



RESEARCH ARTICLE

THE INFLUENCE OF SUGAR CONSUMPTION ON AGGRESSION AND HYPERACTIVITY IN CHILDREN

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ARTICLE INFO

Article History

Received 30th January, 2025

Received in revised form

17th February, 2025

Accepted 26th March, 2025

Published online 30th April, 2025

Keywords:

High Sugar Consumption, Mental Health, Hyperactivity, Aggression, Children.

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ABSTRACT

It is widely acknowledged that poor diet quality, or an unhealthy dietary behaviour, is a key risk factor for various chronic diseases in children and adolescents, such as obesity, diabetes and cardiovascular diseases. Rising concerns over childhood nutrition and behavioural disorders have intensified research into dietary influences on child development. High sugar intake, prevalent in processed foods and sugary beverages, has been hypothesized to exacerbate aggressive tendencies and hyperactivity symptoms among children. Therefore, the present review aims at understanding the relationship between sugar consumption and behavioural outcomes, like aggression and hyperactivity, in children. This review includes the findings from epidemiological studies, clinical trials, and experimental research to suggest that there is a correlation between excessive sugar consumption and increased behavioural issues, including irritability, impulsivity, and aggression. Proposed mechanisms include rapid fluctuations in blood glucose levels, insulin response, and the impact of sugar on neurotransmitter regulation, particularly dopamine and serotonin pathways, which influence mood and behaviour. Additionally, sugar-induced inflammation and gut microbiota imbalances have been implicated in behavioural disturbances. These physiological changes may contribute to emotional instability and impulsive behaviour, further complicating the understanding of sugar's impact on child behaviour. Therefore, this review emphasizes the need for more thorough, long-term studies to better understand the complex link between sugar intake and behaviour. Gaining insight into these relationships is essential for public health efforts focused on improving children's mental health and overall quality of life. Reducing high sugar consumption could help decrease aggression and hyperactivity in children.

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Citation: Sampada Agnihotri, Mansi Mehta, Shonima Venugopal, Devanshi Gandhi. 2025. "The influence of sugar consumption on aggression and hyperactivity in children." International Journal of Recent Advances in Multidisciplinary Research, 12, (04), 11107-11109.

INTRODUCTION

In recent decades, a significant transformation has transpired, progressively altering the dietary, hydration, and mobility patterns of the worldwide population, resulting in a conflict with human biology that has led to substantial alterations in body composition. Urbanization has contributed to global obesity, with overweight and obesity more prevalent in low- and middle-income nations. A major concern is childhood obesity, which correlates with an increased risk of premature mortality and impairment in adulthood. Overweight and obese children are more likely to stay obese into adulthood and to develop non-communicable diseases (NCDs) like diabetes and cardiovascular diseases at a younger age (WHO, 2020). The International Association for the Study of Obesity (IASO) and International Obesity Task Force (IOTF) reckon that 200 million school children worldwide are either overweight or obese. Obesity and metabolic syndrome have

been associated with the increased consumption of easily available processed foods coupled with sedentary lifestyle (Popkin B. et al, 2012). A low dietary diversity superimposed with poor quality monotonous diets is a major problem that results in micronutrient deficiencies. It has both short-term consequences, such as mortality, morbidity, disability and long-term consequences, such as stunting, impaired cognitive ability, poor economic productivity, poor reproductive performance, increased metabolic and cardiovascular diseases, and intergenerational consequences (National Institutes of Health (NIH), 2015 and Global Nutrition Report 2015). This highlights the severe implications of consuming unhealthy diets. Also, Malik V.S. et al. (2019) and Park M. et al. (2012) have reported that consuming sugar-sweetened beverages (SSBs) in excess raises the risk of several chronic illnesses, including high blood pressure and cardiometabolic disorders. Beverages that have added caloric sugar with little to no other nutritional value are referred to as

SSBs (WHO, 2020). Consumption of SSBs is a major cause of excess sugar in diets among children and adolescents, and it can result in a number of health problems, including diabetes, dental caries, and unhealthy weight increase (WHO, 2021). Additionally, poorer academic achievement and sedentary lifestyles have been linked to high sugar consumption in children and adolescents (Park S. *et al*, 2012). In addition to metabolic health concerns like obesity, diabetes, and cardiovascular disease, significant increases in the consumption of high-sugar meals such as processed foods, sweetened beverages, and sweets have also been linked to mental health disorders. It is interesting to note that people frequently turn to sweets for comfort and enjoyment, and numerous studies have revealed that those who consume a lot of sugar have a higher risk of mental illnesses like melancholy (Kose J. *et al*, 2021). Anxiety and depression are the most prevalent mental illnesses, affecting over 970 million people worldwide (GBD 2019 Mental Disorders Collaborators, 2022). According to the WHO (2023), 4% of people worldwide suffer from anxiety, while 5% of adults worldwide suffer from depression.

The Impact of High Sugar Intake on Mental Health:

Evidence suggests that excessive intake of products high in added sugars might play a role in altering the body's stress regulation systems. Specifically, overconsumption of sugar has been proposed to enhance the reactivity of the hypothalamus–pituitary–adrenocortical (HPA) axis, a critical system involved in the stress response. This heightened activity can lead to an increase in glucocorticoid levels, such as cortisol, which, if sustained over time, may result in the long-term dysregulation of the stress response system. Such dysregulation has been implicated in the development and exacerbation of various mental health conditions, including anxiety and depression (Harrell C. *et al.*, 2015). Moreover, sugar present in processed meals may induce increased release of proinflammatory cytokines, resulting in inflammation, and is positively connected with the prevalence of depression (Otero-Losada M. *et al*, 2016). Overconsumption of sugar can lead to weight gain and fat accumulation, factors that may exacerbate HPA axis dysregulation. When the HPA axis becomes hyperactive, it results in elevated levels of glucocorticoids, such as cortisol, which are known to influence mood, cognitive function, and stress regulation. Chronic activation of this axis due to obesity-related metabolic changes may contribute to an increased vulnerability to mental health conditions such as depression and anxiety (Dionysopoulou S. *et al.*, 2021). Therefore, the interplay between obesity, systemic inflammation, and HPA axis dysfunction creates a complex physiological environment that may further heighten the risk of developing mental health disorders.

High sugar consumption from SSBs and fructose consumption was associated with poor childhood cognitive performance (Berger P. *et al*, 2020) along with social-emotional development (Gao H. *et al*, 2022) and impairments in brain tissue (Berger P. *et al*, 2021; Cohen *et al*, 2018). Consuming high levels of sugar were found to have an association with functional and structural neurological impairments (neuroinflammation and hippocampal impairment in particular) over a 4-to-6-week period in adolescents as well as adults (Hamelin H. *et al*, 2022; Hsu T. *et al*, 2015). Zhang and colleagues (2022) conducted a cross-sectional survey on 13–18-year-old adolescents (n=1427) and reported that an increased consumption of SSBs led to a reduction in working

memory and cognitive flexibility. SSBs also encourage aggressive behaviour. Neuropeptides and neurotransmitters have been implicated in influencing aggressive behaviours. A study conducted by Choi *et al.* (2017) in mice investigated the long-term impact of SSBs on social aggression. SSBs were observed to significantly enhance social aggression, along with elevation in blood corticosterone levels and diminished body weight. SSBs substantially dysregulated transcriptional networks associated with immune function. An elevated quantity of inflammatory cells in peripheral blood was noted in mice administered sucrose solution.

Reducing SSB consumption in children and adolescents has been recognized as a priority in health plans and strategies of governments worldwide due to the short-term and long-term negative health effects of excessive SSB consumption (Koplan J. *et al*, 2005). In light of this, the World Health Organization (WHO) has issued guidelines suggesting that consumption of free sugar should not exceed 10% of daily energy intake, and ideally not exceed 5%. This includes sugar from SSBs, whose intake should be strictly limited (WHO Guidelines: sugars intake for adults and children, 2021).

CONCLUSION

A notable rise in the consumption of unhealthy diets, especially those containing food with high amounts of sugar, like processed foods, sweets, and sweetened drinks, has been associated with mental health issues along with metabolic health issues like obesity, diabetes, and heart disease. Clinical and psychological research focussed on mental health conditions like anxiety and depression, in case of children and adolescents, indicates that excessive consumption of food products with high amounts of added sugars may contribute to changes in the body's stress-reduction mechanisms. Overconsumption of sugar has also been found to be linked with an increase in behavioural problems like hyperactivity and aggression, and also with poor memory and cognitive function in children, through various neurological mechanisms. However, further long term, and more comprehensive research is required to fully comprehend this intricate relationship. For public health initiatives aimed at enhancing the mental health and general quality of life of children, understanding these links, and lowering the intake of sugar, including that from SSBs, is crucial.

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