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Review Article

Dietary regulation for children with autism: Is it important?

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Abstract

Autism is a kind of pervasive developmental disorder that is related to many behavioral problems including perception, communication, motor development, and social disorder. World Health Organization (WHO) estimates that about six in 1,000 children world wide are affected by an autism spectrum disorder. Nutritional regulation is one of the main concerns of children with autism due to many problems in the biochemical process, digestion process, and food allergy. Food selection in autistic children is not different from any other normal children, following standard requirement of a balanced diet, by implementing specific elimination and supplementation diet. There are many indications for dietary regulation in autistic children including developmental disorder, obvious digestion problems, and atopic signs. Implementing dietary regulation is not free from problems, inclusive of child factor, parent factor, and external factor.

Keywords: autism, child health, diet, nutrition

1. Introduction

Autism is a kind of pervasive developmental disorder that is related to many behavioral problems including perception, communication, motor development, and social disorder [1]. All of these problems appeared before three years in three main aspects, made up of social interaction, communication, and limited as well as repetitive behavior [2].

Autism made up the biggest contribution to developmental disorder prevalence. United States Center for Disease Control (CDC) reported that the autism cases ratio in eight years old children is 1:59 by 2014 [3]. World Health Organization (WHO) also released the statement explaining that about six in 1,000 children worldwide are affected by an autism spectrum disorder. In our country, Indonesia, WHO stated that the ratio is even higher, reaching eight in 1,000 children, comparable with 134,000 estimated cases by 2015 [4].

Nutritional regulation is one of the main concerns of children with autism. It is shown by some studies that nutrient deficiency and heavy metal exposure will lead to neurological changes and activating the oxidative stress cascade. Recent studies also showed metabolic profile abnormalities in autistic children. Sulfation, glutathione, methylation, and oxidative stress is a normal process of the biochemical pathway in a normal person, but not in autistic patients, related to many psychological problems [5-7]. Besides disturbing the biochemical process, 60% of autistic children also have a defective digestive system causing an alteration to digest food. In Indonesia, a study of 200 children with autistic symptoms demonstrated that all participants were affected by multiple food allergies, the majority (95%) is afflicted

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with cow milk (casein) and wheat (gluten) allergy [8]. Faulty digestion, combined with a food allergy could lead to brain damage and worsened autism symptoms. It can be concluded that food regulation is really important for this special population [9].

2. Food Regulation for Autistic Children

Nutrition is a considerable factor affiliated with autism cases in children. It is related to the synaptic formation and neuronal plasticity demanding good nutrient supply. In the pathophysiology of autism spectrum disorder (ASD), all of these processes are disrupted. We can take the example from vitamin and mineral supplementation function for brain biochemistry due to its function as coenzymes. Neurotransmitter generation (e.g. dopamine and serotonin) is regulated by nutrient precursor availability [10].

Food selection in autistic children is not different from any other normal children, following standard requirements of a balanced diet. However, dietary intervention in an autistic patient is needed to suppress autism symptoms, halt or delay degenerative processes, giving good nutritional status, and thus improving their quality of life [11]. Supplementation of specific vitamins, minerals, and other nutrients can be considered for bettering the autism condition. This is a sustainable process, like a marathon, not a sprint, but significantly advantageous for depressing ASD manifestation [12].

In addition to providing better nutritional support, dietary arrangements are also needed to prevent food allergies. Food allergy causes embarrassing complications, because of its systemic effects, including abnormal brain functions. As a consequence, developmental and behavioral problems appear, such as concentration problems, emotional problems, and worsening ASD symptoms [13]. The beneficial effects of dietary regulation adjustment in the ASD patient can be viewed from two big groups, elimination and supplementation diet.

3. Elimination Diet

Past research showed that gluten and casein elimination from ASD patient diet is valuable for improving behavioral problems, increasing cognitive function, and correcting social relationships [14]. One acceptable hypothesis is relating that phenomenon with incapability of ASD patients to digest gluten and casein due to dipeptidyl-peptidase IV (DPP-IV) enzyme insufficiency. DPP-IV is responsible for breaking the peptide bond after the proline group which leads to imperfect nutrient absorption through increased intestinal permeability (leaky gut syndrome) [15]. Abnormal cytokine production is also generated in this condition, contributing to the defective immunology pathway and deteriorating central nervous system. Gluten and casein, due to its structural similarity with an opiate, can enter the blood-brain barrier, conferring language and social delay in addition to withdrawal behavior [16]. With the high discipline of gluten-free and casein-free diet implementation, gastrointestinal problems are suppressed, communication, speaking, attention, and focus improved, hyperactive behavior concealed, and sleep problems extinguished [17]. However, it is still controversial and needs to be evaluated in a better manner due to data inconsistency.

The ketogenic diet is an elimination diet used for controlling ASD symptoms. Ketogenic diet usage is based on its method which is relying on ketone bodies instead of carbohydrates (in ASD patients, carbohydrate digestion problem is common) as the main source of energy. Along with that condition, this method is believed to reversing abnormality of cerebrocortical inhibition/excitation and activating social exploratory neuronal function in many regions of the brain, but not related to monoamine neurotransmitter (norepinephrine only) [18]. Mitochondria function is also positively affected by this diet [19]. The effectiveness of the ketogenic diet is mainly observed in the female patient which shows improvement in repetitive behavior and sociability [20].

Result from Sanlier et al. tried to evaluate many different elimination diet effects on the autistic patient. It is stated that the best performance of children assessed by their parents is achieved by implementing a specific carbohydrate diet (71% well-functioning) and gluten-casein-free diet (69% well-functioning) [21].

4. Supplementation Diet

There are many available supplementation methods for autistic children, including vitamin, mineral, probiotic, and so on. All of these types of supplementation showed different benefits in many aspects of the psychological status of the autistic patient [22].

Vitamin A supplementation in the form of Codfish (*Gadus morhua*) oil is recommended for improving ASD symptoms. It is based on vitamin A function for cell growth and protecting epithelial integrity, especially in the intestine, causing better nutrient digestion and assimilation [23].

Probiotic supplementation in the form of *Bifidobacterium* (*bifidum*, *breve*) and *Lactobacillus* (*acidophilus*, *casei*) is related to immunity and vitamin production augmentation in addition to enhancing nutrient absorption [24]. A recent study on mice showed that selective reintroduction of specialized probiotic compound (*Lactobacillus reuteri*) can repair gut microbiota changes and ameliorating behavioral problems (same measures as observed in ASD patients) in high-fat diet animal model [25].

Long-chain Omega-3 Polyunsaturated Fatty Acids (PUFAs) addition is believed to be useful for ASD children. As shown from some studies investigating ASD patients, blood omega-3 level is low or omega-6 PUFA/omega-3 ratio is higher than found in normal children [26-28]. PUFA deficiency is hypothesized to induce autistic behavior (hyperactivity, aggression, and stereotypic habits) associated with pro-inflammatory cytokine cumulation, escalation of oxidative process and neurotransmitter imbalance (cholinergic, GABAergic, and dopaminergic neurotransmission in conjunction with a diminished level of serotonin in the prefrontal cortex) [29-31]. Omega-3 PUFA supplementation is also related to neuroinflammation regulation, microglia activity, and synaptic plasticity although future research with a longer period of follow-up is still needed [32].

Antioxidant, like carotenoids (vitamin A derivative), vitamin C (ascorbic acid), vitamin B6 (pyridoxine, in combination with magnesium), vitamin B12 (cobalamin), folic acid, vitamin E (α -tocopherol), copper, manganese, selenium, zinc, and flavonoid (quercetin and luteolin) can affect autistic symptoms [33]. These compounds' functions are linked to autism mechanism which is dependent on the oxidative process [34] causing neuronal and brain structural disturbance, inflammation and immune function disruption [34,35]. They are augmenting speech, eye contact, and social response meanwhile decreasing aggression and stereotypic behavior [22].

Curcumin is reported to positively affect autism treatment as a result of glutathione (GSH) increase and suppressing inflammatory component. Animal studies confirmed that curcumin supplementation is responsible for fixing core ASD-related symptoms by conquering tumor necrosis factor-alpha (TNF- α) and matrix metalloproteinase 9 (MMP-9) production. Observed results including neurological, behavioral, biochemical, and molecular changes are associated with ASD phenotype [36].

5. Indication and Implementation of Dietary Regulation

Indication for dietary supplementation in children with autism includes one of these signs: (I) severe speech disorder, (II) observed developmental deterioration after one year of age, (III) defecation disorder, (IV) often feel thirsty, (V) atopic signs including allergic shiner, atopic dermatitis, and eczema [37]. Diet implementation must be done progressively. If it is not done gradually, the withdrawal effect would come into effect. For a gluten-free casein-free diet, Sunderland protocol is the guidance. This diet is divided into three steps, (I) case free, (II) preliminary agreement, and (III) active reconstruction [37].

6. Problems for Applying Nutritional Regulation

An elimination diet (gluten-free casein-free diet) faces many problems in its implementation. Problems are related to child factors (refusing to eat, picky eaters, inability to consume new food, temper tantrum, and slow chewing ability), parental factors (inadequate knowledge to prepare suitable food and deficient source for implementing the diet), and external factors (school problems, drug effects) [38]. The parents' role, especially for the mother is really important for dietary regulation in autistic children due to high dependence to their moms [39].

7. Conclusion

Nutritional regulation is the main concern in autistic children. Food choice for children with autism the same as normal children, following a balanced diet guide. There are two kinds of proposed diets in autistic children, namely the elimination diet (gluten-free casein-free) and supplementation diet (vitamin, mineral, antioxidant). The problem in diet regulation including picky eaters' children, inadequate parents' knowledge for preparing suitable food, school problems, and sparse supply for implementing the diet.

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Conflict of interest

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