CHAPTER 11

THE UTILIZATION OF VITAMIN-MINERAL THERAPY AS AN INTERVENTIONAL STRATEGY ON LEARNING ABILITIES OF CHILDREN WITH ATTENTION DEFICIT HYPERACTIVE DISORDERS (ADHD)

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Introduction

Vitamins and minerals are biological nutrients contained in food products either in natural or fortified forms. Human beings require these vitamins and minerals in minute quantity for growth, development and daily activities including learning exercises. Vitamins and minerals are essential elements present in all body cells and tissues in varying amounts and chemical forms. Studies have shown that excess, deficiency, or lack of these micronutrients have been attributed to varieties of health, educational and mental problems such as Attention Deficit Hyperactive Disorders (ADHD) (Ihenacho, 2007).

The most common nutritional deficiencies seen in patients with mental dysfunctions such as ADHD are omega–3 fatty acid, B vitamins, minerals and amino acids which are precursors to neurotransmitters (Sathyanarayana, Asha, Ramesh & Jagannatha, 2008). The writers added that low levels of neurotransmitter such as serotonin, dopamine, noradrenaline and γ-aminobutyric acid (GABA) were linked to behavioral problems. Since the problems of ADHD was linked with inconsistency of the brain in processing of sensory information as a result poor neurotransmitters due to irregularities in the bodies' biochemical elements, this study sort for the cheapest and reliable method of managing children with attention deficit hyperactive disorders using vitamins and minerals therapy.

ADHD is a neuro-developmental disorder characterized by inattention, restlessness, short attention span, impulsiveness, frustration, intolerance, distraction and hyperactive behaviours which occur in more than one setting with an increased prevalence (Biedeman & Faraone, 2005). These disorders significantly affect the child's learning and behavioural abilities because for learning to take place the child needs to be attentive, calm, focused, follow instructions, responsive, committed and remember what was taught. Unfortunately, researchers stated that about 3% to 7% of school-aged children are affected with ADHD (Strine, Lesesne, Okoro, McGuire, Chapman, Ballus & Mokad, 2006). In the classroom, children with ADHD are said to be over playful, quarrelsome, impulsive, destructive and unmanageable. They live the classroom with or without permission, distracting both teachers and students and interfering with the learning activities in a

classroom setting (Bloch & Qawasim, 2011). According to Biedeman& Faraone (2005), ADHD disorder persists into adult life and apart from learning disabilities, the disorder is associated with increased risk of antisocial behaviour, substance misuse, poor educational attainment, frequent failure, poor workplace performance, unemployment and friendship difficulties. Also studies have shown that ADHD is among the mental disabilities that have a distinct link to genetic and environmental toxin. Other causes of ADHD include maternal misuse of substances, maternal stress, low birth weight, prematurity and unhealthy nutrition.

The thesis statement of this chapter is hinged on the fact that children with learning disabilities suffer deficiencies in essential vitamin-minerals which result in attention deficit hyperactivity disorders and therefore there is need for them to be provided with these essential vitamin mineral therapies to enhance their learning abilities. To achieve this target, the discussion will begin by identifying the utilization of vitamin-mineral supplementary therapy, challenges of intervention to children with ADHD, intervention strategies on learning abilities of children with ADHD, prospects of utilization of vitamin-mineral therapy on learning abilities of children with ADHD and implications of vitamin-mineral therapy on learning abilities of children with ADHD. Conclusion and suggestions will end the discussion.

Utilization of Vitamin-Mineral Supplementary Therapy

Attention Deficit Hyperactivity Disorder (ADHD) is a neurological syndrome which is characterized by distractibility, impulsivity and restlessness. The role of vitamin-mineral in ADHD has been examined and debated. Significant findings show a link between sugar consumption, food additives, food allergies, vitamin and mineral status and heavy metal toxicity and hyperactive/attention deficit behaviours (Iliades, 2010; Scott, Hunter, Joseph, O'Shea, Hooper & Kuban, 2017). These findings have been largely discredited by the orthodox medical profession, who predominantly support the view that the cause is a biochemical imbalance in the brain which requires medication to rectify. The result of this is a large number of people destined for a life of medication, who claim to 'feel' so much better on the medication, but who are not really treating the underlying mechanisms, nor learning new skills to adapt to their disorder.

Vitamins are vital organic compounds that are primarily acquired through the diet, with the exception of vitamin D, which is synthesised when skin is exposed to sun. Vitamin deficiency may cause severe illness, because of the vitamins' involvement in essential physiological and biochemical processes. For instance, vitamin A is important for growth and development, B vitamins are central in cell metabolism and nucleotide and neurotransmitter synthesis, vitamin D regulates cell and tissue growth and differentiation, and vitamin E plays a role in gene expression and in neurological function (Adebisi, 2018). As these processes are crucial for normal brain development and function, vitamin status and deficiencies may be important in ADHD. It has been reported that serum vitamin D levels are

significantly lower in children and adolescents with ADHD compared with controls (Kamal, Bener & Ehlayel, 2014). Accordingly, nutritional supplements including vitamins have repeatedly been suggested as treatment in ADHD.

There is evidence in literature that a vitamin-mineral supplement reduces ADHD (Rucklidge, Frampton, Gorman & Boggis, 2014), and a vitamin B6-related supplement, metadoxine respectively. In another study, it was found that serum folate levels were significantly higher among adult ADHD patients than controls, whereas there was no statistically significant group difference for vitamin B12 (Karababa, Savas, Selek, Cicek, Cicek & Asoglu, 2014). Owing to the important and neurologically relevant functions of vitamins and the lack of studies exploring this topic in ADHD, the researchers measured serum levels of the major vitamin classes in a sample of adult ADHD patients and controls to determine whether vitamin levels are associated with ADHD diagnosis and psychiatric symptoms.

Polyunsaturated Fatty Acids (PUFAs) are a well-studied complementary treatment for ADHD. Omega-3 fatty acids cannot be synthesized by humans and are required in our diet. In the Western diet, omega-6 fatty acids or their precursors (e.g. linoleic acid) are much more abundant than omega-3 fatty acids or their precursors (e.g. alpha-linoleic acid) (Simopoulos, 2002). A high omega-6 to omega-3 ratio can alter cell membrane properties and increase production of inflammatory mediators because arachidonic acid, an omega 6 fatty acid found in cell membranes, is the precursor of inflammatory eicosanoids, such as prostaglandins and thromboxanes. By contrast, omega-3 fatty acids are anti-inflammatory (Simopoulos, 2002). Therefore, a high dietary omega-6 to omega-3 fatty ratio could promote neuro-inflammation. Increased omega-3 fatty acid concentration in the diet may also act by altering central nervous system cell membrane fluidity and phospholipid composition which may alter the structure and function of the proteins embedded in it (Freeman & Rapaport, 2011). By this mechanism, increased omega-3 fatty acid concentrations in cell membranes have been shown to affect serotonin and dopamine neurotransmission especially in the frontal cortex and may be of importance in ADHD pathogenesis. Omega-3 fatty acids may also potentially act in reducing oxidative stress, which has been demonstrated to be elevated in ADHD (Joseph, Zhang-James, Perl & Faraone, 2013).

An initial meta-analysis involving ten trials including 699 children with ADHD demonstrated a significant benefit of PUFA supplementation compared to placebo. The benefits of PUFA supplementation were small (compared to the effect sizes observed for conventional pharmacological treatments for ADHD, but statistically significant (Bloch & Qawasmi, 2011). Additionally, meta-regression demonstrated a significant relationship between eicosapentaenoic acid (EPA) dose within supplements and measured efficacy (Bloch & Qawasmi, 2011). However, two recent systematic reviews have raised questions regarding the benefits of omega-3 supplementation of ADHD (Gillies, Sinn, Lad, Leach & Ross, 2012; Puri & Martins, 2014). The divergent results of these meta-analyses are attributable to methodological differences from the other systematic reviews. A recent Cochrane

review in the area failed to demonstrate a significant benefit of omega-3 supplementation on most but not all outcome measures for ADHD. As is traditional for Cochrane reviews, the authors did not pool results across different study designs (e.g. crossover vs. parallel-group trials) and this difference in methodology led to comparatively underpowered meta-analyses for many outcomes. Another recent systematic review, by contrast, added additional trials which examined the effects of omega-3 fatty acid supplementation on ADHD symptoms in other clinical populations (e.g. children with reading difficulties, developmental coordination disorders and dyslexia) (Puri & Martins, 2014).

This meta-analysis found a significant benefit of PUFA supplementation but also noted evidence of publication bias in the literature that might be inflating effect estimates. Publication bias was detected through asymmetry in the funnel plot. However, the addition of trials involving subjects with primary diagnoses other than ADHD (included only in this meta-analysis) was likely responsible for asymmetry in the funnel plot (as none of the previous ADHD-only meta-analyses detected funnel plot asymmetry). One particular trial examining ADHD symptoms in children with reading disabilities included a larger number of participants (comprised 24% of the total weight of the meta-analysis) and demonstrated a minimal effect of PUFA supplementation in improving ADHD Inclusion of this large trial is responsible for the funnel plot asymmetry in the meta-analysis. However, it is quite plausible that children with primary reading disabilities would have less benefit from PUFA supplementation in improving ADHD symptoms (because they are secondary to reading difficulties or less severe than in a ADHD clinical population).

Furthermore, melatonin is a hormone secreted primarily by the pineal gland in response to variations in the circadian cycle and has been used for the last two decades for the treatment of sleep disorders in adults and children. In contrast to most available sleep medications, melatonin has little dependence potential, is not associated with habituation and typically produces no hangover. Given its reported hypnotic effects, relatively gentle side-effect profile and over-the-counter availability, melatonin has been widely utilized in the developed countries (Bliwise & Ansari, 2007). Melatonin has been demonstrated in meta-analysis of randomized controlled trials to decrease sleep latency, increase total sleep time and improve sleep quality in both children and adults with primary sleep disorders (Ferracioli-Oda, Qawasmi & Bloch, 2013). Given that sleep problems are common in children with ADHD and are hypothesized to possibly be related to the pathogenesis of the disorder there remains the possibility that melatonin may help improve both sleep problems and ADHD symptoms in children with both conditions. It has been hypothesized that a subset of children with ADHD experience chronic sleep-onset insomnia that leads to excessive daytime sleepiness associated with disinhibition, hyperarousal, and problems with executive function that mimics ADHD.

Moreover, zinc is a cofactor for enzymes that are important for cell membrane stabilization, and in the metabolism of neurotransmitters, melatonin

and prostaglandins. Zinc has indirect effects on dopamine metabolism and antioxidant functions (Arnold & DiSilvestro, 2006). Chinese children with zinc deficiency have demonstrated impaired neuropsychological function and growth that improved with zinc repletion (Sandstead, Penland & Alcock, 1998). Symptoms of zinc deficiency can include inattention, jitters and delayed cognitive development, which mimic the symptoms of ADHD. Zinc intake is primarily from the diet and its main sources include red meat, poultry, beans, fortified breakfast cereals and dairy products. Zinc deficiencies can be due to insufficient dietary intake or malabsorption (diarrhea, lack of intestinal absorption, liver or kidney disease, sickle-cell anemia or other chronic disease).

Randomized, placebo-controlled trials of zinc supplementation either as an adjunct to psychostimulant treatment or as monotherapy have provided conflicting evidence of efficacy. These discrepant results are likely related to differences in underlying study quality and prevalence of zinc deficiency in the study populations (Arnold & DiSilvestro, 2006). A more recent randomized, placebo-controlled trial examined the addition of zinc sulfate 10mg/day (compared to placebo) as an adjunct to methylphenidate (0.3mg/kg/d) in 40 Chilean children with ADHD (Zamora, Velasquez, Troncoso, Barra, Guajardo & Castillo-Duran, 2011). This trial demonstrated no significant differences between zinc supplementation and placebo on attentional measures but did demonstrate a trend towards greater improvement with zinc supplementation on Connor's attentional measures that did not reach statistical significance. Zinc plasma levels were normal in the sample at baseline and decreased throughout the trial in both the placebo and zinc supplementation groups.

A randomized, placebo-controlled trial examining the efficacy of zinc glycinate (15–30mg/day) monotherapy over 8 weeks in 52 American children with ADHD (Arnold, Disilvestro & Bozzolo, 2011), failed to demonstrate any benefit of zinc supplementation over the 8 weeks of treatment on any ADHD rating scales. Additionally, measures of zinc were not appreciably affected by supplementation. However, when children were given d-amphetamine over the next five weeks of the trial lower doses of d-amphetamine (37% reduction compared to placebo) were needed to achieve the same clinical effects in the zinc supplementation group. Taken together, these data suggest zinc supplementation may be a reasonable treatment option in areas where zinc deficiencies are common, in patients with demonstrated (or at a high risk) for zinc deficiency.

Challenges of Intervention to Children with ADHD

Children who have difficulties paying attention in class face the risk of poor grades and even school failure. Inattention may be a symptom of an underlying condition such as Attention Deficit Hyperactivity Disorder. However, teachers should not overlook other possible explanations for children task not done. It could be, for example, that a child who does not seem to be paying attention is actually mismatched to instruction (the work is too hard or too easy) or preoccupied by

anxious thoughts (DuPaul & Ervin, 1996). It is important to note that children with ADHD are influenced by factors in their classroom setting and that these children's level of attention is at least partly determined by the learning environment. Teachers who focus on making their instruction orderly, predictable, and highly motivating would find that they can generally hold the attention of their children most of the time, enabling them to get their work done.

Moreover, the behaviour of children with ADHD is characterised by poor sustained attention, impaired impulse control, an inability to delay gratification and excessive task-avoidance and irrelevant activity. Children may often fidget with their hands or feet, appear restless, leave their seat in the classroom or in other situations in which remaining seated is expected, may run about or climb excessively in situations where it is inappropriate, thereby leading to writing tasks non completion (Thapar, Cooper, Jefferies & Stergiakouli, 2012).

Intervention Strategies on Learning Abilities of Children with ADHD

Determining whether a child has ADHD entails a comprehensive, multi-step process. No single test can diagnose ADHD, and ruling out other problems (such as learning disabilities, anxiety, and depression) that may present with similar symptoms is important. Also important is ruling out poor academic instruction; neurological, sensory, or motor impairment; and an intellectual disability or emotional disturbance as causes for a child's inattention, hyperactivity, and impulsivity (Barkley, 2006). A multimodal approach utilizing information obtained from multiple sources, including parents, teachers, and clinicians is recommended (DuPaul & Stoner, 2003). A behavioural assessment approach is typically employed in the evaluation of ADHD where multiple methods of data collection are employed across informants and settings. For example, information regarding a child's behaviour is typically collected from first-hand observations of his or her performance across multiple settings and under variant task conditions in conjunction with interviews and questionnaires completed by the child's parents and teachers. School psychologists have direct access to these sources of information and data (e.g., teachers, observations of child behaviour in the school setting). In fact, problems with attention and behavioural control are the most common reasons for referral to school psychologists. Therefore, school psychologists may be called upon to determine whether referred children qualify for services under this category.

The American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders (DSM-5) (2013) is used by mental health professionals to help diagnose ADHD. The DSM-5 replaces the previous version, the text revision of the fourth edition (American Psychiatric Association, 2000). This diagnostic standard helps to ensure that people are appropriately diagnosed and treated for ADHD. In addition, the use of DSM criteria helps structure assessment in a standardized fashion, which may increase inter-professional agreement regarding an ADHD diagnosis (DuPaul & Stoner, 2003). The DSM approach also presents with several

limitations, however. For example, the DSM was developed in the context of the medical model which implies that the problem exists within the child. This characterization diminishes the role or importance of environmental variables that may often serve as triggers to children with ADHD.

Furthermore, the use of a psychiatric classification system and diagnostic labels may compromise a child's self-esteem and make him or her feel disordered (DuPaul & Stoner, 2003). The American Psychiatric Association (2013) identified several symptoms of inattention, hyperactivity, and impulsivity in the DSM-5. For children up to age 16 years, six or more of the symptoms listed must be present for at least 6 months to a degree that is considered disruptive and developmentally inappropriate. According to the American Psychiatric Association (2013), symptoms of inattention include failing to give close attention to details or making careless mistakes in schoolwork, at work, or with other activities; trouble holding attention on tasks or play activities; not listening when spoken to directly; not following through on instructions and failing to finish school work, chores, or duties in the workplace (e.g., loses focus, side-tracked); trouble organizing tasks and activities; avoiding, disliking, or being reluctant to do tasks that require mental effort over a long period of time, such as schoolwork or homework; losing supplies necessary for tasks and activities (e.g., school materials, pencils, books, tools, keys, paperwork, mobile telephones); being easily distracted; and being forgetful in daily activities.

Moreover, symptoms of hyperactivity and impulsivity include fidgeting with or tapping hands or feet, or squirming in seat; leaving seat in situations when remaining seated is expected; running about or climbing in situations where doing so is not appropriate (adolescents or adults may be limited to feeling restless); being unable to play or take part in leisure activities quietly; being "on the go" or acting as if "driven by a motor;" talking excessively; blurting out an answer before a question has been completed; having difficulty waiting his or her turn; and interrupting or intruding on others (e.g., butting into conversations or games). In addition, several symptoms must be present before age 12 years that cause significant impairment of functioning in two or more settings (e.g. home, school). Based on the types of symptoms, three presentations of ADHD may occur: i. Predominantly Inattentive Presentation; ii. Predominantly Hyperactive-Impulsive Presentation; and iii. Combined Presentation in which symptom criteria of inattention and hyperactivity-impulsivity are both met (American Psychiatric Association, 2013).

Prospects of Utilization of Vitamin-Mineral Therapy on Learning Abilities of Children with ADHD

The prospects of using vitamin-mineral therapy on learning abilities of children with ADHD cannot be overemphasized. A range of nutrients have been linked to brain development and functioning. Thus diet may be a relevant factor in the high incidence and prevalence of mental disorders. According to

Sathyanarayana, Asha, Ramesh & Jagannatha (2008), growing evidence suggests that nutrients, diet and other lifestyle factors may play a role in the pathophysiology and management of mental disorders including ADHD. The researchers added that major dietary compounds proposed to be helpful in the treatment of ADHD include micronutrients such as minerals, vitamins and polyunsaturated fatty acids. These elements occur in very small amounts usually less than 1 to 10 parts per million. Thus, absence or deficiency of these elements in the body may result in stunted growth, mental disorders, learning disabilities and hyperactivity. Several studies have demonstrated reduced blood levels of various minerals such as magnesium, iron and zinc in children with ADHD and their supplementation may reduce ADHD symptoms in individuals with respective deficiencies (Lange, 2020).

Vitamins-mineral elements are needed in minute quantities for the proper growth, development and physiology of the human organism. They are required in maintaining proper physical functioning. The intervention involves the use of micronutrients such as vitamins B1, B2, B3, B6, folic acid and macro-elements like zinc, magnesium, calcium, iron and sodium (Sathyanarayana, Asha, Ramesh & Jagannatha, (2008). The presence of vitamins B1, B2, B3, B6, folic acid, zinc, magnesium, calcium, iron, sodium and so on, either in excess, absence or low amount of them could alter several metabolic pathways in the human body system including those with ADHD (Ihenacho, 2007). The writer posited that abnormality of the level of vitamin-mineral in the body also affect the attention and focus of children in the class room, leading to poor academic achievement. Consequently, vitamin-mineral supplementation was presumed to improve attention and help normalize biochemical markers in children with ADHD. The expectation is that when supplementation is given, vitamins and minerals will to reactivate the body cells, including the brain and sense organs, facilitate production of neurotransmitters as well as improves focus and attention, enhance learning, improve the child’s eating habit and ability to complete routine task (Sathyanarayana, Asha, Ramesh, & Jagannatha, 2008).

The importance of vitamins and minerals elements simply could not be overstated. Vitamin and minerals elements are the fundamental elements that form the bones, tissues and biochemical elements in the body. Taking good multivitamin and mineral supplements daily is essential. Villagomez and Ramtekkar (2014) stated that dietary supplements containing phenyl alanine and/or tyrosine cause alertness and arousal. Methionine combines with adenosine triphosphate (ATP) to produce S-adenosylmethionine (SAM), which facilitates the production of neurotransmitters in the brain. Researchers attribute the decline in the consumption of omega-3 fatty acids from fish and other sources in most populations to an increasing trend in the incidence of major behavioral disorders (Sathyanarayana, Asha, Ramesh & Jagannatha, 2008). The researchers added that omega-3 fatty acids, eicosapentaenoic acid (EPA) which the body converts into docosahexanoic acid (DHA), found in fish oil, have been found to elicit behavioural effects in humans. Also, randomized, controlled trials that involve folate and vitamin B12 suggest that patients treated with 0.8 mg of folic acid/day or 0.4 mg of vitamin B12/day will exhibit decreased behavioural symptoms.

A study conducted by Adebisi (2018), revealed that, of all the areas of vitamin – mineral elements tested, all the children were deficient in vitamin and minerals as a result of the low or reduced vitamin – mineral levels as tested by Quantum Magnetic Resonance Image Analyzer (QMRIA). His finding revealed that post-test vitamin – mineral levels of children in the experimental group have better improvement on vitamin – mineral levels, as a result of vitamin-mineral supplementation than children in the control group. The study also found that there were significant differences in the copying task performances and learning behaviours of the two groups, as a result of the intervention which resulted in the children's better class performance and reduced learning behaviour problems of children with ASD in the experimental group.

The study conducted by Landaas, Aarsland, Ulvik, Halmøy, Ueland & Haavik (2016), indicated that lower concentrations of vitamins B2, B6 and B9 were associated with the ADHD diagnosis, and B2 and B6 also with symptom severity. Arnold, Hurt & Lofthouse (2013), discovered that children with learning disabilities are found to be more deficient in iron more than those without learning disabilities. Moreso, low level of iron in children with learning disabilities are found to be responsible for their low cognitive functions and academic performance. It also found that there were significant differences in the iron deficient status between children with and without learning disabilities. There were also significant differences in the cognitive functions between children with and without learning disabilities, that is, children with iron deficiency and without iron deficiency.

Similarly, a study conducted by Ndoh (2021),revealed that vitamin-mineral supplementation indicated significant effect on copying, tracing, colouring and drawing tasks at post-test. This meant that there was significant effect between the experimental and control groups on all writing tasks scores. The size or the

magnitude of the effect of the intervention falls above 0.8, thus, the finding has very large effect, meaning that, its clinical value has a significant result. The experimental group reported improvement over the control group on all writing tasks performance scores. Since the intervention resulted in significant improvements on all writing task scores after two months, the researcher deduced that vitamin-mineral supplementation resulted in an increase in all writing tasks classroom performance of children with ADHD at post-test.

Implications of Vitamin-Mineral Therapy on Learning Abilities of Children with ADHD

In order to ensure that attention deficit hyperactivity disorders are prevented and by extension people with learning disabilities are effectively treated, the benefits of using vitamin-mineral therapy will be drawn up as implications of the discussions. They are listed below:

1. From the thesis statement, it was evident that hyperactivity in whatever level was a serious behavioural problem that needs appropriate action that vitamin-mineral supplements can solve in order to give parents considerable relief in the management of children with learning disabilities.
2. The administration of trace elements such as Vitamins B1, B2, B3, B5, B12, E, folic acid, zinc, iron, calcium, and magnesium are helpful in the treatment of attention deficit hyperactivity disorders.
3. A substantial effort towards addressing the problems that children with learning disabilities encounter in their learning process will help in boosting the overall learning capabilities of the younger generation and enhance the prospects of future working population.

Suggestions

1. There is need for educational intervention for children with learning disabilities.
2. To effectively address the plight of children with learning disabilities, the problem of attention deficit hyperactivity disorder should be effectively tackled.
3. Vitamin-mineral therapy has shown great prospects in tackling the menace of attention deficit hyperactivity disorder.
4. Children with learning disabilities will experience greater transformation in their learning capabilities if due attention is given to their vitamin-mineral status, and adequate administration is given to address these areas of deficiencies.
5. The intake of vitamin-minerals could help reduce the inattention, restlessness of the children, improve eating habit and consequently learning capabilities.
6. Educational interventions should be run concurrently with clinical or medical intervention for adequate improvement.

7. Teachers as care givers should be aware that the use of vitamin-mineral supplementation could be an adjunct intervention to aid classroom tasks, when appropriate behaviours are improved.
8. Government should assist in the purchase and acquisition of vitamin-mineral supplements in order to aid the treatment on children affected with ADHD problems.

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