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Meta-analysis

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Meta-Analysis: Factors Related with Obesity in Adolescents

Karismatika Surya Gumilar, Betriza, Nurcahyo Aji Legowo, Bhisma Murti, Ayu Novita Wulandari

Master's Program in Public Health, Universitas Sebelas Maret

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ABSTRACT

Background: Obesity is excess body weight above the normal BMI limit. This can be experienced by anyone, starting from children, productive teenagers who do not maintain a healthy lifestyle, which can cause premature death. There are various factors that cause obesity from several research findings. This study aims to analyze and estimate factors that influence the risk of obesity in adolescents.
Subjects and Method: This research is a systematic review and meta-analysis with PRISMA and PICO diagrams. Population= teenagers. Intervention= strong physical activity, high income, female gender, strong consumption of fruit, and high maternal education. Comparison= weak physical activity, low income, male gender, weak consumption of fruit, and low maternal education. Result= obesity. The search for this article came from databases namely PudMed and Science Direct. The article keywords used are "physical activity" AND "Income" AND "fruit consumption" AND "maternal education" AND "obesity" AND "young factor". The articles included in this research are full paper articles, cross-sectional study design, publication year range 2013-2023, and the magnitude of the Adjusted Odds Ratio relationship. Articles were filtered using the PRISMA flow diagram and analyzed using the Review Manager 5.3.
Results: There are 10 articles with cross-sectional studies that show the risk of obesity is significantly influenced by high income by 2.04 times (aOR= 2.04; 95% CI=0.97 to 4.30; p= 0.060), female gender by 2.28 times (aOR= 2.28; 95% CI= 1.64 to 3.17; p<0.001), strong fruit consumption was 2.11 times (aOR= 2.11; 95% CI= 1.30 to 3.44; p= 0.003), and high maternal education was 1.64 times (aOR=1.64; 95% CI= 1.10 to 2.45; p= 0.020) and the influence of weak physical activity which is 0.59 times the risk of obesity with statistically significant results (aOR= 0.59; 95% CI= 0.41 to 0.83; p=0.003).
Conclusion: Risk factors that influence obesity in adolescents include high income, female gender, fruit consumption, high maternal education, and weak activity.

Keywords: Obesity, risk factors, health problems, teenagers.

Correspondence:
Karismatika Surya Gumilar. Masters Program in Public Health, Universitas Sebelas Maret. Jl. Ir Sutami 36A, Surakarta, Central Java 57126. Email: tikasuryagumelar@gmail.com Mobile: +62813-91354007.

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BACKGROUND

Obesity is excess weight than normal limits which can trigger health problems. Obesity data has increased in the last 50 years (Panuganti et al., 2023). Obesity is measured by body mass index (BMI), which is >30.0. If it is less than that, a person cannot be said to be obese, as 25-30 is considered overweight. It is called a long-term disease and is mostly experienced in the productive age, starting from childhood. The ranking of this disease in the years 1990-2019 is in the top 5 health problems that can pose a risk of death in the world. Obesity among those aged 5-19 years has increased every year by 16% from 2016. Risk factors that can cause an increase in obesity include an imbalance between nutritional intake and daily energy expenditure (Kinansi et al., 2018).Based on research, several factors that cause obesity include uncontrolled food intake, unhealthy lifestyle, parental hereditary factors, and lack of activity (Al-Saadi et al., 2023).

A few research studies have highlighted the complex linkages between maternal education, family income, and the risk of childhood obesity. Several studies, including research by Conklin et al. (2019) and Gibson-Smith et al. (2020), suggest that families with higher incomes have a greater chance of providing food and lifestyles that may contribute to being overweight in children. These factors can include easier access to high-calorie foods and less activity, as well as a home environment that may be less supportive of a healthy lifestyle. On the other hand, the mother's education level also plays an important role. According to research by Hales et al. (2012), mothers with lower levels of education tend to have limited knowledge about nutrition and healthy lifestyles, which can affect their children's eating habits and physical activity. In contrast, other research shows that a mother's education and higher family income are more likely for a child to be obese or overweight (Hossain et al., 2023).

Program implementation in reducing obesity rates is focused on prevention based on evidence of risk factors. Based on the description above, researchers are interested in summarizing primary research research evidence regarding the risk of obesity in adolescents. This study aims to analyze and estimate factors that influence the risk of obesity in adolescents.

SUBJECTS AND METHOD

1. Study Design

This systematic review and meta-analysis research was conducted using articles published from 2013 to 2023. The selection of articles used a flow diagram, namely the PRISMA Flow Diagram. The keywords used in the article search were "physical activity" AND "Income" AND "consumption of fruit" AND "maternal education" AND "obesity" AND "young factor".

2. Steps of Meta-Analysis

1) Create research questions using the PICO format, which involves defining the Population, Intervention, Comparison, and Outcome.
2) Search electronic and non-electronic databases such as PubMed, Science Direct, and Scopus for primary study articles.
3) Conduct a screening process to establish criteria for inclusion and exclusion, followed by a thorough critical assessment.
4) Gather data from the primary studies and compile effect estimates using the RevMan application.
5) Analyze the findings and formulate conclusions based on the interpreted results.

3. Inclusion Criteria

This study used inclusion criteria, such as full-text articles with a cross-sectional re-

search design. This article was published in English from 2013 to 2023. Data analysis was interpreted using odds ratios (aOR).

4. Exclusion Criteria

This study was conducted using exclusion criteria, namely qualitative study articles, articles published before 2013 in languages other than English.

5. Operational Definition of Variables

Physical activity: physical activities that teenagers do every day that will affect the energy they expend.

Income: the income or pocket money teenagers have which will influence the frequency of becoming food consumers.

Gender: gender differences in adolescents that will influence the mindset of becoming obese.

Fruit consumption: the frequency of fruit consumption every day or rarely or even not at all which influences the healthy lifestyle of teenagers.

Maternal Education: maternal education will play a role in providing support to teenagers in a healthy lifestyle.

6. Study Instruments

The instrument for determining the quality of articles uses a critical appraisal checklist assessment format in a cross sectional study design. The assessment criteria include if the answer is "Yes" to each question, give a score of "2". The answer "Undecided" gives a score of "1". The answer "No" gives a score of "0.

7. Data Analysis

The research in this study followed the PRISMA flowchart to gather articles and employed the Review Manager 5.3 software for analysis. The analysis involved determining the effect size and assessing the consistency of heterogeneity (I^2) within the chosen research findings.

RESULTS

The results of the article search process in online publications of primary studies resulted in 10 selected articles. Figure 1 shows the PRISMA diagram of the flow of influence factors to the risk factors of obesity in adolescents. Some of them come from various countries such as Ethiopia, Nepal, Gambia, UAE, Nigeria, Oman, and Bangladesh.. Figure 2. shows the map of the research area on the effect of influence factors to the risk factors of obesity on adolescents.

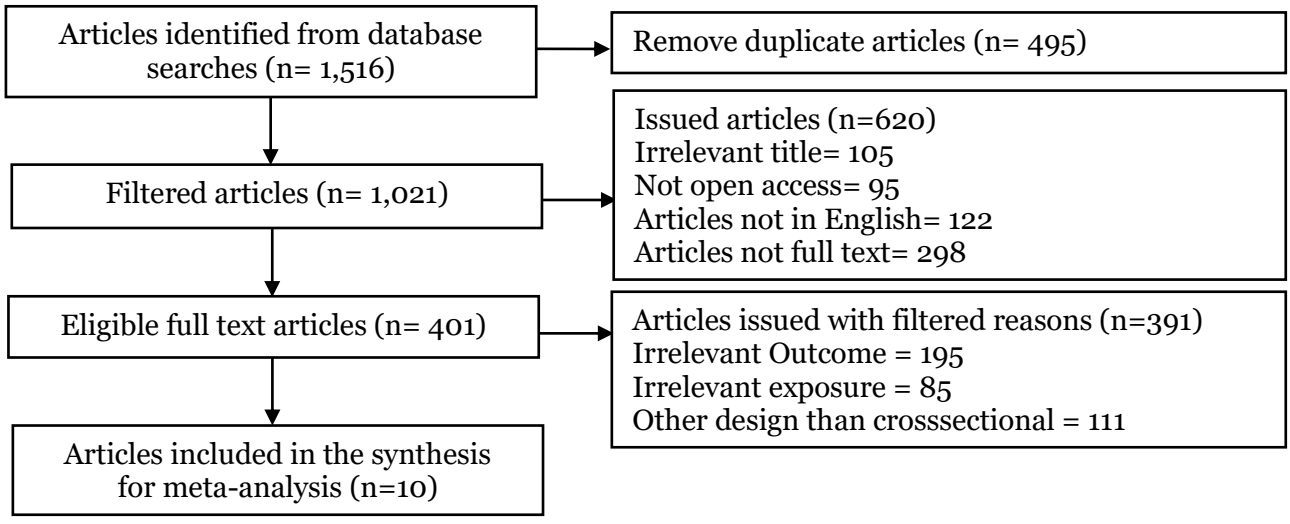

Figure 1. PRISMA flowchart

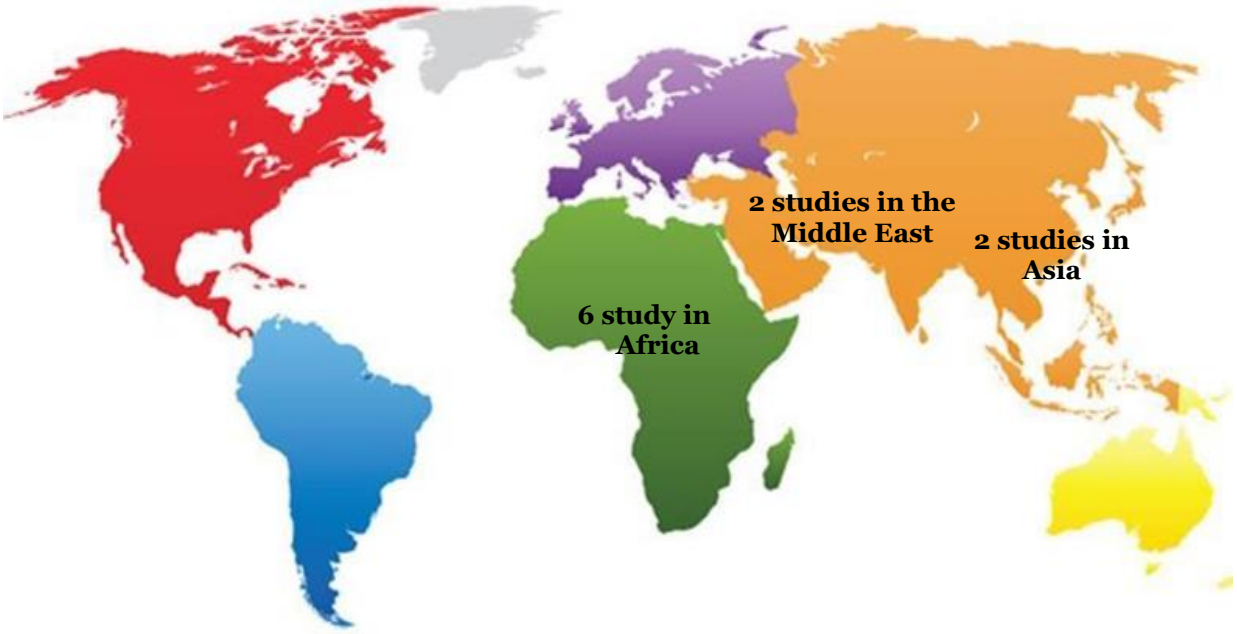

Figure 2. Map of the distribution of articles included in the meta-analysis

Table 1. Critical appraisal assessment in cross-sectional studies

Author (Year)	Criteria of Questions													Total
	1a	1b	1c	1d	2a	2b	3a	3b	4	5	6a	6b	7	
Teshome et al. (2013)	2	2	2	2	2	2	2	2	2	2	2	2	2	26
Shegaze (2015)	2	2	2	2	2	1	2	2	2	2	2	2	2	25
Piryani et al. (2016)	2	2	2	2	2	0	2	2	2	2	2	2	2	24
Moges et al. (2018)	2	2	2	2	2	0	2	2	2	2	2	2	2	24
Jallow-Badjan et al. (2020)	2	2	2	2	2	0	2	2	2	2	2	2	2	24
Baniissa et al. (2020)	2	2	2	2	2	2	2	2	2	2	2	2	2	26
Adeomi et al. (2022)	2	2	2	2	2	0	2	2	2	2	2	2	2	24
Hunegnaw et al. (2022)	2	2	2	2	2	0	2	2	2	2	2	2	2	24
Al-Saadi et al. (2023)	2	2	2	2	2	1	2	2	2	2	2	2	2	25
Hossain et al. (2023)	2	2	2	2	2	0	2	2	1	2	2	2	2	23

Description of the question criteria:

1. Formulation of research questions in the acronym PICO.

a. Is the population in the primary study the same as the population in the PICO meta-analysis?

b. Is the operational definition of intervention, namely exposed status in the primary study, the same as the definition intended in the meta-analysis?

c. Is the comparison, namely the unexposed status used by the primary study, the same as the definition intended in the meta-analysis?

d. Are the outcome variables examined in the primary studies the same as the definitions intended in the meta-analysis?

2. Methods for selecting research subjects

a. In analytical cross-sectional studies, do researchers choose samples from the population randomly (random sampling)?

b. Is an alternative, if in a cross-sectional analytical study the sample is not selected randomly, does the researcher select the sample based on outcome status or based on intervention status?

3. Methods for measuring exposure and outcome variables
a. Are the exposure and outcome variables measured with the same instruments (measuring tools) in all primary studies?
b. If the variable is measured on a categorical scale, are the cutoffs or categories used the same across primary studies?
4. Design-related bias

If the sample was not selected randomly, has the researcher made efforts to prevent bias in selecting research subjects? For example, selecting subjects based on outcome status is not affected by exposure status (intervention), or selecting subjects based on exposure status (intervention) is not affected by outcome status.

5. Methods for controlling confusion
a. Whether the primary study investigators have made efforts to control the influence of confounding (for example, conducting a multivariate analysis to control for the influence of a number of confounding factors).
6. Statistical analysis methods
a. Did the researcher analyze the data in this primary study with a multivariate analysis model (for example, multiple linear regression analysis, multiple logistic regression analysis).
b. Does the primary study report the effect size or association of the results of the multivariate analysis (adjusted OR).
7. Conflict of Interest

Is there no possibility of a conflict of interest with the research sponsor, which could cause bias in concluding the research results?

Description of answer score:

0= No

1= Hesitant

2= Yes

Table 2. Description of primary study factors influence risk of obesity in adolescents with cross-sectional design (n= 8,038)

Author (year)	Country	Sampel	P	I	C	O
Teshome et al. (2013)	Ethiopia	554	Teenager	High income, women, fruit consumption	Low income, male, weak fruit consumption	Obesity
Shegaze (2015)	Ethiopia	456	Teenager	Vigorous physical activity	Weak physical activity	Obesity
Piryani et al. (2016)	Nepal	360	Teenager	High income, women, fruit consumption, maternal education	Low income, male, weak fruit consumption, low maternal education	Obesity
Moges et al. (2018)	Ethiopia	1,276	Teenager	High income, women, fruit consumption, maternal education	Weak physical activity, low income, male, low maternal education	Obesity
Jallow-Badjan et al. (2020)	Gambia	901	Teenager	High income, women, maternal education	Weak physical activity, male, low maternal education	Obesity
Baniissa et al. (2020)	UAE	932	Teenager	High income, women, fruit consumption	Weak physical activity, male, weak fruit consumption	Obesity
Adeomi et al. (2022)	Nigeria	1,200	Teenager	High income, women, physical activity	Weak physical activity, Low income, Male	Obesity
Hunegnaw et al. (2022)	Ethiopia	1,060	Teenager	High income, women, fruit consumption, physical activity	Weak physical activity, low income, male, weak fruit consumption	Obesity

Author (year)	Country	Sampel	P	I	C	O
Al-Saadi et al. (2023)	Oman	714	Teenager	Physical activity	Weak physical activity	Obesity
Hossain et al. (2023)	Bangladesh	585	Teenager	High income, women, physical activity, maternal education	Weak physical activity, low income, male, low maternal education	Obesity
Hunegnaw et al. (2022)	Ethiopia	1,060	Teenager	High income, women, fruit consumption, physical activity	Weak physical activity, low income, male, weak fruit consumption	Obesity

Table 3. Adjusted odd ratio data on the influence of physical activity levels on obesity in adolescents (N= 7,124)

Author (Year)	aOR	95% CI	
		Upper Limit	Lower Limit
Shegaze (2015)	0.21	0.08	0.57
Moges et al. (2018)	1.20	0.84	1.73
Jallow-Badjan et al. (2020)	0.48	0.24	0.95
Baniissa et al. (2020)	0.47	0.31	0.73
Adeomi et al. (2022)	0.55	0.39	0.78
Hunegnaw et al. (2022)	0.32	.015	0.69
Al-Saadi et al. (2023)	0.84	0.49	1.44
Hossain et al. (2023)	0.80	0.46	1.38

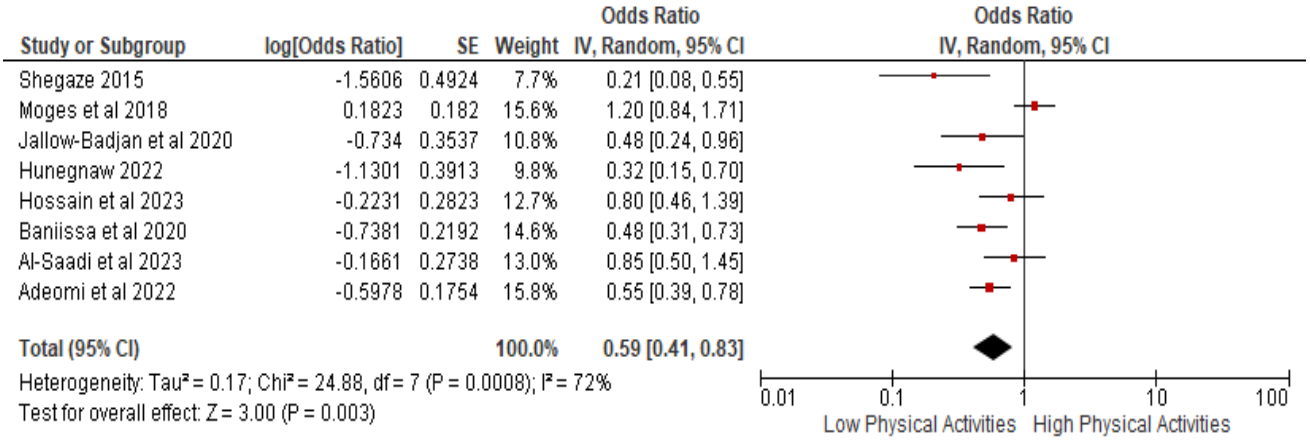

Figure 3. Forest Plot of the effect of strong physical activity to obesity on adolescents

The Forest Plot in Figure 3 shows that weak physical activity has an effect on the risk of obesity 0.59 times compared to vigorous physical activity, the results were declared statistically significant (aOR= 0.59; 95% CI= 0.41 to 0.83; p=0.003). Heterogeneity in the article population was high between primary studies (I^2= 72%; p=0.001) with the calculation of the average effect estimate carried out using a random effect model approach.

The Funnel Plot in Figure 4 show that the distribution of effect estimates is uneven, which means that there is publication bias in the primary studies found.

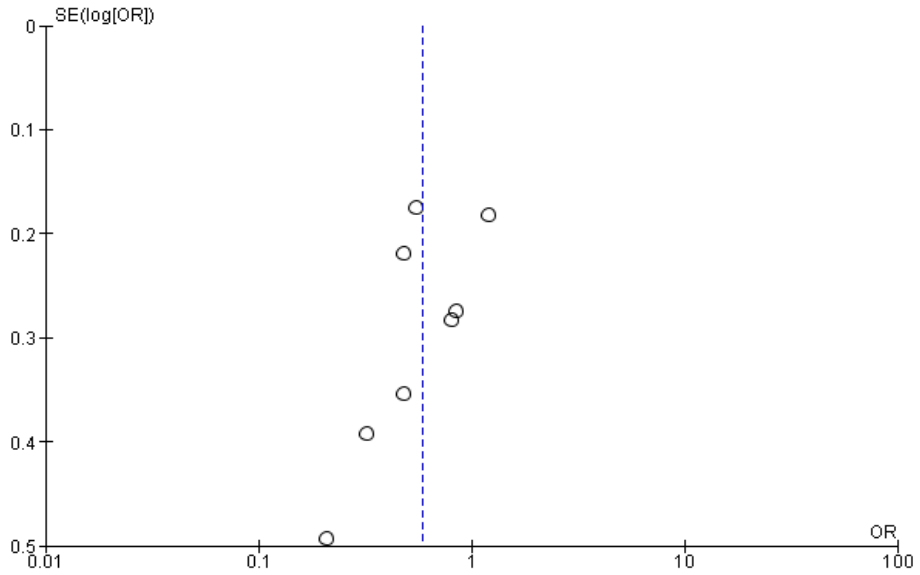

Figure 4. Funnel Plot of the effect of physical activity to obesity on adolescents

Table 4. Adjusted odd ratio data on the influence of high income levels on obesity in adolescents (N= 3,975)

Author (Year)	aOR	95% CI	
		Upper Limit	Lower Limit
Teshome et al. (2013)	7.19	2.60	**19.89**
Piryani et al. (2016)	4.77	1.36	16.72
Moges et al. (2018)	1.42	0.79	2.57
Adeomi et al. (2022)	0.47	0.25	0.88
Hunegnaw et al. (2022)	2.79	0.87	8.94
Hossain et al. (2023)	1.95	1.14	3.35

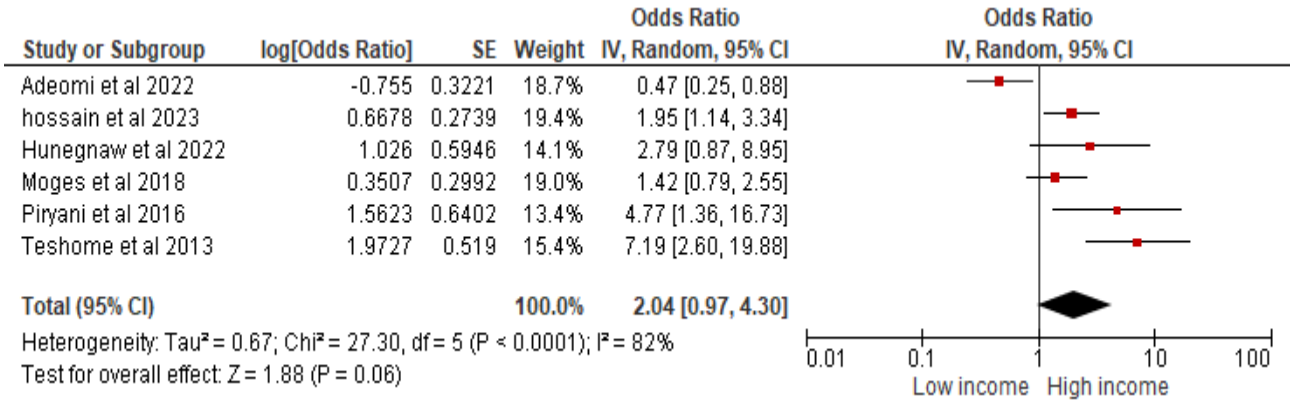

Figure 5. Forest Plot of the effect of high Income to obesity on adolescents

The Forest Plot in Figure 5 shows that high income increases the risk of obesity 2.04 times compared to low income, with statistically significant results (aOR= 2.04; 95% CI= 0.97 to 4.30; p= 0.06). Heterogeneity in the article population was high between primary studies (I^2= 82%; p= 0.006) with the calculation of the average effect estimate carried out using a random effect model approach.

The Funnel Plot in Figure 6 show that the distribution of effect estimates is uneven, which means that there is publication bias in the primary studies found.

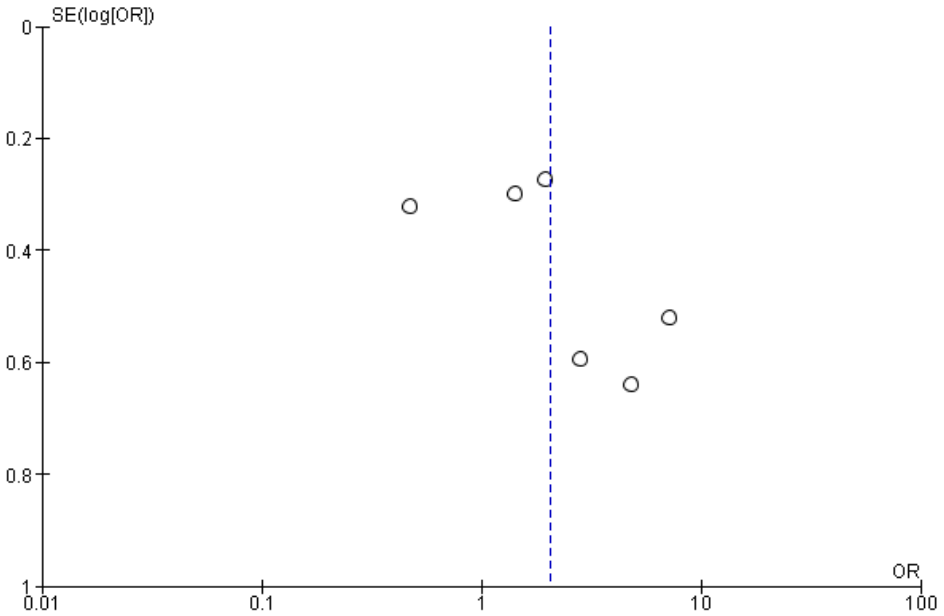

Figure 6. Funnel Plot of the effect of high income to obesity on adolescents

Table 5. Adjusted odd ratio data on the influence of female gender on obesity in adolescents (N=6,868)

Author (Year)	aOR	95% CI	
		Upper Limit	Lower Limit
Teshome et al. (2013)	5.14	2.41	10.99
Piryani et al. (2016)	2.64	1.18	4.88
Moges et al. (2018)	1.47	0.92	2.37
Jallow-Badjan et al. (2020)	3.15	1.43	6.93
Baniissa et al. (2020)	3.35	2.20	5.10
Adeomi et al. (2022)	1.73	1.11	2.69
Hunegnaw et al. (2022)	2.29	0.99	5.29
Hossain et al. (2023)	1.31	0.79	2.21

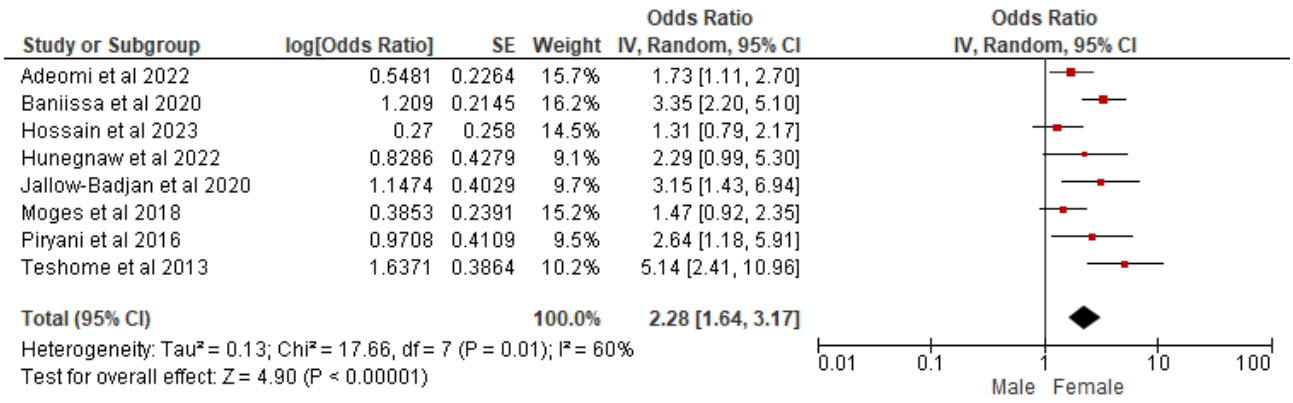

Figure 7. Forest Plot of the effect of female gender to obesity on adolescents

The Forest Plot in Figure 7 shows that women are 2.28 times more at risk of obesity compared to men, with statistically significant results (aOR= 2.28; 95% CI= 1.64 to 3.17; p<0.001). Heterogeneity in the article population is high between primary studies (I^2= 60%; p<0.001) with the calculation of the average effect estimate carried out using a random effect model approach.

The Funnel Plot in Figure 8 show that the distribution of effect estimates is uneven, which means that there is publication bias in the primary studies found.

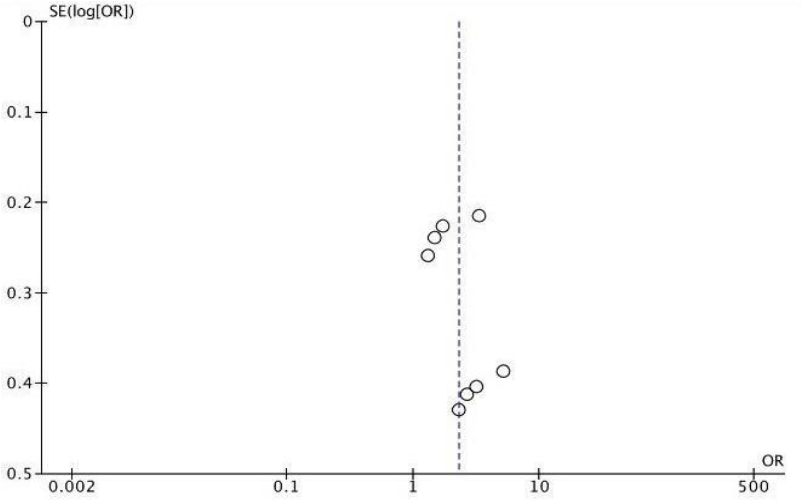

Figure 8. Funnel Plot of the effect of the effect of high fruits consumption to obesity on adolescents

Table 6. Adjusted odd ratio data on the influence of strong levels of fruit consumption on obesity in adolescents (N=2,906)

Author (Year)	aOR	95% CI	
		Upper Limit	Lower Limit
Teshome et al. (2013)	1.39	0.61	3.16
Piryani et al. (2016)	3.13	1.39	7.01
Baniissa et al. (2020)	2.41	1.73	3.36
Hunegnaw et al. (2022)	0.19	0.01	5.35

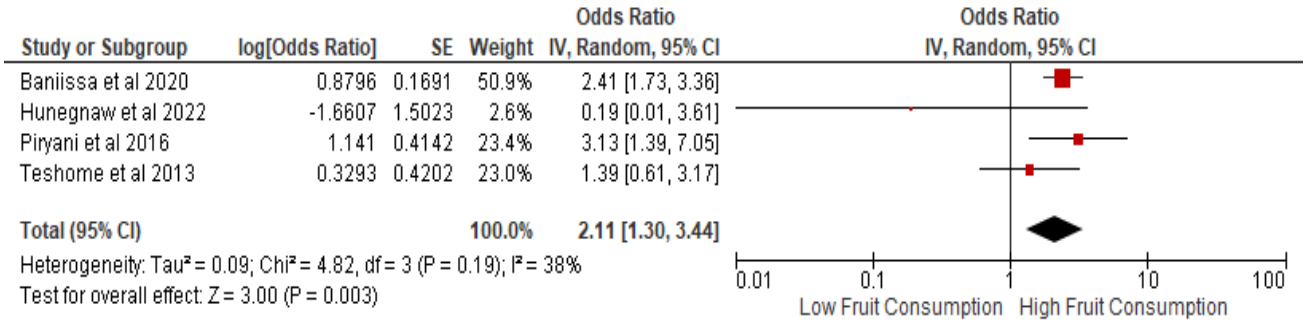

Figure 9. Forest Plot of the effect of high fruits consumption to obesity on adolescents

The Forest Plot in Figure 9 shows that strong fruit consumption has an effect on reducing the risk of obesity 2.11 times compared to weak fruit consumption, with statistically significant results (aOR= 2.11; 95% CI= 1.30 to 3.44; p= 0.003). Hetero-

geneity in the article population was low between primary studies (I^2= 38%; p= 0.003) with the calculation of the average effect estimate carried out using a random effect model approach.

The Funnel Plot in Figure 10 show that the distribution of effect estimates is not symmetrical, which means that there is publiccation bias in the primary studies found.

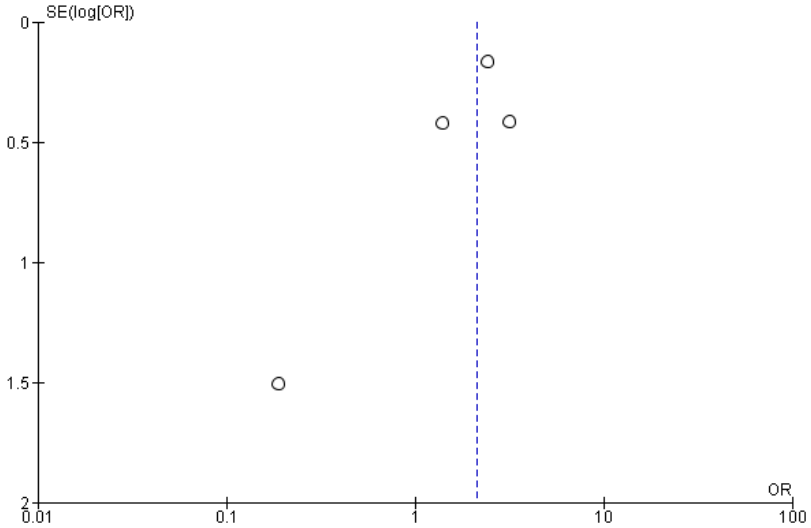

Figure 10. Funnel Plot of the effect of strong fruits consumption to obesity on adolescents

Table 7. Adjusted odd ratio data on the influence of high maternal education on obesity in adolescents (N= 3,122)

Author (Year)	aOR	95% CI	
		Upper Limit	Lower Limit
Piryani et al. (2016)	0.85	0.32	2.22
Moges et al. (2018)	1.06	0.50	2.24
Jallow-Badjan et al. (2020)	2.86	1.16	7.07
Hossain et al. (2023)	2.33	1,19	4.78

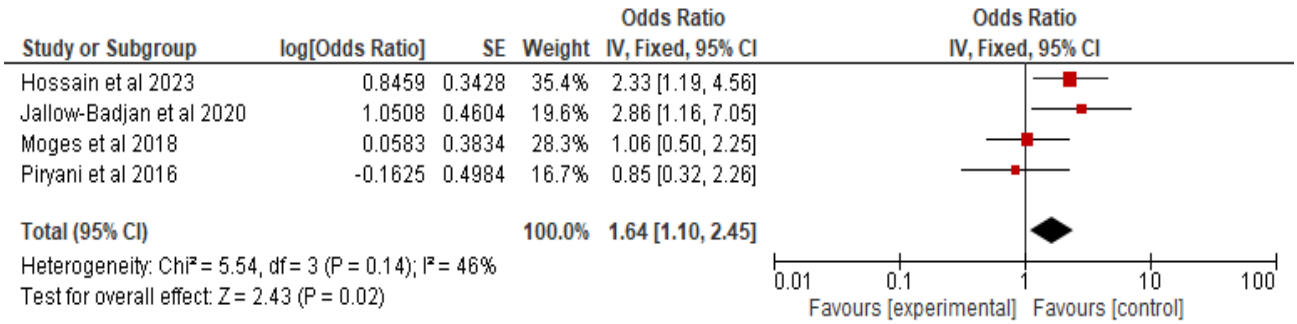

Figure 11. Forest Plot of the effect of high mother's education to obesity on adolescents

The Forest Plot in Figure 11 shows that high maternal education influences the risk of obesity 1.64 times compared to low maternal education, with statistically significant results (aOR= 1.64; 95% CI= 1.10 to 2.45; p= 0.02). Heterogeneity in the article

population was high between primary studies (I^2=46%; p=0.140) with the calculation of the average effect estimate carried out using a fixed effect model approach.

The Funnel Plot results in Figure 12 show that the distribution of effect estimates is not symmetrical, which means that there is publication bias in the primary studies found.

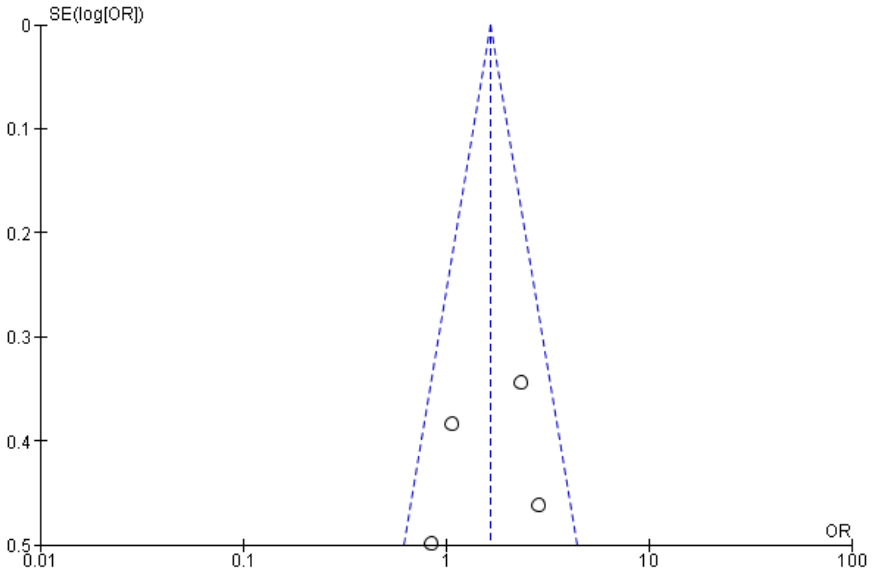

Figure 12. Funnel Plot of the effect of high mother's education to obesity on adolescents

DISCUSSION

This meta-analysis study analyzes factors that can influence the incidence of obesity in adolescents. The analysis uses aOR (Adjusted Odds Ratio) which aims to obtain multivariate results.

1. The effect of weak physical activity on obesity

This study shows that weak physical activity has an effect on the risk of obesity 0.59 times compared to vigorous physical activity, the results were declared statistically significant (aOR= 0.59; 95% CI= 0.41 to 0.83; p=0.001). In line with research conducted by Carbone et al. (2019) shows that physical activity and food intake will influence a person's obesity. Unhealthy lifestyle habits will cause health problems such as obesity and even trigger diabetes mellitus. Implementation of lifestyle changes is carried out from an early age. Minimum physical activity is 150 minutes every week (Jallow-Badjan et al., 2020). Physical activity is not just exercise but doing activities and being productive every day.

2. The effect of high income on obesity

This study shows that high income increases the risk of obesity 2.04 times compared with low income, with statistically significant results (aOR= 2.04; 95% CI= 0.97 to 4.30; p= 0.060). High income is associated with the level of wealth of the teenager's family. Adeomi et al. (2022) states that greater wealth means smaller families so that parenting styles easily provide more of what children want. In addition, food adequacy is more guaranteed compared to those with lower incomes. Pocket money is also associated with the definition of high income, such as teenagers who have high pocket money, it is easier to become a consumer pattern.

3. The influence of female gender on obesity

This study shows that women are 2.17 times more at risk of obesity compared to men, with statistically significant results (aOR= 2.17; 95% CI=1.78 to 2.65; p <0.001). Women tend to have a higher intensity of mood changes than men, which can influence unhealthy food consumption patterns (Adeomi et al., 2022).

4. Strong influence of fruit consumption on obesity

This study shows that strong fruit consumption has an effect on reducing the risk of obesity 2.11 times compared to weak fruit consumption, with statistically significant results (aOR= 2.11; 95% CI= 1.30 to 3.44; p= 0.003). The current trend of low fruit intake increases the incidence of obesity in adolescents. Balancing fruit consumption with other healthy lifestyle patterns is carried out for better health outcomes (Baniissa et al., 2020).

5. The effect of high maternal education on obesity

This study shows that high maternal education influences the risk of obesity 1.64 times compared to low maternal education, with statistically significant results (aOR= 1.64; 95% CI= 1.10 to 2.45; p= 0.020).

Low maternal education can increase obesity in adolescents. This is not in accordance with the results of high-income increasing obesity because when a family has a high education they will also have a high income, thereby increasing the risk of obesity. There is a need for further research into these findings (Jallow-Badjan et al., 2020).

AUTHOR CONTRIBUTION

Karismatica Surya Gumilar, Betriza, and Nurcahyo Aji Legowo are researchers who create topics, search for articles and analyze data. Bhisma Murti and Ayu Novita Wulandari reviewed the study article.

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CONFLICT OF INTEREST

There is no conflict of interest in this study.

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