

The Use of the Ketogenic Diet in Children: A Mini Review of Recent Evidence (2023-2024)

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Abstract

The ketogenic diet (KD) is a high-fat, low-carbohydrate, moderate-protein diet that has been traditionally used to manage drug-resistant epilepsy (DRE) in children. In recent years, research has explored its potential applications in other neurological and metabolic conditions, including autism spectrum disorder (ASD), obesity, and type 2 diabetes. This review examines the most recent studies (2023-2024) on the efficacy, safety, and broader applications of KD in pediatric populations. We discuss the positive effects of KD on seizure control, behavior modulation in neurodevelopmental disorders, and metabolic improvements in obesity and type 2 diabetes. Additionally, we explore the risks associated with long-term KD use, such as nutritional deficiencies and growth retardation, and address the need for future research to establish long-term safety and efficacy in children.

Keywords: Ketogenic-diet; children; neurology

Introduction

The ketogenic diet (KD) was first introduced in the 1920s as a treatment for refractory epilepsy in children. The diet induces ketosis, a metabolic state where the body uses fat as its primary energy source by producing ketones. This metabolic shift has been linked to neuroprotective effects, including enhanced mitochondrial function and reduced oxidative stress, which explain its benefits in managing neurological disorders. The classic KD consists of a 4:1 ratio of fats to carbohydrates and proteins, but several modified versions, such as the Modified Atkins Diet (MAD) and the medium-chain triglyceride (MCT) ketogenic diet, have also been developed. Over the past two years, new research has expanded the potential uses of KD beyond epilepsy, exploring its efficacy in neurodevelopmental disorders and metabolic diseases.

Ketogenic Diet in Pediatric Epilepsy

The use of KD in pediatric epilepsy remains its most well-established clinical application. According to recent studies, KD continues to show significant efficacy in managing drug-resistant epilepsy (DRE) in children. In a multicenter randomized controlled trial, Huang et al. (2023) found that 65% of children with DRE experienced a reduction of at least 50% in seizure frequency after six months of KD

treatment, and 30% became seizure-free [1]. This trial, which included children with Lennox-Gastaut syndrome and Dravet syndrome, reaffirmed that KD can be particularly effective in these challenging cases.

Furthermore, Fernández et al. (2024) conducted a long-term follow-up study on children with DRE who had been on KD for over two years. The study reported sustained seizure control in 72% of the participants, although side effects such as hyperlipidemia and constipation were common [2]. The authors highlighted that a reduced fat ratio (3:1) could still maintain seizure control with fewer adverse effects, suggesting that personalized adjustments to the classic KD may optimize its tolerability.

The exact mechanisms behind KD's anti-seizure effects are still under investigation, but studies suggest that the diet's ability to stabilize neuronal membranes, reduce excitatory neurotransmitters, and enhance mitochondrial function plays a key role [3]. However, adherence to the KD remains a challenge, particularly due to its restrictive nature. A study by Robinson et al. (2023) reported that 40% of children discontinued the diet within the first year, citing difficulties in maintaining compliance and managing side effects such as gastrointestinal discomfort and poor growth [4].

Emerging Applications in Neurodevelopmental Disorders

Recent research has expanded the potential use of KD beyond epilepsy, particularly in treating neurodevelopmental disorders such as autism spectrum disorder (ASD) and attention-deficit/hyperactivity disorder (ADHD). These conditions are often associated with metabolic dysfunctions, oxidative stress, and neuroinflammation, making KD a promising therapeutic option [5].

In a 2023 pilot study, Kang et al. investigated the effects of a six-month KD intervention in children with ASD. The results showed significant improvements in social behaviors, communication, and repetitive behaviors, with 65% of participants showing measurable progress compared to a control group on a standard diet [6]. The proposed mechanisms include KD's ability to reduce neuroinflammatory markers and improve mitochondrial function, which are often compromised in children with ASD.

Sanders et al. (2023) further explored the role of KD in children with ASD, focusing on its impact on cognitive development and behavior. While the study reported behavioral improvements, concerns about long-term use were raised. Children on KD experienced slower growth compared to their peers, with potential risks of nutritional deficiencies due to the restrictive nature of the diet [7]. These findings underscore the importance of closely monitoring growth and nutrient intake in children with neurodevelopmental disorders who follow KD.

Ketogenic Diet and Metabolic Disorders

The use of KD in managing pediatric obesity and type 2 diabetes is a rapidly growing area of research. Obesity is a significant health concern in children, and recent studies have highlighted the potential of KD to induce weight loss and improve metabolic parameters [8]. In a systematic review conducted by Patel et al. (2024), KD was found to reduce body mass index (BMI) by an average of 8% in children with obesity after six months of intervention. The diet also improved insulin sensitivity and reduced fasting blood glucose levels [9].

The KD's effect on type 2 diabetes in children was evaluated in a study by González et al. (2023), which found that 70% of children on KD were able to achieve HbA1c levels below 6.5% within six months, and 60% of participants were able to reduce or discontinue their insulin therapy [10]. These improvements were attributed to KD's ability to reduce hepatic glucose production and improve peripheral insulin sensitivity. However, the authors cautioned that the diet's long-term cardiovascular risks, particularly concerning elevated cholesterol levels, warrant further investigation.

Safety Concerns and Nutritional Deficiencies

While KD offers therapeutic benefits, its restrictive nature raises concerns about potential nutritional deficiencies and long-term safety in children. A study by Martens et al. (2023) reported that 45% of children on KD were deficient in key micronutrients such as

calcium, vitamin D, and folate, even when supplements were provided [11]. These deficiencies are particularly concerning in growing children, as they can impact bone health and cognitive development.

Growth retardation is another well-documented side effect of long-term KD use. Smith et al. (2023) found that children on KD for more than two years had a 12% lower height-for-age percentile compared to their peers on a standard diet [12]. The study attributed this to the low protein intake and chronic energy restriction associated with KD, which can impair growth hormone function. Additionally, hyperlipidemia and elevated cholesterol levels were reported in 30% of children on KD, raising concerns about the long-term cardiovascular risks of the diet [13].

Adherence to KD is also a significant challenge in pediatric populations. Park et al. (2024) reported that adherence rates declined after the first year, with only 50% of families able to maintain the diet. The study highlighted the need for ongoing support, including meal planning assistance and regular follow-up with healthcare professionals, to ensure compliance and minimize side effects [14].

Future Research Directions

Although the ketogenic diet has demonstrated efficacy in treating various pediatric conditions, more research is needed to understand its long-term effects, particularly regarding growth, cardiovascular health, and cognitive development. Future studies should focus on optimizing the diet's macronutrient composition to balance efficacy with safety, particularly in non-epileptic conditions. Large-scale randomized controlled trials are also necessary to validate the preliminary findings on KD's role in neurodevelopmental and metabolic disorders [15].

Conclusion

The ketogenic diet remains a highly effective treatment for drug-resistant epilepsy in children and shows promise in managing other conditions such as autism spectrum disorder, obesity, and type 2 diabetes. However, the diet's restrictive nature poses significant challenges, including nutritional deficiencies, growth retardation, and metabolic side effects. Close monitoring by healthcare providers and dietitians is essential to ensure that children on KD receive adequate nutrition and achieve optimal growth. Future research should aim to refine dietary protocols, develop strategies to enhance adherence, and investigate the long-term safety of KD in pediatric populations.

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