Artificial sweeteners and their association with Diabetes: A review.

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Abstract

Over a century ago, Artificial Sweeteners (AS) were developed as food additives to provide sweetness without the associated high caloric content of sugar. The United States Food and Drug Administration (FDA) have approved five artificial sweeteners: aspartame, saccharin, acesulfame potassium, neotame and sucralose. These sweeteners have also been deemed safe for people with diabetes and are used to reduce both caloric and carbohydrate intake. However, despite the widespread consumption of artificial sweeteners by lean, overweight and obese individuals alike, obesity and diabetes continue to dramatically rise. This review examines the relationship between artificial sweeteners and diabetes and the need for continued investigation into the consumption of artificial sweeteners.

Introduction

Artificial Sweeteners (AS) are used as food additives in the United States, as sugar alternatives. AS are sweeter than sugar and contain few to zero calories [1]. Although, AS sound like a great alternative, recent research has shown that chronic consumption can lead to an altered glucose metabolism [2]. Consumption of AS has been associated with an increased risk of weight gain, obesity and type II diabetes [3].

There are two types of diabetes mellitus: type I and type II. Type I diabetes is an autoimmune condition usually diagnosed in childhood or adolescence. Type II diabetes is caused by insulin resistance and is more common in obese patients [4]. Type II diabetes was once thought to be diagnosed mostly in adults but has recently become a common diagnosis in obese children and adolescents, as well [5].

An estimated twenty-three million people, or seven percent of the United States population have been diagnosed with diabetes mellitus. Of those diagnosed, only five percent have type 1 diabetes, while type II diabetes accounts for the other ninety-five percent [6].

The classic Hippocrates triad of diabetes symptoms includes, but is not limited to: polydipsia, polyuria and polyphagia [7]. Other various signs and symptoms of diabetes include: fatigue, poor wound healing, visual changes, numbness or tingling [4], unexplained weight loss, infections, as well as Acanthosis nigricans [8]. Obesity is a key risk factor for the development of diabetes [5]. The United States Preventative Task Force (USPTF) recommends screening for diabetes in all patients from ages forty to seventy who are overweight or obese [4].

Methodology

An electronic literature review search was performed on PubMed, Google Scholar, and MedLine Plus. The search was limited to peer-reviewed articles published from January 1, 1996 until 2018. The articles were elected if the publication included keywords, including but not limited to: artificial sweeteners, diabetes, obesity, non-caloric artificial sweeteners, sugar substitutes, and non-nutritive sweeteners. Articles were then reviewed and included based on the applicability to the topic.

Artificial sweeteners

Aspartame

Since the FDA of the United States Department of Health and Human Services recognized aspartame as safe for use human consumption, it has gained popularity as an alternative to sucrose [9]. Aspartame is a white, odorless powder that is two hundred times sweeter than sucrose and readily dissolves in water. Although it is a low caloric sweetener and has no effect on glycemic control, diabetic patients are advised to consume only minimal quantity as studies have shown that aspartame has both harmful and beneficial effects on the lifestyle and metabolism of diabetic patients who depend on it [9]. Particularly, aspartame has been linked to the exacerbation of diabetes, headache, seizures, depression, arthritis and other medical conditions [10]. Other research shows a relationship between the use of artificial sweeteners in diabetes and obesity [11]. One study was able to show a gradient of risk as a function after many years of consumption and per the packs

consumed each day. Artificial sweeteners may not be a healthy alternative [12].

Saccharin

Saccharin is an artificial sweetener that has been widely accepted as a sugar substitute. It is three hundred to five hundred times sweeter than sucrose and is the most important and widely used sweetener, especially for diabetic patients, as it goes directly through the human digestive system without being digested [13,14]. Although, saccharin has been extensively investigated, most of research has produced conflicting reports. Studies have shown that consumption of larger amounts of saccharin results in reduced hyperinsulinemia, a decrease in the resistance of insulin and improvement in the overall control of blood sugar in mice subjects compared to control subjects [15]. In contrast, other research studies have shown an association between consumption of saccharin and an increased accumulation of body fat, despite decreased caloric intake, increased food intake and weight gain [16]. A research study conducted by Suez et al. indicates that regular consumption of artificial sweeteners has been seen to alter glucose tolerance by altering gut flora [17]. Suez et al. also report that at the FDA recommended dose of 5 mg/kg [18], saccharine showed the highest level of alteration in glucose intolerance in both lean and obese mice when compared with control models [17]. Furthermore, treating the test models with antibiotics resulted in the resolution of glucose tolerance [17,18]. Another study has shown that there is a correlation between the sweetness of saccharin and metabolic syndromes, such as glucose intolerance leading to obesity and diabetes mellitus [19]. Although, it is widely accepted as a sugar substitute, consumption of saccharin should be in adherent to the FDA recommended approved daily limit [20]. Furthermore, consumers should be aware of its risks and benefits, as several reports have shown association with bladder cancer, as well as incidents of other cancers [13].

Acesulfame potassium

Acesulfame potassium is an artificial sweetener that is two hundred times sweeter than sucrose and it was accepted by the FDA as an all-purpose sweetener in 2003 [21]. Acesulfame potassium has no glycemic effects by itself and is widely available commercially under brand names such as sweet and safe and Sunett. It is not metabolized in the body and therefore, it is excreted by the kidney unchanged [21]. No studies were found that met the criteria with acesulfame.

Neotame

Neotame was approved by the FDA as a general-purpose sweetener in 2002 [20]. It is not available commercially and it is only used in food manufacturing. It is over seven thousand times sweeter than sucrose. No studies were found that met the criteria with neotame.

Sucralose

Sucralose is a derivative of sucrose and is a high intensity sweetener [22]. Various studies have been done to investigate the safety of sucralose and the results of these studies demonstrate the safety of sucralose for human consumption [22]. Of note, a study investigated the effect of daily sucralose consumption on glycemic control in patients with type 2 diabetics. This study found no significant difference in hemoglobin A1c (HbA1c) - a measure of blood sugar/glucose that is attached to hemoglobin, fasting plasma glucose, or fasting serum C-peptide changes from baseline between the study group and control group [23]. Furthermore, they reported a decrease in blood glucose and HbA1C were reported to have decreased during the study period in the sucralose group [24].

Summary

The effect of artificial sweeteners on human metabolism and their role in diabetes is controversial amongst the research community and its educators. Of the five artificial sweeteners discussed: aspartame, saccharin, acesulfame, neotame, and sucralose, the FDA approves and supports their uses when consumed under the recommended guidelines [21]. Artificial sweeteners may not be a healthy alternative, as noted by a research study that showed a gradient risk after many years of consumption and per the quantity of AS consumed each day [11, 12]. Consumption of AS above the recommend FDA guidelines may have catastrophic effects and may play a larger role in the development of obesity, leading to diabetes [25]. Both healthcare professionals and individuals with diabetes can benefit from learning more about AS to help make informed decisions about their uses based on available evidence [21]. As various limitations exist in clinical study designs, further exploration is required with well-designed large-scale studies in the general population to perhaps determine AS role in diabetes [25].

Conclusion

Since AS has been reported to be associated with an increased risk of weight gain, obesity and type II diabetes, there is the need to continue monitoring the impact of consumption on consumer diet, as well as further researching the adequate health and nutrition reference standards needed for their quantity and healthy consumption.

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