

# The Relationship between Carbohydrate Consumption and Depression

Jiayi Li

*School of The High School Affiliated to Renmin University International Curriculum Center, Beijing, 100086, China*

*\*Corresponding author. Email: felciali1217@gmail.com*

## ABSTRACT

The present literature review analyzed three papers to evaluate the correlation between carbohydrate consumption and depression. Some biological causation of depression from intaking sugar is going to be discussed as well. The experimental objectives of three studies are almost the same---try to find out the relationship between sugar intake and depression. Whereas their results are considerably distinct. This literature review not only finds out the relationship between sugar and depression, but also discusses the drawbacks of each study to figure out what makes the results of the studies different. The main insufficiency of the three studies is the use of questionnaires, out-of-date resources and inaccurate adjust in the study. However, despite the influence of those defects in the papers, the literature review finds out that a higher or lower carbohydrate quality index will increase the risk of getting depressed and the reverse causation of sugar consumption and depression do not exist.

*Keywords: sugar consumption, depression, carbohydrate index, relationship*

## 1. INTRODUCTION

Some people respond that they will feel happy after having a cup of coke, mom often gives their children candies to stop them from crying. Does sugar truly influence people's moods? In our contemporary society, people's life is improving significantly during this period that is full of technology booms. The consumption of all kinds of sugar is increasing because people have extra money and are willing to buy sweet food that contains much sugar like candies and chocolate because they are tasty but not necessary. The world sugar consumption increases by about twenty million metric tons in five years until 2021 [1]. As a result, sugar consumption is also in an increasing trend. At the same time, according to the world health organization (WHO), sadness, low self-worth, feelings of guilt, loss of interest or pleasure are the main symptoms of depression. This psychological disorder is always accompanied by poor concentration, feelings of tiredness, and disturbed sleep or appetite. Depressive disorder can seriously impair a person's ability to cope with daily life, work, and study because it can be recurrent or long-lasting. In the most severe situation, depressive disorder can even lead to suicide. WHO ranks depression as the single largest contributor to global disability. There was a shocking number of

people who experienced depression. There were 172 million people around the world suffering from depression during 1990. Until 2017, the number of depressed individuals represented an increase of 49.86% and reached about 25,8 million incident cases of depression worldwide [2]. In recent years, more than 300 million individuals worldwide, are appraised to have a depressive disorder, which is 4.4% of the population in the world [1]. The depressive disorder is a health problem that becomes increasingly serious that requires people to pay more attention to this common mental disease. Compare with those two aspects, both depression and sugar consumption rates are in an upsurge trend. Maybe there is some undisclosed relationship between sugar and depression. This literature review will evaluate the relationship between sugar intake and depression.

## 2. DISCUSSION

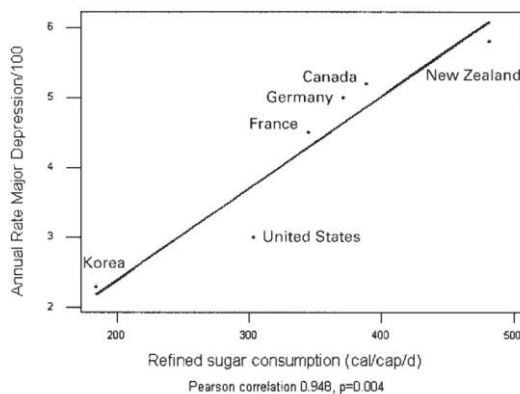
### 2.1 Biology perspective

Humans with depression have the lower brain-derived neurotrophic factor (BDNF) [3] but High refined sugar intake will reduce the hippocampal level of BDNF and spatial learning performance [4]. Moreover, Sugar over consumption will lead to obesity and subsequently lead to Low-grade inflammation that physically influences

one's health then increases the chance of being depressed and mentally depressed because of an imperfect body due to being overweight and other's negative judgment [5-7]. Furthermore, sugar can release opioids and dopamine that will potentially cause people to be addicted to it, and therefore the withdrawal reaction and other side effects will indirectly lead to depression [8]. Additionally, carbohydrate consumption will cause a more exaggerated response in insulin and induce hypoglycemia which brings a potential black mood that contributes to the increased risk of getting depressed [9].

### 2.2 Cross country

This study uses the data of the Cross-National Epidemiology of Major Depression and Bipolar Disorder study [10], the Food and Agricultural Organization (FAO) of the United Nations (data on file, FAO). recent theories of omega-3 fatty acids and depression, prior work of Hibbeln[11], and FAO fish consumption data were obtained from the World Health Organization (1996) to get data about the annual rate of major depression and refined sugar consumption in different counties[10]. The researcher uses the Pearson correlation coefficient to evaluate the association between carbohydrate intake and the depression rate. The result shows that there is a proportional increase of the annual major depression rate increase when refined sugar consumption increases. Consequently, the correlation between carbohydrate consumption and major depression rate may exist. The relationship graph shows below.



**Figure1** Refined sugar consumption and prevalence of major depression [10]

As shown in Figure 1, Korea has the smallest sugar consumption and at the same time the lowest annual rate of major depression. Both the highest rate of major depression and refined sugar intake in the six countries that had been measured in the test occur in New Zealand. The distribution of carbohydrate intake and major major depression per year of all six countries forms a line approximately and form a proportional relation.

The cross-national relationship between sugar consumption and major depression is the original study

that first raise the hypothesis that there is a relevance between carbohydrate consumption and depression rate exist.

However, this study still has some shortcomings. The data collected on sugar consumption is from 1991, while the study is in 2001. At the same time, the fish consumption data used to calculate sugar consumption is in 1996. As a result, the data is not fully matched and is a little outmoded. The magnitude of sugar produced and imported cannot reflect total sugar consumption precisely. There was a surplus of production in 1991. Moreover, the study use Pearson correlation coefficient is not rigorous because it is to a great extent influenced by the extreme items' value and based on many assumptions and that may not always hold good. Subsequently, Different countries have different evaluations in the depression that caused the inaccuracy of data. For instance, as is claimed in the paper, China underreports depressive symptoms. Those issue needs to be adjusted. Apart from that, the research study about the difference between sugar intake and depression correlation, but it did not explain why different countries the difference in sugar consumption and depression in the discussion have so the analysis been relatively inadequate.

### 2.3 Whitehall II study

This is a ten-year study using questionnaires with a follow-up visit [12]. The study area is separated into 11 phases, researchers give questionnaires and follow-up visits to collect the data of sugar consumption, depression degree and rate and common disorder (CMD) degree and rate in every phase. The test subjects were invited for evaluation in a research clinic additionally during phases 1, 3, 5, 7, 9, and 11. The researchers used a 127-item machine-readable semi-quantitative food frequency questionnaire (FFQ) in 3,5,7 phases to collect carbohydrate consumption from sweet food or beverages. 30-item General Health Questionnaire (GHQ), the 20-item Center of Epidemiologic Studies Depression Scale (CES-D) in the 7,9,11 phase, was used to measure depressive symptoms. International Classification of Diseases (ICD-10) and the Revised Clinical Interview Schedule (CIS-R) were used for the clinical interview of depression in phase11, which can validate the information of GHQ and CES-D [12]. The participant in this study is 10,308 (initial) non-industrial civil servants, who were recruited in London at age 35 to 55 years during 1985–1988[12]. The study shows two results, one is that sugar intake from sweet food/beverages increases the chance of incident mood disorders in men and limited evidence regarding recurrent mood disorders in both sexes. The other is that neither CMD nor depression predicted 5-year changes in sugar intake. This is a very important result of the study and in the field of all studies about sugar and depression. Because it excludes the reverse causation of sugar consumption and depression,

which means, people are not going to consume more sugar when they get depression, or their depression becomes more serious.

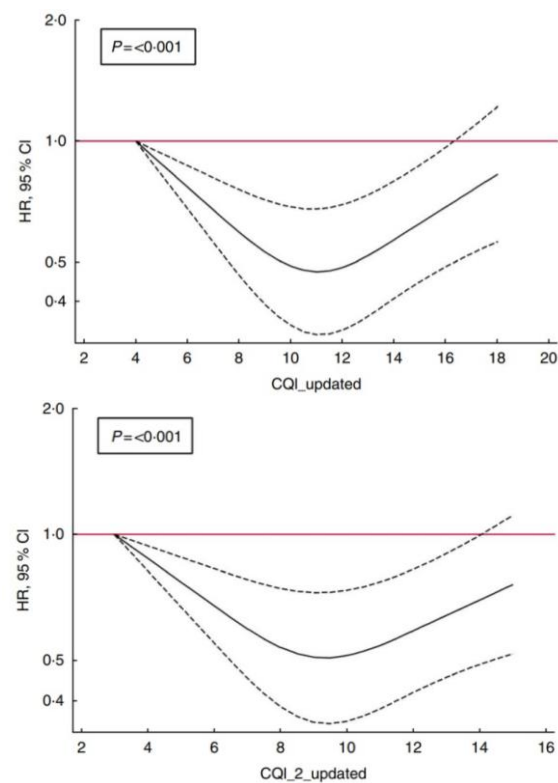
The study is rigorous because of the strict measurement of depression, the exclusion of extreme values and the value that might be wrong, the contraction with general practitioners to conform participants' physical health condition, the complicated statistical method and diagnosing of depression by doctors.

Whereas there is some flow in the study that may influence the accuracy of the result. Firstly, the use of questionnaires will unavoidably cause some inaccuracy. The questionnaires will sometimes have to underreport and misreporting. The questionnaire about 15 items is still limited. Although 15 items are the main elements that contain carbohydrates, there are lots of other food or drink that can cause sugar consumption. Besides, different cakes and biscuits contain different amounts of sugar. The standard of adding sugar is not the same. So, there is a certain amount of error that will happen inescapably. Secondly, food composition tables are from 1991. The data of the tables are relatively old. Thirdly, the study of the relationship between sugar and depression is easy to be affected by another element in diet such as saturated fat that has been mentioned in the paper, but it did not do further research to exclude the impact of a particular component. Lastly, there is a divergence in the study. The study mentions the conclusion of prospective association of sugar intake from sweet food/beverages and incident common mental disorder after 2 and 5 years in men, sugar intake was positively associated with incident clinical depression after 10 years in men \ but negatively in women. While, according to the result of prevalent common mental disorders, in women, no associations were found for incident CMD with one-third of sugar intake from sweet food/beverages. These two results are contradicted with the hypothesis of the paper. There are three reasons for the contradictory result on women. Firstly, depression is to a large extent influenced by gender. The influence on gender is much higher than the consumption of sugar. As a result, the association between sugar consumption and depression is hard to be found. Secondly, as was stated in the paper, the number of women participants is less than half of the number of men. It is a relatively small number so the result is less obvious that the association cannot be observed. Thirdly, compared with men and women, the latter has a higher risk of getting depressed. For instance, the depression during pregnancy that man will never experience. However, the study did not adjust the item that is specific to men or women.

#### 2.4 Seguimiento Universidad de Navarra (SUN) Project

This project is a 10-year follow-up study for 22,564 participants, who are composed of Spanish university

graduates [13]. It uses three kinds of questionnaires to gather information about sugar intake and depression degree and rate: the 136-item validated semiquantitative FFQ record, the dietary intake of the participants from the baseline to 10 years later, and the Nutrient intake is calculated by using an ad hoc computer program specifically developed for this aim and a nutrient database that is updated by a trained dietitian using the latest available information. Carbohydrate quality index (CQI) added sugars and sugar-sweetened drinks were also involved in the calculation. Depression rates are recorded by structured clinical interviews using DSM-IV [13]. Other related elements that are capable to influence depression rates were involved in the study as well. Information about socio-demographic, physical activity, BMI, and health degree are collected in the self-report of questionnaires. Certain types of disease are recorded during baseline and following-up visits [13]. Time-dependent Cox proportional-hazards regression models were used to assess the relationship between energy-adjusted added sugars and sweetened drink consumption and the CQI and the items used to its construction and the incidence of depression during follow-up. The result of the study shows that higher added sugars and the lower quality of carbohydrate consumption were associated with depression risk, the relationship between CQI and depression is revealed as a U-shape. The graph below shows the relationship between CQI and the rate of depression [13].



**Figure 2** Spline regression models of the hazard ratio (HR) of depression according to Carbohydrate Quality Index (CQI) and CQI\_2 without the ratio of whole grains/total carbohydrate (CH) (repeated measures) [13]

Figure 2 shows two trials of repetitive measures of the relationship of CQI and hazard ratio of depression. For the first chart, when CQI\_updated is between 4 and 11, the hazard ratio decreases when CQI increases. when CQI is higher than 11, the HR is in the trend of upward growth. However, in the trial without the ratio of whole grains or total carbohydrates, the HR still decrease at first during the decrease of CQI\_2\_updated but start to increase when the CQI is more than nine. The imaginary lines are the exact data of two trials and their repetitive measures. Two full lines are the mean of the first test and the repeat test. Both trials begin when HR is 1.0 and will finally reach 1.0 again after a reduction and raise of HR. The HR in the trial that does not exclude the CH reach 1.0 for the second time earlier.

There is some defect in this study that needs people to pay attention to. The sample is composed of Spanish university graduates. Although it makes the study easier because the participants are highly educated, the sample is not diverse enough. That participator may not comprehensively reflect the circumstance of the most public, so the result is limited. In addition, one of the analyses is stratified by age groups but data collected from graduates does not have a diversity of age that leads to the constraint of the result. The assessment of sugar intake is more detailed and rigorous than the Whitehall II study. CQI was calculated considering four criteria: the glycaemic index (GI); total dietary fiber intake (g/d); the ratio of solid carbohydrates and finally the ratio of carbohydrates from whole grain. The paper mention on its result that none of the four singular criteria considered building the CQI was significantly associated with depression risk, but their sum (total intake of all kinds of carbohydrate) was. This is contradicting the hypothesis. The result in some existence proves that there is a relationship between sugar intake and depression, but different types of sugar have different degrees of influence on depression that influence the observation of the relationship between carbohydrate and depression risk. This might be because the amount of sample is not enough so that the influence of one single kind of sugar is too small to be discovered. However, different sugar consume together will have an amplification effect. Among all sugar, fructose has been raised as an important public health issue. Furthermore, the carbohydrate calculated in the study is divided into liquid carbohydrates and solid carbohydrates, but not only liquid carbohydrates in the beverage in the Whitehall II study. Moreover, the food tables used for calculating participants' diet are up to date. but the same problem with Whitehall II is that the data collected from the questionnaire might be misreported and underreported. Besides, the study uses time-dependent Cox proportional-hazards regression models, but sometimes simple time-dependent exposure indicators can be very misleading [14].

## 2.5 Limitation

In the current literature review, the major limitation is the need for more accurate and current data and papers to provide information because it only analyzed three papers and most data are based on seven papers. Besides, because the correlation between sugar and depression is relatively small, the results of the study are easy to be influenced by other more effective elements such as age.

## 2.6 further expectation

To elucidate the association further, more studies should be replicated, especially adjusting the effect of the specific issue that causes depression to observe a more precise relationship between sugar intake and depression risk; further study of the amplification effect of different kinds of sugar consumption together and extra study between sugar and depression with wider age diversity that can fully adjust the influence of the age issue that influence the result of the previous study.

## 3. CONCLUSION

There is a relationship between sugar and depression. It depends on the carbohydrate index. Too high or too low will all increase the risk of getting depressed. The reverse causation of sugar consumption and depression does not exist so that the consumption of sugar will not change when people get depression, or their depression becomes more severe. As a result, people should control their intake of sugar in a normal range, keeping CQI in the range between eight and twelve to lower the risk of depression.

## REFERENCES

- [1] WHO. (2021, September 13). *Depression*. World Health Organization; World Health Organization. <https://www.who.int/news-room/fact-sheets/detail/depression>.
- [2] Liu, Q., He, H., Yang, J., Feng, X., Zhao, F., & Lyu, J. (2019). Changes in the global burden of depression from 1990 to 2017: Findings from the Global Burden of Disease study. *Journal of Psychiatric Research.*, 126: PP.134-140
- [3] Binder, D., & Scharfman, H. (2004). Brain-derived Neurotrophic Factor. *Growth Factors.*, 00: PP.1-9.
- [4] Sen, S., Duman, R., & Sanacora, G. (2008). Serum Brain-Derived Neurotrophic Factor, Depression, and Antidepressant Medications: Meta-Analyses and Implications. *Biological Psychiatry.*, 131: PP.1-106.
- [5] Calder, P. C. (2011). More citations, but a fall in impact factor. *British Journal of Nutrition.*, 106: PP.789-792.

- [6] Heyward F D, Walton R G, Carle M S, Coleman M A, Garvey W T and Sweatt J D (2012) Adult mice maintained on a high-fat diet exhibit object location memory deficits and reduced hippocampal SIRT1 gene expression. *Neurobiology of Learning and Memory.*, 98: PP.25-32.
- [7] Kivimäki M, Shipley M J, Batty G D, Hamer M, Akbaraly T N, Kumari M, Jokela M, Virtanen M, Lowe G D, Ebmeier K P, Brunner E J and Singh-Manoux A (2013) Long-term inflammation increases risk of common mental disorder: a cohort study. *Molecular Psychiatry.*, 19: PP.149-50.
- [8] Avena N M, Rada P and Hoebel B G (2008) Evidence for sugar addiction: Behavioral and neurochemical effects of intermittent, excessive sugar intake. *Neuroscience & Biobehavioral Reviews.*, 32: PP.20-39.
- [9] Schwartz N S, Clutter W E, Shah S D and Cryer P E (1987) Glycemic thresholds for activation of glucose counterregulatory systems are higher than the threshold for symptoms. *Journal of Clinical Investigation.*, 79: PP.777-81.
- [10] Westover A N and Marangell L B (2002) A cross-national relationship between sugar consumption and major depression? *Depression and Anxiety.*, 16: PP.118-20.
- [11] Hibbeln J R. (1998) Fish consumption and major depression. *Lancet (London, England).*, 351: PP.1213.
- [12] Knüppel A, Shipley M J, Llewellyn C H and Brunner E J (2017) Sugar intake from sweet food and beverages, common mental disorder and depression: prospective findings from the Whitehall II study. *Scientific Reports.*, 7: PP.6287.
- [13] Sanchez-Villegas A, Zazpe I, Santiago S, Perez-Cornago A, Martinez-Gonzalez M A and Lahortiga-Ramos F (2017) Added sugars and sugar-sweetened beverage consumption, dietary carbohydrate index and depression risk in the Seguimiento Universidad de Navarra (SUN) Project. *British Journal of Nutrition.*, 119: PP.211-21.
- [14] Sitlani C M, Lumley T, McKnight B, Rice K M, Olson N C, Doyle M F, Huber S A, Tracy R P, Psaty B M and Delaney J A C (2020) Incorporating sampling weights into robust estimation of Cox proportional hazards regression model, with illustration in the Multi-Ethnic Study of Atherosclerosis. *BMC Medical Research Methodology.*, 20: PP.62.