



(REVIEW ARTICLE)



Correlation of The Gluten-Free Diet and Caries in Children with Attention Deficit Hyperactivity Disorder (ADHD)

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Abstract

Background: ADHD children exhibit a higher risk of dental caries due to dietary factors, irregular eating patterns, and challenges in maintaining proper oral hygiene. A gluten-free diet is one dietary intervention that has gained attention in managing ADHD symptoms.

Purpose: Investigates the potential relationship between gluten-free diets and caries in children with ADHD.

Reviews: Several studies suggest that children with ADHD on a gluten-free diet may have a lower risk of dental caries due to reduced carbohydrates. Improved dietary habits and enhanced oral hygiene may contribute. However, the impact varies based on diet, oral care, and genetics. The availability of gluten-free products with added sugars poses a potential risk to dental health, emphasizing the importance of considering overall dietary patterns.

Conclusion: The increased adoption of gluten-free diets can reducing the risk of dental caries in children with ADHD, but further research is needed to validate the potential relationship between that.

Keywords: ADHD; Children with ADHD; Caries; Oral Health; Gluten-Free Diet; Dietary Intervention

1. Introduction

Attention deficit hyperactivity disorder (ADHD) is a chronic neurobehavioral developmental disorder, as defined by the DSM-5. It is characterized by a persistent and pervasive pattern of inattention and/or hyperactivity-impulsivity that is associated with significant functional impairment and frequently occurs with other emotional, behavioral, and learning problems^{1,2}. Based on a systematic review of 102 studies, it has been found that 1 out of every 19 individuals worldwide is affected by ADHD³. However, as of now, there is no precise data available regarding the number of individuals with ADHD in Indonesia. Research on ADHD is limited to specific regions and has not yet been integrated⁴. One example is a study conducted in 2013 involving 992 students from the East Padang District, Padang, which reported an ADHD prevalence rate of 8%⁵. Males receive diagnoses 3 to 6 times more frequently than females. However, there is a belief that ADHD might often go undiagnosed in females due to variations in the clinical presentation of symptoms⁶.

The impact of the three combinations of ADHD symptoms disrupts physical development and functioning, leading to suffering and hindrance in the daily lives of children with ADHD⁷. One of them is their lack of ability to clean their own oral cavity, which increases the risk factors for oral health problems. Oral health problems in children with ADHD

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include increased risk of cavities (dental caries), poor dental hygiene, bruxism, dietary habits, medication side effects, behavioral challenges, and overall health impact⁶.

Children with ADHD typically exhibit a higher occurrence of dental caries, as indicated by several studies that have noted that these children are twice as likely to fall into the high caries risk category. This increased likelihood can be attributed to their notably elevated consumption of carbohydrates, irregular eating schedules, and less systematic and shorter-duration tooth brushing due to the symptoms of ADHD⁸. Hence, for managing children with ADHD, dietary intervention is an encouraging approach⁹. Among these interventions is the implementation of a gluten-free diet (GFD) to mitigate hyperactivity¹⁰.

Diet doesn't solely influence ADHD symptoms; it can also impact one's oral health, which in turn can affect overall body health⁸. A GFD is assumed to correlate with caries in ADHD children, and therefore this review addresses this issue.

2. Reviews

2.1. Understanding ADHD: Characteristics, Comorbidities, and Challenges

ADHD is a neurobiological disorder that typically appears in childhood but can persist into adolescence and adulthood¹¹. The main characteristics of ADHD include difficulties regulating attention, impulsivity, and hyperactivity. Attention difficulties are defined as trouble maintaining focus on tasks or activities that require concentration, often being fidgety, easily distracted by external stimuli, and frequently losing personal belongings. Impulsivity refers to actions taken without considering their consequences, difficulty in delaying gratification, and quick, unplanned reactions. Meanwhile, hyperactivity is defined as a high level of physical activity, such as running or moving incessantly, even in situations that require calmness¹². ADHD has significant comorbidity potential with disorders such as depression, anxiety, and learning difficulties, which can have long-term negative impacts. Adults with a history of ADHD during childhood tend to have higher rates of accidents, injuries, health problems, pregnancy issues, as well as job and marriage difficulties compared to adults without a history of ADHD. Therefore, early detection and diagnosis of ADHD are crucial for addressing these challenges¹¹.

To date, the exact cause of ADHD is not known. However, the interaction of genetic and neurobiological factors consistently contributes to the development of ADHD^{13,14}. Environmental aspects, both biological and psychosocial, have been extensively studied as one of the risk factors for ADHD. The idea that certain foods can exacerbate ADHD symptoms has received significant attention¹⁵. Several studies have attempted to link the consumption of specific foods, such as artificial colorings, artificial sweeteners, and high-sugar foods, to increased ADHD symptoms in children, particularly hyperactivity¹⁶. Furthermore, some children with ADHD may have allergies or intolerances to certain foods that can affect their behavior. Monitoring potential allergy-causing foods can be helpful¹⁷. Therefore, improving dietary patterns, also known as dietary therapy, is a promising option for children with ADHD⁹. Dietary management is a therapy that can facilitate other treatment outcomes, such as pharmacological and non-pharmacological interventions. Nutritional therapy or diets commonly used in ADHD management include elimination diets (including GFD), trial diets, mediterranean diets, keto modifications, and so on¹⁶.

2.2. Exploring Gluten-Free Diets as a Dietary Therapy for ADHD

Gluten is a protein derived from wheat flour and is often found in the form of grains such as wheat, barley, and oats, or in dishes that contain hidden gluten, such as bread, cakes, cookies, and more. Gluten is a complex protein that is insoluble in water and acts as a structural component in the formation of the framework of products¹⁸. For children with ADHD, there are several considerations that motivate the choice of a gluten-free diet (GFD), such as the potential sensitivity to gluten, the presence of anxiety symptoms or sensory processing disorders, and behavioral changes. Some studies suggest that a small number of children with ADHD may have undiagnosed sensitivity to gluten or wheat allergies⁹. In some cases, gluten consumption can lead to intestinal inflammation and gastrointestinal symptoms, which in turn can affect behavior and concentration¹⁹. Foods containing gluten can form gliadorphins, affecting the central nervous system and causing hyperactivity. Children with ADHD experience changes in gut microbiome composition that can hinder the production of digestive enzymes. Complex proteins such as gluten cannot be effectively digested, resulting in the production of opioid peptides known as gliadorphins. Gliadorphins can impact neurotransmitter activity, such as dopamine and serotonin, which play a role in exacerbating ADHD symptoms¹⁹. By eliminating gluten, they may experience more stable and sustained attention spans, leading to improved academic and daily life performance²⁰. Some children with ADHD also experience sensory processing disorders or have anxiety symptoms that can worsen their response to certain foods, including gluten²¹. Eliminating these potential triggers can lead to a reduction in anxiety and stress, promoting a calmer and more balanced emotional state²⁰. Hyperactivity due to gluten is not only manifested in

physical movements but also in emotions, such as anger, tantrums, and sleep disturbances²². With a GFD, self-confidence of ADHD children may get better. The removal of gluten-containing foods from their diet may lead to reduced discomfort or adverse reactions, contributing to a sense of well-being and self-assuredness in these children²⁰.

2.3. Gluten-Free Diet Impact on Oral Health in ADHD Children

Dental health is crucial for a person's overall well-being. There are various factors contributing to an individual's dental health, including diet. ADHD children have special characteristics of oral health conditions²³. Oral health conditions commonly found in ADHD children include caries, periodontitis, gingivitis, xerostomia, dental trauma, and poor oral hygiene. Data show that caries occur mostly to ADHD children compared to normal children due to cariogenic diet, high physical activity levels and impulsive behavior, difficulty accessing dental care, side effects from stimulant medications, and poor oral hygiene²⁴. The significant functional impairments in children with ADHD require parents to provide support in various daily activities, including maintaining dental and oral health and managing their dietary patterns, such as implementing a GFD⁸.

A gluten-free diet (GFD), which often means reducing the consumption of foods and beverages containing added sugars, tends to have a lower risk of dental caries (tooth decay) compared to children who do not follow a GFD²⁵. Additionally, GFD often involve the consumption of better sources of calcium, such as dairy products and green vegetables. This can have a positive impact on children's dental health²⁶. While a GFD can have benefits for children, there is potential for nutritional deficiencies if the diet is not well-balanced. Deficiencies in certain minerals and vitamins, such as calcium, vitamin D, and vitamin B, can affect the dental and bone health of children because calcium is crucial for the formation and maintenance of strong tooth enamel. Therefore, in its implementation, it is important to consult with a medical professional or nutrition expert to manage it safely and in a balanced way so that children with ADHD can still receive all the necessary nutrients for their growth and development²⁷.

A GFD can provide physical and psychological benefits for children with ADHD and for those at risk of suffering from celiac disease, dermatitis herpetiformis, and gluten sensitivity²⁸. With a GFD, self-confidence, focus, and concentration may get better, and anxiety and stress may get lower. Beyond these psychological benefits, a GFD can improve the overall health of children with ADHD. It can positively influence metabolic health by encouraging the consumption of healthier food choices. In summary, a GFD has the potential to enhance ADHD children's overall physical and psychological well-being, promoting better metabolic and oral health²⁰.

3. Discussion

This review questions whether a gluten-free diet (GFD) is correlated with caries in children with ADHD. It showed a GFD greatly affects the lower risk of caries. Caries is a dental and oral health problem that often occurs in ADHD children. Gluten diet, especially wheat flour, contains a lot of starch, namely carbohydrates and protein. In a GFD, there are changes in the carbohydrate composition that can have implications for dental health. Several studies have indicated that carbohydrate consumption in a GFD may undergo alterations. A reduction in carbohydrate intake in a GFD is closely associated with the risk of dental caries in children with ADHD. Carbohydrates are most commonly linked to dental caries because they are cariogenic in nature. Acidogenic bacteria such as *Streptococcus mutans*, which are generally found in dental plaque, have the ability to decompose sucrose into lactic acid through a fermentation process. The presence of this acid dissolves hydroxyapatite crystal structure in enamel and dentin or is called demineralization. By reducing carbohydrates in implementing a GFD, the risk of caries in ADHD children also decreases^{10,29}. The problem above is also proven in previous studies reporting that in 30 children with celiac disease who followed a GFD, there was a decrease in the prevalence of dental caries compared to the group that did not follow a GFD³⁰. Similar studies also found a substantial difference in dental caries between the study group and the control group, with celiac disease children who followed the GFD experiencing fewer dental caries than those who did not³¹. A statistically significant difference in dmft values was also seen between the groups that had previously and recently applied GFD, according to another study³². A carefully managed GFD can make children with ADHD more diet-conscious by allowing them to have a low-cariogenic diet that affects their oral health³³.

The present study found that children receiving a GFD had a lower degree of dental plaque³⁰. Gluten is a protein complex consisting of gliadin and glutenin components that impart viscoelastic properties and insolubility in water¹⁸. This property makes foods or substances containing gluten more resistant to saliva, leading to increased retention on the tooth surfaces³⁴. Additionally, due to ADHD symptoms, significantly higher carbohydrate intake, irregular eating patterns, and compulsive consumption of cariogenic snacks between more frequent meals can also contribute to increased plaque accumulation and gingival inflammation⁹.

According to a study, several individuals said that adopting a gluten-free diet improved their oral health³⁵. Another study mentions that the group who followed a GFD had significantly better oral hygiene habits than the other groups³⁰. This explains that a GFD can also improve oral hygiene habits in children with ADHD, which are typically poor due to the symptoms of ADHD itself. ADHD symptoms, such as a lack of attention, impulsivity, and executive function disorders, can lead to a less systematic and shorter duration of tooth brushing, thereby affecting the development of caries⁹.

Some individuals who follow a GFD also tend to consume healthier natural foods such as vegetables, fruits, meat, and fish²⁶. This dietary pattern can support dental health and provide the necessary nutrients to maintain strong teeth and gums³⁶. Furthermore, those who adopt a GFD may switch to alternative sweeteners like xylitol or sorbitol in the food products or candies they consume. Some of these alternative sweeteners have been associated with benefits in preventing tooth decay³⁷. Consuming gluten can cause intestinal inflammation and other digestive disorders. Therefore, when gluten is eliminated from the diet of children with ADHD, we can assume that the intestinal inflammation and digestive disorders associated with gluten may decrease. Reducing intestinal inflammation and improving nutrient absorption may play a role in improving dental health. Intestinal inflammation can disrupt the absorption of nutrients that are important for dental health, such as calcium and vitamin D. Calcium is an important component in the formation and maintenance of tooth enamel, while vitamin D plays a role in the absorption of calcium. Thus, improving nutrient absorption can help strengthen the teeth of children with ADHD, reducing the risk of tooth decay²⁷.

A GFD often involves cutting out foods and drinks that contain added sugar. This can also help reduce the risk of tooth decay. However, there are many products marketed as gluten-free foods contain added sugars to enhance taste and texture³⁸. When the nutritional values of the 25 product pairings were compared, research was done, and it was found that all gluten-free foods had greater average quantities of calories, total carbohydrates, and total sugar³⁹. Excessive sugar consumption is one of the major risk factors for tooth decay because it can trigger the colonization of bacteria that lead to the demineralization process. Therefore, if someone on a GFD consumes a lot of high-sugar substitute products, their risk of cavities can still increase²⁵. Like many aspects of health, individual responses to the risk of cavities can vary. There are many factors that can influence dental health, including genetics, dietary habits, dental care, and environmental factors. In assessing dental health, it's important to consider an individual's overall dietary patterns and dental care habits, not just whether they are following a GFD or not^{8,9}.

ADHD children are at higher risk of several oral health problems compared to normal children. For example, they have poor oral hygiene habits, which may increase their caries index^{8,9}. Therefore, oral health needs to be a priority for daily activities as it can improve health in general. Well-maintained oral health vigorously results in various biological functions, considering caries that affects the symptoms of ADHD children^{8,9}.

Nevertheless, it is essential to acknowledge that the available evidence supporting the connection between a GFD and dental caries in children with ADHD remains limited. Some existing studies may have constraints, such as small sample sizes or insufficient controls. Thus, further research with more robust study designs is imperative to substantiate these findings. Moreover, the effects of a GFD may differ among individuals. While some children with ADHD may experience substantial advantages, others may not. This diversity needs to be considered when contemplating clinical implications. In essence, despite the potential of a GFD to impact the caries index of children with ADHD, it is crucial to recognize that the existing evidence is still in its nascent stages, warranting further research to ascertain the extent of potential benefits. A more profound conclusion drawn from these findings is that the potential relationship between a GFD and the caries index of children with ADHD lays the foundation for further considerations. The implications of these findings can be highly diverse. Parents of children with ADHD should recognize that diet plays a role in the oral health of their children. Understanding the potential benefits of a GFD in reducing the risk of dental caries can offer valuable insights. However, it is crucial to consult with healthcare professionals before making significant dietary changes for their children. This underscores the importance of a personalized approach, considering that the benefits of a GFD may vary among individuals. For dental healthcare practitioners, these findings emphasize the importance of understanding the dietary impact on the oral health of children with ADHD. This insight can influence treatment recommendations and advice provided to patients. Dental professionals may contemplate offering additional information regarding the benefits of a GFD for caries prevention to patients with ADHD or their parents. However, practitioners must also acknowledge that each patient is a unique individual, and responses to dietary changes may differ.

4. Conclusion

These findings present an opportunity to enhance the understanding of the relationship between a GFD and the caries index of children with ADHD. Nonetheless, further research is required to validate these findings and identify practical recommendations that can assist parents and dental healthcare practitioners in caring for children with ADHD.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest to be disclosed.

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