

# Junk Food Consumption and Symptoms of Mental Health Problems: A Meta-Analysis for Public Health Awareness

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## Abstract

Junk food consumption increases the risk of having symptoms of mental health problems. This study aimed to conduct a meta-analysis to assess the association between junk food and symptoms of mental health problems. The study was conducted by a systematic literature review from October to December 2020. The data sources were selected from PubMed and ScienceDirect articles published from 2010 to 2020. Those websites were check-marked for text availability for original articles, using keywords for junk foods and mental health. This study had inclusion criteria for selecting articles and organizing articles using the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guideline. The full-text articles were selected for conducting a meta-analysis using R Studio Software. The 5,079 article titles were obtained, seven of which met the relevant requirements for meta-analysis. The range of respondents who experienced symptoms of mental illness was 1.38%–79.8%. There was no heterogeneity based on the tau-squared test. The correlation coefficient was 0.11 (95% CI = 0.09–0.14), with no publication bias based on Egger's regression test (0.602 or p-value > 0.05). The frequent consumption of junk food can contribute to mental illness symptoms, even within minimal effects.

**Keywords:** children, junk food, mental health problems, meta-analysis

## Introduction

Mental illness symptoms, such as stress, depression, and anxiety, causes long-term nervousness and psychological problems,<sup>1</sup> weight loss,<sup>2</sup> drug abuse,<sup>3</sup> self-torture,<sup>4</sup> suicide,<sup>5</sup> murder,<sup>6</sup> and premature mortality.<sup>7</sup> In Indonesia, people with mental disorders were isolated using tied ropes or “*dipasung*,” to prevent them from endangering the lives of others.<sup>8</sup> People in any age group can have a mental illness, including children.<sup>9</sup> In fact, children might have prolonged mental illness up to their adulthood.<sup>10</sup>

A study showed that the risk factors for mental illness are social environment, family issues, and violence.<sup>5</sup> Several studies also revealed that a healthy diet contributes to reducing the risk of mental illness.<sup>11</sup> Consumption of fruits and vegetables is believed to improve mental health because micronutrients such as vitamins, antioxidants, and minerals protect against mental illness.<sup>12</sup> Unfortunately, the habit of fruit consumption has been pushed aside by the increasing trend of high salt/sugar-laden diets.

The habit of junk food consumption has increased around the world.<sup>13</sup> Foods with high sugar and salt con-

tent are widely recognized as causes of non-communicable diseases such as diabetes, heart disease, and stroke.<sup>14</sup> Recent evidence demonstrates an association between junk food consumption and an increased risk of mental disorders.<sup>15</sup> Previous studies only applied meta-analysis techniques between nutritious foods and mental problems. The results did not include junk foods to quantify the findings.<sup>16</sup>

## Method

The systematic literature review (SLR) was conducted by six authors, consisted of two primary authors and four authors assistants, organized from October to early December 2020. The SLR refers to the guidelines for systematic review and meta-analysis, called the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guideline.<sup>17</sup> This study has been registered to the International Prospective Register of Systematic Reviews, known as PROSPERO, with ID CRD42020218992 and accepted as a type of systematic review and meta-analysis. PROSPERO is an international database of prospectively registered systematic reviews, rapid reviews, and umbrella reviews in health and social

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care also does not accept scoping reviews or literature scans. Key features from the review protocol are recorded and maintained as a permanent record in PROSPERO. The Ethics Committee has approved the study at Sekolah Tinggi Ilmu Kesehatan Indonesia Maju, reference number: 2417/Sket/Ka-Dept/RE/STIKIM/IX/2020.

The source of this study used was from PubMed and ScienceDirect website. The reason for choosing these two databases was because they are well-known health databases and their bibliometrics offer free and easy access to verify work conducted by others. The first step is to go to the address <https://pubmed.ncbi.nlm.nih.gov/>. Then enter keywords into the website search engine, representing study material to find relevant articles. On the PubMed website, “check-mark” the text availability article (full text and free full text), article type (book and documents, clinical trial, and Randomized Control Trial), with the publication of the last ten years (2010–2020). For ScienceDirect: go to the address <https://sciencedirect.com>. Do the same as with the PubMed website, by specifying the article type or research article, “check-mark” all categories for the publication title, and all subject areas.

The next step was following the PRISMA guideline.<sup>17</sup> The guideline was: 1) Identifying: It was to identify the titles of relevant journal articles in the search column on the two website addresses for this study, the authors used keywords for study themes by using quotation marks or apostrophes. For two or more keywords, the authors used the boolean symbol “AND” between keywords. The keywords used to find articles related to junk food consumption (as an exposure) and mental illness (as an outcome) are: “junk food” and “mental health,” “Junk food” and “mental disorders,” “Junk food” and “depression,” “junk food” and “stress,” “junk food” and “sadness,” “junk food” and “insomnia,” “junk food” and “anxiety;” “mental health” and “snacks,” “mental health” and “bread,” “mental health” and “ice cream,” “mental health” and “chocolate,” “mental health” and “sweetened food,” “mental disorder” and “snacks,” “mental disorder” and “bread,” “mental disorder” and “ice cream,” “mental disorder” and “chocolate,” and finally, “mental disorder” and “sweetened food.” Additionally, junk food components were defined as “canned food,” “chocolate,” “instant noodles,” and “bread,” paired with “processed cheese,” “frozen cake,” “ice cream,” “candy,” “baked food,” and “dried sweet food”.<sup>18–20</sup> Duplicate articles that appeared several times during keyword searches were not reused; 2) Screening: to screen journal articles' titles, select the article title that matches the research theme. All abstract identifications were read and reviewed based on the inclusion criteria. The inclusion criteria are that they are original articles discussing junk food and mental health. Study interviews were conducted

in person and written in English, and the study's method was quantitative. Mental health inclusion criteria were “depression,” “stress,” “sadness,” “insomnia,” and “anxiety” because these five disorders have a high prevalence worldwide.<sup>18,19</sup> Abstract articles that did not meet the criteria were eliminated; 3) Eligibility: Selected journals that meet the inclusion criteria should be downloaded with full text. The criteria prevail to both open- and closed-access journals. All journals are reviewed and selected to find the association between junk food consumption and symptoms of mental health problems. Articles where no associations were found will not be used; 4) Included: All journals articles at this phase that meet all the inclusion criteria are arranged by author year, country study, study design, study period, sample size, number, respondents, average age, type of junk food, consumption frequency, cases of mental problems, sample case(s) of mental problems, percentages, covariates, and OR values. This data is required to compute a meta-analysis using R Studio Software, an open-source software named “The Metaphor Package” (can be downloaded from <https://cran.r-project.org/package=metaphor>). The OR values of journals that were not found were excluded.

The final step calculates the meta-analysis by showing the three components: 1) heterogeneity figure (Q-statistic, I-squared, tau-squared). It seeks to obtain whether the data results on the selected journals are homogenous or heterogeneous; 2) Looking at the publication bias figure (Funnel Plot, Egger's regression test) with the target result that there is no publication bias; and 3) Visual Effect size figure shows a significant target yield and no bias. If the article found does not provide a 2x2 table information, then to calculate the meta-analysis it is necessary to transform the OR value into the Pearson Product Moment Value through Cohen's d Calculation.<sup>21</sup>

## Results

Figure 1 shows the process of identification of eligible articles for a meta-analysis of the association between junk food consumption and symptoms of mental health problems. A review of the database online journals found 1,889 articles that were necessarily removed due to duplication. On the other hand, 2,209 articles were excluded because 611 articles did not discuss junk food, 94 articles did not use humans subjects, 141 and 987 articles were comment and review articles, respectively, and 376 articles used a qualitative design. During the full-text article review, 82 articles were excluded for not reporting the association test. Upon completion, seven eligible articles relevant to the study remained.

Table 1 shows the resulting characteristics of the eligible article for the systematic review. Most of the studies were carried out in developed countries such as the

United Kingdom,<sup>19,22</sup> and Norway,<sup>23</sup> from continental Europe, Korea,<sup>24</sup> and China,<sup>25</sup> from Asia. All studies used a cross-sectional design. One article from the publication year fell within the inclusion time frame of this study. The study used data from 2006 and 2009.<sup>22</sup> All articles used large sample sizes. The least was 334 respondents,<sup>26</sup> and the most were 105,061 respondents.<sup>27</sup> The age groups of respondents varied from children to 15–19 year-old,<sup>15</sup> adolescents,<sup>24</sup> and all age ranges. The lowest age group was 12 years.<sup>22,23</sup> The oldest was 58 years.<sup>26</sup>

Table 2 shows, in the eligible articles, that the various types of junk food were salty and unhealthy snacks,<sup>15,19</sup> cakes, biscuits, sugary products, sweetened food, and pizza.<sup>27</sup> All studies mentioned that daily junk food consumption is associated with developing symptoms of

mental health problems. The other frequent categories were “high frequency”,<sup>24</sup> and “always consuming” junk food.<sup>22</sup> In general, mental health problems were comprised of poor mental health,<sup>22</sup> and mental health illness.<sup>15,22–25,27</sup> They also included psychiatric disorders,<sup>15,23</sup> sleep dissatisfaction,<sup>24</sup> stress,<sup>25</sup> and suicide attempts.<sup>27</sup>

The proportions of respondents suffering from mental health problems ranged from 1.38%,<sup>24</sup> to 79.8%.<sup>27</sup> Covariates of the study were sociodemographic conditions (age, gender, level of education, hostile behaviors such as smoking,<sup>15,18,19,22</sup> alcohol use,<sup>19,24</sup> and body mass index (BMI)).<sup>15,18,22</sup> The control variables to reduce the adverse mental health effects were routine fruit and vegetable,<sup>27</sup> consumption and physical activity.<sup>22,27</sup>

All of the articles produced OR ranged from 1.31 to 1.9.<sup>25,27</sup> Nor did all of the articles present the total cases of respondents with mental health problems,<sup>19,26</sup> as presented in Table 2. Because there is no 2x2 table information in Table 2, the OR value of the seven selected articles must be transformed into a Pearson Product moment value that shown in Figure 2.

The meta-analysis based on R Studio Software, the random effect model's heterogeneity analysis results show that the estimated amount of total heterogeneity using the tau-squared test was equal to 0.0008 and Q-statistic with a p-value equal to 0.0001. Furthermore, the calculation of the I-squared result was 93.91%. The three

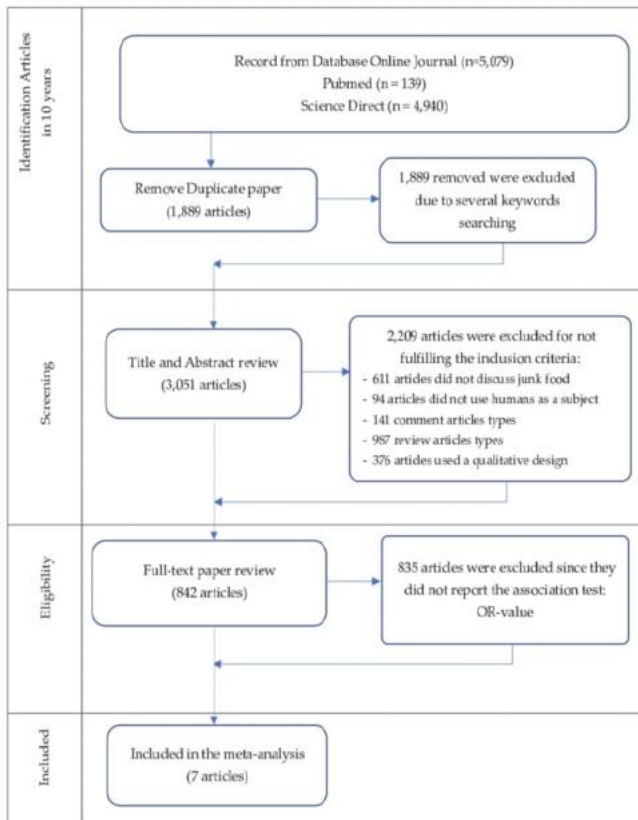


Figure 1. Flowchart of PRISMA Guideline

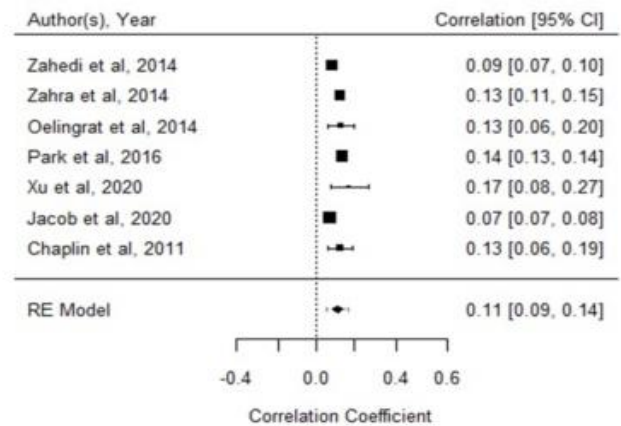


Figure 2. Forest Plot between Junk Food Consumption and the Symptoms of Mental Health Problems

Table 1. Eligible Articles Characteristic

Author	Year	Country Study	Study Design	Study Period	Sample Size	Respondents	Age (Mean in Years)
Zahedi, et al., <sup>15</sup>	2014	Iran	Cross-sectional	2011–2012	15,486	Children	15–19
Zahra, et al., <sup>22</sup>	2014	United Kingdom	Cross-sectional	2006 and 2009	10,645	Participants	12–14
Oelingrath, et al., <sup>23</sup>	2014	Norway	Cross-sectional	2010	789	Participants	12–13
Park, et al., <sup>24</sup>	2016	Korea	Cross-sectional	2015	68,043	Adolescents	15.07
Xu H, et al., <sup>25</sup>	2020	Chinese	Cross-sectional	2017– 2018	14,500	Middle schools	14.9
Jacob, et al., <sup>27</sup>	2020	32 Countries	Cross-sectional	2009–2015	105,061	Adolescents	13–15
Chaplin, et al., <sup>19</sup>	2011	United Kingdom	Cross-sectional	2011	870	Participants	45

Table 2. Type of Junk Food and Mental Health Problems in the Eligible Article

Author	Type of Junk Food	Consumption Frequency	Case of Mental Problem	n	%	Covariate	OR
Zahedi, <i>et al.</i> , <sup>15</sup>	Salty Snacks, Sweets, Sweetened Beverage, Fast Food	Daily	Psychiatric distress (worry, depression, confusion, insomnia, anxiety, aggression, and feelings of worthlessness) and violent behaviors (physical fighting, victimizing, and bullying)	5,352	39.86	Family size, father's occupation, mother's occupation, father's education, mother's education, sedentary lifestyle, screen time, physical activity, socio-economic status, family history, body mass index (BMI), body image, passive smoking, current smoking.	1.37
Zahra, <i>et al.</i> , <sup>22</sup>	Hamburger, chips, crisps, fizzy drinks, sweets	Always	Poor mental health	1,836	17.24	Eat at irregular times, eat junk food daily, gender, age, ethnicity, overcrowded, free school meal, special educational needs, smoking, parenting style, poor physical health.	1.59
Oelingrath, <i>et al.</i> , <sup>23</sup>	Junk foods	Daily	Psychiatric disorders	72	9.1	Child's BMI category, maternal education, family income, family structure, child's gender, child's gender, child's physical activity, inactivity of child.	1.6
Park, <i>et al.</i> , <sup>24</sup>	Energy drinks and junk food	High frequency	Sleep dissatisfaction, perceived stress, persistent depressive mood, suicidal ideation, suicide plan, suicide attempt(s)	945	1.38	Males, high school, rural residence, non-residence with family, high academic achievement, lifetime alcohol use, physically active, age.	1.65
Xu H, <i>et al.</i> , <sup>25</sup>	Western junk food, Chinese junk food, takeaway junk food, hot food packed in disposable fastfood box	During last week, 1-2 times	Severe stress, depressive mood, suicidal ideation, suicide plans, suicide attempts, and sleep dissatisfaction	432	3.1	Age, gender, residence, boarding school, being the only child in the family, father's education level, mother's education level, the number of close friends, sports, and self-perceived socio-economic status.	1.9
Jacob, <i>et al.</i> , <sup>27</sup>	Adherence to Western dietary patterns (snacks, pizza, sweets, and desserts)	Daily	Suicide attempts	NA	26.7-79.8	Sex, age, food insecurity (a proxy of socioeconomic status), alcohol consumption, smoking, physical activity, obesity, carbonated soft drink consumption, fruit, and vegetable consumption.	1.31
Chaplin, <i>et al.</i> , <sup>19</sup>	Unhealthy snacks	More than three times a week	Life stress	NA	NA	Alcohol consumption, smoking, difficulty sleeping, gender, age, neuroticism, total negative job score.	1.59

Note: OR = Odds Ratio; NA = Not Available

tests above resulted in different statuses of heterogeneity. Two tests said the study had heterogeneity (Q-statistic and I-squared), one study said no heterogeneity (tau-squared). It was caused by a range of sample sizes among the selected articles.

Figure 2 shows the magnitude of association measured by the correlation coefficient showed a small association between junk food consumption and the symptoms of mental health problems (0.11 with 95% CI = 0.09–0.14).

In Figure 3, the results of publication bias analysis using a Funnel Plot showed asymmetric results since the distribution of dots has no balance. There is another test, Egger's regression test, which aims to compare the Funnel Plot result. The results of Egger's regression test analysis showed a value of 0.602 or a p-value of more than 0.05, which indicates that there is no publication bias.

### Discussion

The results of the meta-analysis of this study indicate a significant positive association between the frequency of junk food consumption and symptoms of mental health problems (0.11 with 95% CI = 0.09–0.14).

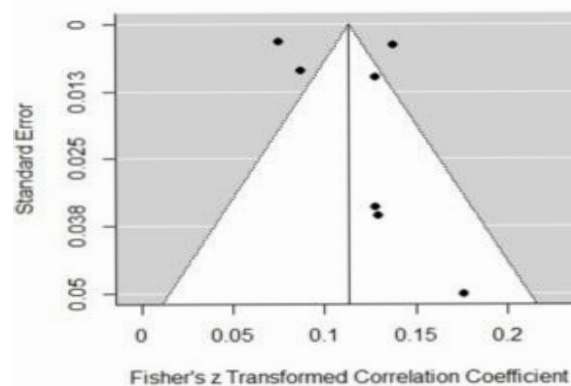


Figure 3. Funnel Plot of Junk Food Consumption and the Symptoms of Mental Health Problems

Several previous systematic review articles between nutrient food and mental illness suggest that it is better to reduce the consumption of high fat and high sugar foods to prevent mental illness symptoms.<sup>16</sup> Polat, *et al.*,<sup>28</sup> revealed that frequent junk food consumption leads to an increase in testosterone and estrogen production, which might cause specific problems, including stress triggers. Palacios, *et al.*,<sup>29</sup> added that junk food substances from nuts trigger phytoestrogens' development, which can

cause stress. This condition will increase with high caloric content, high salt, high saturated fat, high sugar, and low fiber in junk food.<sup>30</sup> Perfluoroalkyl substances (PFASs) found in foods such as hamburgers, sausages, and pizza can interfere with the function of testosterone and other steroid hormones.<sup>31</sup> This condition is worrying because the quick reaction to these substances can cause increased risks of anemia, anxiety, and insomnia as triggers for mental health problems.<sup>32</sup> These quick reaction symptoms were clearly shown in the selected articles, which use the cross-sectional design in this study. It differs from the effects of non-communicable diseases such as heart disease, diabetes, stroke, and cancer, which take a long time to manifest after junk food consumption.<sup>33,34</sup> The reaction will stimulate a higher impact if junk food is consumed in large quantities, exceeding the standard daily dose of health, and consumed frequently.

Although it proved a significant positive association, the results of this study's meta-analysis showed that differences are resulting in the heterogeneity of the association between junk food consumption and the symptoms of mental health problems. Heterogeneity might occur due to the various outcomes and sample sizes of mental health problems, including mental disorders, psychiatric disorders, sleep dissatisfaction, stress, autistic fantasy, and suicide attempts.<sup>15,20,22–27</sup> However, based on the tau-squared test, the heterogeneity has not occurred that one of the requirements for further analysis in this study. A meta-analysis study meets high qualifications if the calculation results do not have heterogeneity of measurement values.

Another prerequisite for better meta-analysis is that there be no publication bias in any of the measurement tests. In this study, publication bias was calculated by two measurements—the Funnel Plot and the Egger's regression test. Both measurements yielded different results. The Funnel Plot showed a publication bias, while the Egger's regression test showed none. Since this study included only seven articles, the Egger's regression test proved more robust or suitable.<sup>35</sup> It can be said that there was no publication bias for this study.

Under real conditions, various types of mental disorders might cause heterogeneity of the result.<sup>36</sup> These results provide strong evidence for a connection between junk food consumption and the occurrence of problematic mental health issues.

The systematic review showed that children are susceptible to symptoms of mental health problems,<sup>23,25</sup> such as depression, anxiety, and low self-esteem due to anatomical and physiological conditions.<sup>37,38</sup> Moreover, junk food such as chips and fries, chocolate, cookies, pizza, and burgers are more consumed by children than adults.<sup>39</sup> Junk food, especially the type that contains excessive sweet or salty taste, can inhibit information pro-

cessing in the brain. Therefore, children and adolescent who consumes a lot of junk food usually have concentration difficulties at school.<sup>40</sup> Junk food also exacerbates existing mental disorders. In Indonesia, schools provide *Unit Kesehatan Sekolah* or School Health Unit to prevent mental illness in children. However, it is still a pilot project, and controlling junk food has not been determined as the program's aim.<sup>41</sup> In India, there is a High in Fat, Sugar, and Salt (HFSS) guideline, regulating children's excessive consumption of junk food because of its association with higher body mass index. However, these guidelines do not address the risks of developing mental illness.<sup>42</sup>

Based on the discussion above, the association between junk food and mental health problems is sufficiently acute. Even minimal but frequent consumption of junk food could contribute to aggravated mental health symptoms. A regular public education awareness campaign to prevent mental illness through improvements to diet and lifestyle is warranted. The community must be aware of policy makers' issues through guidelines, rules, and publicity campaigns. The community needs to ramp up awareness of junk food consumption risks, mainly to prevent long-lasting mental health problems for children.

The findings from several eligible articles showed that negative behaviors, such as smoking, and drinking were significant determinants of poor mental health conditions.<sup>19,26,27</sup> These findings were consistent with the other studies.<sup>43</sup> Both sugar and fat nutrients and nicotine exposure may activate stressors in the body.<sup>44</sup> Further study is required to support this finding.

Body mass index is also considered a covariate in several eligible studies.<sup>15,18,23</sup> Obesity affects stress because it strains emotional function, causes depression, and delays the development of teeth, bones, and muscles.<sup>45</sup> Therefore, maintaining an ideal BMI, smoking, and alcohol cessation are also necessary to prevent the aggravation of mental illness symptoms.

Food is not the only risk factor for poor mental conditions. It can be seen from the covariate variations that affect the associations between junk food consumption and the incidence of mental illness in all eligible studies for meta-analysis in this study. However, the potential for mental illness from junk food consumption has not received much awareness from public health personnel and medical personnel.<sup>46</sup> The efforts of mental illness prevention implemented by health personnel have included junk food consumption control.<sup>47</sup> Some nutritionists have implemented campaigns against junk food consumption in patients because of the risk of mental illness, but it has not been implemented by other health personnel.<sup>48</sup> For example, nurses in primary health care have not actively advertised the importance of controlling junk food consumption to prevent stress symptoms in their

patients.<sup>49</sup> Treatment of mental illness in health services should include encouraging the consumption of vegetables and fruit instead of junk food. Public health personnel as the front liners in preventing mental illness should campaign on junk food consumption restriction.

The existing health policy has linked the consumption of junk food with malnutrition. However, it has not emphasized the potential risks of developing mental illness.<sup>50–52</sup> Developing and developed countries such as the United States, France, Mexico, Chile, Brazil, and South Africa have imposed taxes on food and sweetened drinks to limit the consumption of foods that pose a health risk.<sup>53–55</sup> Other countries might need to implement a similar policy.

Regular consumption of fruits and vegetables, instead of junk food, can prevent mental illness. Fruits and vegetables provide a wide variety of vitamins, minerals, fiber, and phytochemicals that the body needs to keep healthy, while junk food provides abundant calories that harm health.<sup>56,57</sup> Promoting regular consumption of fruit and vegetable have been routinely encouraged by health personnel to patients and the community. However, policy needs to be developed especially for children, to regularly eat fruits and vegetables to avoid various mental health problems.<sup>58–60</sup>

This study's novelty is that it is the first meta-analysis conducted to determine the positive relation between junk food consumption and the symptoms of mental health problems by using two well-known health databases. The existing meta-analysis research method approaches the subject from a less comprehensive point of view. This approach is to the importance of healthy food intake to improve the symptoms of mental health problems.<sup>16</sup> Simply the result of this first meta-analysis will allow future researchers around the world to examine the different effects of junk food consumption and the symptoms of mental problems by using observatory data from their own countries. Using combination of two databases that are sufficiently strong for SLR study such as journal searches becomes less time-consuming and efficient. It obtains high index articles without having to identify other well-known databases. These two databases have advanced the search, facilitating the specific journal search process.

Limitations of this study only used five categories of mental health problems and did not include other symptoms such as schizophrenia. Meanwhile, junk food categories did not measure fried foods (*gorengan*) that contain unhealthy carbohydrates and fats and are widely consumed by society. The source of the meta-analysis comes from just two databases. It might still be possible to find a stronger association between exposure and outcome. Therefore, other researchers could investigate more varied types of junk food and mental health problems for

the next SLR research and use more databases and website resources.

## Conclusion

This systematic review and meta-analysis study demonstrated a significant positive association between frequent junk food consumption and the potential for symptoms of mental health problems. These problems can be suffered by all age categories, including children and adolescence. On the other hand, routine junk food consumption coupled with negative behaviors such as smoking and drinking alcohol, and being overweight or obese, contribute to the growth of mental health problems. Therefore, society and policymakers together must be made aware of the outcomes of this study and the need to develop junk food consumption controls, especially for children, to raise public health awareness toward the negative outcome of mental health problems.

## Abbreviations

PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analysis; SLR: Systematic Literature Review; PROSPERO: International Prospective Register of Systematic Reviews; BMI: Body Mass Index; CI: Confident Interval; NA: Not Available; OR: Odds Ratio; PFASs: Perfluoroalkyl Substances; HFSS: High in Fat, Sugar, and Salt.

## Ethics Approval and Consent to Participate

The analysis used an online database journal from PubMed and ScienceDirect. Ethics approval was obtained by the Ethics Committee of Sekolah Tinggi Ilmu Kesehatan Indonesia Maju, reference number: 2417/Sket/Ka-Dept/RE/STIKIM/IX/2020.

## Competing Interest

The author declares that there are no significant competing financial, professional, or personal interests that might have affected the performance or presentation of the work described in this manuscript.

## Availability of Data and Materials

The data is publicly available from Pubmed and Science Direct from October 2010 to October 2020. The data of this study can be obtained from seven eligible articles that have been included in references. Also, the reader may contact the corresponding author for further information.

## Authors' Contribution

MH contributed to the conception, data screening, supervising, and writing of the manuscript. RKH participated in the conception and writing of the manuscript.

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analysis.

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