JMCH Journal of Maternal and Child Health (2023), 08(03): 264-277
Masters Program in Public Health, Universitas Sebelas Maret

Meta-Analysis

Open Access

Meta-Analysis: The Effect of Lifestyle Interventions on Decreased Postpartum Weight Retention

Gina Fazrina[1)], Uki Retno Budi Hastuti[2)], Rita Benya Adriani[3)]

[1)]Master's Program in Public Health, Universitas Sebelas Maret
[2)]Faculty of Medicine, Universitas Sebelas Maret
[3)]Study Program of Occupational Therapy, Health Polytechnics, Ministry of Health, Surakarta

Received: 23 February, 2023; Accepted: 24 April, 2023; Available online: 16 May, 2023

ABSTRACT

Background: Postpartum weight retention is the increase in postnatal weight compared to pre-pregnancy weight. This weight gain may persist and increase the long-term prevalence of obesity in women. The application of lifestyle interventions consisting of diet, physical activity, and behavior change interventions is believed to be able to reduce postpartum weight retention. This study aims to determine the effectiveness of lifestyle interventions carried out during pregnancy for reducing postpartum weight retention based on various types of interventions derived from studies that have been conducted.
Subjects and Method: The writing of this meta-analysis was based on the PRISMA 2020 flow diagram with population: pregnant women, intervention: lifestyle intervention, comparison: without lifestyle intervention, and outcome: postpartum weight retention. The selected articles are full articles, randomized controlled trials (RCT) issued in 2013 – 2022, and are in English. Selected studies were assessed based on the JBI Critical Appraisal Checklist for RCT and then analyzed using RevMan 5.3.
Results: 778 articles were identified from December 2022 to January 2023 and 14 RCT articles were obtained for meta-analysis. The diet subgroup accompanied by a behavior change intervention had the largest effect size (SMD = -0.60, 95% CI -0.86 to -0.33, p<0.001), followed by the diet subgroup accompanied by physical activity and behavior change intervention (SMD = -0.10, CI 95 % -0.14 to -0.06, p < 0.001). Physical activity was found to reduce postpartum weight retention, but not statistically significant. The results of the type of intervention subgroup difference test showed a statistically significant effect (p = 0.001).
Conclusion: Diets coupled with behavioral interventions show superior results. Variations in the types of lifestyle interventions carried out during pregnancy can influence the success of interventions for postpartum weight loss.

Keywords: Postpartum weight retention, lifestyle intervention, diet, physical activity, meta-analysis.

Correspondence:
Gina Fazrina. Master's Program in Public Health, Universitas Sebelas Maret Surakarta, Jl. Ir. Sutami 36A, Central Java 57126, Indonesia. Email: ginafazrina@gmail.com. Mobile: +6281212533833.

Cite this as:
Fazrina G, Hastuti URB, Andriani RB (2023). Meta-Analysis: The Effect of Lifestyle Interventions on Decreased Postpartum Weight Retention. *J Matern Child Health*. 08(03): 264-277. https://doi.org/10.26911/thejmch.2023.08.03.02.

BACKGROUND

Globally, the average prevalence of obesity in adult women is greater than that of men and is expected to increase in the next 20 years (World Obesity Federation, 2022). The high rate of obesity in women is specifically due to pregnancy. 1 in 6 women who have normal weight before pregnancy can experience overweight and obesity within one year after giving birth or commonly known as post-partum weight retention (PPWR) or post-partum obesity (Endres et al., 2015).

In particular, the handling of obesity caused by postnatal weight retention can be carried out through interventions related to a healthy lifestyle or lifestyle interventions such as diet and increased physical activity (Dodd et al., 2018) or weight management accompanied by one of the modification interventions. behavior, such as: counseling and self-management (Jensen et al., 2014).

Lifestyle interventions carried out during pregnancy were found to be able to properly control gestational weight gain (GWG) or weight gain during pregnancy (Peaceman et al., 2018). GWG is known to be a strong indicator in determining the incidence of postpartum weight retention (Mannan et al., 2013).

This study was made to find out whether differences in the length of time for evaluating interventions and variations in the types of lifestyle interventions carried out during pregnancy can affect the success of reducing postnatal weight retention.

SUBJECTS AND METHOD

1. Design Study

This study was meta-analysis research conducted based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines 2020 (Page et al., 2021). Article search was carried out by considering the eligibility criteria defined using the PICO model.

Article searches were conducted from December 2022 to January 2023 through several bibliographical databases, namely: PubMed, Cochrane, Proquest, and Google Scholar using search keywords: "pregnant women" AND "lifestyle intervention" OR "lifestyle behavior" OR "diet" OR “physical activity” AND “postpartum weight retention” OR “postpartum obesity”.

2. Steps of Meta-Analysis

The meta-analysis was carried out through 5 steps as follows:

1) Formulating research questions using the PICO model (PICO as follows Population: pregnant women. Intervention: lifestyle intervention. Comparison: not a lifestyle intervention. Outcome: postnatal weight retention.
2) Searching primary study research articles from electronic databases and libraries, such as PubMed, Springer Link, Science Direct, and Google Scholar.
3) Conducting screening and quality assessment of primary research articles.
4) Extracting and analyzing data into the RevMan 5.3 application.
5) Interpreting the results and draw conclusions.

3. Inclusion Criteria

Inclusion criteria for articles used in this study were full articles with Randomized Control Trial (RCT) study design, output 2013 – 2022 and using English, research subjects were pregnant women, research interventions were lifestyle interventions in the form of diet, physical activity, or both were accompanied by behavior modification interventions, and the outcome of the study was postpartum weight retention which was calculated from the difference in pre and post pregnancy weight.

4. Exclusion Criteria

Excluded articles were articles whose research subjects experienced mental disorders, research subjects under the age of 18, research

outcomes were not in kilograms, did not include the Mean SD in the outcome.

5. Operational Definition of Variables

Postpartum weight retention was the difference in weight gain before and after delivery.

Lifestyle interventions were healthy lifestyle interventions that consist of diet, physical activity, or both accompanied by behavior modification interventions.

6. Instrument

Assessment of the quality of the studies to be analyzed in this study was carried out using The Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Randomized Controlled Trials (Tufanaru et al., 2020).

7. Data Analysis

Data analysis was performed using Review Manager (Revman) 5.3 by calculating effect size and heterogeneity. In this study, the effect size used is the standardized mean difference (SMD) together with the 95% confidence interval (CI). Positive values in SMD indicate a positive effect of the intervention, while negative values indicate the opposite. SMD values of 0.2, 0.5, and 0.8 represent small, medium, and large effect size values. Meanwhile, heterogeneity is known from the I2 value which describes the proportion of the variance size around the sumary effect on a scale of 0 to 100 percent (Retnawati et al., 2018).

RESULTS

The process of searching for articles in research was carried out using bibliographic databases, namely: PubMed, Cochrane, ProQuest, and Google Scholar. The systematic search for articles based on the 2020 PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) guidelines is shown in Figure 1.

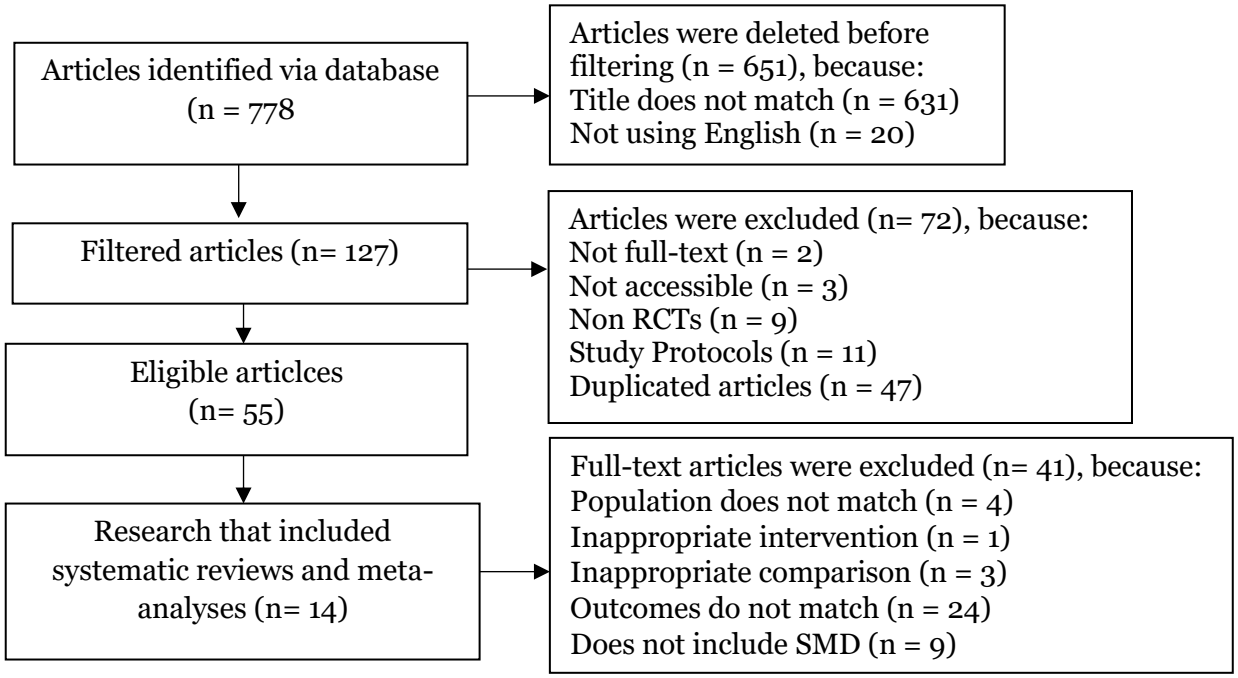

Figure 1. PRISMA 2020 flow diagram of the effectiveness of lifestyle interventions for reducing postpartum weight retention

The initial search process yielded 778 articles. A total of 651 articles were deleted because the title was irrelevant and not in English, resulting in 127 articles being filtered, of which 55 articles met the requirements for a full article review. Full articles were

excluded because the population was not pregnant (n = 4), the intervention provided was social support from the family and the surrounding environment (n= 1), comparison was a comparison between normal population weight retention, overweight and obesity (n= 3) , outcomes in the form of weight retention based on baseline or weight at the beginning of the intervention, postpartum body mass index, post-partum weight loss, postpartum weight loss calculated from before delivery, or has units of pounds (lbs.) (n= 24), and did not include the Standardized Mean Difference (SMD) (n= 9). Based on this process, the results of articles that met the requirements for qualitative and quantitative synthesis were found in 14 RCT articles.

Figure 2 shows the regional distribution of the 14 selected RCT articles, namely: North America, Asia, Australia, and Europe. There are 5 articles from North America (one article each from Rhode Island, California, Kansas, Philadelphia, and Iowa), 2 articles from Asia (one article each from Turkey and Iran), 2 studies from Australia, and 5 articles from Europe (2 articles from Germany and Norway, and 1 article from Sweden).

Data extraction from the 14 selected RCT articles is summarized in Table 2. Several articles were found to have multiple data with different samples based on the length of evaluation time. Assessment of the quality of the study was carried out using 13 questions based on the JBI critical appraisal checklist for RCT listed in Table 1. with the conditions 1 = yes, 2 = no, 3 = unclear, 4 = not applicable. The results of meta-analysis and subgroup analysis can be found in Figure 3. Through forest plots based on various types of lifestyle interventions. While the risk of occurrence can be illustrated through a funnel plot based on subgroups of various types of intervention (Figure 4).

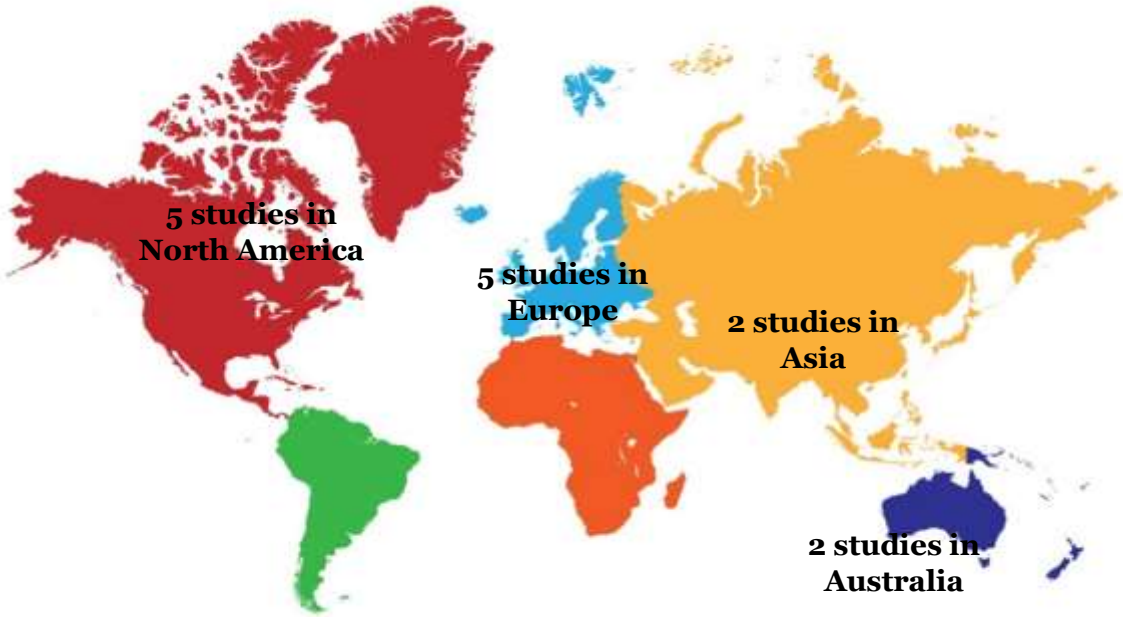

Figure 2. Map of research areas on the effectiveness of lifestyle interventions for reducing postpartum weight retention

Tabel 1. Description of the RCT studies included in the meta-analysis

Author (Year)	Country	Length of evaluation time (weeks)	Sample		Population (P)	Intervention (I)	Comparison (C)	Outcome (O)
			Lifestyle intervention	Non-lifestyle intervention				
Rauh et al. (2013)	Germany	16	152	72	Pregnant women > 18 years, BMI before pregnancy ≥ 18.5 Kg/m²	Diet, physical activity, behavior change intervention	Antenatal care standard	Postpartum weight retention
Kong et al. (2014)	The USA	4	8	10	Pregnant women 18 – 45 years, BMI before pregnancy ≥ 25 Kg/m²	Physical activity and behavior change interventions	Antenatal care standard	Postpartum weight retention
		24	8	10				
Kong et al. (2014)		4	7	9	Pregnant women 18 – 45 years, BMI before pregnancy ≥ 30 Kg/m²			
		24	7	9				
Phelan et al. (2014)	The USA	48	164	167	Pregnant women > 18 years, BMI before pregnancy 19.8 – 40 Kg/m²	Diet, physical activity, behavior change intervention	Antenatal care standard	Postpartum weight retention
Martin et al. (2015)	Australia	12	9	11	Pregnant women > 18 years, BMI before pregnancy 25 – 35 Kg/m²	Diet and behavior change interventions	Antenatal care standard	Postpartum weight retention
		24	9	9				
Wilkinson et al. (2015)	Australia	24	18	10	Pregnant women > 18 years, BMI before pregnancy > 25 Kg/m2	Diet, physical activity, behavior change intervention	Antenatal care standard	Postpartum weight retention
Asci and Rathfisch (2016)	Turkey	6	45	45	Pregnant women aged > 20 years, BMI before pregnancy all categories	Diet, physical activity, behavior change intervention	Antenatal care standard	Postpartum weight retention
Ferrara et al. (2016)	The USA	6	352	377	Pregnant women aged ≥ 18 years, diagnosed with gestational diabetes mellitus, BMI before < 25 Kg/m2	Diet, physical activity, behavior change intervention	Antenatal care standard	Postpartum weight retention
		24	266	299				
		48	230	259				
Ferrara et al.		6	648	752	Pregnant women aged ≥ 18			

Author (Year)	Country	Length of evaluation time (weeks)	Sample		Population (P)	Intervention (I)	Comparison (C)	Outcome (O)
			Lifestyle intervention	Non-lifestyle intervention				
(2016)		24	498	576	years, diagnosed with gestational diabetes mellitus, BMI before ≥ 25 kg/m2			
		48	446	485				
Ronnberg et al. (2016)	Swedia	< 16	137	130	Pregnant women aged ≥ 18 years, BMI before pregnancy > 19 Kg/m2	Diet, physical activity, behavior change intervention	Antenatal care standard	Postpartum weight retention
		48	87	81				
Chao et al. (2017)	The USA	6	16	16	Pregnant women aged 18-40 years, BMI before pregnancy 25-50 kg/m2	Diet and behavior change interventions	Antenatal care standard	Postpartum weight retention
Sagedal et al. (2017)	Norway	48	203	188	Pregnant women aged ≥ 18 years, BMI before pregnancy ≥19 Kg/m2	Diet, physical activity, behavior change intervention	Antenatal care standard	Postpartum weight retention
Hoffman et al. (2019)	Germany	6 – 8	970	929	Pregnant women aged ≥ 18 years, BMI before pregnancy ≥18.5 and ≤ 40 Kg/m2	Diet, physical activity, behavior change intervention	Antenatal care standard	Postpartum weight retention
Hull et al. (2020)	The USA	48	6	10	Pregnant women aged 18-45 years, BMI before pregnancy ≥ 22 – 40 Kg/m2	Diet and behavior change interventions	Antenatal care standard	Postpartum weight retention
Haakstad et al. (2021)	Norway	288	40	40	Pregnant women aged ≥ 18 years, BMI before pregnancy all categories	Physical activity and behavior change interventions	Antenatal care standard	Postpartum weight retention
Mahmoodabad et al. (2021)	Iran	8	77	81	Pregnant women aged ≥ 18 years, BMI before pregnancy < 40 Kg/m2	Diet and behavior change interventions	Antenatal care standard	Postpartum weight retention
		26	77	81				
		52	78	85				

Table 2. JBI critical appraisal checklist for randomized controlled trials

Primary Study	Items of Question													
	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
Rauh et al. (2013)	1	1	1	2	2	2	1	1	1	1	2	1	1	17
Kong et al. (2014)	1	1	1	2	2	2	1	1	1	1	1	1	1	16
Phelan et al. (2014)	1	1	1	2	1	1	1	1	1	1	1	1	1	14
Martin et al. (2015)	1	1	1	2	1	2	1	1	1	1	1	1	1	15
Wilkinson et al. (2015)	1	1	1	2	1	2	1	1	1	1	1	1	1	15
Asci and Rathfisch. (2016)	1	1	1	1	2	2	1	1	1	1	1	1	1	15
Ferrara et al. (2016)	1	1	1	1	1	1	1	1	1	1	1	1	1	13
Ronnberg et al. (2016)	1	1	1	2	2	2	1	1	1	1	3	1	1	18
Chao et al. (2017)	3	1	1	2	3	3	1	1	1	1	1	1	1	20
Sagedal et al. (2017)	1	1	1	2	1	1	1	1	1	1	1	1	1	14
Hoffman et al. (2019)	1	1	1	2	1	2	1	1	1	1	3	1	1	17
Hull et al. (2020)	1	1	1	2	2	3	1	1	1	1	1	1	1	17
Haakstad et al. (2021)	1	1	1	2	1	1	1	1	1	1	1	1	1	14
Mahmoodabad et al. (2021)	1	1	1	2	1	1	1	1	1	1	3	1	1	16

Question Item Description:

1 = Was randomization used in the selection of control and treatment group participants?

2 = Is the allocation of participants between groups hidden?

3 = Are the characteristics of the participants the same between the control and treatment groups?

4 = Did the participant not know the type of intervention he was receiving?

5 = Did the intervention provider not know which group was given the intervention?

6 = Did the outcome assessor not know the allocation of participants and intervention allocation?

7 = Is the treatment group treated the same other than the desired intervention?

8 = Has the follow-up research been completed? If not, were differences in follow-up between groups adequately described and analyzed?

9 = Were participants analyzed in randomized groups?

10 = Was the outcome measured in the same way for the treatment group?

11 = Were outcomes measured in a consistent manner?

12 = Was the statistical analysis used correct?

13 = Is the research design appropriate? And were deviations from standardized RCT research designs (eg individual randomization, parallel groups) taken into account in the conduct and analysis of the study?

Rating Description: 1 = yes, 2 = no, 3 = unclear, 4 = cannot be applied

Table 3. Mean and SD of lifestyle intervention and non-lifestyle intervention

Author (Year)	Length of evaluation time (weeks)	Lifestyle 5Intervention			Non Lifestyle Intervention		
		Mean	SD	Total	Mean	SD	Total
Rauh et al. (2013)	16	2.1	4.3	152	3.3	5.1	72
Kong et al. (2014)	4	5.34	6.05	8	1.62	5.58	10
overweight population	24	1.64	2.09	8	-0.96	5.6	10
Kong et al. (2014)	4	1.43	5.36	7	3.05	8.24	9
obese population	24	-0.1	8.11	7	6.35	7.47	9
Phelan et al. (2014)	48	1.4	6.3	164	3.0	5.7	167

Author (Year)	Length of evaluation time (weeks)	Lifestyle 5Intervention			Non Lifestyle Intervention		
		Mean	SD	Total	Mean	SD	Total
Martin et al. (2015)	12	0.9	7.03	9	7.7	6.8	11
	24	0.8	7.2	9	5.9	4.9	9
Wilkinson et al. (2015)	24	1.0	8.7	18	2.3	9.0	10
Asci and Rathfisch (2016)	6	5.19	4.71	45	5.95	4.79	45
Ferrara et al. (2016) no obese population	6	3.03	4.46	352	3.37	4.06	377
	24	1.28	5.01	266	1.67	4.03	299
	48	0.55	4.49	230	0.96	4.28	259
Ferrara et al. (2016) obese population	6	-0.66	5.68	648	-0.58	5.6	752
	24	-0.08	5.77	498	0.56	6.05	576
	48	0.02	6.43	446	0.25	5.95	485
Ronnberg et al. (2016)	< 16	1.81	4.52	137	3.19	4.77	130
	48	0.3	5.52	87	1.0	5.46	81
Chao et al. (2017)	6	4.8	4.6	16	3.0	5.5	16
Sagedal et al. (2017)	48	0.66	5.48	203	1.42	4.96	188
Hoffman et al. (2019)	6 – 8	4.0	4.8	970	4.3	4.8	929
Hull et al. (2020)	48	-0.2	4.8	841	0.6	5.2	828
Haakstad et al. (2021)	48	0.35	1.8	6	4.4	2.6	10
Mahmoodabad et al. (2021)	288	1.3	4.3	40	1.5	6.9	40
Mahmoodabad et al. (2021)	8	3.35	5.07	77	6.68	5.66	81
	26	2.17	5.21	77	5.89	5.69	81
	52	-0.01	5.07	78	2.95	5.08	85

The forest plot in Figure 3 shows that lifestyle interventions carried out during pregnancy can reduce the incidence of postpartum weight retention with statistically significant results (SMD = -0.17, 95% CI -0.25 to -0.10, p < 0.001). The heterogeneity of the research data as a whole showed I2 = 57% with a p-value <0.001, so that the distribution of the data was considered heterogeneous and was processed using a random effect model.

Subgroup analysis showed that diet was accompanied by a behavior change intervention (SMD = -0.60, 95% CI -0.86 to -0.33, p < 0.001) and the diet subgroup was accompanied by physical activity and behavior change intervention (SMD = -0.10, 95% CI -0.14 up to -0.06, p <0.001) was able to reduce postpartum weight retention with statistically significant results. Success in losing postpartum weight was also found in the physical activity subgroup with behavioral interventions, but the results were not statistically significant (SMD= -0.03, 95% CI -0.39 to 0.44, p= 0.890).

Tests for subgroup differences in the type of lifestyle intervention showed that the subgroup effect was statistically significant (p = 0.001). This can be interpreted that the selection of various types of lifestyles interventions carried out during pregnancy can affect the success of postpartum weight loss.

The risk of bias is illustrated through the funnel plot in Figure 4. which shows that the right and left sides of the funnel plot are found to be asymmetrical, so it can be interpreted that bias occurs due to missing results or commonly referred to as publication bias. The form of asymmetry can also be seen from the sparse plots at the bottom of the diagram. This is due to the existence of research with small sample sizes that have low methodological quality, causing the results of the analysis to be overestimated.

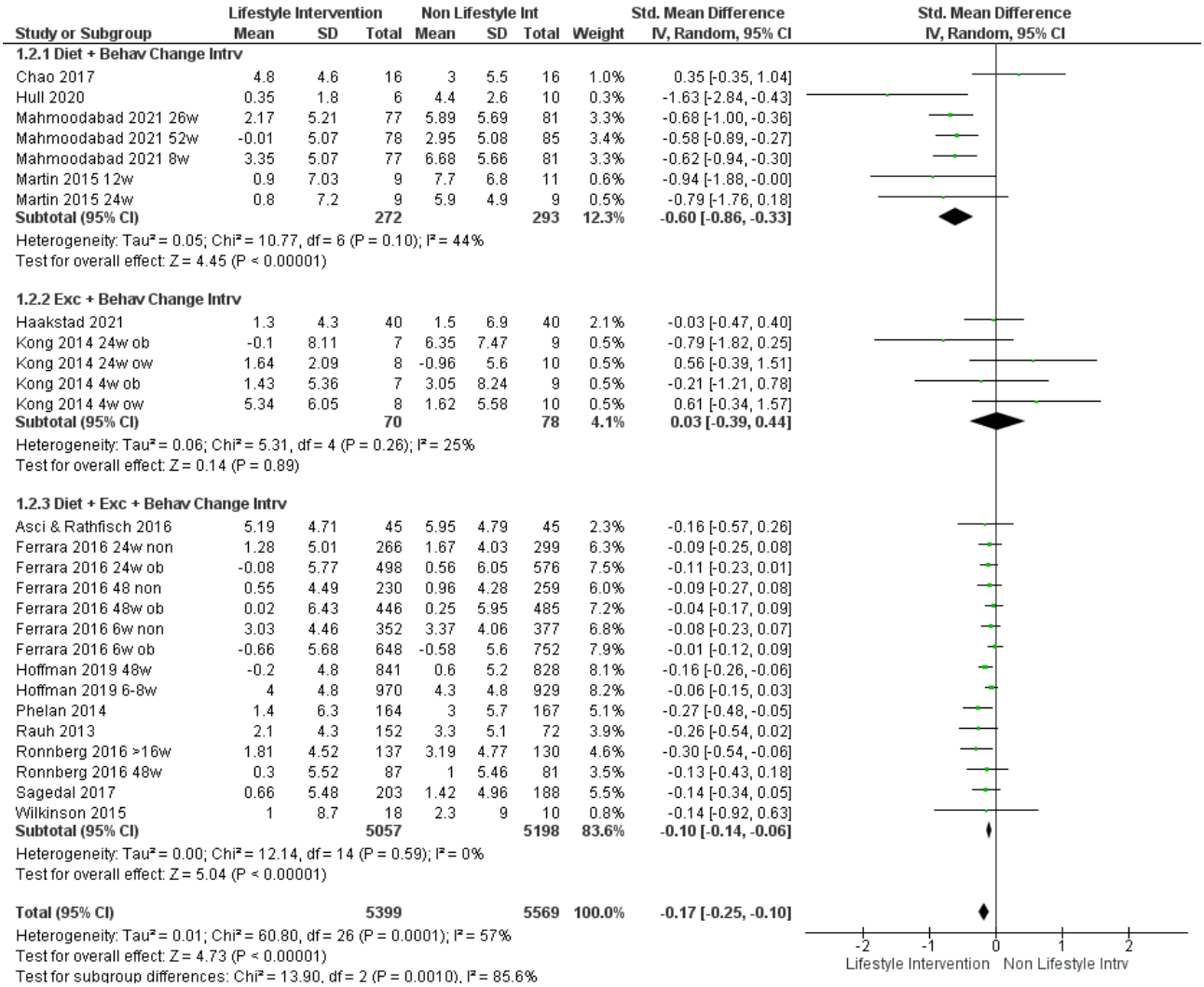

Figure 3. Forest plot of the effectiveness of lifestyle interventions on reducing postpartum weight retention based on various types of interventions

DISCUSSION

Significant subgroup effects indicate that the choice of a variety of lifestyle interventions can affect differences in decreased postpartum weight retention (Richardson et al., 2019). In this study, diet accompanied by behavior change interventions was found to have the largest effect size. This is because diet is a means of regulating energy intake. Changes in postpartum weight are more likely to be caused by fluctuations in energy intake than energy expenditure during pregnancy to the postpartum period (Most et al., 2020).

The high level of leptin at the end of the second trimester and the beginning of the third trimester according to Lacroix et al. (2016) has a relationship with gestational weight gain which can have a large potential for postpartum weight retention. Decreasing leptin levels after delivery will stimulate hunger and appetite so that it will have an impact on increasing food intake consumed (Andersson-Hall et al., 2018).

Physical activity accompanied by lifestyle change interventions did not have a significant effect on reducing body weight retention (p= 0.89). This is in line with the research of Craemer et al. (2019) which showed that the results of a meta-analysis of the effects of exercise with and without

supervision on ideal GWG controls were found to be insignificant. Even though GWG is known as an indicator in determining the incidence of postnatal weight retention in the short and long term (Mannan et al., 2013).

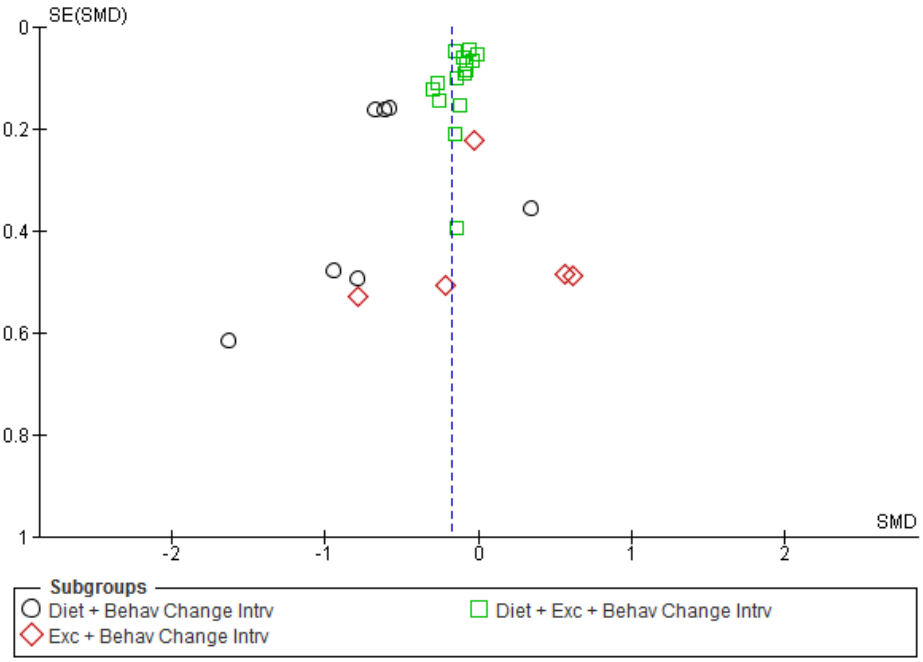

Figure 4. Funnel plot of the effectiveness of lifestyle interventions on reducing postpartum weight retention based on various types of interventions

DISCUSSION

Meanwhile, in another study it was stated that moderate intensity exercise is able to control weight during pregnancy better if done 3 times per week with a duration of 35 to 45 minutes (Wang et al., 2019).

Physical activity which did not contribute to postpartum weight loss in this study could be caused by several factors, namely the lack of the number of studies examined in subgroups. In the physical activity subgroup, only 5 research results were found to be analyzed. There was also a non-uniformity in the length of time for evaluation in the results of this study, namely 4 weeks postpartum (Kong et al., 2014) and 288 weeks postpartum (Haakstad et al., 2021).

The results of the subgroup analysis of diet accompanied by physical activity and behavior change interventions given to pregnant women showed effectiveness with a small effect size in reducing postpartum weight retention. The success of lifestyle interventions was also found by Dodd et al. (2018) who found that a combination of diet and physical activity in postpartum women can reduce postpartum weight better with results that are maintained for up to 1 year postpartum.

Diet and physical activity have their respective roles in weight loss. Diets that are carried out separately without physical activity can be detrimental. This is because diet not only reduces fat mass in the body, but diet can also reduce fat-free body mass or lean mass which consists of muscle and bone (De Souza et al., 2012). Meanwhile, diet accompanied by physical activity can reduce weight without reducing fat-free body mass (Joseph et al., 2020).

In addition to helping maintain fat-free

mass, physical activity can also help mitochondrial metabolism in diet-resistant obese women. Obesity is related to low mitochondria in the body caused by mitochondrial dysfunction of skeletal muscles and can lead to disturbances in bioenergetic function. Physical activity and sports performed on obese individuals can stimulate skeletal muscle mitochondrial biogenesis better than caloric restriction (Pileggi et al., 2022).

The bias in this study was caused by publication bias and weak methodological quality in studies with small samples due to the minimal bibliographic database used and the limitation of only English-language articles included in the inclusion criteria, so that there could be the possibility of an overestimation of the meta-analysis results.

This study aims to determine the effectiveness of various lifestyle interventions carried out during pregnancy and their effect on the incidence of weight retention after delivery. Various conditions after childbirth such as breastfeeding, physical activity status after childbirth, and psychosocial conditions may affect the results of interventions and require further analysis in future studies.

AUTHOR CONTRIBUTION

Gina Fazrina (GF) as the main researcher is in charge of selecting research topics, searching and evaluating articles, as well as data analysis. Uki Retno Budi Hastuti and Rita Benya Adriani acted as supervisors.

FUNDING AND SPONSORSHIP

This research was funded by the Ministry of Education, Culture, Research and Technology (Kemendikbudristek) of the Republic of Indonesia as part of the Indonesian Ministry of Education Scholarship (BPI) awarded by GF.

CONFLICT OF INTERESTS

There is no conflict of interest.

ACKNOWLEDGMENT

This research was made as a requirement for the Master of GF education at Sebelas Maret University, Surakarta. We thank the Ministry of Education and Culture, various parties who have supported this research, as well as the PubMed, Cochrane, Proquest, and Google Scholar database bibliographies.

REFERENCES

Andersson-Hall U, Svedin P, Andreasson U, Gren M, Ingemansson A, Zetterberg H, Blennow K, et al. (2018). Central and peripheral leptin and agouti-related protein during and after pregnancy in relation to weight change. Clin Endocrinol. 88(2): 263–271. doi: 10.1111/-cen.13520.

Aşcı Ö and Rathfisch G (2016). Effect of lifestyle interventions of pregnant women on their dietary habits, lifestyle behaviors, and weight gain: a randomized controlled. J Health Popul Nutr. 35(7): 1–9. doi: 10.1186/s41043-016-0044-2.

Chao AM, Srinivas SK, Studt SK, Diewald LK, Sarwer DB, Allison KC. (2017).A Pilot Randomized Controlled Trial of a Technology-Based Approach for Preventing Excess Weight Gain during Pregnancy among Women with Overweight. Front Nutr. 4(57): 1–7. doi: 10.3389/fnut.2017.00057.

Craemer KA, Sampene E, Safdar N, Antony KM, Wautlet CK (2019). Nutrition and Exercise Strategies to Prevent Excessive Pregnancy Weight Gain: A Meta-analysis. Am J Perinatol Rep. 9(1): E92–E120. doi: 10.1055/s-0039-168-3377.

Dodd JM, Deussen AR, O'Brien CM, Schoenaker DAJM, Poprzeczny A, Gordon A, Phelan S (2018). Targeting the postpartum period to promote weight loss: a systematic review and meta-analysis.

Nutr Rev. 76(8): 639–654. doi: 10.1093/nutrit/nuy024.

Endres LK, Straub H, McKinney C, Plunkett B, Minkovitz CS, Schetter CD, Ramey S, et al. (2015). Postpartum weight retention risk factors and relationship to obesity at one year. Obstet Gynecol. 125(1): 144–152. doi: 10.1097/AOG.0000000000000565.

Ferrara A, Hedderson MM, Brown SD, Albright CL, Ehrlich SF, Tsai AL, Caan BT (2016). The comparative effectiveness of diabetes prevention strategies to reduce postpartum weight retention in women with gestational diabetes mellitus: the gestational diabetes' effects on moms (GEM) cluster randomized controlled trial. Diabetes Care. 39(1): 65–74. doi: 10.2337/dc15-1254.

Haakstad LAH, Kissel I, Bø K (2021). Long-term effects of participation in a prenatal exercise intervention on body weight, body mass index, and physical activity level: a 6-year follow-up study of a randomized controlled trial. J Matern-Fetal Neonatal Med. 34(9): 1347–1355. doi: 10.1080/14767058.2019.1636028.

Hoffmann J, Günther J, Stecher L, Spies M, Meyer D, Kunath J, Raab R (2019). Effects of a lifestyle intervention in routine care on short-and long-term maternal weight retention and breastfeeding behavior—12 months follow-up of the cluster-randomized gelis trial. J Clin Med. 8(6). doi: 10.3390/jcm8060876.

Hull HR, Herman A, Gibbs H, Gajewski B, Krase K, Carlson SE, Sullivan DK, et al. (2020). The effect of high dietary fiber intake on gestational weight gain, fat accrual, and postpartum weight retention: A randomized clinical trial. BMC Pregnancy and Childbirth. 20(1): 1–10. doi: 10.1186/s12884-020-03016-5.

Jensen MD, Ryan DH, Apovian CM, Ard JD, Comuzzie AG, Donato KA, Hu FB, et al. (2014). 2013 AHA/ACC/TOS guideline for the management of overweight and obesity in adults: a report of the American College of Cardiology/ American Heart Association task force on practice guidelines and the obesity society. Circulation, 129(25): 102–138. 10.1161/01.cir.0000437739.71477.ee.

Joseph G, Arviv-Eliashiv R, Tesler R (2020). A comparison of diet versus diet + exercise programs for health improvement in middle-aged overweight women. Women's Health (Lond). 16. doi: 10.1177/1745506520932372.

Kong KL, Campbell C, Wagner K, Peterson A, Lanningham-Foster L (2014). Impact of a walking intervention during pregnancy on post-partum weight retention and infant anthropometric outcomes. J Dev Orig Health Dis. 5(3): 259–267. doi: 10.1017/S2040174414000117.

Lacroix M, Battista MC, Doyon M, Moreau J, Patenaude J, Guilemette L, Menard J, et al. (2016). Higher maternal leptin levels at second trimester are associated with subsequent greater gestational weight gain in late pregnancy. BMC Pregnancy Childbirth. 16(62): 1–9. doi: 10. 1186/s12884-016-0842-y.

Mahmoodabad SSM, Molavi S, Nadjarzadeh A, Riahi FMR, Ardian N, Salehi K, Goodarzi-Khoigani M (2021). Prevention of Postpartum Weight Retention during One Year after Childbirth by Prenatal Nutrition Education: A Randomized Controlled Trial. Int J Prev Med. 12(117): 1–7. doi: 10.4103/ijpvm.IJPVM_37_20.

Mannan M, Doi SAR, Mamun AA. (2013). Association between weight gain during pregnancy and postpartum weig-

ht retention and obesity : a bias-adjusted meta-analysis. Nutr Rev. 71(6): 343–352. doi: 10.1111 /nure.12034.

Martin J, MacDonald-Wicks L, Hure A, Smith R, Collins CE (2015). Reducing postpartum weight retention and improving breastfeeding outcomes in overweight women: A pilot randomised controlled trial. Nutrients. 7(3): 1465–1479. doi: 10.3390/nu7031464.

Most J, Altazan AD, Amant MSt, Beyl RA, Ravussin E, Redman LM (2020). Increased energy intake after pregnancy determines postpartum weight retention in women with obesity. J Clin Endocr. 105(4): E1601–E1611. doi: 10.1210/clinem/dgz330.

Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffman TC, Mulrow CD, Shamseer L, et al. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. The BMJ. 372. doi: 10.1136/ bmj. n71.

Peaceman AM, Clifton RG, Phelan S, Gallagher D (2018). Lifestyle Interventions Limit Gestational Weight Gain in Women with Overweight or Obesity: LIFE-Moms Prospective Meta-Analysis. Obesity (Silver Spring). 26(9): 1396–1404. doi: 10.1002/oby.22250.

Phelan S, Phipps MG, Abrams B, Darroch F, Grantham K, Schaffner A, Wing RR. (2014). Does behavioral intervention in pregnancy reduce postpartum weight retention? Twelve-month outcomes of the Fit for Delivery randomized trial1-3. Am J Clin Nutr 99(2): 302–311. doi: 10.3945/ajcn.113.070151.

Pileggi CA, Blondin DP, Hooks BG, Parmar G, Alecu I, Patten DA, Cuillerier A, et al. (2022). Exercise training enhances muscle mitochondrial metabolism in diet-resistant obesity. eBioMedicine. 83: 1–20. doi: 10.1016/j.ebiom.2022.-104192.

Rauh K, Gabriel E, Kerschbaum E, Schuster T, von Kries R, Amann-Gassner U, Hauner H. (2013). Safety and efficacy of a lifestyle intervention for pregnant women to prevent excessive maternal weight gain: A cluster-randomized controlled trial. BMC Pregnancy and Childbirth. 13(1). doi: 10.1186/1471-2393-13-151.

Retnawati H, Apino E, Kartianom Djidu H, Anazifa RD (2018). Pengantar analisis meta (Introduction to meta-analysis.) Edisi pertama. Yogyakarta: Parama Publishing.

Richardson M, Garner P, Donegan S. (2019). Interpretation of subgroup analyses in systematic reviews: A tutorial. Clin Epidemiology Glob Health. 7(2): 192–198. doi: 10.1016/j.cegh.2018.05.005.

Ronnberg AK, Hanson U, Ostlund I, Nilsson K (2016). Effects on postpartum weight retention after antenatal lifestyle intervention – a secondary analysis of a randomized controlled trial. Acta Obstet Gyn Scan. 95(9): 999–1007. doi: 10.1111/aogs.12910.

Sagedal LR, Sanda B, Øverby NC, Bere E, Torstveit MK, Lohne-Seiler H, Hillesund ER, et al. (2017). The effect of prenatal lifestyle intervention on weight retention 12 months postpartum: results of the Norwegian Fit for Delivery randomised controlled trial. BJOG: Int J Obstet Gynaecol. 124(1): 111–121. doi: 10.1111/1471-0528.138-63.

de Souza RJ, Bray GA, Carey VJ, Hall KD, LeBoff MS, Loria CM, Laranjo NM, et al. (2012). Effects of 4 weight-loss diets differing in fat, protein, and carbohydrate on fat mass, lean mass, visceral adipose tissue, and hepatic fat: Results from the POUNDS LOST trial. Am J Clin Nutr. 95(3): 614–625. doi: 10.39-45/ajcn.111.026328.

Tufanaru C, Munn Z, Aromataris E, Campbell J, Hopp L (2020). Systematic reviews of effectiveness, dalam Aromataris, E. dan Munn, Z. (eds) JBI Manual for Evidence Synthesis. JBI. Available at: https://synthesis manual.-jbi.global.

Wang J, Wen D, Liu X, Liu Y (2019). Impact of exercise on maternal gestational weight gain: An updated meta-analysis of randomized controlled trials. Medicine (United States). 98(27): 1–10. doi: 10.1097/MD.0000000000016199.

Wilkinson SA, van der Plight P, Gibbons KS, McIntrye HD (2015). Trial for reducing weight retention in New Mums: A randomised controlled trial evaluating a low intensity, postpartum weight management programme. J Hum Nutr Diet. 28(s1): 15–28. doi: 10.1111/-jhn.12193.

World Obesity Federation (2022). World obesity atlas 2022. London: World Obesity Federation.