

## Reflections on the Increase in Autism, ADHD, Anxiety, and Depression: Part 2 – Exposure to Neurotoxins and Ultraprocessed Foods

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### Abstract

Mental health symptoms of attention-deficit/hyperactivity disorder (ADHD), autism, anxiety, and depression have increased over the last 15 years. An additional risk factor that may affect mental and physical health is the foods we eat. Even though our food may look and even taste the same as compared to 50 years ago, it contains herbicide and pesticide residues and often consist of ultraprocessed foods. These foods (low in fiber and high in sugar, animal fats, and additives) are a significant part of the American diet and correlate with higher levels of inattention and hyperactivity in children with ADHD. Due to affluent malnutrition, many children are deficient in essential vitamins and minerals. We recommend that diet and lifestyle are assessed before beginning neurofeedback and behavioral treatments (we call this Grandmother therapy assessment). If the diet appears low in organic foods and vegetable, and high in ultraprocessed foods and drinks, then nutritional deficiencies should be assessed. The next intervention step is to then reduce the nutritional deficiencies and implement diet changes from ultraprocessed foods to organic whole foods. Meta-analysis demonstrates that providing supplements such as vitamin D, reducing simple carbohydrates and sugars, and eating more vegetables, fruits, and healthy fats during regular meals can ameliorate the symptoms and promote health.

**Keywords:** ADHD; anxiety; depression; mental health; diet; vitamins; malnutrition; pesticides; herbicides

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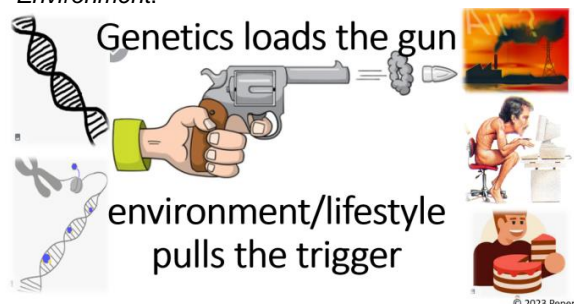
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The previous article “Reflections on the Increase in Autism, ADHD, Anxiety, and Depression: Part 1 – Bonding, Screen Time, and Circadian Rhythms” pointed out how the changes in bonding, screen time, and circadian rhythms affected physical and mental health (Peper, 2023). However, there are many additional factors, including genetics, that may contribute to the increase in ADHD, autism, anxiety, depression, allergies, and autoimmune illnesses (Swatzyna et al., 2018). Genetics contribute to the risk of attention-deficit/hyperactivity disorder (ADHD) since family, twin, and adoption studies have reported that ADHD runs in families (Durukan et al., 2018; Faraone & Larsson, 2019). In most cases, genetics is a risk factor that may or may not be

expressed. The concept underlying this paper is that genetics loads the gun, while environment or behavior pulls the trigger.

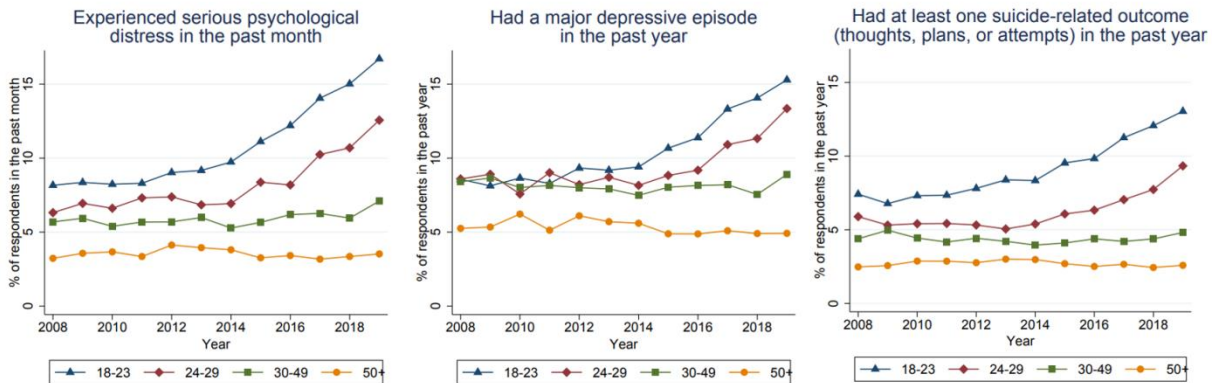
**Figure 1.** Interaction Between Genetics and Environment.



The pandemic only escalated trends that already were occurring. For example, Bommersbach et al. (2023) analyzed the national trends in mental health-related emergency department visits among USA youth, 2011–2021. They observed that, in the United States over the last 10 years, the proportion of pediatric emergency department visits for mental health reasons approximately doubled, including a

fivefold increase in suicide-related visits. The mental health-related emergency department visits increased an average of 8% per year, while suicide related visits increased 23.1% per year. Similar trends have been reported by Braghieri et al. (2022) from the National Survey on Drug Use and Health, as shown in Figure 2.

**Figure 2.** Mental Health Trends in the United States by Age Group in 2008–2019.



**Note.** Data from the National Survey on Drug Use and Health. Reproduced with permission from Braghieri et al. (2022).

The trends reported from this data show an increase in mental health illnesses for young people ages 18–23 and 24–29 and no changes for the older groups which could be correlated with the release of the first iPhone 2G on June 29, 2007. Thus, the COVID-19 pandemic and social isolation were *not* the cause but an escalation of an ongoing trend. For the younger population, the cellphone has become the vehicle for personal communication and social connections. Many young people communicate more with texting than in person and spend hours on screens, which impacts sleep (Peper, 2023). At the same time, there are many other concurrent factors that may contribute to the increase of ADHD, autism, anxiety, depression, allergies, and autoimmune illnesses.

Without ever signing an informed consent form, we all have participated in lifestyle and environmental changes that differ from that evolved through the process of evolutionary natural selection and promoted survival of the human species. Many of those changes in lifestyle are driven by demand for short-term corporate profits over long-term health of the population, as exemplified by the significant increase in vaping in young people as a covert strategy to increase smoking (Centers for Disease Control and Prevention [CDC], 2023) or the

marketing of ultraprocessed foods (van Tulleken, 2023).

This paper focuses on how pesticides and herbicides (exposure to neurotoxins) and changes in our food negatively affect our health and well-being and may be another contributor to the increased risk for developing ADHD, autism, anxiety, and depression. Although our food may look and even taste the same compared to 50 years ago, it is now different—containing more herbicide and pesticide residues and is often ultraprocessed. It contains lower levels of nutrients and vitamins such as vitamin C, vitamin B2, protein, iron, calcium, and phosphorus than 50 years ago (Davis et al., 2004; Fernandez-Cornejo et al., 2014). Nonorganic foods as compared to organic foods may reduce longevity, fertility, and survival after fasting (Chhabra et al., 2013).

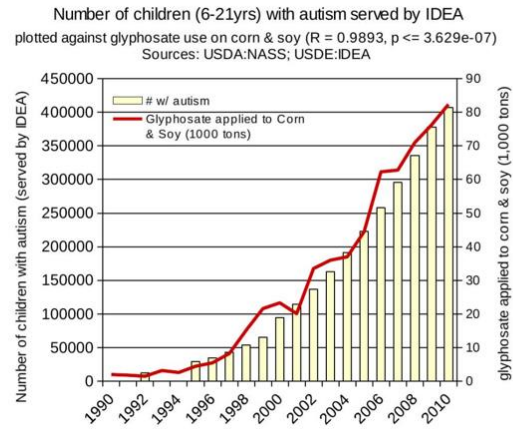
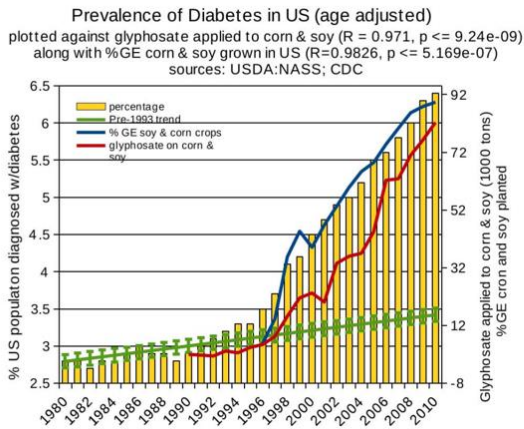
### Being Poisoned by Pesticide and Herbicide Residues in Food

Almost all foods, except those labeled organic, are contaminated with pesticides and herbicides. The United States Department of Agriculture reported that “pesticide use more than tripled between 1960 and 1981. Herbicide use increased more than tenfold (from 35 to 478 million pounds) as more U.S.

farmers began to treat their fields with these chemicals” (Fernandez-Cornejo et al., 2014, p. 11). The increase in herbicides and pesticides is correlated with a significant deterioration of health in

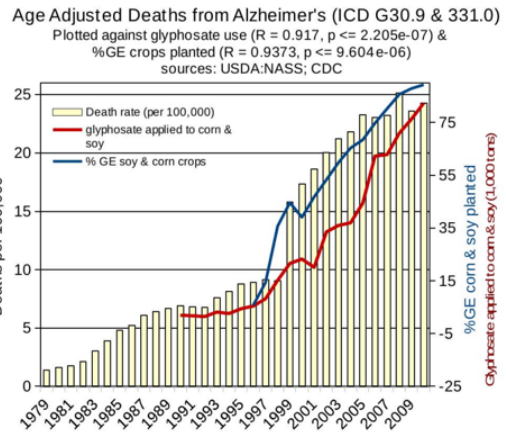
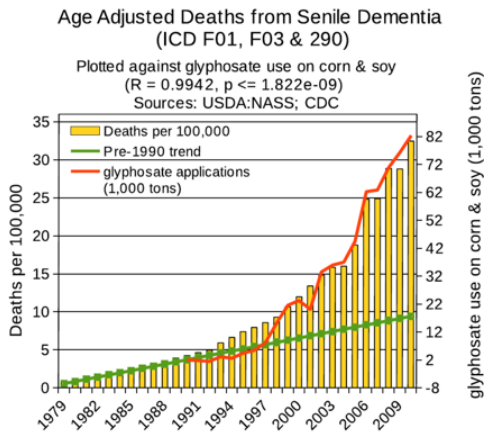
the United States (Swanson et al., 2014), as illustrated in the following figures reproduced with permission.

**Figure 3. Correlation Between Disease Prevalence and Glyphosate Applications.**



Correlation between age-adjusted diabetes prevalence and glyphosate applications and percentage of US corn and soy crops that are GE. Reproduced from Swanson et al. (2014).

Correlation between children with autism and glyphosate applications. Reproduced from Swanson et al. (2014).



Correlation between age-adjusted dementia deaths and glyphosate applications. Reproduced from Swanson et al. (2014).

Correlation between age-adjusted Alzheimer's disease deaths and glyphosate applications and percentage of US corn and soy crops that are GE. Reproduced from Swanson, et al. (2014).

Although correlation is not causation, and similar relationships could be plotted by correlating consumption of ultrarefined foods, antibiotic use, decrease in physical activity, increase in computer, cellphone and social media use, etc.; nevertheless, it may suggest a causal relationship. Most pesticides and herbicides are neurotoxins and can accumulate in the person over time, affecting physical and mental health (Arab & Mostafloou, 2022; Bjørling-

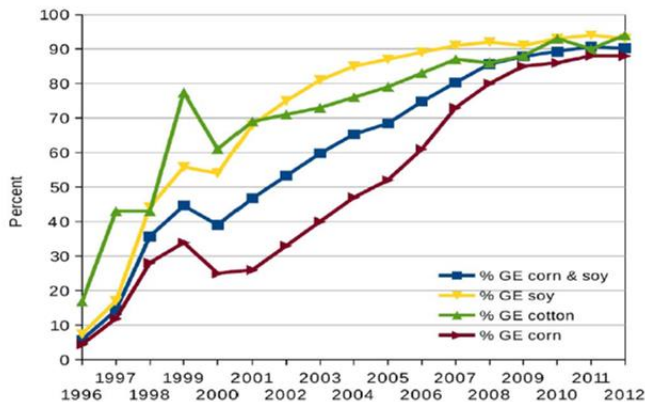
Poulsen et al., 2008). Even though the United States Environmental Protection Agency (EPA) has determined that the residual concentrations in foods are safe, their long-term safety has not been well established (Leoci & Ruberti, 2021). Other countries—especially those in which agribusiness has less power to affect legislation through lobbying and utilize the research findings from studies not

funded by agribusiness—have come to different conclusions.

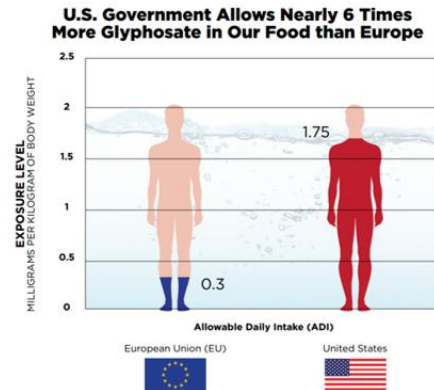
For example, the USA allows much higher residues of pesticides such as Round-Up, with a toxic

ingredient glyphosate (0.7 parts per million), in foods than European countries (0.01 parts per million; European Commission, 2023; EPA, 2023; Wahab et al., 2022), as is graphically illustrated in Figure 4.

**Figure 4.** Percent of Crops Sprayed With Glyphosate and Allowable Glyphosate Levels in the USA Versus the EU.



Adoption of GE crops in US. Reproduced by permission from Swanson et al. (2014).



[https://s3.amazonaws.com/media.fooddemocracynow.org/images/FDN\\_Glyphosate\\_FoodTesting\\_Report\\_p2016.pdf](https://s3.amazonaws.com/media.fooddemocracynow.org/images/FDN_Glyphosate_FoodTesting_Report_p2016.pdf)

The USA allows this higher exposure than the European Union even though about half of the human gut microbiota are vulnerable to glyphosate exposure (Puigbò et al., 2022). The negative effects most likely would be more harmful in a rapidly growing infant than in an adult. Most likely, some individuals are more vulnerable than others and are the “canary in the mine.” They are the early indicators for possible low-level, long-term harm. Research has shown that fetal exposure from the mother (gestational exposure) is associated with an increase in behaviors related to ADHD and executive function in the child when they are 7 to 12 years old (Sagiv et al., 2021). Also, organophosphate exposure is correlated with ADHD prevalence in children (Bouchard et al., 2010). We hypothesize this exposure is one of the cofactors that have contributed to the decrease in mental health of adults 18 to 29 years.

At the same time as herbicides and pesticides acreage usage has increased, ultraprocessed food has become a major part of the American diet (van Tulleken, 2023). Eating a diet high in ultraprocessed foods, which are low in fiber and high in sugar, animal fats, and additives, has been associated with higher levels of inattention and hyperactivity in children with ADHD; namely, high consumption of sugar, candy, cola beverages, and non-cola soft drinks, and low consumption of fatty fish were also

associated with a higher prevalence of ADHD diagnosis (Ríos-Hernández et al., 2017).

In international studies, less nutritional eating behaviors were observed in the ADHD risk group as compared to the normal group (Ryu et al., 2022). Artificial food colors and additives are also a public health issue and appear to increase the risk of hyperactive behavior (Arnold et al., 2012). In a randomized, double-blind, placebo-controlled trial, 3- and 8- to 9-year-old children had an increase in hyperactive behavior for those whose diet included extra additives (McCann et al., 2007). The risk may occur during fetal development since poor prenatal maternal care is a critical factor in the infant’s neurodevelopment and is associated with an increased probability of developing ADHD and autism (Li et al., 2016; Zhong et al., 2020).

### Poor Nutrition Even Affects Your Unborn Grandchild

Poor nutrition not only affects the mother and the developing fetus through epigenetic changes, it also impacts the developing eggs in the ovary of the fetus that can become the future granddaughter. At birth, the baby has all of her eggs. Thus, there is a scientific basis for the old wives’ tale that curses may skip a generation. Providing maternal support is even more important since it affects the newborn and the future grandchild. The risk may even begin a



generation earlier since the grandmother's poor nutrition as well as stress causes epigenetic changes in the fetus eggs. Thus 50% of the chromosomes of the grandchild were impacted epigenetically by the mother's and grandmother's dietary and health status.

### Highly Processed Foods

Highly refined foods have been processed to remove many of their nutrients. These foods include white bread, white rice, pasta, sugary drinks, and almost all fast foods and snacks. These foods are low in fiber, vitamins, and minerals and high in sugars, unhealthy fats, and calories. In addition, additives may have been added to maximize taste and mouth feel and implicitly encourage addiction to these foods. A diet high in refined sugars and carbohydrates increases the risk of diabetes and can worsen the symptoms of ADHD, autism, depression, and anxiety and increase metabolic disease and diabetes (Lustig, 2021; van Tulleken, 2023; Woo et al., 2014). Del-Ponte et al. (2019) noted that a diet high in refined sugar and saturated fat increased the risk of symptoms of ADHD; whereas, a healthy diet, characterized by high consumption of fruits and vegetables, would protect against the symptoms.

Most likely, a diet of highly refined foods may cause blood sugar to spike and crash, which can lead to mood swings, irritability, anxiety, depression, and cognitive decline; often labeled as "hangryness" (the combination of anger and hunger; Barr et al., 2019; Gonçalves et al., 2023). At the same time, a Mediterranean diet improves depression significantly more than the befriending control group (Bayles et al., 2022). In addition, refined foods are low in essential vitamins and minerals as well as fiber. Not enough fiber can slow down digestion, affect the human biome, and make it harder for the body to absorb nutrients. This can lead to nutrient deficiencies, which can contribute to the symptoms of ADHD, autism, depression, and anxiety. Foods impact our mental and physical health, as illustrated by foods that tend to reduce depression (LaChance & Ramsey, 2018; MacInerney et al., 2017). By providing appropriate micronutrients such as minerals (iron, magnesium zinc), vitamins (B6, B12, B9, and D), omega-3s (Phosphatidylserine) and

changing our diet, ADHD symptoms can be ameliorated.

Many children with ADHD, anxiety, and depression are low on essential vitamins and minerals. For example, low levels of omega-3 fatty acids and vitamin D may be caused by eating ultrarefined foods and fast food and drinking soft drinks. At the same time, children are sitting more indoors in front of the screen and thereby have lower sun exposure than is necessary for vitamin D production.

Because of lifestyle changes and sunscreen use, about 42% of Americans are deficient in vitamin D. Among children between 1 and 11 years old, an estimated 15% have vitamin D deficiency. And researchers have found that 17% of adolescents and 32% of young adults were deficient in vitamin D (Porto & Abu-Alreesh, 2022).

Reduced sun exposure is even more relevant for people of color and older people, since their darker skin (increased melanin) protects them from ultraviolet light damage but at the same time reduces the skin's production of vitamin D.

Northern Europeans were aware of the link between sun exposure and vitamin D production. To prevent rickets (a disease caused by vitamin D deficiency) and to reduce upper respiratory tract infections, their children were given a tablespoon of cod liver oil to swallow (Lindsay, 2010). Cod liver oil, although not always liked by children, is more nutritious than taking vitamin D supplements. It is a whole food and a rich source of vitamin A and D as well as contains a variety of omega-3 fatty acids (eicosapentaenoic acid; U.S. Department of Agriculture [USDA], 2019; US EPA, 2023).

Research studies suggest that ADHD can be ameliorated with nutrients and herbs supplements (Henry & CNS, 2023). Table 1 summarizes some of the nutritional deficits observed and the reduction of ADHD symptoms when nutritional supplements were given (adapted from Henry, 2023; Henry & CNS, 2023).

**Table 1**

*Examples of Vitamin and Mineral Deficiencies Associated With Symptoms of ADHD and Supplementation to Reduction of ADHD Symptoms.*

Nutritional deficits observed in people with ADHD	Decrease in ADHD symptoms with nutritional supplements
<p><b>Vitamin D:</b> In meta-analysis with a total number of 11,324 children, all eight trials reported significantly lower serum concentrations of 25(OH)D in patients diagnosed with ADHD compared to healthy controls. (Kotsi et al., 2019).</p>	<p>After 8 weeks, children receiving vitamin D (50,000 IU/week) plus magnesium (6 mg/kg/day) showed a significant reduction in emotional problems as observed in a randomized, double-blind, placebo-controlled clinical trial (Hemamy et al., 2021).</p>
<p><b>Iron:</b> In meta-analysis, lower serum ferritin was associated with ADHD in children (Wang et al., 2017) and the mean serum ferritin levels were lower in the children with ADHD than in the controls (Konofal et al., 2004).</p>	<p>After 12 weeks of supplementation with iron (ferrous sulfate) in double-blind, randomized placebo-controlled clinical trials, symptoms in children with ADHD as compared to controls were reduced (Pongpitakdamrong et al., 2022; Tohidi et al., 2021).</p>
<p><b>Omega-3s:</b> Children with ADHD were more likely to be deficient in omega-3s than children without ADHD (Chang et al., 2017).</p>	<p>Adding omega-3 supplements to their diet resulted in an improvement in hyperactivity, impulsivity, learning, reading, and short-term memory as compared to controls in 16 randomized controlled trials including 1,514 children and young adults with ADHD (Derbyshire, 2017).</p>
<p><b>Magnesium:</b> In meta-analysis, subjects with ADHD had lower serum magnesium levels compared with to their healthy controls (Effatpahah et al., 2019).</p>	<p>The 8 weeks of supplementation with vitamin D and magnesium caused a significant decrease in children with conduct problems, social problems, and anxiety/shy scores (Hemamy et al., 2020).</p>
<p><b>Vitamins B2, B6, B9, and B12:</b> Deficiency has been found in many patients with ADHD (Landaas et al., 2016; Unal et al., 2019).</p>	<p>Vitamin therapy appears to reduce symptoms of ADHD and ASD (Poudineh et al., 2023; Unal et al., 2019). The 8 weeks supplementing with vitamin B6 and magnesium decreased hyperactivity and hypermotivity or aggressiveness. When supplementation was stopped, clinical symptoms of the disease reappeared in a few weeks (Mousain-Bosc et al., 2006).</p>

Supplementation of vitamins and minerals in many cases consisted of more than one single vitamin or mineral. For an in-depth analysis and presentation, see the superb webinar by Henry and CNS (2023): <https://divcom-events.webex.com/recording-service/sites/divcom-events/recording/e29cefcae6c1103bb7f3aa780efee435/playback?> (Henry & CNS, 2023).

Whole foods are more than the sum of individual parts (the identified individual constituents/nutrients). The process of digestion is much more complicated than ingesting simple foods with added vitamins or minerals. Digestion is the interaction of many food components (many of which we have not identified)

which interact and affect the human biome. A simple added nutrient can help; however, eating whole organic foods is most likely healthier. For example, whole-wheat flour is much more nutritious. Whole wheat is rich in vitamins B1, B3, B5, riboflavin, folate, and fiber. Refined white flour has been bleached and stripped of fiber and nutrients to which some added vitamins and iron are added.

### Recommendation

When working with clients, follow Talib's principles as outlined in Part 1 by Peper (2023), which suggest that to improve health first remove the unnatural, which in this case are the ultraprocessed foods, simple carbohydrates, exposure to pesticides, and

herbicides (Taleb, 2014). The approach is beneficial for prevention and treatment. This recommendation to optimize health is both very simple and very challenging. The simple recommendation is to eat only organic foods and as much variety as possible as recommended by Professor Michael Pollan in his books, *Omnivore's Dilemma: A Natural History of Four Meals* and *Food Rules* (Pollan, 2006; Pollan, 2011).

Look at your hand or your brain and remember that every cell is constructed out the foods you ingested. If you ingested inferior foods (raw materials to be built your physical structure), the structure can only be inferior. If you use superior foods, you have the opportunity to create a superior structure which provides the opportunity for superior functioning. —Erik Peper

Do not eat foods that contain herbicides and pesticide residues or are ultraprocessed. Although organic foods, especially vegetables and fruits, are often much more expensive, you have a choice: You can pay more now to optimize health or pay later to treat disease. Be safe and not sorry. This recommendation is similar to the quote, "Let food be thy medicine and medicine be thy food," that has been attributed falsely since the 1970s to Hippocrates, the Greek founder of western medicine (5th Century, BC; Cardenas, 2013).

There are many factors that interfere with implementing these suggestions, since numerous people live in food deserts (no easy access to healthy unprocessed foods) or food swamps (a plethora of fast-food outlets) and 54 million Americans are food insecure (Ney, 2022). In addition, we and our parents have been programmed by food industry advertising to eat ultraprocessed foods and may no longer know how to prepare healthy foods such as exemplified by a Mediterranean diet. Recent research by Bayles et al. (2022) has shown that eating a Mediterranean diet improves depression significantly more than the befriending control group. In addition, highly processed foods and snacks are omnipresent, often addictive, and more economical.

Remember that clients are individuals and almost all research findings are based upon group averages. Even when the data implies that a certain intervention is highly successful, there are always some participants for whom it is very beneficial and some for whom it is ineffective or even harmful. Thus, interventions need to be individualized for

which there is usually only very limited data. In most cases, the original studies did not identify the characteristics of those who were highly successful or those who were unsuccessful. In addition, when working with specific individuals with ADHD, anxiety, and depression, there are multiple possible causes.

Before beginning specific clinical treatment such as neurofeedback or medication, we recommend the following:

1. "Grandmother assessment" that includes an assessment of screen time, physical activity, outdoor sun exposure, and sleep rhythm, as outlined in Part 1 by Peper (2023). Then follow-up with a dietary assessment that investigates the prevalence of organic and nonorganic foods, ingestion of fast foods, ultraprocessed foods, soft drinks, high simple carbohydrate and sugar, salty/sugary/fatty snacks, fruits, vegetables, and eating patterns (eating with family or by themselves in front of screens). Be sure to include an assessment of emotional reactivity and frequency of irritability and "hangryness."
2. If the assessment suggests low levels of organic whole foods and the predominance of ultrarefined foods, it may be possible that the person is deficient in vitamins and minerals. Recommend that the child is tested for vitamin deficiencies. If vitamin deficiencies are identified, recommend supplementing the diet with the necessary vitamins and minerals and encourage eating foods that naturally include these substances (Henry & CNS, 2023).
3. If there is a high level of emotional reactivity and "hangryness," a possible contributing factor could be hypoglycemic rebound from a high simple carbohydrate (sugar) intake or not eating breakfast, combined with hyperventilation (Barr et al., 2019; Engel et al., 1947). Recommend eliminating simple carbohydrate breakfast and fast-food snacks and substitute organic foods that include complex carbohydrates, protein, fats, vegetables, and fruit. Be sure to eat breakfast.
4. Implement "Grandmother Therapy" by having the family and child change their diet to eat a wide variety of organic foods (vegetables, fruits, some fish, meat, and possibly dairy) and eliminate simple carbohydrates and sugars. In time, this diet will reduce nutritional deficits and may eliminate the need for supplements.
5. Concurrent with the stabilization of the physiology, begin psychophysiological treatment strategies such as neurofeedback biofeedback and cognitive behavior therapy.

## Author Disclosure

Authors have no grants, financial interests, or conflicts to disclose.

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