

Research on the Effects of High Fructose Corn Syrup on the Fatty Liver Disease and Cardiovascular Disease

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Abstract. Excessive intake of added sugars and fructose has been associated with leading to adverse health outcomes. This article reviews the effects of sugar intake in a variety of ways, categorized as increased body weight fat, fatty liver (NAFLD), and cardiovascular-related diseases in humans. The analysis showed that decreasing consumption of sugar and sugar products significantly reduced weight, whereas increasing consumption of sugar and sugar products, especially from sugary beverages, led to weight gain. In addition, excessive intake of high sugar is associated with the accumulation of liver fat, a key factor contributing to the increased incidence of fatty liver. The findings highlight the key role of fructose, especially from high fructose corn syrup, in promoting metabolic dysfunction. In conclusion, reducing intake of added sugars is critical to preventing chronic disease and improving public health. Subsequent studies should explore individual differences in response to sugar metabolism and the long-term effects of interventions for small intakes of sugar.

Keywords: Body weight, Fatty liver disease (NAFLD), Cardiovascular disease (CVD), High fructose corn syrup (HFCS).

1. Introduction

Since humans are born with a strong liking for sweetness, the discussion around the health dangers of sugar, fructose, and high fructose corn syrup (HFCS) really reflects the reality that these compounds are of concern due to their sweet taste. The debate would not arise if fructose, HFCS, and sugar had no sweet taste since their intake would be much lower.

The relationship between sugar intake and global health problems has become a hot research topic in nutrition and public health research in recent years. With the change in dietary patterns, the association between the intake of sugar and chronic illnesses like obesity and diabetes has increasingly been apparent, particularly with the rise in the ingestion of sugary foods and drinks. Numerous studies have demonstrated that consuming too much added sugar can have a negative impact on a range of health outcomes, including metabolism. The exact process by which sugar influences human wellness and the degree of damage wrought by various forms of sugar remain somewhat debatable, though. Thus, in order to provide a theoretical foundation for future research into the intricate mechanisms underlying sugar's health effects, this paper will undertake a systematic review of the body of literature currently in publication, concentrating on the effects of sugar on metabolic health, cardiovascular disease, obesity, and related chronic diseases. The significance of this study lies in its potential to clarify the nuanced

health effects of different types of sugar, including the much-debated high fructose corn syrup and fructose, thereby offering more precise guidelines for dietary recommendations. This study seeks to give a thorough knowledge of how different sugars affect chronic diseases by summarizing existing research, which will aid in the creation of more potent public health initiatives to avoid diet-related disorders.

2. Health risks associated with sugar intake

Newborns are sensitive to sweetness and this preference is further enhanced as they grow through childhood. Early exposure to potent sweeteners may even exacerbate "cravings" for sweets, thereby influencing long-term eating behavior[1]. "Some element of nutrition or behavior is going to be responsible for gaining weight because human beings are biologic and our fundamental DNA cannot be altered in such a brief amount of time"[2].

Reducing dietary sugar intake was linked to an average weight loss of 0.80 kg, according to a meta-analysis of people on an ad libitum diet; increasing sugar intake was linked to an average weight gain of 0.75 kg. Additionally, the exchange of starch for sugar under isoenergetic conditions did not influence body weight. Therefore, changing sugar intake alone would directly affect body weight unless other nutrient intake changed. Furthermore, a study on beverages sweetened with sugar revealed that over the course of a year, individuals with the greatest consumption gained 1.55 kg more than those with the lowest intake. Thus, the researchers came to the conclusion that consuming free sweets or drinks sweetened with sugar on an ad libitum basis influences overall calorie intake, which in turn causes variations in body weight[3]. In another meta-analysis, there was a direct correlation between the gross domestic product and the rates of urbanization in over 75 nations and the use of animal products and sugar. Multiple regression models revealed that consumption of sugar ($P = 0.03$), physical inactivity ($P = 0.003$), and cereal eating ($P < 0.001$) were significant predictors of obesity. These scientists came to the conclusion that sedentary lifestyles and excessive sugar intake are linked to a higher risk of obesity.[4].

Another survey of 75 countries showed that annual per capita consumption of soft drinks worldwide expanded in 2010 from 9.5 gallons in 1997 to 11.4 gallons. The study discovered that for every 1 percent increase in soft drink usage, there would be 48 more obesity in adults, 2.3 more individuals who are obese and 0.3 more individuals with diabetes per 100 persons. This pattern is still notable in nations with low or middle incomes, highlighting the detrimental effects of increased sugar consumption on the likelihood of being overweight or obese.[5].

Although fructose originates from a variety of sources, high fructose corn syrup first brought it to prominence. Fructose in any sugar is equally harmful, whether it's in drinks or solid foods. Over the past 40 years, a number of studies have demonstrated that the total number of calories in our meals has grown, especially from drinks.[6-9].

According to a recent meta-analysis, adding fructose to the diet increased weight gain in controlled trials unless it was combined with a decrease in the amount of calories from other sources. That is, additional caloric intake from fructose can trigger weight gain if it is not cut by other calories[10]. High fructose corn syrup, on the other hand, is the primary source of fructose ingestion; it is frequently found in drink mixes and fruit juice concentrates.

3. Health risks associated with fructose

The relationship between sugary drinks and Obesity has two distinct processes involved. First, sugary drinks increase total calorie intake. As studies have shown, the addition of fructose without reducing other energy sources tends to lead to weight gain [11,12]. Multiple meta-analyses support this view. Next, Because they don't work to successfully reduce the consumption of other foods, calories from drinks are sometimes seen as "extra" calories that can't be made up for by consuming less other foods, which raises the risk of obesity. Secondly, beverages are not effective in reducing calorie intake from other foods to prevent weight gain. As a result, the calories in beverages are often considered "extra" calories, further increasing the risk of obesity.

About half of sucrose and high fructose corn syrup are composed of fructose. While the fructose within sucrose can have a significant impact on obesity as well as other health issues, high intake of fructose appears to have especially severe adverse effects on health. Fructose is the sweetest of all natural sugars; it tastes sweet and is found naturally in fruits and some vegetables. It has been a part of the human diet in modest proportions for millennia. As previously mentioned, added sugars make up approximately 75 percent of Americans food and drinks, with glucose-fortified corn syrup primarily serving as a sugar substitute in sugary beverages, yogurt, and certain other meals categories. But during the 1980s, the general intake of fructose has increased substantially due to the increasing usage of added sugars. Observations clearly link excessive fructose intake to fatty liver, a health problem that has significantly increased in both the United States and Europe[13].

A number of brief clinical studies have yielded important information about the metabolic effects of consuming fructose from caloric drinks. In a preliminary investigation, Cohen and Schall [14] examined the effects of glucose, fructose, and sucrose on plasma triglycerides and discovered that postprandial triglyceride levels were considerably raised by both sucrose and equivalent quantities of fructose, whereas glucose did not have this effect. Thus, they concluded that fructose, either on its own or combined with sucrose (table sugar), was the main cause of elevated triglycerides, not glucose. Another 10-week trial found that fructose significantly raised triglycerides, especially at night, when drinks with twenty-five percent of the calories coming from fructose vs 25 percent from glucose were consumed[15]. In addition, the study showed increased body fat synthesis (adipogenesis from head) in those who consumed fructose-containing beverages, and most notably, a significant increase in the storage of visceral fat, which has the highest association with cardiovascular disease risk. Fructose intake for just 10 weeks produced these effects, while glucose intake did not show similar results [16,17]. In a third trial, the metabolic consequences of consuming one liter of various beverages each day—the equivalent of two 16-ounce glasses of Coke, Diet Coke, milk, or water—were compared.

According to many research, consuming sugar-filled colas for six months raised triglycerides, visceral fat, muscle fat, and liver fat in comparison to other beverages. Thus, the risk of fatty liver and metabolic syndrome rose by drinking two 16-ounce sugary cola drinks daily for as little as six months, while this risk did not rise when drinking milk, water, or beverages containing aspartame. The following graph illustrates the negative effects on health and combines the data into a model[18-21].

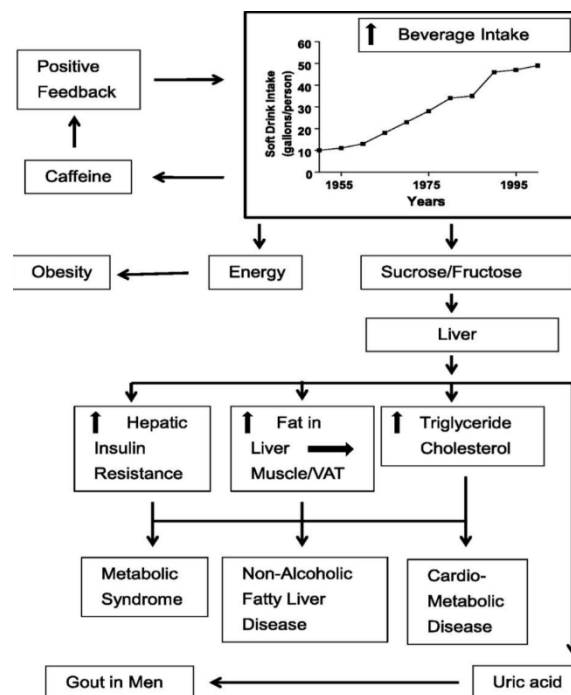


Figure 1. The graph of model

The model illustrates a few possible outcomes of raising the calorie consumption of beverages containing fructose and sugar, or HFCS. Visceral Adipose Tissue, or VAT.

People widely recognize the excessive consumption of drinks sweetened with sugar and other drinks sweetened with sugar[17, 23, 24, 25, 26] is a primary cause of higher calorie and fructose consumption, which is crucial for the emergence of obesity and the metabolic effects covered in this article.[27]. Sugar-sweetened beverages not only provide a large number of "empty calories", but also provide the basis for excessive fructose intake. It is quickly converted into fat and raises insulin resistance; this is one of the main causes of obesity and metabolic diseases. It is processed in the liver.

At the same time, the caffeine often contained in these beverages may further enhance the frequency of beverage consumption by stimulating the central nervous system, creating a positive feedback mechanism that drives consumers to consume more sugary beverages. Interestingly, studies have indicated that caffeine may be moderately addictive, which may contribute to the high frequency of beverage consumption. For this reason, the U.S. Food and Drug Administration (FDA) is now investigating the use of caffeine.

Studies have also shown that even just three weeks of drinks sweetened with sugar intake is enough to change an individual's fat metabolism as evidenced by variations in the levels of high-density lipoprotein (HDL) and low-density lipoprotein (LDL), two significant indicators of cardiovascular health that are frequently closely linked to an increased risk of cardiovascular disease.[28, 29]. These results emphasize even more the damaging consequences of long-term use of sugary drinks on the cardiovascular system.

In addition, this study, along with that of Aeberli et al. [30], further reveals the specific function of fructose in causing hepatic impairment. Compared to glucose, fructose has a different metabolic route that is mostly processed in the liver and its metabolites are more easily converted to fat for the liver's storage, which raises the risk of non-alcoholic fatty liver disease (NAFLD). The increasing global prevalence of NAFLD has recognized excessive fructose intake as a significant contributing factor to the disease. Furthermore, fructose has a high correlation with the development of the metabolic syndrome, a metabolic condition that comprises dyslipidemia, hypertension, insulin resistance, and obesity and is becoming a global public health concern.[31, 32].

In summary, the widespread drinking liquids sweetened with sugar not only raises the chance of obesity and metabolic disorders through energy and fructose intake, but the presence of caffeine in the beverages may also exacerbate the severity of the problem by facilitating dependent intake. Numerous pieces of data indicate that the detrimental impacts of fructose on the liver and overall health during metabolism cannot be ignored. This particularly contributes significantly to the rising incidence of metabolic syndrome and non-alcoholic fatty liver disease. Therefore, limiting the use of drinks with added sugar and reducing the excessive consumption of fructose are important for the prevention of several metabolic disorders associated with obesity. Meanwhile, Future research should examine fructose's metabolic pathways in greater detail in order to better understand how it contributes to the onset of chronic illnesses and to inform public health initiatives.

4. Relevant findings and discussion

Initially, concerning weight change, several research investigations have verified that consuming more sugar is favorably linked to gaining weight. Specifically, consuming additional sugars and beverages sweetened with sugar greatly augments the likelihood of gaining weight. According to meta-analyses, eating less sugar results in an average weight reduction of 0.80 kg, whereas eating more sugar causes an average weight increase of 0.75 kg. Ad libitum settings are used to determine these trends.

Secondly, in terms of metabolic health, the negative consequences of a diet heavy in fructose on metabolic health were particularly significant, especially as additional fructose intake greatly elevated the chance of obesity without reducing other energy sources. Studies have also found that fructose consumption is strongly connected to a higher prevalence of fatty liver.

Finally, it talks about fructose's specific effects. While both glucose and fructose in sucrose affect body weight and metabolic health, excessive fructose consumption has been found to have a particularly

noticeable impact on liver health, resulting in a marked rise in the frequency of fatty liver, particularly in the US and Europe.

The findings of a substantial body of research on the harmful consequences of consuming a lot of sugar are corroborated by the findings of this study. Firstly, there is a clear correlation between weight increase and metabolic problems and excessive sugar consumption, particularly with added sugar. This shows that avoiding obesity and maintaining a healthy body weight both depend on limiting added sugar intake.

In addition, the specific role of fructose in metabolic health deserves further attention. Compared with other sugars, the fructose metabolism process is more burdensome to the liver and tends to cause fat to build up in the liver. This ultimately causes non-alcoholic fatty liver disease (NAFLD) to develop. This outcome aligns with the research findings in the existing literature, suggesting that excessive fructose intake is one of the important factors contributing to fatty liver. Despite its limited use as a primary sweetener in certain foods, the extensive usage of fructose corn syrup exacerbates the increase in fructose intake.

Notably, although sugar intake is closely linked to a number of health issues, individual metabolic responses vary from person to person. Therefore, future studies should further explore differences in sensitivity to sugar intake in different populations and the long-term effects of reduced sugar intake on different metabolic phenotypes. Overall, for the purpose of controlling weight, preventing metabolic diseases, and lowering cardiovascular risk, it is important to limit the consumption of added sugars, especially sugary drinks and high-fructose meals.

5. Discussion

The study's findings support the conclusions of a large body of literature on the negative health implications of consuming a lot of sugar. First, there is a direct relationship between excessive consumption of sugar, especially added sugar, as well as weight gain and metabolic disorders. This suggests that controlling added sugar intake is crucial to preserving a healthy body weight and preventing obesity.

In addition, the specific role of fructose in metabolic health deserves further attention. Compared with other sugars, the fructose metabolism process is more burdensome to the liver and tends to lead to accumulation of liver fat, which in turn triggers the development of NAFLD. This result is consistent with the findings in the existing literature, suggesting that excessive fructose intake is one of the important factors contributing to fatty liver. Although glucose-fortified corn syrup is only found as the main sugar in several dishes, its widespread use exacerbates the increase in fructose intake.

Notably, although sugar intake is closely linked to a number of health issues, individual metabolic responses vary from person to person. Therefore, future studies should further explore differences in sensitivity to sugar intake in different populations and the consequences throughout time of reduced sugar consumption of different metabolic phenotypes. Overall, cutting back on added sugar consumption, particularly on sugar-filled drinks and high-fructose foods, is essential for weight control and prevention of metabolic diseases and cardiovascular risk.

6. Conclusions

Through a systematic analysis of the existing literature, the present study identifies the multiple adverse effects of high sugar intake, especially added sugar and fructose, on human health. The outcomes demonstrated that excessive sugar intake greatly elevated the chance of obesity, cardiovascular disorders and fatty liver disease. Fructose, particularly high fructose corn syrup, has significant detrimental effects on the liver and general metabolic health because of its metabolic properties.

Research has shown that reducing sugar intake, especially from sugary drinks and high fructose foods, is a crucial tactic for reducing obesity and associated chronic illnesses. In addition to assisting in maintaining a healthy weight, limiting sugar intake lowers the risk of developing metabolic syndrome and cardiovascular disease. Thus, in order to enhance population health generally, public health

strategies should focus more on encouraging improved dietary structure and lowering the use of added sugars.

One drawback of the current research is that it relies heavily on observational data, which may not demonstrate a direct causal relationship between consumption of sugar and specific health outcomes. Additionally, variations in individual metabolism, genetic factors, and lifestyle behaviors were not deeply explored, which may influence how different people are affected by sugar consumption. Further research with more controlled trials is required to confirm both of these findings.

Future research should focus on the sensitivity of different populations to sugar intake, to further elucidate the relationship between sugar consumption and the pathogenesis of various chronic diseases, and to evaluate the long-term health benefits of cutting up on sugar consumption.

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