ECRONICON OPEN ACCESS

EC NUTRITION
Research Article

Assessment of the Nutritional status of Children (3 - 12 yrs) with Attention Deficit Hyperactivity Disorder in Al-Madinah Al-Munawarah, Saudi Arabia

Ahlam B El Shikieri*, Amwaj Al Ahmadi, Eman Hossam, Maali Junaid, Safia Al Othmani, Shaima Hadi and Shatha Al Rohaily

Clinical Nutrition Department, Taibah University, Saudi Arabia

***Corresponding Author**: Ahlam Badreldin Ibrahim Mukhtar El Shikieri, Associate Professor, Consultant Clinical Nutritionist, Certified Public Health Nutritionist, Taibah University, Al Madinah Al Munawarah, Saudi Arabia.

Received: June 17, 2017; **Published:** July 12, 2017

Abstract

Background: Attention deficit hyperactivity disorder (ADHD) is a chronic condition that affects millions of children and often persists into adulthood. It includes a combination of problems such as difficulty sustaining attention, hyperactivity and impulsive behavior.

Objectives: To assess the nutritional status of children aged 3 - 12 yrs with ADHD

Study Design: A case-control study was conducted to fulfil the objectives of the study.

Results: The body mass index and mid upper arm circumference of children with ADHD were higher compared with their healthy counterparts and reference measures. Most of the cases (81%) and controls (75%) consumed 1 - 3 meals daily. There were no significant differences between cases and controls regarding their intake of fruit, vegetables, milk, water, coffee and tea as well as fast food consumption. However, more cases than controls consumed chocolates. Certain foods were reported to worsen the symptoms of ADHD including chocolates, candies and soft drinks.

Conclusion: More focus should be paid to the nutritional intake of children with ADHD.

Keywords: *Dietary Intake; Children; ADHD; Nutritional Status; Anthropometric Measurements*

Abbreviations

ADHD: Attention Deficit/Hyperactivity Disorder

Introduction

Attention-Deficit/Hyperactivity Disorder "ADHD" is a neurobiological disorder which has significant problems with executive functions (e.g., attentional control and inhibitory control) that causes attention deficits, hyperactivity, or impulsiveness, which are not appropriate for a person's age [1]. The disease affects many areas of a child's functioning, most notably self-control of behavior, school achievement, and the development of social skills and positive relationships [2]. Furthermore, the global ADHD prevalence for boys aged 5 - 19 is 2.2% and for girls 0.7%, based on a review of 44 studies covering 21 world regions [3]. The worldwide-pooled prevalence of ADHD for persons age 18 and under was 5.3%, based on a review of 102 studies comprising 171,756 subjects from all world regions [4]. A study conducted in King Saud Bin Abdul-Aziz University for Health Sciences, Riyadh, Saudi Arabia, aiming at assessing the epidemiology of ADHD in Arab countries revealed that the prevalence of ADHD ranged between 1.3 - 16%, prevalence of hyperactive type ADHD between 1.4 - 7.8% [5].

The etiology of ADHD is complex and is associated with many factors including genetic, environmental, neurological, and biological factors. Research that has also focused on the nutritional influences on ADHD. In the current research, focus will be on selected nutritional factors and their relationship with ADHD. Studies revealed that children with ADHD may be at risk for a variety of nutrients' deficiencies

due to the attentional demands and being difficult to control while making them sit during a family meal [6]. In addition, carbohydrates affect brain function and mood. Studies indicated that excess sugar in a child's diet often leads to behavioral problems. Foods with low-glycemic index are associated with a steady supply of sugar, helping persons with ADHD to control their behavior and improve performance. Refined sugars, especially sucrose, and aspartame, were related to ADHD and other behavioral problems in children. Foods with the best brain sugars include fresh fruits which have a lower glycemic index than fruit juices [7]. However, detailed studies have shown that there is no association between excess sugar in diet and raised risk of ADHD [8]. A study conducted in Korea aiming at investigating the association between sugar, vitamin C and ADHD amongst children. Those who consumed less sugar from fruit snacks or whose vitamin C intake were lower than the recommended intake, had increased risks for ADHD; there was no significant relationship between total volume of simple sugar intake from snacks and ADHD development [9].

Furthermore, two essential fatty acids linoleic (omega-6) and alpha linolenic (omega-3) are the prime structural components of brain cell membranes and play important part in the enzymes that allow cell membranes to transport nutrients in and out of cells. Many children with ADHD have noticeable symptoms of essential fatty acid deficiency and supplementation with omega-3 fatty acid showed a small but significant effect in improving ADHD symptoms [10]. Furthermore, certain micronutrients' deficiencies were shown to be associated with ADHD symptoms including magnesium [11], iron [12], zinc [13,14] and vitamin D [5,15]. Moreover, a link between ADHD and body weight dysregulation has been reported.

On the other hand, artificial colors, preservatives and caffeinated beverages were found to have an adverse effect on ADHD patients. High consumption of soft drinks was associated with mental health problems among adolescents [16]. A study also showed that parents reported significantly more disruptive behavior when their children drank beverages containing additives whereas there was a reduction in hyperactive behavior once the child stopped drinking those beverages [17].

The current study aims to assess the nutritional status of ADHD children aged 3 - 12 years in Al Madinah Al Munawarah city in Saudi Arabia. It is hypothesized that children with ADHD had an unhealthy dietary pattern were overweight compared to their healthy counterparts.

Materials and Methods

A case-control hospital and community-based study was conducted to achieve the research aim. Patients were selected from the Amal hospital for Mental health and Psychiatric disorders and the Maternity and Children hospital. Apparently healthy aged matched controls were selected from schools. Both boys and girls were recruited. Participants who had chronic diseases such as diabetes mellitus were excluded. Ethical permission to conduct this study was obtained from the facilities were the sample was collected. Consent forms were signed by the parents prior to the start of the study.

Dietary intake was assessed using diet history method where parents were asked about their children's usual diet during the past month. Parents were asked specifically about the intake of dairy products, vegetables' and fruit consumption, caffeinated drinks including chocolate, sweets, coffee, tea and soft drinks. The total number of meals consumed daily was also determined. Portion sizes were estimated using local utensils. Parents of ADHD children were further asked if they noticed any relationship between certain foods and an increase in the symptoms of ADHD. The data collection tool was pretested on a sub-sample (n = 10) participants to check for the clarity of questions.

Selected anthropometric measurements were taken from both cases and controls. Weight and height were measured twice using Dual reading medical scale, Detecto-339 following standard methods, Body mass index (BMI) was calculated and results were compared with the World Health Organization standards using growth charts. The mid-upper arm circumferences (MUAC) was measured by a non-stretchable tape and results were compared with MUAC-for-age charts.

Statistical analysis was conducted using the Statistical Package for Social Sciences (SPSS version 19, Chicago) and Anthro-program version 3.1. Descriptive data included mean, standard deviation and frequencies. Pearson's correlation was used to determine the association between different variables. Student's t-test was to find the differences between cases and controls. Statistical significance difference was set at ≤ 5%.

Results and Discussion

A total of 215 children were recruited and of these 180 were eligible for inclusion in the study. Children with ADHD (n = 80, 52 boys and 28 girls) and apparently healthy controls (n = 100, 51 boys and 49 girls) were included. More boys with ADHD were included. Table 1 shows the number of boys and girls included from each group. Large number of boys had ADHD in the hospitals included in the study. This is similar to previous studies which showed that boys were three times more likely to develop ADHD than girls [18].

Age (years)	Cases n (%)		Controls n (%)		P value
	Boys	Girls	Boys	Girls	0.271
3 - 5	20 (38.5)	9 (32.1)	23 (45.1)	2 (4.1)	
6 - 8	20 (38.5)	13 (46.4)	17 (33.3)	37 (75.5)	
9 - 11	12 (23.1)	6 (21.4)	11 (21.6)	10 (20.4)	
Total	52 (100)	28 (100)	51 (100)	49 (100)	

Table 1: *Age distribution among ADHD cases and apparently healthy controls according to age.*

As has been hypothesized, boys who are aged 6-8 years with ADHD were classified as being overweight based on their mean BMI-for-age charts (Table 2). Previous studies indicated that children with ADHD tend to eat more than healthy children so, they are more likely to be overweight [19]. In addition, boys with ADHD aged 6 years and above had > 3rd standard deviations for MUAC-for-age (Table 3). Although cases are hyperactive, they weighed more than their healthy counterparts. This agrees with the fact that the impulsivity and inattention that characterize ADHD might lead to deregulated eating patterns and, consequently, weight gain [16,19].

Age	Cases Mean BMI		Controls Mean BMI		Standards		
	Boys	Girls	Boys	Girls	Boys	Girls	
3 - 5	16.71	15.31	16.77	15.72	15.7 - 17	15.4 - 16.9	
6 - 8	18.02	16.13	15.02	16.34	15.6 - 17.4	15.5 - 17.6	0.005
9 - 11	16.75	16.33	17.0	-	16.6 - 19.4	16.9 - 19.8	

Table 2*: The mean BMI - for - age for ADHD cases and apparently healthy controls according to age.*

Age	Cases Mean MUAC		Controls Mean MUAC		Standards		P value
	Boys	Girls	Boys	Girls	Boys	Girls	0.002
3 - 5	13.8	11.5	17.1	17	16.6 - 17.4	16.4 - 17.3	
6 - 8	19.3	16.2	18.7	20.3	16.2 - 17.7	16.6 - 17.9	
9 - 11	23.8	18.7	23.6	-	18.3 - 19.5	18.5 - 20	

Table 3: *MUAC-for-age for ADHD cases and apparently healthy controls according to age.*

Dietary data showed that most of the participants (cases and controls) consumed 1 - 3 meals daily (81% of cases and 75% of controls). Cases significantly consumed more soft drinks (cans/week) and sweetened beverages in the form of juices compared to their counterparts. In general, more ADHD boys than girls consumed < 11 cups of coffee weekly and more girls with ADHD compared with their healthy

counterparts consumed soft drinks' cans weekly (Table 4). Similar pattern was noticed regarding the consumption of water. Previous studies indicated that high consumption of soft drinks was associated with mental health problem and hyperactivity among children diagnosed with ADHD [20]. Also, recent studies showed that consumption of sugary beverages increase the symptoms of ADHD [9]. The current study showed no significant differences between cases and controls regarding their intake of coffee and/or tea (P = 0.062) (Table 4).

Drinks	Case n (%)		Control n (%)		P value
	Boys	Girls	boys	girls	
Milk (cups/d)					
0 - 2	46 (88.4)	14 (50)	45 (88.2)	37 (75.5)	0.666
> 3	6 (11.5)	14 (50)	6 (11.8)	12 (24.9)	
Water (cups/d)					
1 - 5	42 (80.7)	23 (82.1)	43 (84.3)	43 (87.7)	0.350
6 - 10	9 (17.3)	4 (14.2)	8 (15.6)	5 (10.2)	
11 - 15	1 (1.9)	1 (3.5)	0	1 (2)	
Coffee/tea (cups/week)					
0 - 10	50 (96.2)	24 (85.7)	46 (93.9)	48 (94.1)	0.062
11 - 20	0 (0)	2 (7.1)	1 (2)	1 (2)	
21 - 30	2 (3.8)	2 (7.1)	2 (4.1)	2 (3.9)	
Soft drinks (can/week)					
0 - 10	49 (94.2)	26 (92.8)	51 (100)	48 (97.9)	0.001*
11 - 20	2 (3.8)	1 (3.6)	0 (0)	1 (2.1)	
21 - 30	1 (2)	1 (3.6)	0 (0)	0 (0)	
Sweetened beverages (juice cartons)					
0 - 10	40 (76.9)	22 (78.6)	50 (98)	49 (100)	0.000*
11 - 20	10 (19.2)	3 (10.7)	1 (2)	0 (0)	
21 - 30	2 (3.9)	3 (10.7)	0 (0)	0 (0)	

Table 4: *Drinks consumed by ADHD cases and controls as determined by the diet history.*

Furthermore, the current study revealed that few amounts of milk were consumed by both cases and controls corresponding to a maximum of two cups (240 ml) daily. Milk provides children with vitamins and minerals that help their healthy growth and development. Consistent with the current findings, a clinical trial examining the effect of overall dietary of children with ADHD, found that a balanced diet, regular meals, and a high intake of dairy products and vegetables were related with fewer attention and behavioral problems [21].

Moreover, similar number of cases and controls reported the consumption of < 2 servings of fruits and < 3 servings of vegetables daily (Table 5). In terms of the chocolate intake, surprisingly, larger number of controls than cases reported consuming around 7 servings and less of chocolate per week. However, more ADHD cases consumed > 8 servings of chocolate compared to their counterparts. A study by found that the intake of sugar and candy, cola beverages, and noncola soft drinks was associated with a higher prevalence of ADHD diagnosis [9].

Furthermore, parents noticed that there was a relationship between certain foods and increased symptoms of ADHD. The most commonly reported foods were chocolates and candies (Figure 1). Also, ADHD children were reported to refuse the intake of certain types of foods such as the colored, high viscosity and spicy ones. This agrees with the Benjamin Feingold Hypothesis which states that "40 - 50%

of hyperactive children are sensitive to artificial food colors, flavors and preservatives and to naturally occurring salicylates and phenolic compounds" [22]. Previous studies suggested that a change in diets consisting of foods free of artificial food colorings is associated with reduced symptoms of ADHD [23,24].

Servings/ day	Cases n (%)		Controls n (%)		P value
	Servings of fruits				
	Boys	Girls	Boys	Girls	0.204
>2	42 (80.8)	22 (78.6)	51 (100)	37 (75.5)	
2 - 4	10 (19.2)	6 (21.4)	0 (0)	12 (24.5)	
Servings of vegetables					
>3	51 (98.1)	21 (75)	50 (98.1)	48 (98)	0.302
3 - 5	1 (1.9)	7 (25)	1 (1.9)	1 (2)	
Servings of Chocolate					
Servings/ week	Boys	Girls	Boys	Girls	0.000
0 - 7	41 (78.8)	25 (89.3)	50 (98)	47 (96)	
8 - 15	6 (11.6)	2 (7.1)	0 (0)	2 (4)	
16 - 23	3 (5.8)	1 (3.6)	1 (2)	0 (0)	
24 - 31	2 (3.8)	0 (0)	0 (0)	0 (0)	

Table 5: *Fruits and vegetables consumption amongst cases and controls. Number and percent are shown.*

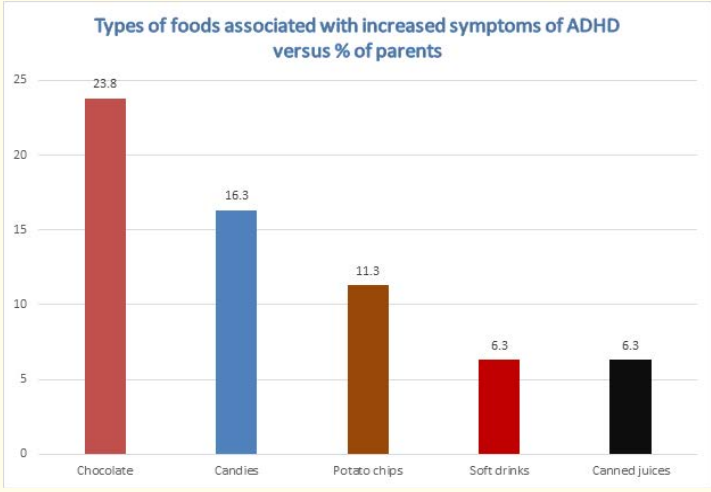

Figure 1: *Types of foods commonly reported by ADHD's parents. Numbers are percents.*

Conclusion

In the current case-control study, ADHD cases had higher BMI, MUAC, as well as soft drinks intake, chocolate intake, sweetened beverages compared to controls. These factors could be associated with increased the symptoms of ADHD in children. Cases consumed similar amounts of fruits, vegetables, and dairy product, coffee, and tea, water compared with controls. One of the limitations of the study was the use of a case-control study design which prevents the assessment of the cause-and-effect associations.

Accordingly, the study recommends the development of an educational program targeting parents. The program aims at informing them about the reduction of certain types of foods that could increase the symptoms of ADHD such as chocolate, sugar and sugary foods, soft drinks and caffeinated beverages. Children with ADHD are encouraged to avoid Feingold foods which have artificial colors and flavors as well as salicylates (such as tea) and notice the effect of certain allergens on their children. Encourage children to reduce their weight by increasing fruit and vegetable intake. Further studies should focus on the nutrient intake and nutritional status of ADHD children including a large sample size.

Acknowledgements

Special and deepest gratitude to the staff of the Psychiatric and Mental Health Hospital, the Maternity and Children Hospital, and the elementary schools in Al-Madinah Al-Munawarah for their helpful and cooperation. Thanks also to the parents for their patience and precious time to participate in the study.

Conflict of Interest

The authors confirm that no financial interests or any conflict of interest exist.

Bibliography

1. Jensen PS and Cooper JR. "The diagnostic classification, epidemiology and cross-cultural validity of ADHD". Kingston, NJ: Civic Research Institute (2002).

2. Jensen PS., *et al*. "ADHD comorbidity findings from the MTA study: comparing comorbid subgroups". *Journal of the American Academy of Child and Adolescent Psychiatry* 40.2 (2001): 147-158.

3. Erskine HE., *et al*. "Epidemiological modelling of attention-deficit/hyperactivity disorder and conduct disorder for the Global Burden of Disease Study 2010". *Journal of Child Psychology and Psychiatry* 54.12 (2013): 1263-1274.

4. Polanczyk G., *et al*. "The worldwide prevalence of ADHD: A systematic review and meta regression analysis". *American Journal of Psychiatry* 164.6 (2007): 942-948.

5. Homidi M., *et al*. "Prevalence of attention deficit and hyperactivity disorder among primary school students in Jeddah city, KSA". *Life Science Journal* 10.3 (2013): 280-285.

6. Kiddie JY., *et al*. "Nutritional Status of Children with Attention Deficit Hyperactivity Disorder: A Pilot Study". *International Journal of Pediatrics* (2010): 767318.

7. Dunn-Meynell AA., *et al*. "Relationship among brain and blood glucose levels and spontaneous and glucoprivic feeding". *Journal of Neuroscience* 29.21 (2009): 7015-7022.

8. Brenda B. "Causes and risk factors of ADHD". *Healthline* (2014).

9. Yujeong K and Hyeja C. "Correlation between attention deficit hyperactivity disorder and sugar consumption, quality of diet, and dietary behavior in school children". *Nutrition Research and Practice* 5.3 (2011): 236-245.

10. Bloch MH and Qawasmi A. "Omega-3 fatty acid supplementation for the treatment of children with attention-deficit/hyperactivity disorder symptomatology: Systematic review and meta-analysis". *Journal of the American Academy of Child and Adolescent Psychiatry* 50.10 (2011): 991-1000.

11. Elbaz F., *et al*. "Magnesium, zinc and copper estimation in children with attention deficit hyperactivity disorder (ADHD)". *Egyptian Journal of Medical Human Genetics* 18.2 (2017): 153-163.

12. Konikowska K., *et al*. "The influence of components of diet on the symptoms of ADHD in children". *Roczniki Państwowego Zakładu Higieny* 63.2 (2012): 127-134.

13. Arnold LE., *et al*. "Zinc for attention-deficient/hyperactivity disorder: placebo-controlled double-blind pilot trial alone and combined with amphetamine". *Journal of Child and Adolescent Psychopharmacology* 21.1 (2011): 1-19.

14. Sinn N. "Nutritional and dietary influences on attention deficit hyperactivity disorder". *Nutrition Reviews* 66.10 (2008): 558-568.

15. Goksugur SB., *et al*. "Vitamin D status in children with attention-deficit-hyperactivity disorder". *Pediatrics International* 56.4 (2014): 515-519.

16. Ríos-Hernández A., *et al*. "The Mediterranean Diet and ADHD in Children and Adolescents". *Pediatrics* 139.2 (2017): pii: e20162027.

17. Arnold LE., *et al*. "Artificial food colors and attention-deficit/hyperactivity symptoms: Conclusions to Dye for". *Neurotherapeutics* 9.3 (2012): 599-609.

18. St Sauver JL., *et al*. "Early life risk factors for attention-deficit/hyperactivity disorder: A population-based cohort study". *Mayo Clinic Proceedings* 79.9 (2004): 1124-1131.

19. Cortese S., *et al*. "Association between ADHD and obesity: A systematic review and meta-analysis". *American Journal of Psychiatry* 173.1 (2016): 34-43.

20. Yu CJ., *et al*. "Sugar-Sweetened Beverage Consumption Is Adversely Associated with Childhood Attention Deficit/Hyperactivity Disorder". *International Journal of Environmental Research and Public Health* 13.7 (2016): 678-696.

21. Ghanizadeh A and Haddad B. "The effect of dietary education on ADHD, a randomized controlled clinical trial". *Annals of General Psychiatry* 14 (2015): 12.

22. Mattes J. "The Feingold Diet: A Current Reappraisal". *Journal of Learning Disabilities* 16.6 (1983): 319-321.

23. Curtis LT and Patel K. "Nutritional and Environmental Approaches to Preventing and Treating Autism and Attention Deficit Hyperactivity Disorder (ADHD): A Review". *Journal of Alternative and Complementary Medicine* 14.1 (2008): 79-85.

24. Zukier Z., *et al*. "The Role of Nutrition in Mental Health: Attention Deficit Hyperactivity Disorder (ADHD)" (2010).

Volume 9 Issue 6 July 2017