International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 6, 2025
https://theaspd.com/index.php

Understanding The Factors Contributing To Obesity Among Adolescents In Indonesia: A Systematic Review And Meta-Analysis

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Abstract

Background: *Adolescent obesity is an escalating public health issue in Indonesia, with long-term implications for morbidity and quality of life. While numerous studies have investigated individual risk factors for adolescent obesity, to date, no systematic review and meta-analysis has comprehensively synthesized the evidence within the Indonesian context. This study aims to identify and analyze the risk factors for adolescent obesity in Indonesia through a systematic review and meta-analysis of available observational studies.*

Methods: *A literature search was conducted in PubMed, Web of Science, EMBASE, and Google Scholar up to April 1, 2025, following PRISMA and MOOSE guidelines. Studies that met the inclusion criteria were analyzed both narratively and quantitatively using Review Manager 5.4.1. A random-effects model was applied for meta-analysis in cases of significant heterogeneity.*

Results: *A total of 30 studies were included in the meta-analysis. The analysis revealed that low physical activity (OR: 1.90; 95% CI: 1.45–2.49), consumption of sugar-sweetened beverages (OR: 1.03; 95% CI: 1.01–1.06), unhealthy dietary patterns (OR: 1.89; 95% CI: 1.00–1.01), poor sleep patterns (OR: 2.23; 95% CI: 1.07–4.44), and stress (OR: 5.28; 95% CI: 2.64–10.53) were significantly associated with increased risk of obesity among adolescents in Indonesia. Vegetable consumption had a protective effect (OR: 0.96; 95% CI: 0.94–0.98). Family-related factors, including genetic history (OR: 1.05; 95% CI: 1.01–1.09), father's education (OR: 1.11; 95% CI: 1.06–1.17), and mother's education (OR: 1.38; 95% CI: 1.04–1.83), also significantly increased the risk. Additionally, adolescents residing in urban areas were found to have a higher risk of obesity (OR: 1.31; 95% CI: 1.28–1.34). No evidence of publication bias was detected based on funnel plot assessment.*

Conclusion: *Individual, familial, and environmental factors significantly contribute to the risk of adolescent obesity in Indonesia. These findings underscore the need for comprehensive and context-specific interventions, including family education, promotion of healthy lifestyles, and policy support that fosters healthier obesogenic environments.*

Keywords: *Obesity, Adolescents, Risk Factors, Systematic Review, Meta-Analysis*

1. INTODUCTION

Obesity is a growing public health concern globally, including in developing countries such as Indonesia [1]. According to the World Health Organization (WHO), the prevalence of obesity among children and adolescents has increased more than fourfold over the past four decades [2]. In Indonesia, the 2023 National Basic Health Survey (Riskesdas) reported that approximately 16% of adolescents aged 13–15 years are classified as obese [3]. Adolescent obesity can lead to a range of complications, including type 2 diabetes, hypertension, dyslipidemia, psychosocial disorders, and reduced quality of life [4]. ddressing obesity requires a multidisciplinary approach involving lifestyle modification, nutritional interventions, physical activity, psychological support, and, in some cases, pharmacological therapy [5]. Thus, adolescent obesity is a complex condition with both short- and long-term impacts, contributing significantly to the burden of chronic diseases in adulthood.

Numerous factors have been identified as contributing to adolescent obesity, spanning individual, familial, and environmental domains [6]. High-calorie, low-fiber diets, insufficient physical activity, and inadequate sleep duration are among the primary risk factors [7]. Sedentary lifestyles driven by excessive screen time and psychological conditions such as stress and depression also contribute to unhealthy eating behaviors [8]. At the family level, parenting style, household dietary habits, and parental nutritional

knowledge significantly influence adolescent behavior [9]. Environmental factors such as limited access to physical activity spaces, exposure to unhealthy food advertisements, and low socioeconomic status further exacerbate the problem [10]. Additionally, a family history of obesity and genetic predisposition increase an adolescent's vulnerability to obesity [11]. Understanding these determinants is essential for designing effective and context-specific prevention interventions.

Although several studies have examined the risk factors for adolescent obesity in Indonesia, the findings remain fragmented and have not been synthesized systematically. Furthermore, there is a lack of studies that quantitatively combine evidence to identify the most consistent and influential contributors to adolescent obesity in the Indonesian context. Therefore, a systematic review and meta-analysis is needed to consolidate the existing evidence and provide a more comprehensive understanding. This study aims to identify and analyze the risk factors contributing to adolescent obesity in Indonesia.

2. METHODS

2.1. Data sources and strategy

This systematic review and meta-analysis was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [12] and the Meta-analysis of Observational Studies in Epidemiology (MOOSE) checklist [13]. A comprehensive literature search was performed across four databases: PubMed, Web of Science, EMBASE, and Google Scholar, up to April 1, 2025. There were no restrictions on the year of publication; however, articles were limited to those published in English or Indonesian. The search strategy focused on studies that reported associations between various risk factors and obesity among adolescents in Indonesia. Search keywords used a combination of English and Indonesian terms, including: "obesity" OR "overweight" OR "adiposity" OR "excess weight" AND "adolescent" OR "teenager" OR "youth" OR "remaja" AND "risk factor" OR "determinant" OR "associated factor" OR "pengaruh" OR "faktor risiko" AND "Indonesia." Searches were conducted across titles, abstracts, and keywords. Full details of the search strategy for each database are presented in Table 1.

2.2. Study selection

All search results from the four databases were exported to EndNote software to remove duplicates. The selection process was conducted in two stages: screening of titles and abstracts, followed by full-text review. Inclusion criteria included: (1) observational studies (cross-sectional, case-control, or cohort); (2) adolescent populations aged 10–19 years residing in Indonesia; (3) studies examining the association between obesity (as the outcome variable) and one or more risk factors such as dietary patterns, physical activity, screen time, sleep, family-related factors, or socioeconomic status; (4) studies reporting effect measures such as odds ratio (OR), relative risk (RR), or hazard ratio (HR); and (5) scientific articles in Indonesian or English available in full-text format. Studies were excluded if: (1) they were editorials, commentaries, or narrative reviews; (2) they did not present quantitative data on the association between risk factors and obesity; (3) they did not involve adolescent populations; or (4) they were not conducted in Indonesia. If relevant data were only available in graphical form or were incomplete, corresponding authors were contacted to obtain additional information.

2.3. Ekstraksi data

Two researchers independently performed data extraction using a pre-specified format. The data collected included: (1) first author's name and year of publication; (2) study location and period; (3) study design; (4) sample size and participant characteristics; (5) definition and measurement method of obesity; (6) types of risk factors analyzed; and (7) reported effect measures (OR, RR, or HR with 95% CI). For methodological quality assessment, the Joanna Briggs Institute (JBI) Critical Appraisal Checklist appropriate to the study type was used [14]. The results of the risk of bias assessment are presented in Table 2.

2.4. Data synthesis and statistical analysis

A narrative systematic review was conducted to summarize the most frequently reported risk factors for obesity in the context of Indonesian adolescents. If two or more studies examined similar risk factors with comparable effect sizes, a meta-analysis was performed using Review Manager (RevMan) software version 5.4.1. Effect sizes were pooled in the form of odds ratios (OR) with 95% confidence intervals (95% CI). A random-effects model was used if there was significant heterogeneity among studies, determined by Cochran's Q statistic ($p < 0.10$) and I^2 (>50%). If no significant heterogeneity was found, a fixed-effects model was applied. A forest plot was used to illustrate the pooled effect sizes, while a funnel plot was used

to assess potential publication bias. Sensitivity analysis was conducted to test the consistency of results and identify potential sources of heterogeneity.

3. Result

3.1. Study characteristics

The database search yielded 331 studies, with 34 studies removed due to duplication (Figure 1). A total of 155 studies were eligible for full-text evaluation. We excluded 43 conference abstracts/reviews/commentaries, 34 studies with different exposures, 37 studies that did not report relevant outcomes, and 11 studies not written in English. For the qualitative analysis, 30 articles were included in the meta-analysis. The characteristics of the studies included in the quantitative and descriptive analysis are presented in Tabel 3.

3.2. Association between individual factors and obesity in adolescents in Indonesia

There was no significant association between individual factors and obesity among adolescents in Indonesia, with an OR of 1.01 (95% CI: 0.98–1.05; $p>0.05$) (Gambar 2). There was a significant association between low physical activity and obesity among adolescents in Indonesia, with an OR of 1.90 (95% CI: 1.45–2.49; $p<0.05$) (Supplementary Figure S1). There was no significant association between gender and obesity among adolescents in Indonesia, with an OR of 1.72 (95% CI: 0.90–3.27; $p>0.05$) (Supplementary Figure S2). There was no significant association between fruit consumption and obesity among adolescents in Indonesia, with an OR of 1.01 (95% CI: 1.00–1.01; $p>0.05$) (Supplementary Figure S3). There was a significant association between vegetable consumption and decreased risk of obesity among adolescents in Indonesia, with an OR of 0.96 (95% CI: 0.94–0.98; $p<0.05$) (Supplementary Figure S4). There was no significant association between consumption of sugary foods and obesity among adolescents in Indonesia, with an OR of 1.01 (95% CI: 1.00–1.01; $p>0.05$) (Supplementary Figure S5). There was a significant association between consumption of sugary drinks and obesity among adolescents in Indonesia, with an OR of 1.03 (95% CI: 1.01–1.06; $p<0.05$) (Supplementary Figure S6). There was a significant association between dietary patterns and obesity among adolescents in Indonesia, with an OR of 1.89 (95% CI: 1.00–1.01; $p<0.05$) (Supplementary Figure S7). There was a significant association between sleep patterns and obesity among adolescents in Indonesia, with an OR of 2.23 (95% CI: 1.07–4.44; $p<0.05$) (Supplementary Figure S8). There was a significant association between stress and obesity among adolescents in Indonesia, with an OR of 5.28 (95% CI: 2.64–10.53; $p<0.05$) (Supplementary Figure S9). There was no significant association between age and obesity among adolescents in Indonesia, with an OR of 1.27 (95% CI: 0.93–1.73; $p>0.05$) (Supplementary Figure S10). Funnel plot analysis indicated no risk of publication bias in the association between family factors and obesity among adolescents in Indonesia (Supplementary Figures S16–S25)

3.3. Association between family factors and obesity in adolescents in Indonesia

There was a significant association between family-related factors and increased odds of adolescent obesity in Indonesia, with an OR of 1.20 (95% CI: 1.05–1.38; $p<0.05$) (Figure 3). There was a significant association between genetic factors and increased odds of adolescent obesity in Indonesia, with an OR of 1.05 (95% CI: 1.01–1.09; $p<0.05$) (Supplementary Figure S11). There was a significant association between father's education level and increased odds of adolescent obesity in Indonesia, with an OR of 1.11 (95% CI: 1.06–1.17; $p<0.05$) (Supplementary Figure S12). There was a significant association between mother's education level and increased odds of adolescent obesity in Indonesia, with an OR of 1.38 (95% CI: 1.04–1.83; $p<0.05$) (Supplementary Figure S13). There was a significant association between other family factors and increased odds of adolescent obesity in Indonesia, with an OR of 3.23 (95% CI: 2.00–5.22; $p<0.05$) (Supplementary Figure S14). Funnel plot analysis indicated no risk of publication bias in the association between family factors and obesity among adolescents in Indonesia (Supplementary Figures S26–S29).

3.4. Association between environmental factors and obesity in adolescents in Indonesia

There was a significant association between urban environmental factors and increased odds of adolescent obesity in Indonesia, with an OR of 1.31 (95% CI: 1.28–1.34; $p<0.05$) (Figure 4). Funnel plot analysis indicated no risk of publication bias in the association between environmental factors and obesity among adolescents in Indonesia (Supplementary Figure S30).

4. DISCUSSION

This study provides a significant contribution as one of the first systematic reviews and meta-analyses to specifically examine the risk factors for adolescent obesity in Indonesia using a quantitative approach. By

synthesizing and analyzing data from 30 observational studies, this research successfully identifies various risk factors consistently associated with increased adolescent obesity, encompassing individual, family, and environmental factors. These findings emphasize that adolescent obesity in Indonesia is a multifactorial issue influenced by the complex interaction of sociodemographic, behavioral, psychological, and environmental aspects.

Individual factors show a substantial influence on the risk of adolescent obesity in Indonesia. Low physical activity was consistently associated with increased obesity risk, in line with global findings indicating a shift in adolescent lifestyles toward sedentary behavior [15]. his is similar to earlier studies reporting that excessive gadget use and a lack of green open spaces are major contributing factors [16]. However, in Indonesia, this issue is exacerbated by a lack of public awareness regarding the importance of physical activity as part of a healthy lifestyle [17]. Healthy eating, particularly vegetable consumption, was associated with reduced obesity risk, in line with WHO reports in developing countries [18]. nterestingly, fruit, sweet, and processed food consumption did not show significant associations in Indonesia, differing from studies in Western countries. This may be due to the lower-calorie content of local fruits and the relatively lower intensity of sweet food consumption culture compared to developed nations [19]. Furthermore, psychological stress emerged as a significant risk factor, supporting previous findings on the link between stress and emotional eating [20]. However, in Indonesia, adolescent stress often stems from academic pressure and family instability rather than social pressure as commonly seen in developed countries [21]. Poor sleep patterns, male gender, and increasing age were also confirmed to raise obesity risk, consistent with global trends, but likely worsened by inadequate health education in schools and poorly managed hormonal changes during puberty at the individual level [22].

At the family level, this study found that father's education was strongly associated with adolescent obesity, while mother's education did not show a significant link. This contrasts with findings in developed countries where maternal education plays a more dominant role in influencing children's nutritional status [23]. This difference may be explained by the more prominent role of fathers in Indonesia in managing family finances and making decisions related to food consumption, compared to mothers [24]. A family history of obesity also heightened the risk, consistent with previous studies showing the combined influence of genetic and social-environmental family factors on childhood obesity [25]. In the Indonesian context, cultural factors such as a high-carbohydrate diet (e.g., rice as a staple food) and a lack of family-based physical activity habits further compound the issue. These findings underscore the need for family-based interventions, not only focusing on the adolescent individually, but also on behavioral changes among all family members to create a home environment that supports healthy living.

The environment also plays a major role in shaping obesity risk among Indonesian adolescents. Adolescents living in urban areas have a higher risk of obesity compared to those in rural areas [26]. However, unlike developed countries where urbanization often improves access to sports facilities and healthy food, urbanization in Indonesia tends to increase access to fast food and a sedentary lifestyle without adequate compensation through health-promoting infrastructure [27]. Factors such as traffic congestion, lack of green open space, and greater academic pressure in large cities also contribute to low physical activity levels among urban adolescents [28]. Therefore, environmental-level obesity prevention must consider local characteristics, including community-based physical activity promotion, the provision of youth-friendly public facilities, and the regulation of unhealthy food advertisements that heavily target young urban populations.

This study has several limitations that should be noted. First, most included studies were cross-sectional in design, limiting the ability to draw causal inferences. Second, variations in the definitions and measurements of obesity and risk factors across studies may lead to heterogeneity in results. Third, although funnel plot analysis indicated no significant publication bias, selection bias may still be present, particularly due to limited access to studies not published in English or Indonesian. Fourth, many studies did not control for all potential confounding variables, such as pubertal status, sleep patterns, or specific food intake. Lastly, the limited number of studies presenting complete quantitative data also restricts the scope of the meta-analysis. Therefore, further longitudinal and intervention studies are needed to strengthen the evidence base and design more effective and contextualized prevention strategies.

5. CONCLUSION

This study demonstrates that various individual, family, and environmental factors play important roles in increasing the risk of adolescent obesity in Indonesia. Individual factors such as low physical activity,

unhealthy dietary patterns, poor sleep, consumption of sugary drinks, and stress significantly increase the risk of obesity. Additionally, family factors including genetic history and parental education, and environmental factors such as urban residence also contribute to the rising prevalence of adolescent obesity. These findings underscore the importance of comprehensive interventions that not only focus on individual behavior change but also involve family engagement and environmental management to prevent and control adolescent obesity.

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International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 6, 2025
https://theaspd.com/index.php

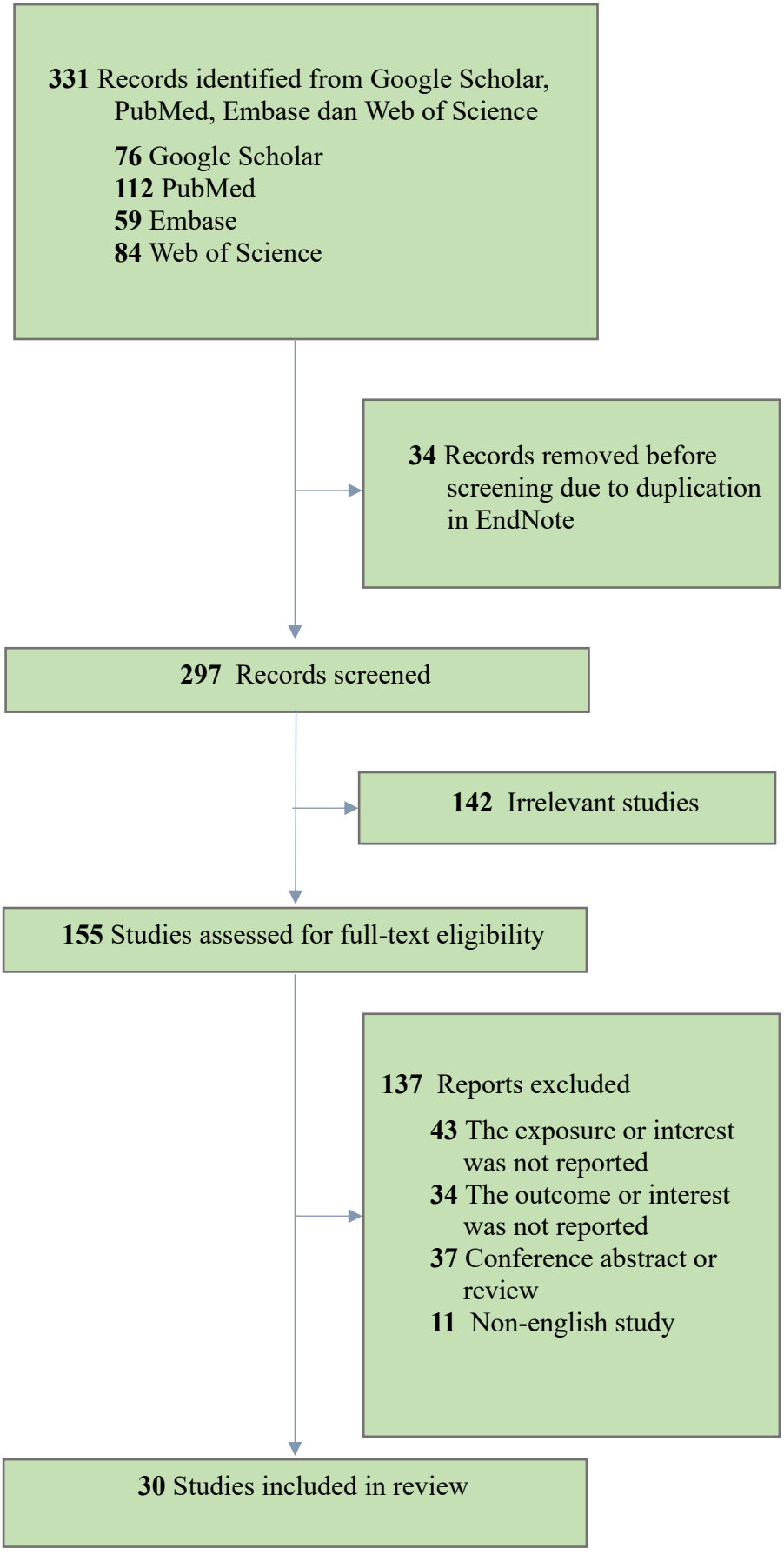


Figure 1

Tabel 1. Search strategies used for online databases

Database	Search strategies	Catatan
Google Scholar	("obesitas remaja" OR "obesitas pada remaja" OR "adolescent obesity") AND ("faktor risiko" OR "faktor penyebab" OR "risk factors" OR determinant* OR cause* OR "associated factor*") AND (Indonesia)	76
PubMed	("Adolescent"[Mesh] OR adolescent* OR teen* OR teenager* OR youth OR "remaja") AND ("Obesity"[Mesh] OR obesitas OR overweight) AND ("Risk Factors"[Mesh] OR "faktor risiko" OR determinant* OR cause* OR "associated factor*" OR "faktor penyebab") AND ("Indonesia"[Mesh] OR Indonesia)	112
Web of Science	TS=(obesitas OR obesity OR overweight) AND TS=(remaja OR adolescent* OR teenager* OR youth OR "young people") AND TS=("faktor risiko" OR "risk factor*" OR determinant* OR cause* OR "associated factor*" OR "faktor penyebab") AND TS=(Indonesia)	84
Medline and EMBASE	('adolescent'/exp OR adolescent* OR teenager* OR youth OR 'remaja') AND ('obesity'/exp OR obesitas OR overweight) AND ('risk factor'/exp OR 'faktor risiko' OR determinant* OR cause* OR 'associated factor*' OR 'faktor penyebab') AND ('indonesia'/exp OR Indonesia)	59

Table 2. Quality assessment and risk of bias of included studies for meta-analysis

ID	Study (Publication year)	Were the criteria for inclusion in the sample clearly defined?	Were the study subjects and the setting described in detail?	Was the exposure measured in a valid and reliable way?	Were objective, standard criteria used for measurement of the condition?	Were confounding factors identified?	Were strategies to deal with confounding factors stated?	Were the outcomes measured in a valid and reliable way?	Was appropriate statistical analysis used?	Total
	Agustina et al., 2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
	Arfines et al., 2020	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
	Fajriyah et al., 2020	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	7
	Hidayanti et al., 2023	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	7
	Perdanawati et al., 2024	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	7
	Pradigdo et al., 2023	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
	Kurdantoi et al., 2015	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	7
	Muharry et al., 2024	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
	Putriana et al., 2018	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
	Riany et al., 2021	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	7
	Rifqi et al., 2025	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	7

	Setiyaningsih et al., 2019	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	7
	Ramadhany et al., 2023	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
	Elizabeth et al., 2021	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	7
	Sari et al., 2024	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
	Sutrisno et al. 2023	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
	Suha et al., 2022	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	7
	Izhar et al., 2020	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
	Syifa et al., 2023	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	7
	Fauzan et al., 2022	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	7
	Nugroho a et al., 2020	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	7
	Rahmah et al., 2023	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
	Nugroho b et al., 2020	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	7
	Dewi et al., 2023	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
	Ratna et al., 2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
	Oktaviani et al., 2023	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	7
	Hariyani et al., 2024	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	7
	Anriyani et al., 2024	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
	Telisa et al., 2020	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	7
	Sitoayu et al., 2021	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	7

Table 3. Characteristics of studies that included in systematic review and meta-analysis

ID	Reference	Year	Age category
1	Agustina et al., 2021	2021	Adolescent
2	Arfines et al., 2020	2020	Adolescent
3	Fajriyah et al., 2020	2020	Adolescent
4	Hidayanti et al., 2023	2023	Adolescent
5	Perdanawati et al., 2024	2024	Adolescent
6	Pradigdo et al., 2023	2023	Adolescent
7	Kurdantoi et al., 2015	2015	Adolescent
8	Muharry et al., 2024	2024	Adolescent
9	Putriana et al., 2018	2018	Adolescent
10	Riany et al., 2021	2021	Adolescent
11	Rifqi et al., 2025	2025	Adolescent
12	Setiyaningsih et al., 2019	2019	Adolescent
13	Ramadhany et al., 2023	2023	13-15 years
14	Elizabeth et al., 2021	2021	Adolescents
15	Sari et al., 2024	2024	Remaja SMA
16	Sutrisno et al. 2023	2023	Adolescent
17	Suha et al., 2022	2022	Adolescent
18	Izhar et al., 2020	2020	Adolescent
19	Syifa et al., 2023	2016	Adolescent
20	Fauzan et al., 2022	2022	Adolescent
21	Nugroho a et al., 2020	2020	Adolescent
22	Rahmah et al., 2023	2023	Adolescent
23	Nugroho b et al., 2020	2020	Adolescent
24	Dewi et al., 2023	2023	Adolescent
25	Ratna et al., 2021	2021	Adolescent
26	Oktaviani et al., 2023	2023	Adolescent
27	Hariyani et al., 2024	2024	Adolescent
28	Anriyani et al., 2024	2024	Adolescent
29	Telisa et al., 2020	2020	Adolescent
30	Sitoayu et al., 2021	2021	Adolescent

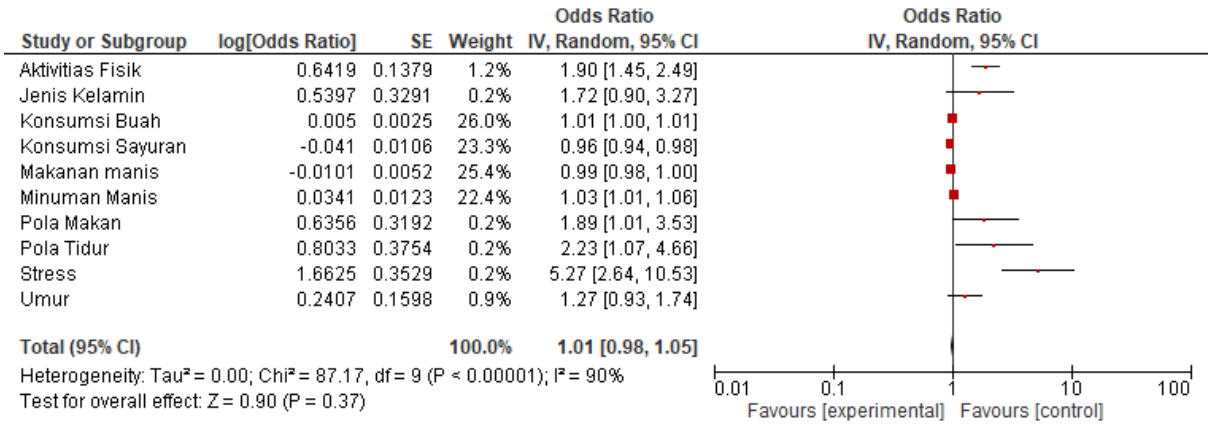


Figure 2. Forest plot of the association between individual factors and obesity in adolescents

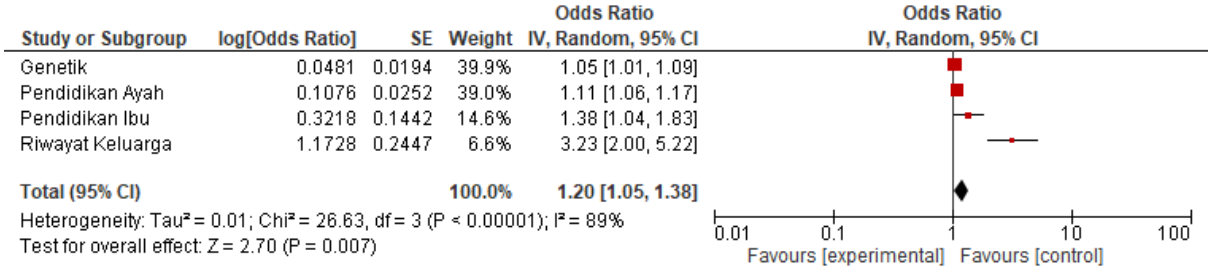
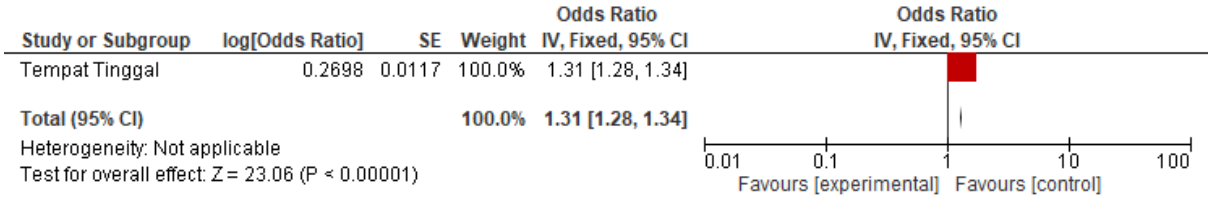


Figure 3.



Forest plot of the association between family factors and obesity in adolescents**Figure 4.** Forest plot of the association between environmental factors and obesity in adolescents