Research

Dietary Pattern As a Risk Factor of Diabetes Mellitus and Obesity: Meta-Analysis

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ABSTRACT

Background: Non-Communicable Disease is a disease that is considered unable to transmit or spread from one person to another but is a cause of death globally, especially diabetes mellitus and obesity. According to WHO, the number of deaths due to PTM in 2016 was 40.5 million (71%) worldwide. Diet is one of the risk factors for Diabetes Mellitus and Obesity. This study aims to analyze the effect of diet as a risk factor for diabetes mellitus and obesity.

Subjects and Method: This study was a systematic review and meta-analysis using a cross-sectional design. The articles used in this study were obtained from several databases, including PubMed, Google Scholar, Springerlink, and ScienceDirect. The articles used in this study were those published from 2011-2020. The article search was carried out by considering the eligibility criteria defined using the PICO model. P: adults, I: unhealthy eating patterns, C: healthy eating patterns, and O: Diabetes Mellitus and Obesity. The keywords to search for articles were "dietary pattern", "risk", "obesity", and "diabetes mellitus," and "adjusted odds ratio". The articles included in this study were full-text articles with cross-sectional study design. Articles were collected using PRISMA flow diagrams. Articles were analyzed using the Review Manager 5.3 application.

Results: A total of 15 articles were reviewed in this study. The meta-analysis showed that an unhealthy diet increased the risk of Diabetes (aOR= 1.65; 95% CI= 1.29 to 2.11; p <0.001). The meta-analysis of 9 articles also showed that an unhealthy diet increased the risk of obesity (aOR= 1.42; 95% CI= 1.21 to 2.66; p <0.001). This meta-analysis combines primary studies from Swaziland, China, Ethiopia, Kenya, America, Malaysia, Ghana, Romania, Nepal, Ireland, and Korea.

Conclusion: Unhealthy diet is a risk factor for diabetes mellitus and obesity.

Keywords: dietary pattern, diabetes mellitus, obesity, cross-sectional

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BACKGROUND

Non-Communicable Disease (NCD) is a disease that is considered unable to be transmitted or spread from one person to another but is a global cause of death (Irwan, 2018). According to WHO, the number of deaths due to PTM in 2016 was 40.5 million (71%) worldwide. Due to PTM in the world in detail, the mortality rate consists of 4% at the age of fewer than 30 years, 38% at the age between 30 to 70 years, 58% at the age more than 70 years. In Indonesia, the death rate caused by NCD in 2016 was 1.3 million (73%) of all cases of

death (WHO, 2018). NCD consists of various diseases, namely cardiovascular disease (coronary heart disease, stroke), cancer, chronic respiratory disease(asthma, chronic obstructive pulmonary disease), and diabetes (WHO, 2018)

According to the World Health Organization (WHO) estimates, globally, 422 million adults over 18 years of age lived with diabetes in 2014. The latest data from the International Diabetes Federation (IDF) Atlas in 2018 shows that Indonesia is ranked 6th globally with 10.3 million people with diabetes mellitus.

Another non-communicable disease that is no less dangerous after diabetes is obesity. The prevalence of obesity in the world almost tripled between 1975 and 2016. Based on data from the World Health Organization (WHO) in 2018, in 2016, there were 1.9 billion adults aged 18 years. And above who are overweight and more than 650 million cases of obesity.

Non-communicable disease arises from a combination of non-modifiable risk factors and modifiable risk factors. The risk factors that cannot be modified by an individual are age, sex, and genetics. Meanwhile, modifiable risk factors can be changed through individual awareness and social intervention, especially regarding diet (Nabilah, 2016). Dietary pattern is a variety of information that provides an overview of the kinds and amounts of food ingredients eaten every day by one person and is a characteristic for a particular community group (Kadir, 2016). This dietary pattern is influenced by several things, including habits, enjoyment, culture, religion, economic level, natural environment, etc. (Sing, 2012).

It is believed that the principles of the Nutrition Guide for Balanced Diet, agreed upon by the 1992 world food conference in Rome, will be able to overcome the double burden of nutritional problems, both deficiency and excess nutrition. In Indonesia, this principle is known as the guidelines for balanced nutrition. Guidelines for balanced nutrition, namely: daily food consumption must contain nutrients in the type and amount (portion) according to each person's needs or age group.

SUBJECTS AND METHOD

1. Study Design
This study was a systematic review and meta-analysis. The articles used in this study were obtained from several databases, including PubMed, Google Scholar, Springerlink, and ScienceDirect. The keywords used to search for articles were: "dietary pattern", "risk" "obesity", and "diabetes mellitus," and "adjusted odds ratio".

2. Inclusion Criteria
The articles included in this study were full paper articles with a cross-sectional study design and in English. Appropriate articles should mention the adult population, unhealthy diet interventions with diabetes mellitus, and obesity outcomes. Articles should be published in 2011-2020 with a multivariate-adjusted Odds Ratio.

3. Exclusion Criteria
The articles issued in this study were articles that use the subject of toddlers and pregnant women. Articles with results were not adjusted to Odds Ratio.

4. Operational Definition of Variables
The article search was carried out by considering the eligibility criteria defined using the PICO model. The study population were adults with an intervention in the form of an unhealthy diet, comparison, namely a healthy diet and outcomes in the form of Diabetes Mellitus and obesity.

Dietary pattern was a method or effort in regulating the amount and type of food with specific purposes such as maintaining

health, nutritional status, preventing or helping to cure diseases.

Diabetes Mellitus was a collection of symptoms that arise in a person caused by an increase in blood sugar (glucose) levels due to an absolute or relative lack of insulin.

Obesity was an excessive accumulation of fat due to an imbalance of energy intake and energy used (energy expenditure) for a long time.

5. Data Analysis

Data processing was carried out by the Review Manager (RevMan 5.3) by calculating the effect size and heterogeneity to determine which research models were combined and formed the final meta-analysis result.

RESULTS

The process of searching for articles by searching through a database with journals can be seen in Figure 1. Figure 2 shows the areas where articles were drawn according to the inclusion criteria. 5 articles were obtained from the continent of Africa, 6 articles from the continent of Asia, 2 articles from the continent of Africa, and 2 articles from North America.
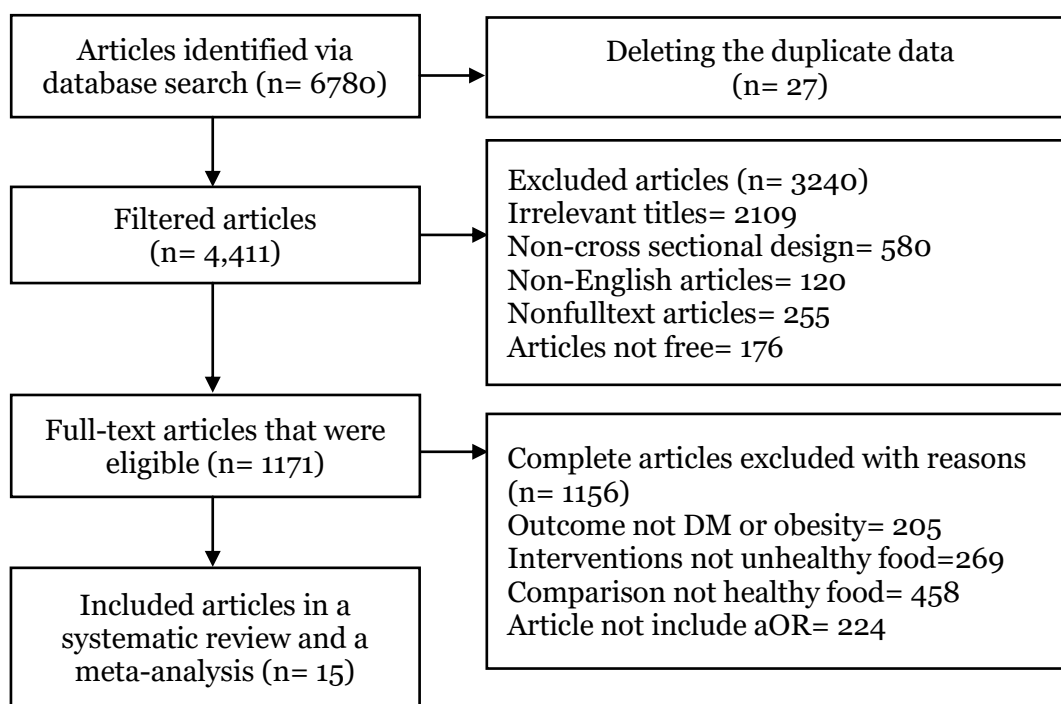
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┌─────────────────────────┐      ┌─────────────────────────┐
│ Articles identified via │ ───► │ Deleting the duplicate  │
│ database search (n= 6780)│     │ data (n= 27)            │
└─────────────────────────┘      └─────────────────────────┘
            │
            ▼
┌─────────────────────────┐      ┌─────────────────────────────────────┐
│ Filtered articles       │ ───► │ Excluded articles (n= 3240)         │
│ (n= 4,411)              │      │ Irrelevant titles= 2109             │
└─────────────────────────┘      │ Non-cross sectional design= 580     │
            │                     │ Non-English articles= 120           │
            ▼                     │ Nonfulltext articles= 255           │
                                  │ Articles not free= 176              │
                                  └─────────────────────────────────────┘
┌─────────────────────────┐      ┌─────────────────────────────────────┐
│ Full-text articles that │ ───► │ Complete articles excluded with     │
│ were eligible (n= 1171) │      │ reasons (n= 1156)                   │
└─────────────────────────┘      │ Outcome not DM or obesity= 205      │
            │                     │ Interventions not unhealthy food=269│
            ▼                     │ Comparison not healthy food= 458    │
                                  │ Article not include aOR= 224        │
┌─────────────────────────┐      └─────────────────────────────────────┘
│ Included articles in a  │
│ systematic review and a │
│ meta-analysis (n= 15)   │
└─────────────────────────┘
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Figure 1. PRISMA flow diagram

1. Dietary Pattern during Pregnancy as a Risk Factor for Diabetes Mellitus
a. Summary of Source Articles
Table 1. Descriptions of primary studies included in the meta-analysis

Author (year)	Title	Country	Study Design	Sample	P Population	I Intervention	C Comparison	O Outcome
Gbadamosi and Tlou (2020)	Modifiable risk factors associated with non-communicable diseases among adult outpatients in Manzini, Swaziland: a cross-sectional study	Manzini, Swaziland	Crossectional	385	Subjects aged 18 years and over	Unhealthy eating and drinking (high in sugar)	Healthy food	Diabetes Mellitus
Shu et al. (2017)	Dietary patterns are associated with type 2 diabetes mellitus among middle-aged adults in Zhejiang Province, China	Zhejiang Province, China	Crossectional	1918	Subjects aged 45-59 years	Eating and drinking (high fat, high sugar, western food)	Healthy food	Diabetes Mellitus
Abas (2019)	Prevalence and associated risk factors for type 2 diabetes mellitus among adults (>=40 years of age) in jigjiga City, Somali region, Eastern Ethiopia	Somali, Ethiopia	Crossectional	175	Subjects aged 40 years and over	Eat and drink (high fat, high sugar)	Healthy food	Diabetes Mellitus
Okube et al. (2020)	Association of dietary patterns and practices on metabolic syndrome in adults with central obesity attending a mission hospital in Kenya: a cross-sectional study	Kenya	Crossectional	404	Subjects aged 18–64 years	Eat and drink (high fat, high sugar)	Healthy food	Diabetes Mellitus
Lee et al. (2018)	Food insecurity is associated with prediabetes and dietary differences in U.S. adults aged 20–39	United States	Crossectional	3684	Subjects aged 20-39 years	Eat and drink (high fat, high sugar)	Healthy food	Diabetes Mellitus
Chopra and Chopra (2016)	Risk perception for diabetes in Appalachian women	Appalachia, New York, Amerika	Crossectional	202	Subjects aged 21–50 years	Food habits high in sugar, high sugar, fizzy	Healthy food	Diabetes Mellitus
Karupaiah et al. (2019)	A cross-sectional study on the Dietary pattern impact on cardio-vascular Disease Biomarkers in Malaysia	Malaysia	Crossectional	577	The subject of adults in Malaysia	High-fat, high-sugar, fizzy food habits	Healthy food	Diabetes Mellitus
Lee et al. (2017)	A Healthy Beverage Consumption Pattern Is Inversely Associated with the Risk of Obesity and Metabolic	Korea	Crossectional	19.800	Subjects aged 20 and over	Foods high in fat and high in sugar	Healthy food	Diabetes Mellitus

	Abnormalities in Korean Adults							
Yin et al. 2020)	Association of dietary patterns with the newly diagnosed diabetes mellitus and central obesity: a community-based cross-sectional study	China	Crossectional	1432	Subjects aged 40–65 years	Foods high in fat and high in sugar	Healthy food	Diabetes Mellitus

2. Dietary Pattern as a Risk Factor for Obesity
a. Summary of Source Articles
Table 2. Descriptions of primary studies included in the meta-analysis

Author (year)	Title	Country	Study Design	Sample	P Population	I Intervention	C Comparison	O Outcome
Mogre et al. (2015)	Demographic, dietary and physical activity predictors of general and abdominal obesity among university students	Ghana	Crossectional	552	College student	Foods high in fat and carbohydrates	Healthy food	Obesity
Zou et al. (2017)	Dietary Patterns and Obesity among Chinese Adults	Zhejiang, cina	Crossectional	1613	Adult subject	Foods high in fat and carbohydrates	Healthy food	Obesity
Roman et al. (2019)	Dietary patterns and their association with obesity: a cross-sectional study	Romania	Crossectional	1398	Adult subject	Foods high in fat	Healthy food	Obesity
Okube et al. (2020)	Association of dietary patterns and practices on metabolic syndrome in adults with central obesity attending a mission hospital	Kenya	Crossectional	404	Subjects aged 18–64 years	Foods high in fat and carbohydrates	Healthy food	Obesity
Shrestha et al. (2015)	Food patterns measured by principal component analysis and obesity in the Nepalese adult	Nepal	Crossectional	1073	Subjects aged 18 and over	Foods high in fat	Healthy food	Obesity
O'Brien et al. (2020)	Overweight and obesity in shift workers: associated dietary and lifestyle factors	Irlandia	Crossectional	1080	Subjects aged 18 and over	Foods high in fat and cholesterol	Healthy food	Obesity
Lee et al. (2018)	A Healthy Beverage Consumption Pattern Is Inversely Associated with the Risk of Obesity and Metabolic Abnormalities in Korean Adults	Korea	Crossectional	19.800	Subjects aged 20 and over	Foods high in fat and high in sugar	Healthy food	Obesity

Yin et al. (2020)	Association of dietary patterns with the newly diagnosed diabetes mellitus and central obesity	China	Crossectional	1432	Subjects aged 40–65 years	Foods high in fat and high in sugar	Healthy food	Obesity
Dagne et al. (2019)	Factors associated with overweight and obesity among adults in northeast Ethiopia: a cross-sectional study	Etiopia	Crossectional	751	Subjects aged 18–64 years	Foods high in fat and high in sugar	Healthy food	Obesity

b. Forest Plot
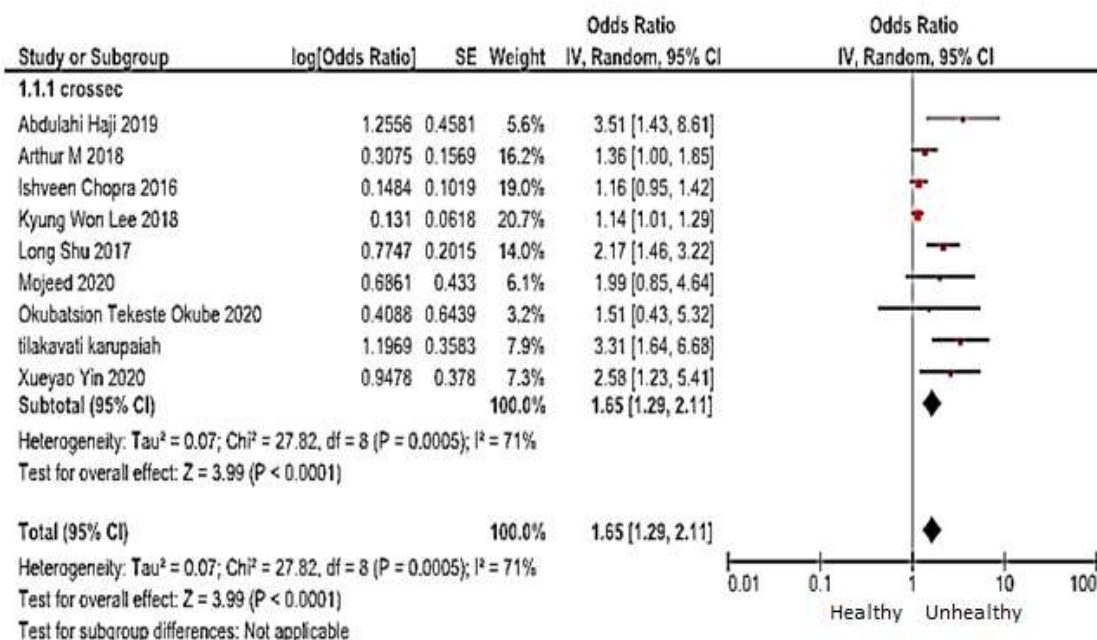
Figure 3. Forest Plot of Diet as a Risk Factor for Diabetes

Based on the forest plot results (Figure 3), an unhealthy diet could increase the risk of diabetes mellitus by 1.65 times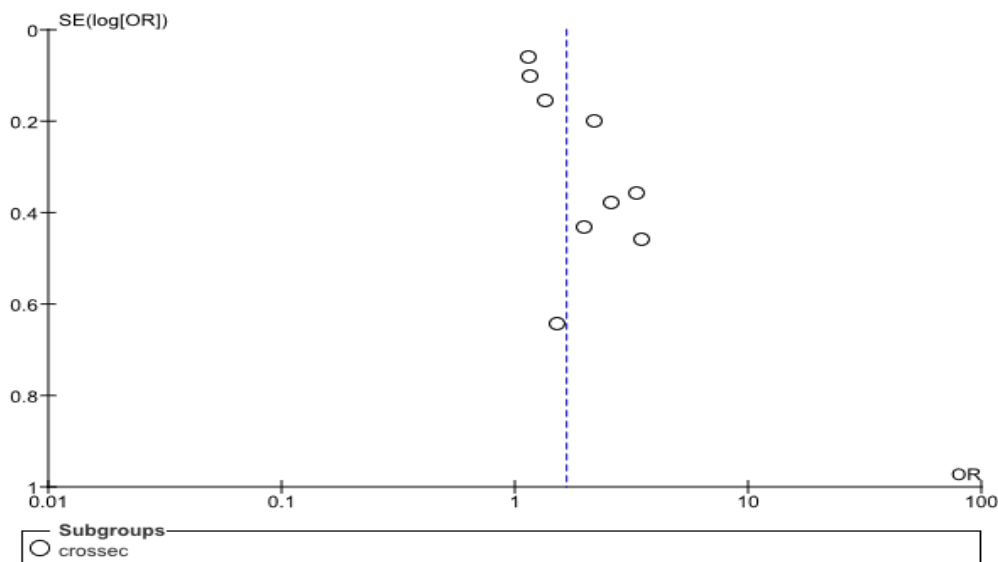 compared to a healthy diet with statistical significance (p=0.001). The heterogeneity of the research data showed I^2= 71%. The distribution of the data was stated as heterogeneous (random effect model).

c. Funnel Plot

Figure 4. Funnel Plot of Diet as a Risk Factor for Diabetes Mellitus

The funnel plot (figure 4) shows a publication bias, characterized by an asymmetry of the right and left plots where 5 plots are on the right, and 1 plot was on the left. The plot on the graph's right had a standard error (SE) between 0.2 and 0.6. The plot on the left of the graph had a standard error (SE) of 0.6.
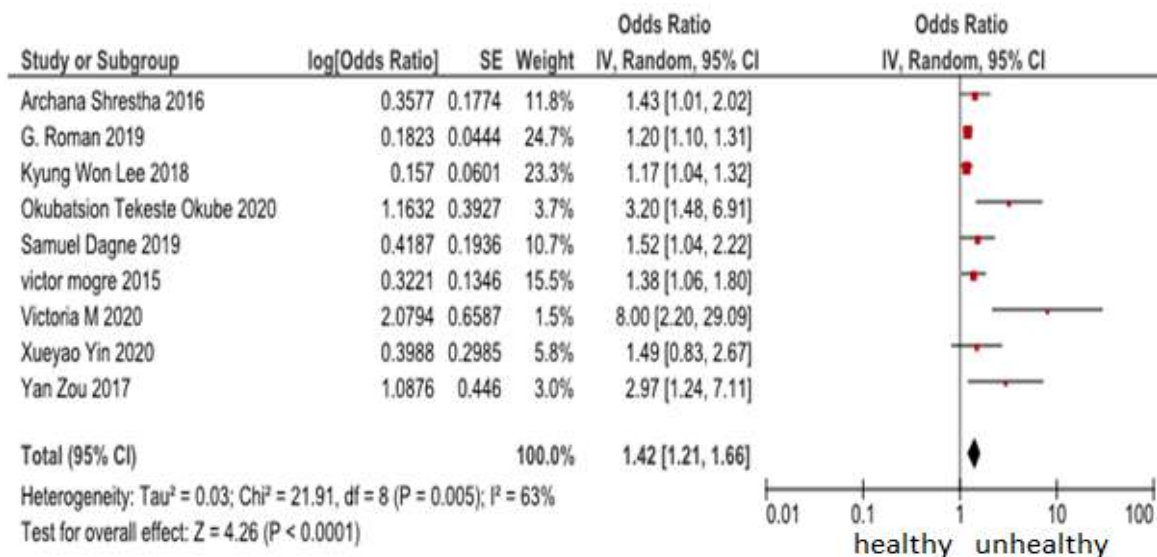
b. Forest Plot

Figure 5. Forest Plot of Diet asRisk Factors for Obesity Disease

Meta-analysis can be seen through the forest plot (Figure 5) showing that an unhealthy diet can increase the risk of obesity by 1.42 times compared to consuming healthy foods and statistically significant(p <0.0001). The heterogeneity of the research data shows I2= 63%, so that the distribution of the data is heterogeneous (random effect model).
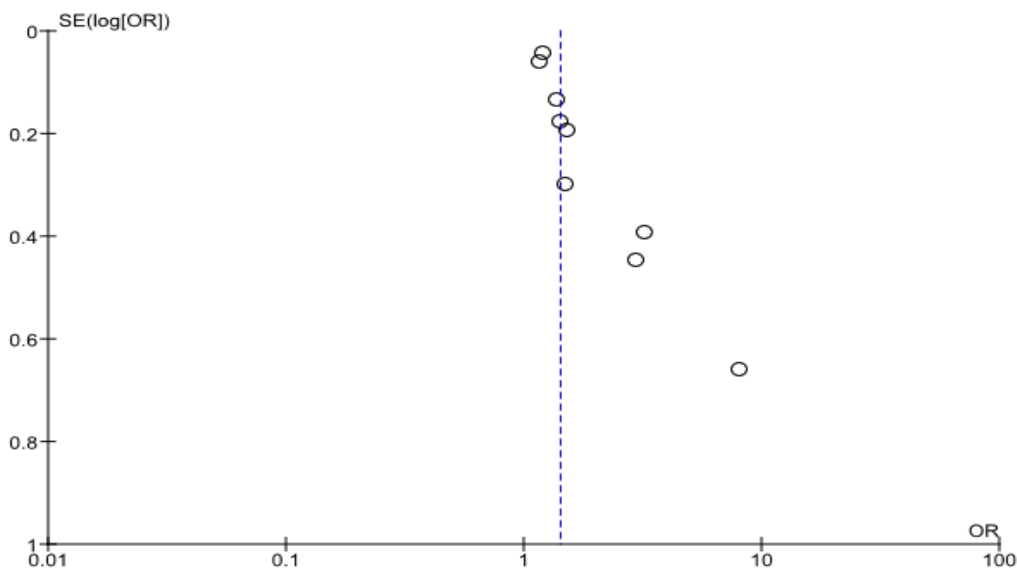
c. Funnel Plot

Figure 6. Funnel Plot of Diet As Risk Factors for Obesity

Figure 6 shows that there is a publication bias based on the funnel plot, which is characterized by an asymmetry of the right and left plots where 5 plots were on the right, 3 plots were on the left, and 1 plot was in the middle. The plot on the graph's right had a standard error (SE) between 0.2 and 0.7. The plot on the left of the graph had a standard error (SE) between 0 and 0.2.

Tabel 3. Critical Appraisal Checklist for Cross-sectional Study

Checklist questions	Gbadamosi et al. (2020)	Shu et al. (2017)	Abas et al. (2019)	Okube et al. (2020)	Lee et al. (2018)	Chopra et al. (2016)	Karupaiah et al. (2019)	Lee et al. (2017)	Yin et al. (2020)
Does this objective address the focus/research problem?	1	1	1	1	1	1	1	1	1
Is the research method (research design) appropriate for answering research questions?	1	1	1	1	1	1	1	1	1
Is the method of selecting research subjects written?	1	1	1	1	1	1	1	1	1
Can the sampling method raise bias (selection)?	0	0	0	0	0	1	0	0	0
Does the research sample taken represent the designated population?	1	1	1	1	1	1	1	1	1
Is the sample size based on pre-study considerations?	0	0	1	0	0	0	0	0	0
Is a satisfactory response achieved?	1	1	1	1	1	1	1	1	1
Are the research instruments valid and reliable?	1	1	1	1	1	1	1	1	1
Is statistical significance assessed?	1	1	1	1	1	1	1	1	1
Are confidence intervals given for the main outcome?	1	1	1	1	1	1	1	1	1
Are there any confounding factors that haven't been taken into account?	0	0	0	0	0	0	0	0	0
Are the results applicable to your research?	1	1	1	1	1	1	1	1	1
Total	9	9	10	9	9	10	9	9	9

Note: Yes= 1, No= 0

Tabel 4. Critical Appraisal Checklist for Cross sectional Study

Checklist questions	Mogre et al. (2015)	Zou et al. (2017)	Roman et al. (2019)	Okube et al. (2020)	Shrestha et al. (2015)	O'Brien et al. (2020)	Lee et al. (2018)	Yin et al. (2020)	Dagne et al. (2019)
Does this objective address the focus/research problem?	1	1	1	1	1	1	1	1	1
Is the research method (research design) appropriate for answering research questions?	1	1	1	1	1	1	1	1	1
Is the method of selecting research subjects written?	1	1	1	1	1	1	1	1	1
Can the sampling method raise bias (selection)?	0	0	1	0	0	1	0	0	0
Does the research sample taken represent the designated population?	1	1	1	1	1	1	1	1	1
Is the sample size based on pre-study considerations?	1	1	0	0	1	0	0	0	1
Is a satisfactory response achieved?	1	1	1	1	1	1	1	1	1
Are the research instruments valid and reliable?	1	1	1	1	1	1	1	1	1
Is statistical significance assessed?	1	1	1	1	1	1	1	1	1
Are confidence intervals given for the main outcome?	1	1	1	1	1	1	1	1	1
Are there any confounding factors that haven't been taken into account?	0	0	0	0	0	0	0	0	0
Are the results applicable to your research?	1	1	1	1	1	1	1	1	1
Total	10	10	10	9	10	10	9	9	10

Note: Yes= 1, No= 0

DISCUSSION

Research studies and systematic meta-analysis use of research to control confounding factors that can be seen from inclusion research are the multivariate analysis and statistical results reported were adjusted odds ratio (AOR).

Estimates of combined diet as a risk factor for Diabetes Mellitus was in the Rev-Man 5.3 application. The systematic study results and meta-analysis are presented in the form of a forest plot and a funnel plot. Forest plots provide an overview of each of the studies examined in the meta-analysis and estimates of the overall results (Murti, 2018).

The funnel plot shows the amount of variation (heterogeneity) (Akobeng, 2005 in Murti, 2018) visually. The funnel plot shows the relationship between the study's effect size and the sample size of the various studies studied, which can be measured in several different ways (Murti, 2018).

Dietary Pattern as a Risk Factor for Diabetes.

The forest plot results showed that an unhealthy diet increased the risk of obesity by 1.42 times compared to a healthy diet (aOR= 1.42; 95% CI= 1.21 to 1.66; p <0.001). This is according to the theory that food plays a role in increasing blood sugar levels. In eating, the food eaten will be digested in the digestive tract and then converted into a form of sugar called glucose (Sum Transport, 2013).

Zaroudi (2016) stated that if you often consume unhealthy foods such as high consumption of salt, offal, sweet dried fruits, animals, and tea, they can increase the risk of developing diabetes mellitus by 2.17 times compared to those who do not consume these foods (aOR= 2.17; 95% CI= 1.0 to 4.50; p= 0.024). The result of rapid changes in lifestyle, physical activity, diet, and better socioeconomic status in Iran has led to an unhealthy diet similar to the western pattern. An unhealthy diet is one of the risk factors for diabetes, the diet that is meant here is an unhealthy diet such as high fat, high carbohydrate, high sugar, aka sweet drinks, drinking alcohol that is done almost every day (Beigrezaei, 2019). Diets that develop with more protein and meat consumption also cause a decline in glucose metabolism (Nguyen, 2016).

Dietary Pattern as a risk factor for obesity.

The results of the forest plot research article that was processed with Revman 5.3 showed that an unhealthy diet increased the risk of obesity by 1.42 times compared to consuming healthy foods (aOR= 1.42; 95% CI= 1.21 to 1.66; p <0.001). This research is in line with the theory that dietary pattern is a risk factor for obesity.

This study is supported by a study conducted by Ali (2018), which stated that consumption of unhealthy foods such as fast food (high fat and high carbohydrates) ≥3 times per week increases the risk of obesity 1.82 times compared to <3 times a week. The statistical results obtained aOR= 1.829 (95% CI; 1.33 to 2.50).

According to Azkia (2018), consuming fried and high-fat foods increases the risk of obesity by 1.03 times compared to those who do not eat the food (aOR= 1.03; 95% CI= 0.9 to 1.1; p <0.001). This is also in accordance with a study conducted by Guallar & Castillon, which showed that fried food was positively related to central obesity because it can produce high energy intake. Consumption of fatty foods can increase stomach circumference and body weight. Besides, the consumption of fatty foods is a factor associated with obesity.

Chamieh (2015) stated that an unhealthy diet such as consuming lots of high-carbohydrate foods (rice, bread, processed flour) and high-fat fast food would increase

the risk of obesity by 2.03 times in adults compared to those who do not consume these foods. (aOR= 2.0; 95% CI= 1.24 to 3.34; p <0.001).

This meta-analysis concluded that an unhealthy diet high in fat, high in sugar, high in carbohydrates increased the risk of developing diabetes (aOR= 1.65; 95% CI= 1.29 to 2.11; p <0.001). This meta-analysis combines 9 primary studies using a cross-sectional design from Swaziland, China, Ethiopia, Kenya, the United States, and Malaysia.

This meta-analysis concluded that an unhealthy diet containing foods high in fat, high in carbohydrates, fried foods, junk food and drinking lots of soda increased the risk of obesity in adults (aOR= 1.42; 95% CI= 1.21 to 2.66; p <0.001). This meta-analysis combines 9 primary studies using a cross-sectional design from Ghana, China, Romania, Kenya, Nepal, Ireland, Korea, and Ethiopia.

AUTHOR CONTRIBUTION

Linda Wahyu Septianawati was the main researcher who selected the topic, explored, and collected research data. Yulia Lanti Retno Dwi and Eti Poncorini Pamungkasari played a role in analyzing data and conducting research document reviews.

CONFLICT OF INTEREST

There is no conflict of interest.

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