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## **The Diet Factor in Attention-Deficit/Hyperactivity Disorder**

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# The Diet Factor in Attention-Deficit/Hyperactivity Disorder

## abstract

This article is intended to provide a comprehensive overview of the role of dietary methods for treatment of children with attention-deficit/hyperactivity disorder (ADHD) when pharmacotherapy has proven unsatisfactory or unacceptable. Results of recent research and controlled studies, based on a PubMed search, are emphasized and compared with earlier reports. The recent increase of interest in this form of therapy for ADHD, and especially in the use of omega supplements, significance of iron deficiency, and the avoidance of the “Western pattern” diet, make the discussion timely.

Diets to reduce symptoms associated with ADHD include sugar-restricted, additive/preservative-free, oligoantigenic/elimination, and fatty acid supplements. Omega-3 supplement is the latest dietary treatment with positive reports of efficacy, and interest in the additive-free diet of the 1970s is occasionally revived. A provocative report draws attention to the ADHD-associated “Western-style” diet, high in fat and refined sugars, and the ADHD-free “healthy” diet, containing fiber, folate, and omega-3 fatty acids.

The literature on diets and ADHD, listed by PubMed, is reviewed with emphasis on recent controlled studies. Recommendations for the use of diets are based on current opinion of published reports and our practice experience. Indications for dietary therapy include medication failure, parental or patient preference, iron deficiency, and, when appropriate, change from an ADHD-linked Western diet to an ADHD-free healthy diet. Foods associated with ADHD to be avoided and those not linked with ADHD and preferred are listed.

In practice, additive-free and oligoantigenic/elimination diets are time-consuming and disruptive to the household; they are indicated only in selected patients. Iron and zinc are supplemented in patients with known deficiencies; they may also enhance the effectiveness of stimulant therapy. In patients failing to respond or with parents opposed to medication, omega-3 supplements may warrant a trial. A greater attention to the education of parents and children in a healthy dietary pattern, omitting items shown to predispose to ADHD, is perhaps the most promising and practical complementary or alternative treatment of ADHD. *Pediatrics* 2012;129:330–337

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### KEY WORDS

additive-free, attention, behavior, diet, elimination, hyperactivity, iron, ketogenic, oligoantigenic, omega-3, pediatrics, sucrose, zinc

### ABBREVIATIONS

ADHD—attention-deficit/hyperactivity disorder  
EFA—essential fatty acids  
EPD—enzyme-potentiating desensitization  
IgG—immunoglobulin G  
LC—long chain  
PUFA—polyunsaturated fatty acids

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The role of diet and dietary supplements in the cause and treatment of attention-deficit/hyperactivity disorder (ADHD) in children is controversial, but the topic continues to interest parents and physicians who prefer an alternative to stimulant medication or seek a complementary therapy. Although prescription of medications for ADHD has shown a steady increase since their introduction in the 1960s, the popularity of various diets has risen and/or fallen in the same time period, sometimes showing a Phoenician revival. In the selection of a therapy for ADHD, physicians generally prefer a medication of value proven by controlled trial. Diets are more difficult to evaluate, and trials requiring elimination of certain foods and dyes may need the supervision of physician and dietician. The list of proposed dietary treatments includes sugar-restricted, additive- and salicylate-free (Feingold diet), oligoantigenic (elimination), ketogenic, megavitamin, and polyunsaturated fatty acid supplements (PUFA) diets. The PUFA or omega-3 supplement is the latest dietary ADHD treatment to receive positive reports, whereas the additive-free Feingold diet that enjoyed its initial popularity in the 1980s shows an occasional, smoldering revival, especially in the United Kingdom, Europe, and Australia. A recent provocative publication from Australia, the Raine study, links ADHD in adolescents with a "Western-style" dietary pattern, high in fat, refined sugars, and sodium and low in fiber, folate, and omega-3 fatty acids.<sup>1</sup> This review focuses on the literature concerning diets and ADHD selected from a PubMed search. Results of recent research and controlled studies are emphasized. Diet recommendations in practice are based on the data presented and on our experience in a neurology clinic for children and adolescents with ADHD. In addition to pharmacotherapy, alternative and/or complementary methods may warrant trial, including

a "healthy" diet pattern,<sup>1</sup> elimination of dyes or food antigens, or omega-3 PUFA supplementation.

### OMEGA-3 AND -6 FATTY ACID SUPPLEMENTS

Low levels of long-chain (LC) PUFA are reported in the plasma and red cells of children with ADHD compared with controls.<sup>2,3</sup> The potential mechanisms leading to abnormal essential fatty acid (EFA) levels in ADHD patients may include reduced EFA intake, reduced conversion of EFA to LC-PUFAs and increased metabolism of LC-PUFAs.<sup>4</sup> These and other similar reports prompted trials of PUFA supplements in treatment of children with ADHD and learning problems.

A frequently cited trial, the Oxford-Durham study,<sup>5</sup> compared the effects of dietary supplementation with omega-3 and omega-6 (in a ratio of 80% to 20%) to placebo in 117 children with developmental coordination disorder, one-third having symptoms of ADHD. Comparing the Conners' Teacher Rating Scale-L/ADHD scores, a reduction and improvement of >0.5 SD occurred during the 3-month treatment phase, whereas no change was seen in the placebo group ( $P < .0001$ ). During a 3- to 6-month follow-up phase, a gain in reading was 3 times that expected, and

spelling advanced twice that expected. Incoordination, a common ADHD comorbidity, was not benefited. No adverse effects were reported.<sup>5</sup> Although the primary aim of this study directed toward alleviation of incoordination was not met, the results demonstrate a reduction of symptoms of ADHD, an effect duplicated in other PUFA supplement trials.<sup>6,7</sup> However, some studies fail to show a beneficial PUFA response,<sup>8,9</sup> leading to the hypothesis of a genetically impaired fatty acid metabolism in some ADHD patients.<sup>10,11</sup>

Review of 16 studies of PUFA blood levels and PUFA dietary supplementation in children with ADHD found only isolated reports from 1995 to 2006 and a flurry of interest from 2007 through 2011. Heterogeneity of design and other factors may have influenced responses and results: the type and dose of fatty acid employed (omega-3 or omega-6 or combination), method of administration, duration of treatment, and measurement of response.

On the basis of reports of efficacy and safety, we use doses of 300 to 600 mg/day of omega-3 and 30 to 60 mg/day of omega-6 FAS, continued for 2 or 3 months, or longer if indicated. Table 1 lists a sample of fatty acid supplements available and the quantities of omega-3, -6, and -9 in each. The wide variation in omega-3

**TABLE 1** Omega Fatty Acid Supplements for Treatment of Children with ADHD

Supplement	Omega-3	Omega-6	Omega-9
Nordic Gummy Bears (3)	82 mg (EPA 41 mg, DHA 27 mg, other 14 mg)		
Nordic Fishes Chews (3)	136 mg (EPA 68 mg, DHA 45 mg, other 23 mg)		
Nordic ProEFA (2 softgels)	565 mg (EPA 270 mg, DHA 180 mg, other 115 mg)	224 mg LA	244 mg OA
MegaRed Krill Oil (1 softgel)	90 mg (EPA 45 mg, DHA 27 mg)		
Nutrigold (1 softgel)	380 mg (EPA 120 mg, DHA 80 mg, ALA 180 mg)	184 mg LA 76 mg GLA	100 mg OA
Nature Made 1200 mg soft gel	360 mg (EPA 180 mg, DHA 120 mg, Other 60 mg)		
Oxford/Durham study <sup>5</sup>	732 mg daily (EPA 558 mg, DHA 174 mg)	60 mg GLA daily	

ALA,  $\alpha$ -linolenic acid; EPA, eicosapentaenoic acid; DHA, docosahexaenoic acid; GLA,  $\gamma$ -linolenic acid; LA, linoleic acid; OA, oleic acid.

content is noteworthy. As initial or add-on therapy, we have occasional reports of improved school grades and lessening of symptoms of ADHD, without occurrence of adverse effects. Most parents are enthusiastic about trying the diet supplements, despite our explanation of only possible benefit and lack of proof of efficacy. In almost all cases, for treatment to be managed effectively, medication is also required. Additional controlled studies of PUFA are warranted, including larger numbers of patients with different age ranges (young and older children), as well as various doses of omega-3 and omega-6 fatty acid, monitored with blood levels. Subjects with and without EFA deficiency should be distinguished. We agree with other investigators<sup>12</sup> that although a link exists between low LC-PUFA and ADHD, the beneficial effects of omega-3 and omega-6 supplements are not clearly demonstrated.

### **ADDITIVE AND SALICYLATE-FREE (FEINGOLD) DIET**

The history of the Feingold diet is well known to physicians who practiced in the 1970s.<sup>13</sup> Amelioration of symptoms was claimed in >50% of hyperactive children treated. The enthusiasm generated by the media led to parental advocacy groups, necessitating federally supported scientific trials. Controlled studies failed to confirm the effectiveness of the diet to the extent claimed.<sup>14,15</sup> Nevertheless, a small subgroup of preschool children responded adversely to additives and preservatives administered as a challenge.<sup>16</sup> An occasional child might react adversely to dyes and preservatives in foods and might benefit from their elimination.

Interest in additives in relation to ADHD has waned in the United States. In the decade 1979–1988, a PubMed search lists 20 pertinent articles; in the 2 decades from 1990 through 2010, only 2 are recorded. Articles appearing in

2010–2011 point to a renewed interest in food additives and ADHD.<sup>17–19</sup> In the latest article,<sup>19</sup> referring to 35 years of research on dietary sensitivities and ADHD symptoms, a literature review shows that of children with suspected sensitivities, 65% to 89% react when challenged with 100 mg of artificial food colors. In addition to being sensitive to these additives, some children are sensitive to common nonsalicylic foods, and cosensitivity is more the rule than the exception. A trial combination antigen- and additive-free diet may be appropriate therapy for children with sensitivities to food antigens or allergens and to dyes.<sup>20,21</sup> Atopic children with ADHD have a significantly higher response rate to a multiple-item elimination (foods, artificial colorings, and preservatives) diet than does a nonatopic group.<sup>22</sup>

According to the Feingold diet,<sup>13</sup> foods to be avoided include apples, grapes, luncheon meats, sausage, hot dogs, and cold drinks containing artificial flavors and coloring agents. Red and orange synthetic dyes are especially suspect, as well as preservatives, butylated hydroxytoluene and butylated hydroxyanisole. Foods permitted include grapefruit, pears, pineapple, and bananas, beef and lamb, plain bread, selected cereals, milk, eggs, and vitamins free of coloring. A parent wishing to follow this diet needs patience, perseverance, and frequent evaluation by an understanding physician and dietician. The same degree of patience and follow-up is required with the oligoantigenic (elimination) diet for ADHD.

### **OLIGOANTIGENIC (HYPOALLERGENIC/ELIMINATION) DIET**

An oligoantigenic diet eliminates most known sensitizing food antigens or allergens. Foods often found to be allergenic include cow's milk, cheese, wheat cereals, egg, chocolate, nuts, and

citrus fruits. Examples of hypoallergenic foods include lamb, potato, tapioca, carrots, peas, and pears. Skin tests for allergic reactivity to foods are unreliable, and elimination diets are required to test for specific food intolerances. An early controlled trial of an oligoantigenic diet in 76 hyperkinetic children found that symptoms improved in 62 (82%), and normal behavior was achieved in 22 (29%).<sup>23</sup> The diet consisted of 2 meats (lamb and chicken), 2 carbohydrates (rice and potatoes), 2 fruits (banana and apple), vegetables and calcium and vitamins for 4 weeks. A subsequent double-blind study, using a “few foods” elimination diet, reported improvement in 76% patients and worsening of behavior ratings and cognitive tests after provoking food challenge.<sup>24</sup>

The term “elimination diet” is now more popular than “oligoantigenic,” with PubMed listing 14 articles under the former and 4 using the latter title, the majority from the United Kingdom and Europe. Interest in the oligoantigenic/elimination diet has increased, but studies have provided mixed opinions of efficacy. A partial benefit of the diet was demonstrated in a small cohort of 21 children tested with both subjective and objective measures.<sup>25</sup> The effect was significant for subjective, but not objective, measures. The oligoantigenic diet may influence only certain dimensions of the ADHD syndrome.

A more favorable effect followed a few foods elimination diet (containing rice, turkey, pear, and lettuce) in 40 children, 36 boys and 4 girls, aged 3 to 7 years, diagnosed with ADHD.<sup>26</sup> Twenty-five patients (62%) showed an improvement in behavior of  $\geq 50\%$ , 9 (23%) withdrew from the study, and 10 (25%) had improved parent and teacher ratings. In this controlled study, the elimination diet resulted in a statistically significant decrease in symptoms of ADHD.

The effectiveness of the diet is demonstrated by a larger randomized controlled

trial in an unselected group of 100 children<sup>27</sup> in the Impact of Nutrition on Children with ADHD study in the Netherlands. This study consisted of an open-label phase (phase 1; 5 weeks of a restricted elimination diet or healthy control diet) followed by a double-blind crossover, challenge phase (phase 2). Responders to challenge with high- or low immunoglobulin (Ig) G foods showed an increase of 20.8 points on the ADHD rating scale ( $P < .0001$ ) and an 11.6 increase of a Conners' Score ( $P < .0001$ ). After the challenge, relapse of ADHD symptoms occurred in 19 of 30 (63%) children, independent of the IgG blood levels.

The utility of IgG blood tests is unsupported, but the effectiveness of a supervised, restricted elimination diet is an indication of the influence of food on ADHD. For some investigators, however, the role of the elimination diet in the treatment of ADHD remains uncertain.<sup>28,29</sup> The report generated criticism that the study did not permit the unqualified recommendation of dietary treatment in all children with ADHD,<sup>30</sup> and a placebo effect could not be excluded.<sup>31</sup> The diagnosis of food sensitivity is complex, time-consuming, and sometimes too burdensome for patient, family, and physician. In selected patients with diligent parents, a short 2- to 3-week period of restricted elimination diet is justified. In patients benefited by the diet, restricted foods are introduced each week, 1 at a time, until the offending item or items are identified. Improvements in behavior may be delayed for 10 days to 2 weeks, and food preferred and consumed most is often the offending item.

### FOOD ANTIGEN DESENSITIZATION

Terms used for food intolerance include "food sensitivity," "food allergy," or "food hypersensitivity," and "psychologically determined food aversions."<sup>32</sup> Food allergy was investigated by a trial of enzyme-potentiating desensitization (EPD) in 40 children with food-induced

hyperkinetic behavior disorder.<sup>33</sup> Of 20 who received active EPD treatment, 16 became tolerant of provoking foods compared with 4 of 20 taking placebo ( $P < .001$ ). EPD permitted children to eat foods previously known to provoke symptoms. Food allergy is a possible mechanism of the hyperkinetic syndrome, and research involving the influence of food triggers could inform clinicians on viable alternative and/or supportive immunotherapy.<sup>34</sup>

### SUGAR, ASPARTAME, AND ADHD

Parents of children with ADHD frequently report a worsening of hyperactivity after an excessive ingestion of candy or diet soda. Isolated reports support the parents' observations, but the majority of controlled studies fail to demonstrate a significant adverse effect of sucrose or aspartame. A PubMed search for "sugar, aspartame, and ADHD" listed 8 articles, dated 1984 through 1995. In a controlled trial involving preschool and school-age children described by parents as sensitive to sugar, diets high in sucrose or containing aspartame and free of additive had no effect on children's behavior or cognitive function.<sup>35</sup> This article provoked much correspondence, mainly critical of the negative conclusion. The authors' subsequent meta-analysis of 16 reported studies, identified through Medline and PsychINFO databases, concluded that sugar does not usually affect the behavior or cognitive performance of children, but a small effect on subsets of children cannot be ruled out.<sup>36</sup> In preschool boys aged 2 to 6 years rated by parents as "sugar responders" and "nonresponders," neither acute sugar loading nor aspartame increased activity level or aggression, but the daily sucrose intake and total sugar consumption correlated with duration of aggression.<sup>37</sup> Inattention was increased after sugar intake, but not aspartame or saccharine. The sugar and placebo challenges were given

with a breakfast high in carbohydrate, a possible reason for the adverse effect of the sucrose challenge.<sup>38</sup> The hyperactive response is blocked if a protein meal is ingested before or with the sugar.<sup>39</sup>

### Reactive Hypoglycemic Response to Sugar Load

An alternative explanation for sugar-induced cognitive impairment and inattention may be a reactive hypoglycemia. Compared with adults, children are more vulnerable to the effects of hypoglycemia on cognitive function. A measure of cognitive function using auditory evoked potentials was significantly reduced when blood glucose was lowered  $<75$  mg/dL in children but was preserved in adults until the level fell to 54 mg/dL.<sup>40</sup> Aspartame used as a control had no adverse effects on behavior or cognition in children with attention-deficit disorder.<sup>41</sup> The avoidance of rapidly absorbed sucrose-containing foods in young children may prevent diet-related exacerbations of ADHD.

In a study of adolescents with insulin-dependent diabetes mellitus, mild hypoglycemia (60 mg/dL) caused a significant transient decline in performance of a battery of cognitive tests, whereas hyperglycemia had no effect.<sup>42</sup> The frontal cortex, known to be involved in the control of attention, was more highly activated than other brain regions during acute hypoglycemia.<sup>43</sup> Children with food-induced ADHD show an increase in  $\beta$  activity in frontotemporal areas during EEG topographic mapping of brain electrical activity after ingestion of provocative foods.<sup>44</sup>

### Sugar and the EEG

The effects of sugar and especially hypoglycemia on the EEG have been studied since the late 1930s.<sup>45,46</sup> Low blood sugar levels are associated with an impairment of the normal electrical activity of the cerebral cortex. A deficiency of glucose to the brain causes the



appearance of slow rhythms in the EEG, with fall in the dominant  $\alpha$  frequency and appearance of  $\theta$  and finally  $\delta$  frequency. It is not surprising that a sugar load would cause an increase in faster  $\beta$  rhythms in the EEG.<sup>44</sup> An electrophysiologic approach, using EEG biofeedback (neurofeedback), in support of a possible relation between sugar and symptoms of ADHD requires additional study. However, studies of EEG biofeedback in the treatment of ADHD provide mixed results and possible benefit, with improvement in only selected attentional brain functions.<sup>47</sup>

In practice, the link between sugar and hyperactive behavior is so universal in the opinion of parents of children with ADHD that no controlled study or physician counsel is likely to change this perception. Parents will continue to restrict the allowance of candy for their hyperactive child at Halloween in the belief that this will curb the level of exuberant activity, an example of the Hawthorne effect. The specific type of therapy or discipline may be less important than the attention provided by the treatment.<sup>21</sup>

### The Ketogenic Diet and ADHD

The ketogenic diet, a diet high in fat content and low in carbohydrate, was introduced for the treatment of epilepsy in 1921.<sup>48</sup> The mechanism is still unclear, but metabolic balance studies in children with absence seizures show that the antiepileptic effect of the diet is correlated closely with a negative balance of sodium and potassium.<sup>49</sup> The re-introduction of carbohydrate to the diet is associated with recurrence of spike-and-wave epileptiform discharges in the EEG. In 65 children with intractable seizures, treatment with the ketogenic diet was effective in control of seizures at 1-year follow-up, and developmental quotients, behavior, attention, and social functioning were significantly improved.<sup>50</sup>

Children with epilepsy frequently exhibit symptoms of ADHD, and children with

ADHD have a high frequency of epileptiform discharges in the EEG.<sup>51</sup> Animals receiving a ketogenic diet show a reversible decrease in activity level.<sup>52</sup> The EEG, of value in prediction of a sustained anticonvulsant effect,<sup>53</sup> may also prove indicative of a behavioral response to the ketogenic diet.

### IRON DEFICIENCY AND ADHD

Iron deficiency is associated with a number of neurologic disorders, including breath-holding, restless leg syndrome, and febrile seizures. A report of low serum ferritin in children with cognitive and learning disorders<sup>54</sup> prompted the inclusion of a serum ferritin level in the battery of laboratory tests obtained on patients attending our neurology clinic for ADHD. In our hospital laboratory, the range of control serum ferritin levels is 300 ng/mL with a low of 22 ng/mL in males and 10 ng/mL in females. In 68 consecutive patients (aged 5–16 years; 54 male, 14 female), the mean serum ferritin level in patients with ADHD was 39.9 ng/mL and was not different from control subjects. Twelve (18%) patients had values <20 ng/mL that were considered abnormal and suggestive of iron deficiency without anemia, and a similar number had levels >60 ng/mL and were not iron deficient. A comparison of clinical characteristics of the low-ferritin and high-ferritin groups disclosed no significant difference in severity or frequency of ADHD and comorbid symptoms or response to drug therapy. In this patient cohort, a causative role for low serum ferritin and iron deficiency in ADHD was not confirmed.<sup>55</sup>

In an earlier study of the effects of iron supplements in ADHD children in Israel, a significant increase in serum ferritin levels (25.9–44.6 ng/mL) was associated with a significant decrease in the Conners' Parent Rating Scale but not in the Teachers' Rating Scales.<sup>56</sup> In later studies of children with ADHD in France, the proportion with low (<30 ng/mL)

and very low (<15 ng/mL) serum ferritin levels was greater than that of our patients in the United States: 84% versus 32%.<sup>57</sup> Low serum ferritin levels were correlated with more severe ADHD symptoms measured with Conners' Parent Rating Scale and greater cognitive deficits. A trial of iron supplementation found improvements in behavior rating scales, but this finding did not reach significance.<sup>58</sup>

A threshold effect may be important in the evaluation of a proposed causative role of iron deficiency in ADHD, and additional controlled studies are probably warranted. The unusually low ferritin levels (mean: 18.4 ng/mL; 23% participants <7 ng/mL) encountered in a recent study of ADHD children in Iowa City may explain the observed correlation with ADHD symptom scores.<sup>59</sup> Low serum ferritin was correlated with baseline inattention, hyperactivity, and impulsivity and also with the dose of amphetamine required to optimize a clinical response. Serum ferritin and iron supplementation as potential predictor or intervention to optimize stimulant therapy is a novel indication for additional study of iron deficiency and ADHD.

### ZINC DEFICIENCY AND ADHD

Published reports of the role of zinc in ADHD show low zinc levels in serum, red cells, hair, urine, and nails of affected children.<sup>60</sup> Most reports are from the Middle Eastern countries, Turkey and Iran, areas with suspected endemic zinc deficiency. Two placebo-controlled trials, one of zinc monotherapy and the other of zinc supplementation of methylphenidate, report significant benefit.<sup>61,62</sup> In one study involving children in the United States, low serum zinc levels correlated with parent/teacher-rated inattention but not with hyperactivity/impulsivity.<sup>63</sup> Zinc supplements enhanced the benefit from d-amphetamine; the optimal dose of stimulant was 37% lower with zinc than with placebo.<sup>64</sup>

Zinc is a cofactor for metabolism of neurotransmitters and fatty acids and also regulates dopamine metabolism involved in ADHD. The relationship of zinc to EFA supplements and stimulants evaluated in treatment of ADHD found that the d-amphetamine response was linear with zinc nutrition. Fatty acids may benefit ADHD by improving or compensating for borderline zinc nutrition.<sup>65</sup> Although zinc supplements are of value in treatment of Middle Eastern children with ADHD associated with endemic zinc deficiency, the incorporation of zinc in the therapy of ADHD in the United States is less well defined.

### OTHER ALTERNATIVE DIETARY THERAPIES FOR ADHD

The concept of orthomolecular (“right molecule”) medicine and megavitamin therapy refers to the use of a combination of nutrients and minerals alleged to provide the optimum molecular environment for the mind. The treatment, subsequently advocated for children with hyperactivity, as well as for mental retardation and Down’s syndrome,<sup>66</sup> is of unproven value.

In a double-blind crossover study of megavitamin therapy in 41 children with ADHD, no significant improvement was demonstrated in behavior scores, and 25% were more disruptive ( $P < .01$ ).<sup>67</sup> Serum transaminase levels exceeded the upper limits of normal in 42% children while receiving vitamins. Megadoses of some vitamins are not without danger of hepatotoxicity, and their efficacy is unconfirmed. Mineral analyses, especially iron and zinc, may be warranted in children with

ADHD and learning disorders, but the need for adequate controls and blood levels is emphasized. Treatment based on inaccurate measurement techniques may lead to adverse reactions.<sup>21</sup>

### “HEALTHY” DIET PATTERN IN PREVENTION AND TREATMENT OF ADHD

In the Australian Raine study, the relationship between dietary patterns and ADHD was examined in a population-based cohort of live births followed to age 14.<sup>1</sup> Two major dietary patterns were identified as “Healthy” and “Western,” according to foods considered the main contributors. (Table 2) The Western dietary pattern associated with an ADHD diagnosis contains higher intakes of total fat, saturated fat, refined sugars, and sodium and is deficient in omega-3 fatty acids, fiber, and folate. The Healthy diet pattern, not associated with ADHD diagnosis, is rich in fish, vegetables, fruit, legumes, and whole-grain foods. A higher risk of having an ADHD diagnosis, inattentive or combined types, is observed for boys compared with girls. The major specific foods in a Western diet are also contributory to an increased tendency to obesity among nonmedicated ADHD children and adolescents.<sup>68</sup>

The relationship between a Western dietary pattern and ADHD may be mediated by other factors, such as poor family functioning and emotional distress, leading to a craving for fat-rich snack foods. Whatever the specific cause, a modification of the child’s dietary pattern may offer an alternative

**TABLE 2** Foods to Avoid and Foods Preferred in Children with ADHD

“ADHD-associated” Foods to Avoid	“Healthy” Foods: Preferred
Takeaway fast foods	Fish, steamed, grilled or canned
Red meat	Vegetables
Processed meats	Tomato
Crisps, potato chips	Fresh fruit
High-fat dairy products	Whole grains
Soft drinks	Low-fat dairy products

Based on Howard AL et al.<sup>1</sup>

method of treatment of ADHD and less reliance on medications.

### SUMMARY AND CONCLUSIONS

Various alternative therapies for ADHD are offered as substitutes or supplements to medication and behavioral treatments. The evaluation of claims for therapies in a disorder such as ADHD, without a single, well-defined cause, is a scientific challenge requiring controls and appropriate neuropsychological testing. The indications for diet therapy include the following: (1) medication failure or adverse reaction, (2) parent or patient preference, (3) symptoms or signs of mineral deficiency, and (4) the need to substitute an ADHD-free healthy diet for an ADHD-linked diet.<sup>1</sup> Diet is one environmental etiology of ADHD that is amenable to modification.<sup>69</sup>

Oligoantigenic, elimination, and additive-free diets are complicated, disruptive to the household, and often impractical, except for selected patients. Supplemental diet therapy is simple, relatively inexpensive, and more acceptable to patient and parent. Public education regarding a healthy diet pattern and lifestyle to prevent or control ADHD may have greater long-term success.

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