Correlation between Overweight and Mental Health in Adolescents: A Meta Analysis

Riski Anisa[1), Yulia Lanti Retno Dewi[2), Hanung Prasetya[3)

[1)Masters Program in Public Health, Universitas Sebelas Maret
[2) Faculty of Medicine, Universitas Sebelas Maret
[3) Study Program of Accupuncture, Health Polytechnics, Ministry of Health Surakarta

ABSTRACT

Background: Adolescence is a critical period in human life because of the various changes that occur during this stage of life. Overweight and obesity in adolescents is a major public health problem in all developing countries, in addition to affecting physical health, can have a negative impact on mental health. This study aims to analyze the primary study of the effect of being overweight and obese on mental health in adolescents with a meta-analysis.

Subjects and Method: This study is a meta-analysis with the following PICO, Population: teenagers. Intervention: overweight and obese. Comparison: normal weight. Outcome: mental health. The articles used in this study were obtained from three databases, namely Google Scholar, Pubmed, and Science Direct. Keywords to search for articles [(adolescent OR teenager OR children) AND ("body mass index" OR BMI OR overweight OR obesity) AND (depression OR "depression symptom") AND (anxiety OR "anxiety symptom")]. The included articles are full text in English in 2010 to 2022 with cohort study design and report on aOR in multivariate analysis. The selection of articles is done by using PRISMA flow diagram. Articles were analyzed using the Review Manager 5.3 application.

Results: Nine studies were included in this study, six studies from the Americas, two studies from the European continent, and one study from the Australian continent. The data collected showed an increased risk for depression and anxiety in adolescents who were overweight and obese than adolescents who had normal weight. Obese adolescents had a higher risk of depression (aOR= 1.64; 95% CI= 1.42 to 1.90; p<0.001) than overweight adolescents (aOR= 1.09; 95% CI= 1.00 to 1.18; p= 0.050). Adolescents who were obese had a higher risk of anxiety (aOR= 1.27; 95% CI= 1.08 to 1.49; p= 0.003) than adolescents who were overweight (aOR= 1.10; 95% CI= 1.01 to 1.19; p= 0.020).

Conclusion: Overweight and obesity can have an influence on the mental health of adolescents.

Keywords: adolescent, overweight, obese, depression, anxiety, meta-analysis.

Correspondence:
Riski Anisa. Masters Program in Public Health, Universitas Sebelas Maret. Jl. Ir. Sutami 36A, Surakarta 57126, Central Java, Indonesia. Email: riskianisa93@gmail.com. Mobile: +6285-749027212.

BACKGROUND

Adolescence is a critical period in human life due to various changes that occur during this stage of life (Mannan et al., 2016). Adolescents experience rapid physical, cognitive and psychosocial growth. Change affects how teens feel, think, make decisions, and interact with the world around them (WHO, 2022).

Overweight and obesity are major public health problems in all developing countries. Obesity is also a growing problem in children and adolescents. The prevalence of overweight and obesity among children and adolescents aged 5-19 years increased dramatically from just 4% in 1975 to more than 18% in 2016. The increase was similar among boys and girls, in 2016 18% of girls and 19% of boys were overweight (WHO, 2021b). The 2018 Basic Health Research estimates that one in five children aged 5-12 years and one in seven adolescents aged 13-18 years in Indonesia is overweight or obese (UNICEF, 2022).

Adolescent overweight, in addition to affecting physical health, can have a negative impact on mental health. Compared with adolescents who have normal weight, adolescents who are overweight or obese have psychosocial problems more often (Van Vuuren et al., 2019). According to WHO (2021), globally it is estimated that 1 in 7 (14%) children aged 10-19 years have mental health conditions, but most of them remain unrecognized and untreated. Adolescents with mental health conditions are particularly vulnerable to social exclusion, discrimination, stigma, educational difficulties, risk-taking behavior, poor physical health and human rights violations (WHO, 2021a).

The results of several studies describe and link obesity and various forms of psychological distress, including anxiety and depressive disorders (Kubzansky et al., 2012). Adolescents who are obese can experience stigmatization, poor body image and low self-esteem thereby increasing their vulnerability to depression. Their behavior and lifestyle, especially poor eating habits and activities in terms of reducing physical activity and sleep disturbances can also cause depression (Mannan et al., 2016).

Based on these data, the authors are interested in knowing the effect of being overweight and obese on mental health in adolescents through a meta-analysis study.

SUBJECTS AND METHOD

1. Study Design
This study was conducted using a meta-analysis. The search for articles in this study was conducted using electronic databases such as Google Scholar, PubMed, and Science Direct. The articles used were published from 2010-2022. The keywords used to retrieve the article were: [(adolescent OR teenager OR children) AND ("body mass index" OR BMI OR overweight OR obesity) AND (depression OR "depression symptom") AND (anxiety OR "anxiety symptom")]. The results of the search for articles in this study are listed in the PRISMA diagram and analyzed using the Review Manager 5.3 application.

2. Steps of Meta-Analysis
The meta-analysis was carried out through 5 steps as follows:
1) Formulate research questions in PICO (Population, Intervention, Comparison, and Outcome).
2) Searching for primary study articles from various databases including Google Scholar, PubMed, and Science Direct.
3) Perform screening and conduct critical quality primary studies.
4) Perform data extraction and enter the estimated effect of each primary study into the RevMan 5.3 application.
5) Interpret the results and draw conclusions

The assessment of critical criteria is carried out by 2 independents using the Critical Appraisal Skills Program published by the 2018 Critical Appraisal Skills Program which consists of 12 questions. The questions are answered by giving a score. A score of 0 for answers was not carried out in the primary study, and a score of 1 for answers if done. The primary study is carried out if the total

is at least 10. Then it is entered into the Rev-Man 5.3 application

3. Inclusion Criteria

Full paper article with a cohort study, multivariate analysis with Adjusted Odds Ratio (aOR) to measure the estimated effect, research subjects are adolescents, research intervention is overweight, comparison is normal weight, mental health outcomes.

4. Exclusion Criteria

Articles published other than English, articles before 2010 and previous studies using meta-analysis.

5. Definition Operational of Variable

In formulating research problems PICO is used. The population is adolescents, the research intervention is overweight, the comparison is normal weight, the outcome of the study is mental health.

Being overweight or obese is defined as a BMI higher than normal, which is above 25.0.

Mental health is defined by the mental health status of adolescents who are categorized as depression or anxiety.

6. Study Instruments

The study was guided by the PRISMA flowchart and quality assessment in this study uses the Critical Appraisal Skills Program for Cohorts.

7. Data Analysis

The articles in this study were analyzed using the Review Manager 5.3 application by calculating effect sizes and heterogeneity to determine the combined research model and form the final results of the meta-analysis.

RESULTS

A total of 2,065 articles were identified through the electronic database. After removing duplication, 1,921 articles were screened. Of these, 83 articles were assessed for eligibility. The following reasons are given for full-text articles that meet the exclusion criteria:

1. The article reports only the crude odd ratio (OR) resulting from bivariate analysis
2. The effect size used is aRR/aHR, not aOR
3. Article reporting outcomes other than depression and anxiety in overweight adolescents.

A total of 9 articles that met the quality assessment were included in the quantitative synthesis using Meta-Analysis. It can be seen in Figure 2 that the research articles come from two continents, namely Americas, European and Australian.

1. Research Quality Assessment

The Critical Appraisal Checklist for Cohort Study published by the Critical Appraisal Skills Program.

This assessment criteria consists of twelve criteria, with each measure given a score of 1 = if you answer yes, 0 = if you answer no. The following are the assessment criteria of the Cohort Study Checklist published by CASP, including:

1) Does the cohort study clearly address the research problem?
2) Does the cohort study clearly address the research problem?
3) Is exposure accurately measured to minimize bias?
4) Are results measured accurately to minimize bias?
5) Did the researcher identify all the important confounding factors? Did the researcher take confounding factors into account in the design and/or analysis?
6) Was the follow-up of the subject sufficiently complete? Was the follow-up of the subject long enough?
7) Is this study reported in aOR?
8) How precise are the results?
9) Are the results reliable?
10) Are the results applicable to the local population?
11) Do the research results match the available evidence?

12) Are the results applicable in practice/community?

Table 1, the researchers conducted an assessment of the quality of the study. The next step is to calculate the overall effect of combining the data. Data analysis was carried out using Review Manager (RevMan) 5.3 software released by the Cochrane Collaboration.

2. The Effect of Overweight on Depression in Adolescents

The Forest Plot in Figure 3 shows that the risk of depression in overweight adolescents was 1.09 times that of normal weight adolescents (aOR = 1.09; 95% CI= 1.00 to 1.18) and statistically significant p= 0.050. Statistical heterogeneity between studies was I2= 53%, indicating a heterogeneous distribution of data so that the average effect of overweight on depression was calculated using the random effects model.

The funnel plot in Figure 4 shows the potential for publication bias as indicated by an asymmetric distribution between plots (two plots on the left and five plots on the right touching the vertical line). The funnel plot shows that the distribution of the estimated effect of being overweight on the risk of depression is more on the right of the vertical line than on the left. The average effect estimate on the forest plot is also to the right of the vertical Ho line, so the publication bias overestimates the effect of being overweight on the true risk of depression (overestimate)

3. The Effect of Overweight on Anxiety in Adolescents

The Forest Plot in Figure 5 shows that the risk of anxiety in overweight adolescents is 1.10 times that of normal weight adolescents (aOR= 1.10; 95% CI= 1.01 to 1.19) and statistically significant p= 0.020. Statistical heterogeneity among studies was I2= 71%, indicating a heterogeneous distribution of data so that the average effect of overweight on anxiety was calculated using a random effects model.

The funnel plot in Figure 6 shows the potential for publication bias as indicated by an asymmetric distribution between plots (two plots on the right and four plots on the right). The funnel plot shows that the distribution of the estimated effect of being overweight on anxiety risk is more on the right of the vertical line than on the left. The average effect estimate on the forest plot is also to the right of the vertical Ho line, so the publication's bias overestimates the effect of being overweight on the actual risk of anxiety (overestimate).

4. The Effect of Obesity on Depression in Adolescents

The Forest Plot in Figure 7 shows that the risk of depression in obese adolescents was 1.64 times that of normal weight adolescents (aOR = 1.64; 95% CI = 1.42 to 1.90) and statistically significant p< 0.001. Statistical heterogeneity between studies was I2= 55%, indicating a heterogeneous distribution of data so that the average effect of obesity on depression was calculated using a random effects model.

The funnel plot in Figure 8 shows the potential for publication bias, which is characterized by an asymmetric distribution between plots. The funnel plot shows that the distribution of the estimated effect of obesity on the risk of depression is more on the left of the vertical line than on the right. The average effect estimate on the forest plot is also to the right of the vertical Ho line, so the publication bias overestimates the effect of obesity on the true risk of depression (overestimate).

5. The Effect of Obesity on Anxiety in Adolescents

The Forest Plot in Figure 9 shows that the risk of anxiety in obese adolescents was 1.27 times that of normal weight adolescents (aOR= 1.27; 95% CI= 1.08 to 1.49) and sta-

tistically significant p= 0.003. Statistical heterogeneity between studies was I2= 0%, indicating a homogeneous distribution of data so that the average calculation of the effect of obesity on anxiety was carried out using a fixed effect model.

Funnel plot Figure 10 shows the potential for publication bias, which is characterized by an asymmetric distribution between plots. The funnel plot shows that the distribution of the estimated effect of obesity on anxiety risk is more on the left of the vertical line than on the right. The average effect estimate on the forest plot is also to the right of the vertical line Ho, so the publication bias overestimates the effect of obesity on the real anxiety risk (over-estimate)
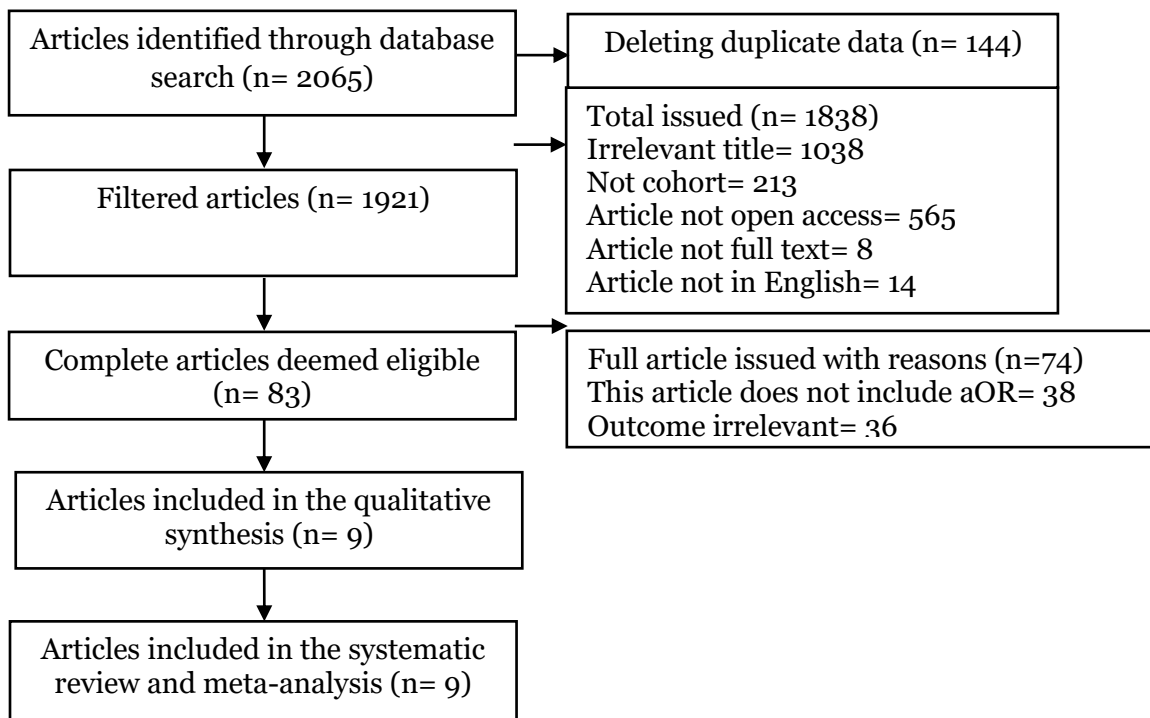

Figure 1 PRISMA Flowchart

Figure 2. Map of Study Area

Table 1. Critical Appraisal of primary studies entered using the Critical Appraisal Skills Program (CASP) assessment

No	Evaluation Indicator	Publication (Author and Year)								
		Kubzansky et al. (2012)	Roberst and Duong (2016)	Roberst and Hao (2013)	Boutelle et al. (2010)	Anderson et al. (2011)	Frisco et al. (2013)	Kvaløy et al. (2021)	Narmandakh et al. (2021)	Wake et al. (2010)
1	Does cohort study clearly address the research problem?	1	1	1	1	1	1	1	1	1
2	Was the group recruited the right way?	1	1	1	1	1	1	1	1	1
3	Is BMI measured accurately to minimize bias?	1	1	1	1	1	1	1	1	1
4	Are outcomes (mental health) measured accurately to minimize bias?	1	1	1	1	1	1	1	1	1
5	Did the researcher identify all confounding factors? Did the researcher take confounding factors into account in the design and/or analysis?	1	1	1	1	1	1	1	1	1
6	Was the follow-up of the subject sufficiently complete and complete?	1	1	1	1	1	1	1	1	1
7	Is this study reported in aOR?	1	1	1	1	1	1	1	1	1
8	How precise are the results?	1	1	1	1	1	1	1	1	1
9	Are the results reliable?	1	1	1	1	1	1	1	1	1
10	Are the results applicable to the local population?	1	1	1	1	1	1	1	1	1
11	Do the research results match the available evidence?	1	1	1	1	1	1	1	1	1
12	Are the results applicable in practice/community?	1	1	1	1	1	1	1	1	1
	Total	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**	**12**

Note: 2= Yes; 1= Can't tell; 0= No

Table 2. Description of the primary studies included in the meta-analysis

| Author (year) | Country | Study Design | Sample | | P | I | C | O | aOR (95%CI) |
			Total Screening Participants	Over-weight					
Overweught-Depression									
Boutelle et al. (2010)	Texas	Prospective cohort	488	561	teenage girl	Overweight teenage girl	Normal weight	Major depression, Depressive symptoms	0.61 (0.24 to 1.55)
Frisco et al. (2013)	United States of America	Prospective cohort	5,243	517	teenage girl	Overweight teenage girl	Normal weight	Depression Onset, Consistent Depression	1.16 (0.48 to 2.80)
Kubzabsky et al. (202)	United States of America	Prospective cohort	1,528	561	5th to 12th graders	overweight teenager	Normal body	Depression and anxiety	1.16 (0.98 to 1.37)
Kvaløy et al. (2021) (female	Norway	Prospective cohort	848	699	Teenagers 13 to 19 years old	overweight teenager	Normal body	Depression and anxiety	1.18 (2.53 to 21.01)
Kvaløy et al. (2021) (male)	Norway	Prospective cohort	985	741	Teenagers 13 to 19 years old	overweight teenager	Normal body	Depression and anxiety	0.82 (0.68 to 0.99)
Roberst and Hao (2013)	Texas	Prospective cohort	3,134	517	Teenagers 11 to 17 years old	overweight teenager	Normal body	Perceived mental health	1.21 (0.89 to 1.64)
Wake et al. (2010)	Australia	Prospective cohort	923	186	Teenager	overweight teenager	Normal body	mental health psychological distress	1.09 (0.71 to 1.67)

| Author (year) | Country | Study Design | Sample | | P | I | C | O | aOR (95%CI) |
			Total Screening Participants	Overweight					
Overweught-Anxious									
Kubzabsky et al. (2012)	United States of America	Prospective cohort	1,528	561	5th to 12th graders	overweight teenager	Normal body	Depression and anxiety	1.15 (0.01 to 1.31)
Kvaløy et al. (2021) (female	Norway	Prospective cohort	848	699	Teenagers 13 to 19 years old	overweight teenager	Normal body	Depression and anxiety	1.18 (1.04 to 1.34)
Kvaløy et al. (2021) (male)	Norway	Prospective cohort	985	741	Teenagers 13 to 19 years old	overweight teenager	Normal body	Depression and anxiety	0.82 (0.68 to 0.99)
Roberst and Duong (2016) (female)	Texas	Prospective cohort	1531	Not Mentioned	Teenagers 11 to 17 years old	overweight teenager	Normal body	Worried	0.59 (0.21 to 1.66)
Roberst and Duong (2016) (male)	Texas	Prospective cohort	1603	Not Mentioned	Teenagers 11 to 17 years old	overweight teenager	Normal body	Worried	2.97 (1.11 to 7.95)
Roberst and Hao (2013)	Texas	Prospective cohort	3,134	517	Teenagers 11 to 17 years old	overweight teenager	Normal body	Perceived mental health	1.43 (0.71 to 2.88)

Author (year)	Country	Study Design	Sample		P	I	C	O	aOR (95%CI)
			Total Screening Participants	Overweight					
Obese-Depression									
Andersons et a (2011)	United States of America	Prospective cohort	918	138	Teenage girls grades 6 to 8	Obese teenage girl	Normal weight teenage girl	depressed mood	2.47 (1.85 to 3.30)
Boutelle et (2010)	United States of America	Prospective cohort	488	9	teenage girl	Obese teenage girl	Normal weight teenage girl	Major depression	1.62 (0.77 to 3.41)
Frisco et al (2013)	United States of America	Prospective cohort	5,243	514	5th to 12th graders	Obese teen	Normal body teenager	Consistent Depression	1.61 (0.86 to 3.01)
Kubzabsky et al. (2012)	United States of America	Prospective cohort	1,528	142	Teenagers 11 to 17 years old	overweight teenager	Normal body teenager	Worried	1.47 (1.15 to 1.88)
Roberst and Hao (2013)	Texas	Prospective cohort	3,134	617	Teenagers 11 to 17 years old	Obese teen	Normal body teenager	Perceived mental health	1.35 (1.01 to 1.80)
Wake et al (2010)	Australia	Prospective cohort	923	56	Teenager	Obese teen	Normal body teenager	Mental health psychological distress	1.16 (0.57 to 2.36)

Author (year)	Country	Study Design	Sample		P	I	C	O	aOR (95%CI)
			Total Screening Participants	Overweight					
Obese-Anxiety									
Kubzabsky et al. (2012)	United States of America	Prospective cohort	1,528	142	5th to 12th graders	Obese teen	Normal body teenager	Depression and anxiety	1.29 (1.05 to 1.58)
Narmadakh et al. (2021)	Netherlands	Prospective cohort	1,584	490	Teenagers aged 10 to 12 years	Obese teen	Normal body teenager	Worried	1.27 (0.96 to 1.68)
Roberst and Duong (2016) (female)	Texas	Prospective cohort	1531	Not mentioned	Teenagers 11 to 17 years old	Obese teen	Normal body teenager	Worried	0.71 (0.22 to 2.29)
Roberst and Duong (2016) (male)	Texas	Prospective cohort	1603	Not mentioned	Teenagers 11 to 17 years old	Obese teen	Normal body teenager	Worried	3.70 (0.77 to 17.78)
Roberst and Hao (2013)	United States of America	Prospective cohort	3,134	617	5th to 12th graders	Obese teen	Normal body teenager	perceived mental health dan any mood disorder	1.04 (0.52 to 2.08)

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI	Odds Ratio IV, Random, 95% CI
Boutelle 2010	-0.4943	0.4759	2.4%	0.61 [0.24, 1.55]	
Frisco 2013	0.1484	0.4502	2.6%	1.16 [0.48, 2.80]	
Kubzansky 2012	0.1484	0.086	23.4%	1.16 [0.98, 1.37]	
Kvaloy (f) 2021	0.1655	0.0644	26.9%	1.18 [1.04, 1.34]	
Kvaloy(m) 2021	-0.1985	0.0955	21.9%	0.82 [0.68, 0.99]	
Roberst-Hao 2013	0.1906	0.1567	13.8%	1.21 [0.89, 1.64]	
Wake 2010	0.0862	0.2187	8.9%	1.09 [0.71, 1.67]	
Total (95% CI)			**100.0%**	**1.06 [0.92, 1.24]**	

Heterogeneity: Tau² = 0.02; Chi² = 12.87, df = 6 (P = 0.05); I² = 53%
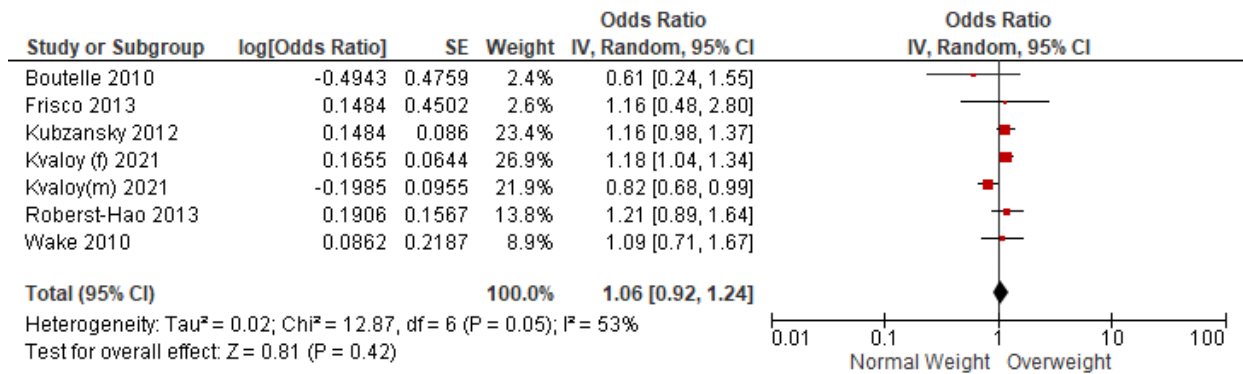Test for overall effect: Z = 0.81 (P = 0.42)

Figure 3. Forest Plot Effect of Overweight on Adolescent Depression
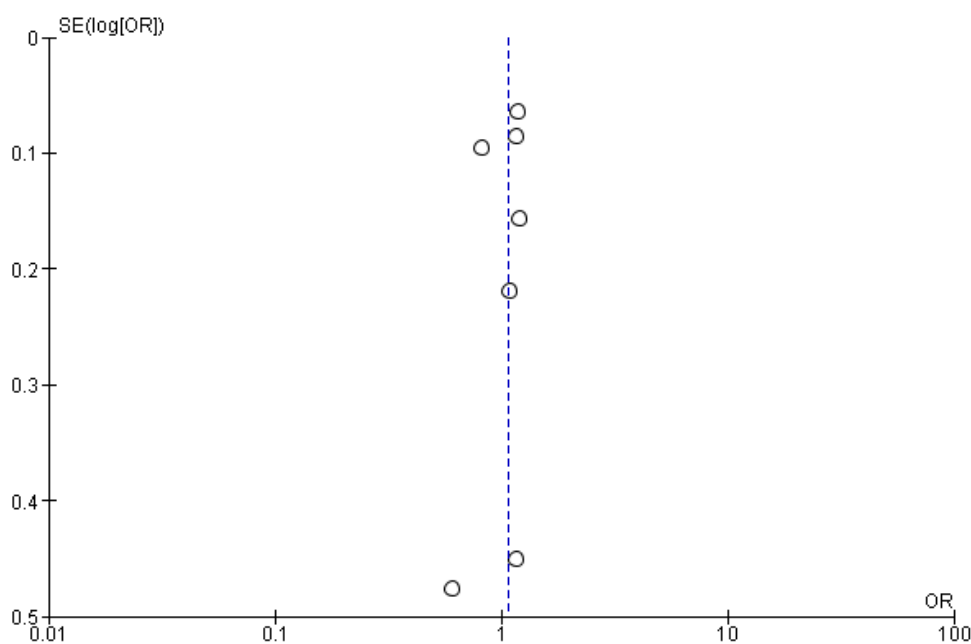
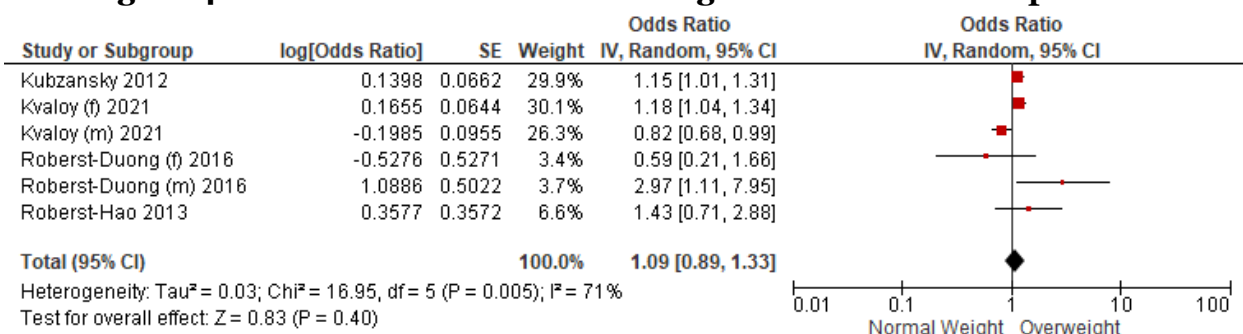**Figure 4. Funnel Plot Effect of Overweight on Adolescent Depression**

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI	Odds Ratio IV, Random, 95% CI
Kubzansky 2012	0.1398	0.0662	29.9%	1.15 [1.01, 1.31]	
Kvaloy (f) 2021	0.1655	0.0644	30.1%	1.18 [1.04, 1.34]	
Kvaloy (m) 2021	-0.1985	0.0955	26.3%	0.82 [0.68, 0.99]	
Roberst-Duong (f) 2016	-0.5276	0.5271	3.4%	0.59 [0.21, 1.66]	
Roberst-Duong (m) 2016	1.0886	0.5022	3.7%	2.97 [1.11, 7.95]	
Roberst-Hao 2013	0.3577	0.3572	6.6%	1.43 [0.71, 2.88]	
Total (95% CI)			**100.0%**	**1.09 [0.89, 1.33]**	

Heterogeneity: Tau² = 0.03; Chi² = 16.95, df = 5 (P = 0.005); I² = 71%
Test for overall effect: Z = 0.83 (P = 0.40)

Figure 5. Forest Plot Effect of Overweight on Anxiety in Adolescents
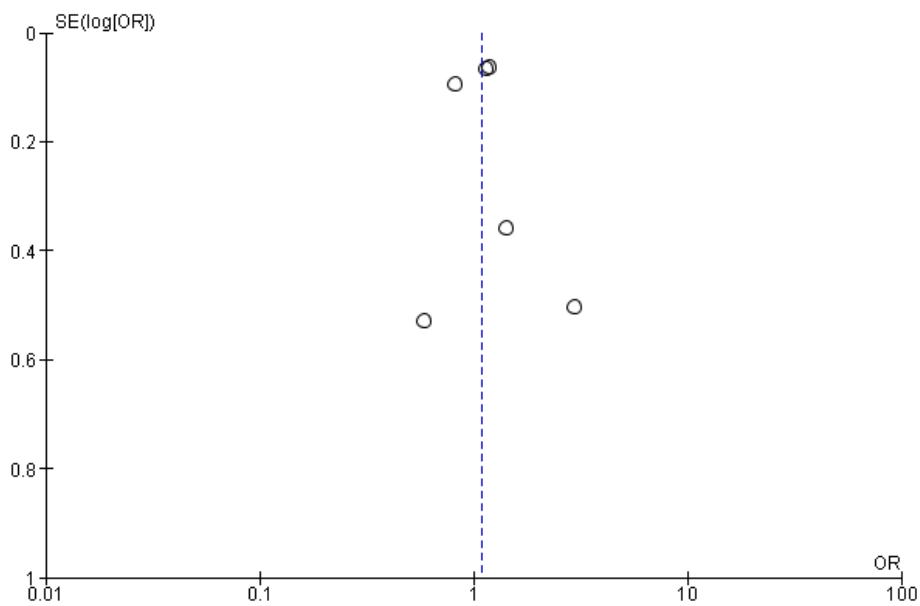
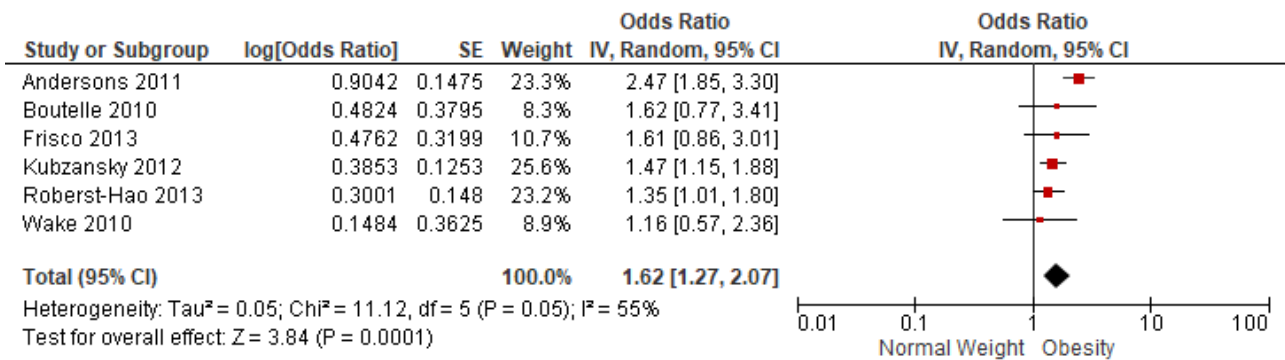**Figure 6. Funnel Plot Effect of Overweight on Anxiety in Adolescents**

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Random, 95% CI
Andersons 2011	0.9042	0.1475	23.3%	2.47 [1.85, 3.30]
Boutelle 2010	0.4824	0.3795	8.3%	1.62 [0.77, 3.41]
Frisco 2013	0.4762	0.3199	10.7%	1.61 [0.86, 3.01]
Kubzansky 2012	0.3853	0.1253	25.6%	1.47 [1.15, 1.88]
Roberst-Hao 2013	0.3001	0.148	23.2%	1.35 [1.01, 1.80]
Wake 2010	0.1484	0.3625	8.9%	1.16 [0.57, 2.36]
Total (95% CI)			100.0%	1.62 [1.27, 2.07]

Heterogeneity: Tau² = 0.05; Chi² = 11.12, df = 5 (P = 0.05); I² = 55%
Test for overall effect: Z = 3.84 (P = 0.0001)

Figure 7. Forest Plot Effect of Obesity on Depression in Adolescents
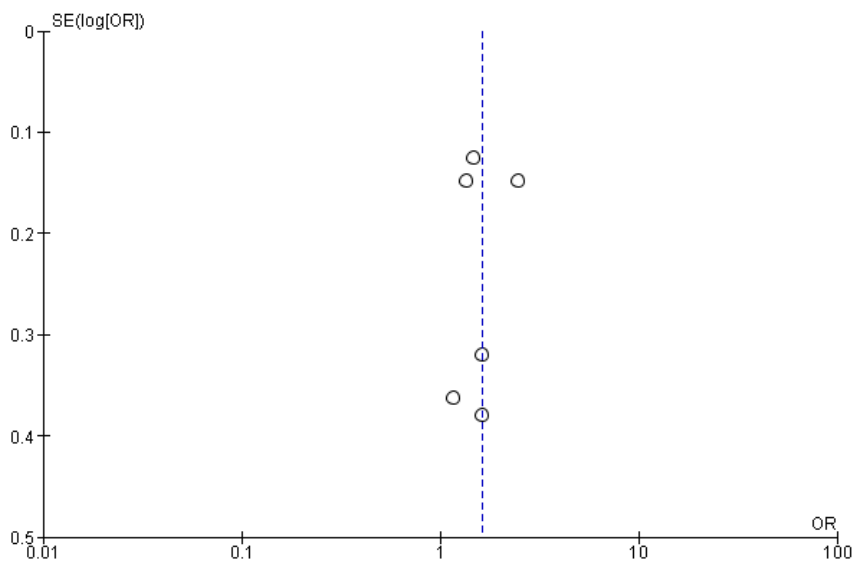
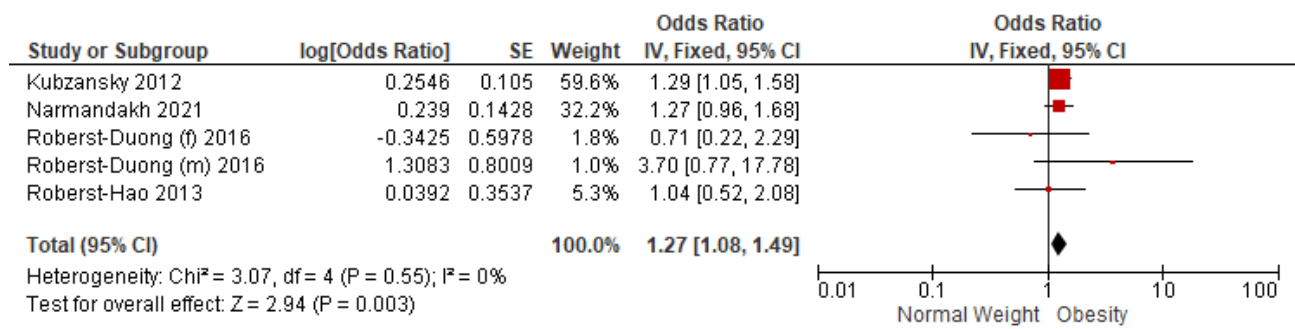**Figure 8. Funnel Plot Effect of Obesity on Depression in Adolescents**

Study or Subgroup	log[Odds Ratio]	SE	Weight	Odds Ratio IV, Fixed, 95% CI
Kubzansky 2012	0.2546	0.105	59.6%	1.29 [1.05, 1.58]
Narmandakh 2021	0.239	0.1428	32.2%	1.27 [0.96, 1.68]
Roberst-Duong (f) 2016	-0.3425	0.5978	1.8%	0.71 [0.22, 2.29]
Roberst-Duong (m) 2016	1.3083	0.8009	1.0%	3.70 [0.77, 17.78]
Roberst-Hao 2013	0.0392	0.3537	5.3%	1.04 [0.52, 2.08]
Total (95% CI)			**100.0%**	**1.27 [1.08, 1.49]**

Heterogeneity: Chi² = 3.07, df = 4 (P = 0.55); I² = 0%
Test for overall effect: Z = 2.94 (P = 0.003)

Figure 9. Forest Plot Effect of Obesity on Anxiety in Adolescents
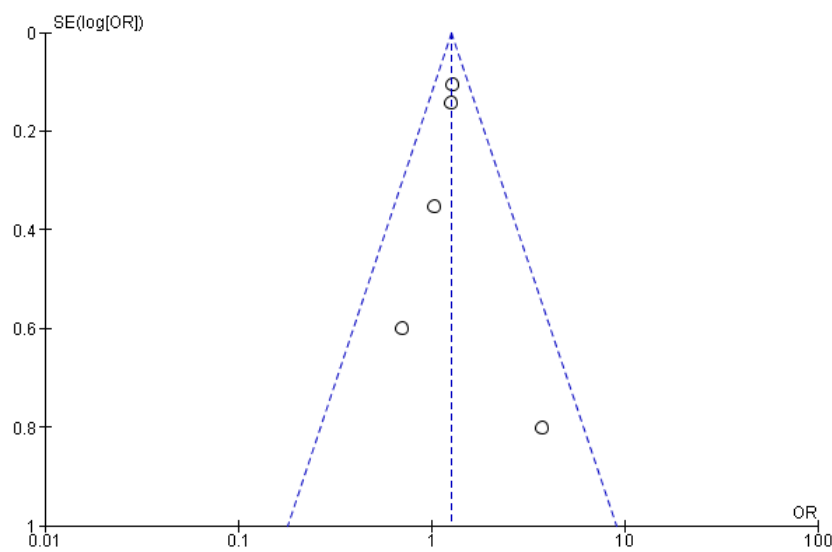
Figure 10. Funnel Plot Effect of Obesity on Anxiety in Adolescents

DISCUSSION

Changes in adolescents physically, emotionally and socially, including economic problems, abuse or violence, can make adolescents vulnerable to mental health problems. Adolescents with mental health conditions are particularly vulnerable to social exclusion, discrimination, stigma, educational difficulties, risk-taking behavior, poor physical health and human rights violations. Depression and anxiety are two common mental disorders in adolescents. Mental disorders in adolescents are associated with significant adolescent problems, such as academic achievement, suicide, violence, drug use, and have the potential to increase the risk of mental disorders in the future (Moradi et al., 2021; Nebhinani and Jain, 2019).

Obesity can affect all aspects of adolescents, not limited to physical health but also psychological health. Physically increases the chances of cardiovascular disease, asthma, type II diabetes, osteoarthritis, chronic back pain, gallbladder disease, and some cancers. Psychologically, being overweight can affect peer relationships and psychosocial well-being. Being overweight is one of the main reasons for rejection and being a victim of isolation in the school environment. Both overweight boys and girls experienced significantly more bullying than normal-weight teens. Adolescents with obesity are reported to have more body dissatisfaction, social iso-

lation, depressive symptoms, and negative self-esteem compared to adolescents with normal weight (Álvarez-García et al., 2020; Sanyaolu et al., 2019).

The dangers caused by obesity in adolescence can affect their overall health of life, which needs more attention and early intervention measures. This meta-analysis study investigated the effect of being overweight and obese on the risk of experiencing depression and anxiety in adolescents. The sample size used was more than 18,785 adolescents from 9 cohort studies conducted in the Americas, Europe, and Australia continent. This study found that overweight and obesity increased the risk of depression and anxiety in adolescents. The results of the forest plot show that there is an increased risk for depression and anxiety in adolescents who are overweight and obese than adolescents who have normal weight. The forest plot also showed that obese adolescents had a higher risk of depression (aOR= 1.64; 95% CI= 1.42 to 1.90; p< 0.001) than overweight adolescents (aOR= 1.09; 95% CI= 1.00 to 1.18; p=0.050). The same results were also shown on the effect of obesity and overweight with the risk of anxiety in adolescents. Adolescents who are obese have a higher risk of anxiety (aOR= 1.27; 95% CI= 1.08 to 1.49; p= 0.003) than overweight adolescents (aOR= 1.10; 95% CI= 1.01 to 1.19; p=0.020). In this study, there is a tendency for publication bias shown by funnel plots with asymmetric distribution plots.

The results of this study are similar to those conducted by Sanders et al. (2015) which explained that adolescents with overweight or obesity had a significant relationship to depression than adolescents with normal weight (OR=3.38, 95% CI= 1.13 to 10.11; overweight OR= 8.95; obese OR= 18.8; p=0.001). Research by Sutaria

et al. (2019) explained that overweight and obesity in children increased the risk of depression than normal weight children (obese OR=1.32; 95% CI= 1.17 to 1.50; overweight OR= 1.04; 95% CI=0.95 to 1.14). Based on the findings of Rao et al. (2020b) approximately 2,11 to 36,5 million children and adolescents suffer from depression (clinical depression: 8,64 to 36,5 million in overweight subjects, 2,11 to 33,11 million in obese subjects; MDD: 19,44 to 36,5 million in overweight subjects, 12,52 to 33,11 million in obese subjects). Wang et al. (2019) found a 1.46 times increased risk of depression in overweight and obese adolescents (OR = 1.46, 95% CI: 1.14 to 1.87; p=0.003) and found a 1.53 times increased risk of anxiety in overweight and obese adolescents (OR= 1.53; 95% CI: 1.21 to 1.79; p<0.001) compared with normal weight adolescents.

Obesity is a condition that is closely related to depression. This metabolic disorder is defined as a BMI > 25kg/m2, caused by an energy imbalance from excess consumption and lack of physical activity. Obesity is often associated with higher rates of cardiometabolic comorbidity and neuropsychiatric disorders, especially depression. Several studies have hypothesized that certains biologic factors, such as dysregulation of the hypothalamic-pituitary-adrenal axis (HPA-axis), in inflammatory states, decreased leptin receptors and metabolic disorders, are potential pathogens for the association between depression and obesity (Rao et al., 2020).

Obesity is associated with substantial changes in adipose tissue (impaired adipocyte and immune cell function) and gut microbiota (modified gut bacterial diversity and increased intestinal permeability), leading to a low-grade chronic inflammatory status. Immune communication to the brain causes an increase in neuroinflam-

matory processes by impacting metabolism and neurotransmitter function, nerve or brain circuit plasticity, and HPA (Hypothalamic-Pituitary-Adrenal) axis activity. Chronic stress and/or initial stress can then trigger HPA axis hyperactivity, which is characterized by increased production of CRH (corticotropin-releasing hormone), ACTH (adrenocorticotrophic hormone), and GC (glucocorticoid) together with impaired regulatory or feedback mechanisms. If sustained high GC levels can play a role in depression, they may also contribute to obesity by creating adipose tissue expansion (increase in adipocyte number and size) and changes in eating behavior (higher consumption of good foods). An unhealthy diet, lack of exercise, and stress can also alter the composition of the gut microbiota and impair gut-brain communication, primaryly through immune or inflammatory effects. Taken together, these changes may contribute to the development of obesity-related depression comorbidities (Huet et al., 2019).

Obesity and psychiatric illness are both associated with stigma, ridicule, and bullying. Compared with their peers, adolescents with obesity report more internalized weight stigma, body dissatisfaction, and lower self-esteem, which can cause or worsen psychological distress and depressive symptoms. Weight related with temptation and bullying were also associated with higher levels of psychological symptoms and depressive symptoms. Stigma associated with psychiatric disorders or obesity can contribute to sub-optimal health care and lack of engagement with health behaviors. Adolescents with obesity and psychiatric illness may be at additional risk, which may exacerbate mental illness and obesity (Chao et al., 2020).

The relationship between mental health and obesity is complex and can vary based on individual (eg age, gender, race, ethnicity and culture) or national characteristics. Age may influence the causes or mental health consequences of obesity and may moderate the mental health-obesity relationship. Early adolescence and late adolescence are very different in terms of cognitive and social functioning. Obesity may differ in terms of shame and stigma during early, middle, or late adolescence. Gender can also change the association between obesity and mental health (Assari, 2014). The limitations of this study are that it only uses three databases, and the language used only uses English articles.

AUTHORS CONTRIBUTION
Riski Anisa as the main researcher who chose the topic, conducted a search for data collection in this study. Yulia Lanti Retno Dewi and Hanung Prasetya conducted data analysis and reviewed research documents.

CONFLICT OF INTEREST
There was no conflict of interest in this study.

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