exercise on the other hand, showed statistically significant differences in the case of: days per week of sports performed at school ($P=0.009$) and days per week of extracurricular sports ($P<0.001$). The sum of minutes per week devoted to exercise as a whole was also statistically significant ($P<0.001$). Nor was minutes per week of sports performed at school ($P=0.165$).

With respect to the average of hours of sleep per week, statistically significant difference was observed between the groups with ADHD and the group without ADHD ($P=0.031$). When analysing sleep variables separately, during the week ($P=0.009$) and at weekends ($P=0.676$), only statistically significant difference was observed from Monday to Friday.

There were statistically significant differences between individuals who had ADHD and controls when analysing sedentary behaviours (time spent watching television and/or using computer/mobile/tablet ($P=0.238$) and reading ($P<0.001$)). There was no statistically significant difference after adding times on all activities ($P=0.057$). In the case of time spent playing on the street, no statistically significant differences ($P=0.086$) were obtained either between cases and controls (Table 2, Fig. 2).

There were statistically significant differences between individuals in group 1 and those in group 2
when analysing KidMed’s final score (P = 0.004), and when analysing those cases that obtained a higher than 7 score (indicative of a healthy diet) (P = 0.046) (Table 3, Fig. 3). When itemizing the analysis of the KidMed questionnaire, statistically significant differences were observed in fish (P = 0.001), cereal (P = 0.002), no breakfast (P = 0.007), and commercially baked goods (P = 0.01) consumption.

An analysis was performed in order to establish if ADHD children that took drugs showed differences in the habits studied with regard to those who did not take any medicines. A non-significant result was obtained (P > 0.05).

**Discussion**

This study shows that low adherence to the Mediterranean diet is associated with odds of an ADHD diagnosis in children and adolescents. Among the habits that characterize a Mediterranean dietary pattern, individuals with ADHD more often missed having a second serving of vegetables daily and showed reduced intakes of fish, pulses, and pasta or rice almost every day when compared with controls. Moreover, subjects with ADHD ate at fast-food restaurants and skipped breakfast more often than controls. In addition, a high consumption of commercially baked goods or pastries, sweets and candy, and a low consumption of yogurts and cheese were also associated with a higher prevalence of ADHD diagnosis.

The role of diet in the behaviour of children has been controversial, but associations between several nutritional factors and child behaviour, such as ADHD, have been continually suggested.² It seems that in addition to analysing the impact that a single food component may have on ADHD, the role of dietary patterns as a whole can be more informative.²⁷ Some studies have analyzed different types of dietary patterns, but just one specifically on the Mediterranean diet.²⁸

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### Table 1 Information on demographics factors, sleep and exercise, by study groups

<table>
<thead>
<tr>
<th></th>
<th>ADHD cases (n = 41)</th>
<th>Controls (n = 48)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>n (%)</td>
<td>n (%)</td>
<td></td>
</tr>
<tr>
<td>Masculine</td>
<td>28 (68.3)</td>
<td>23 (47.9)</td>
<td>0.052</td>
</tr>
<tr>
<td>Feminine</td>
<td>13 (31.7)</td>
<td>25 (52.1)</td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>Mean ± SD</td>
<td>10.4 ± 2.4</td>
<td>9.5 ± 1.6</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>142.5 ± 12.7</td>
<td>141.7 ± 11</td>
<td></td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>36.4 ± 12.2</td>
<td>38.5 ± 9.4</td>
<td></td>
</tr>
<tr>
<td>BMI</td>
<td>17.6 ± 3.6</td>
<td>18.9 ± 2.8</td>
<td></td>
</tr>
<tr>
<td>Waist circumference (cm)</td>
<td>60.5 ± 31.9</td>
<td>76.04 ± 20.9</td>
<td></td>
</tr>
<tr>
<td>Weight percentile</td>
<td>50.4 ± 31.2</td>
<td>76.4 ± 21</td>
<td></td>
</tr>
<tr>
<td>Sleep (mean hrs/week)</td>
<td>9.5 ± 1.3</td>
<td>9.9 ± 1.04</td>
<td></td>
</tr>
<tr>
<td>Sleep Saturday to Sunday</td>
<td>10.1 ± 1.4</td>
<td>10.1 ± 1.4</td>
<td></td>
</tr>
<tr>
<td>Exercise at school (min/week)</td>
<td>3.04 ± 2.02</td>
<td>2.2 ± 0.4</td>
<td>0.009*</td>
</tr>
<tr>
<td>Exercise after school (days/week)</td>
<td>146.6 ± 72.4</td>
<td>130 ± 22.6</td>
<td>0.165</td>
</tr>
<tr>
<td>Exercise after school (min/week)</td>
<td>1.7 ± 1.5</td>
<td>3.1 ± 1.6</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Exercise (mean min/week)</td>
<td>104.1 ± 100.6</td>
<td>130 ± 22.6</td>
<td></td>
</tr>
</tbody>
</table>

*Statistically significant differences, P value <0.05.

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### Table 2 Information on sedentary behaviour, by study groups

<table>
<thead>
<tr>
<th></th>
<th>n (%)</th>
<th>n (%)</th>
<th>n (%)</th>
<th>n (%)</th>
<th>n (%)</th>
<th>n (%)</th>
<th>n (%)</th>
<th>n (%)</th>
<th>n (%)</th>
<th>n (%)</th>
<th>n (%)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 minute</td>
<td>TV</td>
<td>Cases</td>
<td>3 (7.3)</td>
<td>17 (41.5)</td>
<td>11 (26.8)</td>
<td>1 (2.4)</td>
<td>1 (2.4)</td>
<td>1 (2.4)</td>
<td>1 (2.4)</td>
<td>1 (2.4)</td>
<td>1 (2.4)</td>
<td>0.238</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Controls</td>
<td>0</td>
<td>25 (53.8)</td>
<td>8 (16.7)</td>
<td>3 (6.3)</td>
<td>1 (2.1)</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Computer/mobile (min/day)</td>
<td>7 (17.1)</td>
<td>26 (58.3)</td>
<td>8 (16.7)</td>
<td>3 (6.3)</td>
<td>1 (2.1)</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td>0.47</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cases</td>
<td>12 (25)</td>
<td>32 (68)</td>
<td>23 (50.4)</td>
<td>8 (1.7)</td>
<td>1 (2.2)</td>
<td>1 (2.2)</td>
<td>0</td>
<td></td>
<td></td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Reading (min/day)</td>
<td></td>
<td>18 (43.9)</td>
<td>17 (41.5)</td>
<td>6 (14.6)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>&lt;0.001*</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Controls</td>
<td>2 (4.3)</td>
<td>13 (28.3)</td>
<td>25 (54.3)</td>
<td>8 (1.7)</td>
<td>1 (2.2)</td>
<td>1 (2.2)</td>
<td>0</td>
<td></td>
<td></td>
<td>0.086</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Playing outside (min/day)</td>
<td>14 (34.1)</td>
<td>3 (7.3)</td>
<td>15 (36.6)</td>
<td>6 (14.6)</td>
<td>2 (4.9)</td>
<td>1 (2.4)</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Controls</td>
<td>6 (13.3)</td>
<td>3 (6.7)</td>
<td>20 (44.4)</td>
<td>11 (24.4)</td>
<td>4 (8.9)</td>
<td>1 (2.2)</td>
<td>0</td>
<td></td>
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</tr>
</tbody>
</table>

*Statistically significant differences, P value <0.05.
In a cohort of Australian adolescents, a dietary pattern identified as the ‘Western’ type, characterized by high intakes of fat, refined sugars, and sodium and low intakes of fibre, folate, and omega-3 fatty acids, was significantly associated with ADHD diagnosis; whereas a healthy dietary pattern, with high intakes of fibre, folate, and omega-3 fatty acids, was not correlated with the diagnosis of ADHD. In Iranian school-aged children, a high intake of sweets and fast food was associated with greater odds for having ADHD. Junk foods are generally high in fat, sugar, additives, artificial food colourings, and preservatives, which may negatively affect ADHD symptoms.

Recently, in a case–control study in Korean children, the traditional-healthy dietary pattern, characterized by high intakes of kimchi, grains, and bonefish and low intakes of fast foods and beverages, was associated with a lower probability of ADHD diagnosis. In a study of adolescents in China, high intakes of snacks or animal-derived foods were associated with higher odds for psychological symptoms.

Children with ADHD displayed more disruptive patterns of eating behaviours and exhibited markedly diminished adherence to a traditional breakfast, lunch, and dinner schedule, which was linked to a significantly higher frequency of irregular eating times. Therefore, low-quality diets are persistently associated with a higher risk of ADHD. However, we cannot overlook that the relationship found between diet and ADHD could represent reverse causation.

All of these factors could support a vicious cycle: impulsiveness and family dysfunction could lead to a worse choice of foods, lowering the diet quality, which eventually could lead to a low intake of certain nutrients. This situation may induce certain nutritional subclinical deficiencies and, hence, worsen ADHD symptoms.

Additionally, high screen time exposure might increase the risk of obesity in both normal children and children with ADHD. Previous studies examined the association between screen time and ADHD, but the results are contradictory. A recent study showed that television exposure appears to be independently associated with ADHD symptoms in children. However, other two prospective studies found no significant associations between hours of watching TV and ADHD. Even though the findings in previous studies are contradictory, most researchers still emphasize the role of electronic devices in predisposing children to gain weight. The relationship between ADHD and screen time in ADHD children still needs to be examined further.

Table 3 Mediterranean Diet Quality (KidMed score) and responses to KidMed test, by study groups

<table>
<thead>
<tr>
<th>KidMed score (Mean ± SD)</th>
<th>Cases (n = 41)</th>
<th>Controls (n = 48)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>KidMed score (Mean ± SD)</td>
<td>6.4 ± 2.7</td>
<td>7.9 ± 2.03</td>
<td>0.004*</td>
</tr>
<tr>
<td>≥7 (healthy diet) (%)</td>
<td>53.7</td>
<td>72.3</td>
<td>0.046*</td>
</tr>
<tr>
<td>&lt;7 (low-quality diet) (%)</td>
<td>46.3</td>
<td>27.7</td>
<td></td>
</tr>
<tr>
<td>KidMed test (% yes)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruit or fruit juice daily</td>
<td>87.80</td>
<td>83.33</td>
<td>0.713</td>
</tr>
<tr>
<td>Second serving of fruit daily</td>
<td>48.78</td>
<td>47.92</td>
<td>0.988</td>
</tr>
<tr>
<td>Fresh or cooked vegetables daily</td>
<td>70.73</td>
<td>68.75</td>
<td>0.958</td>
</tr>
<tr>
<td>Regular fish consumption (at least 2–3/week)</td>
<td>78.05</td>
<td>96.83</td>
<td>0.003*</td>
</tr>
<tr>
<td>More than once/week at fast-food (hamburger) restaurant</td>
<td>48.78</td>
<td>37.50</td>
<td>0.322</td>
</tr>
<tr>
<td>Pulses more than once a week</td>
<td>78.05</td>
<td>87.50</td>
<td>0.148</td>
</tr>
<tr>
<td>Pasta or rice almost every day (≥5 times/week)</td>
<td>63.41</td>
<td>68.75</td>
<td>0.499</td>
</tr>
<tr>
<td>Cereals or cereal product (bread) for breakfast</td>
<td>68.29</td>
<td>91.67</td>
<td>0.002*</td>
</tr>
<tr>
<td>Regular nut consumption (at least 2–3 times/week)</td>
<td>29.27</td>
<td>27.08</td>
<td>0.867</td>
</tr>
<tr>
<td>Use of olive oil at home</td>
<td>97.56</td>
<td>93.75</td>
<td>0.64</td>
</tr>
<tr>
<td>No breakfast</td>
<td>14.63</td>
<td>0</td>
<td>0.007*</td>
</tr>
<tr>
<td>Dairy product for breakfast (yogurt, milk, etc.)</td>
<td>85.37</td>
<td>89.58</td>
<td>0.367</td>
</tr>
<tr>
<td>Commercially baked goods or pastries for breakfast</td>
<td>75.61</td>
<td>47.92</td>
<td>0.01*</td>
</tr>
<tr>
<td>Two yogurts and/or some cheese (40 g) daily</td>
<td>46.34</td>
<td>56.25</td>
<td>0.298</td>
</tr>
<tr>
<td>Sweets and candy several times every day</td>
<td>21.95</td>
<td>10.42</td>
<td>0.148</td>
</tr>
</tbody>
</table>

*Statistically significant differences, P-value <0.05.
On top of external eating and extended screen time, physical inactivity is another factor predictive of child obesity. Understandably, people have assumed that children with ADHD would lose weight easily due to a high level of physical activity, since hyperactivity would seem to increase daily energy expenditure. However, studies showed that children with ADHD were involved in few physical activities. A study found that children with ADHD, regardless of medication status and gender, are less likely to participate in vigorous physical activity and organized sports compared to those without ADHD. Our findings are not in line with those findings, since statistical differences in BMI were found between cases and controls in our study, even though physical activity at school was higher in cases than in controls.

In the light of the findings above and high relevance of lifestyle-related behaviours, it suggested that these behaviours should be considered as a whole, especially for children with ADHD.

Conclusion
We found a positive relationship between a lower adherence to the Mediterranean diet and ADHD diagnoses. The current findings suggest that certain dietary habits may play a role in ADHD development, even though further work is required to investigate causality and to determine if dietary manipulation could reverse the symptoms of ADHD. Statistical differences in BMI, height, and weight percentile were found between ADHD cases and controls, even though physical activity was higher in cases than in controls and anthropometry measures were lower.

Limitations
Since this is an observational case–control study, no causal relationship can be established between the markers analysed, but they allow understanding and finding behaviour patterns and habits that relate/associate with symptoms or with the condition. As this was a case–control study, it is possible that dietary intake was affected by an individual’s health status and social background. Thus, causal inference cannot be determined.

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