

Meta-Analysis: The Effect of Physical Activity in Reducing Excessive Gestational Weight Gain and Gestational Diabetes Mellitus among Overweight and Obese Pregnant Women

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ABSTRACT

Background: The prevalence of overweight and obesity among women continues to increase every year. Overweight and obesity can lead to complications in pregnancy such as Excessive gestational weight gain (EGWG) and Gestational diabetes mellitus (GDM). Physical activity intervention is an option to prevent EGWG and GDM. The study aims to analyze the effects of physical activity interventions in reducing EGWG and GDM.

Subjects and Method: The study used a meta-analysis study design by following PRISMA guidelines. The research question was formulated in PICO. The population was pregnant women with a Body Mass Index (BMI) of > 25 kg/m². The intervention used was measured physical activity. The comparison was without measured physical activity. The outcomes were EGWG and GDM. Article search was carried out through the databases such as PubMed, Cochrane Library, Scopus Database, and PEDro which was published from 2011 to 2020. The article search used the following keywords: "pregnancy" OR "pregnant woman" AND "obese" OR "overweight" AND "excessive gestational weight gain" OR "gestational weight gain" OR "weight gain" AND "gestational diabetes mellitus" OR "gestational diabetes" AND "exercise" OR "antenatal exercise" OR "physical activity". Articles that met the criteria were full-text articles with a Randomized Control Trial (RCT) study design. The assessment of the quality of the study was conducted with Cochrane Collaboration's Tool for Assessing Risk of Bias and the articles were subsequently analyzed using the Review Manager 5.4 application.

Results: A total of 10 articles analyzed in this study came from Asian, European, Australian, and American countries with a total sample of 2,086. The results of the meta-analysis showed that overweight and obese pregnant women who performed measured physical activity did not experience weight changes compared to those who did not engage in physical activity (SMD= 0.03; 95% CI= 0.17 to 0.73; p=0.770). However, overweight and obese pregnant women who do measured physical activity experience changes in fasting sugar levels compared to those who did not do measured physical activity (SMD= 0.20; CI95%= 0.30 to 0.10; p=0.001).

Conclusion: The results of this study state that physical activity interventions are effective in reducing GDM but not for EGWG in overweight and obese pregnant women.

Keywords: physical activity, excessive gestational weight gain, gestational diabetes mellitus, overweight and obese pregnant women, meta-analysis.

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BACKGROUND

Overweight and obesity are still considered health problems that become a global concern. The prevalence of overweight and obese women continues to increase. From 1980 to 2019 it elevated by 6% to 15.7% (Chopra et al., 2020). Psychological factors, a high-fat diet, and a low level of education (Agustina et al., 2021) not only lead to obesity but also lead to nutritional imbalances as well as pregnancy complications. Pregnancy complications that often appear in overweight and obese women are gestational diabetes mellitus (GDM) and excessive gestational diabetes mellitus (EGWG) (Bider-Canfield et al., 2017; Chopra et al., 2020).

Pregnancy complications have a great impact on both the mother and the infant. It may increase the risk of maternal postpartum hemorrhage, postpartum weight retention, cesarean deliveries, prolonged spontaneous labor as well as premature delivery (Catalano and Shankar, 2017). In babies can increase the risk of big baby births, meconium inhalation syndrome, and the risk of asphyxia (Rahman et al., 2015). Physical activity is an alternative to reduce the risk of complications in pregnancy with overweight and obesity. A study states that physical activity can prevent excessive gestational weight gain (Muktabhant et al., 2015), lower the risk of gestational diabetes mellitus, prevent premature birth (Mascio et al., 2017), lower the risk of gestational hypertension and preeclampsia (Tomasso et al., 2017)

Several studies have discussed the effects of physical activity on pregnancy complications; however, they use different

study designs, and methods, and produce different outcomes. A study by Chen et al (2021), investigate the effects of exercise on maternal and perinatal outcomes and populations with normal Body Mass Index (BMI) values and obese BMI. Another study by Du et al. (2019) also investigate the effects of exercise with outcomes on maternal and perinatal but using a population of pregnant women with different standards of overweight and obese BMI. Considering several previous studies, the authors would conduct a meta-analysis study to analyze the effects of physical activity with outcomes that focus on maternal complications, namely excessive gestational weight gain and gestational diabetes mellitus. The population involved in the study were overweight and obese pregnant women with a BMI of $> 25 \text{ kg/m}^2$.

SUBJECTS AND METHOD

1. Study Design

This was a meta-analysis study design. The study was conducted in October 2022. The analyzed article is a study conducted between 2011 and 2022. Furthermore, it follows prism guidelines. The search for articles is carried out according to the formulation of PICO. Article searches were conducted through the database: PubMed, Cochrane Library, Scopus Database, and Physiotherapy Evidence Database (PEDro) using keywords: "pregnancy" OR "pregnant woman" AND "obese" OR "overweight" AND "excessive gestational weight gain" OR "gestational weight gain" OR "weight gain" AND "gestational diabetes mellitus" OR "gestational diabetes" AND "exercise" OR "antenatal exercise" OR "physical activity".

2. Steps of Meta-Analysis

The meta-analysis was performed in five steps as the following:

1. Formulating research questions in PICO format (population, intervention, comparison, results).
2. Searching for primary study articles from various electronic databases including PubMed, Cochrane Library, Scopus Database, and Physiotherapy Evidence Database (PEDro).
3. Conducting screening and critical appraisal of RCT articles using Cochrane Collaboration's Tool for Assessing Risk of Bias.
4. Extracting data and synthesizing effect estimates into RevMan 5.4
5. Interpreting and concluding the results.

3. Inclusion Criteria

The inclusion criteria specified in the study were as the following: The studies used a Randomized Control Trial (RCT) study design; The population involved were pregnant women who were overweight and obese (BMI > 25 kg/m²); The intervention group obtained a measured physical activity program; The control group did not obtain a measured physical activity program; The study outcomes were excessive gestational weight gain (kg) and gestational diabetes mellitus (mg/dl); Study articles were published from 2011 to 2022; Articles were in Indonesian and English; Articles were in full text, full access, and open access.

4. Exclusion Criteria

The established exclusion criteria were as the following: Anonym studies; Duplicated or previously published studies; The studies came from non-reputable journals either nationally or internationally.

5. Operational Definition of Variables

The search for articles was carried out according to the formulation of PICO. The population in this study was pregnant women with a Body Mass Index (BMI) of > 25 kg/m². The intervention used was a

measured physical activity. The comparison was without measured physical activity, The outcomes were EGWG and GDM

Excessive gestational weight gain represents a weight gain beyond the recommended weight gain that occurs during pregnancy. The recommended weight gain for women with overweight is 7 to 11 kg, while for obese women is 5 to 9 kg.

Gestational diabetes mellitus is an increase in glucose tolerance that occurs during pregnancy with fasting glucose levels of > 92 mg/dl.

Physical activity is an activity that is carried out in a planned and structured manner through repetitive body movements including walking, static cycling, and strengthening exercises.

6. Instrument

The study used Collaboration's Tool for Assessing Risk of Bias as the instrument of article assessment and critical appraisal on the effect of physical activity on EGWG and GDM in overweight and obese pregnant women.

7. Data Analysis

Data analysis was performed using Software Review Manager 5.4. Statistical results were presented in forest plots. The data were represented by Effect Size as the effect quantity, and the measurement data was represented by the standard mean difference (SMD), both using a Confident Interval (CI) of 95%. The degree of homogeneity or heterogeneity of the study was assessed using I square (I²) approach. If I² is below 50% then all the study results are considered homogeneous so it is recommended to use a fixed effect model. On the other hand, if I² is above 50%, then all study results are considered heterogeneous so it is recommended to use a random effect model. The results of the publication bias test can be seen from the funnel plot.

RESULTS

The article search process followed PRISMA's guidelines with a flow diagram (Figure 1). The article search was conducted through electronic databases including PubMed, Cochrane Library, Scopus Database, and Physiotherapy Evidence Database (PEDro) using keywords: "pregnancy" OR "pregnant woman" AND "obese" OR "overweight" AND "excessive gestational weight gain" OR "gestational weight gain" OR "weight gain" AND "gestational diabetes mellitus" OR "gestational diabetes" AND "exercise" OR "antenatal exercise" OR "physical activity".

The initial process of the search obtained 1817 articles, in the identification process, a total of 225 articles were duplicated and 743 articles were excluded for the following reasons: irrelevant topic (345

articles), non-full-text articles (98 articles), and non-RCT articles (257 articles). Hence, 849 full-text articles were eligible for the review. In this stage of assessment of full-text articles, 828 articles were excluded due to inappropriate population (347 articles), non-physical activity interventions (228 articles), non-EGWG and GDM outcomes (183 articles), and non-SMD effect size units (70 articles) and leaving only 21. 11 articles were then excluded, and obtained 10 articles that met the quantitative requirements.

The RCTs came from 4 continents, namely America (2 articles), Europe (6 articles), Asia (1 article), and Australia (1 article). The total sample size was 2,086 people. The distribution of articles by country of origin can be seen in Figure 1. Characteristics description of the articles can be seen in Table 1.

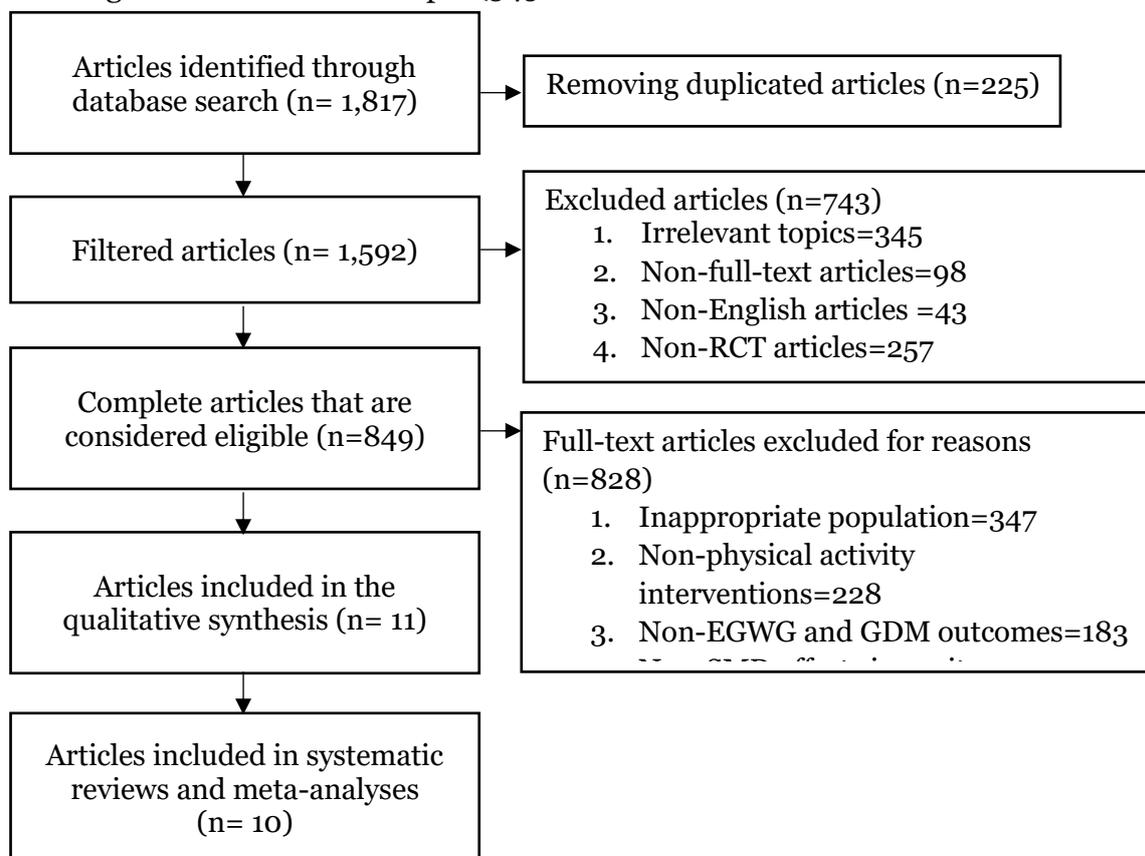


Figure 1. PRISMA flowchart diagram



Figure 2. Map of the research area

Table 1 is an outline of 10 articles with RCT studies that prove the effect of physical activity in reducing EGWG and GDM in overweight and obese mother. A total of 10 primary studies articles met the criteria.

Most of the studies came from Europe such as Norway, Denmark, the Netherlands, and the United Kingdom. The other articles came from America, Brazil, and New Zealand.

Table 1. Outline of the Articles with RCT studies in Meta-Analysis

| Author | Country | Sample | Population | Intervention | Comparison | Outcome |
|---------------------------|-------------|--------|---------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|-------------------------------------------------|------------------------------------------------------------------|
| Garnaes et al. (2016) | Norwegia | 91 | Pregnant women aged: >18 years BMI: >28 kg/m ² | Measured physical activity: Walking (30 minutes), strengthening exercise (25 minutes) | Unmeasured physical activity | Excessive Gestational weight gain, Gestational diabetes mellitus |
| Renault et al. (2014) | Dermark | 389 | Pregnant women aged: >18 years BMI: 30 kg/m ² | Measured physical activity: Walking 11.000 steps at the maximum/day | Without measured physical activity intervention | Excessive Gestational weight gain, Gestational diabetes mellitus |
| Oostdam et al. (2012) | Belanda | 121 | Pregnant women aged: >18 years BMI: > 25 kg/m ² | Measured physical activity: Aerobic dan resistance exercise (at the minimum 60 minutes/day) | No measured physical activity | Excessive Gestational weight gain, Gestational diabetes mellitus |
| Simmons et al. (2016) | Europe | 541 | Pregnant women aged: >18 years BMI: >29 kg/m ² | Measured physical activity: aerobic exercise dan muscle strengthening exercise at the minimum 50 minutes/day | Only obtained advice about a healthy life style | Excessive Gestational weight gain, Gestational diabetes mellitus |
| Sereviratne et al. (2015) | New Zealand | 75 | Pregnant women aged: >18-40 years old | Measured physical activity: cycling exercise, moderate | No measured physical activity | Excessive Gestational weight gain |

| Author | Country | Sample | Population | Intervention | Comparison | Outcome |
|----------------------------|----------------|--------|---------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|-----------------------------------|
| | | | BMI: > 25 kg/m | intensity, at the minimum 30 minutes/ day | | |
| Nascimento et al. (2011) | Brazil | 82 | Pregnant women aged: >18 years BMI: > 26 kg/m ² | Measured physical activity with moderate intensity: stretching (10 minutes), strengthening (20 minutes), relaxation (10 minutes) | No measured physical activity | Excessive Gestational weight gain |
| Vinter et al. (2012) | Denmark | 360 | Pregnant women aged: >18 – 40 years BMI: 30-45 kg/m ² | Measured physical activity with moderate intensity: aerobic exercise at the minimum 30 minutes/day | Only obtained information about the importance of physical activity | Excessive Gestational weight gain |
| Kong et al. (2014) | Amerika | 46 | Pregnant women aged: >18 -45 years BMI: > 25 kg/m ² | Measured physical activity with moderate intensity: walking at the minimum 30 minutes/day | No measured physical activity | Excessive Gestational weight gain |
| Serevi Ratne et al. (2015) | New Zealand | 75 | Pregnant women aged: >18 – 40 years BMI: > 25 kg/m ² | Measured physical activity with moderate intensity: cycling exercise, moderate intensity, at the minimum 30 minutes/day | No measured physical activity intervention | Excessive Gestational weight gain |
| Daly et al. (2017) | United Kingdom | 81 | Pregnant women aged: >18 -45 years BMI: 30 kg/m ² | Measured physical activity: Aerobic and resistance exercise for 50-60 minutes/day | No measured physical activity | Gestational diabetes mellitus |

Table 2. Standard Mean Different (SMD) of the effect of physical activity to reduce excessive gestational weight gain in overweight and obese pregnant women

| Authors | SMD | 95% CI | |
|---------------------------|-------|-------------|-------------|
| | | Lower Limit | Upper Limit |
| Vinter et al. (2011) | -0.27 | -0.52 | -0.03 |
| Oostdam et al. (2012) | 0.75 | 0.38 | 1.11 |
| Kong et al. (2014) | 0.10 | -0.48 | 0.68 |
| Renault et al. (2014) | -0.06 | -0.26 | 0.14 |
| Sereviratne et al. (2015) | -0.21 | -0.67 | 0.24 |
| Garnaes et al. (2016) | 0.16 | -0.25 | 0.58 |
| Simmons et al. (2016) | -0.06 | -0.23 | 0.11 |
| Daly et al. (2017) | 0.00 | -0.24 | 0.42 |

Table 3. Standard Mean Different (SMD) of the effect of physical activity to reduce gestational diabetes mellitus in overweight and obese pregnant women

| Authors | SMD | 95% CI | |
|-----------------------|-------|-------------|-------------|
| | | Lower Limit | Upper Limit |
| Oostdam et al. (2012) | 0.17 | -0.19 | 0.53 |
| Renault et al. (2014) | -0.17 | -0.37 | 0.03 |
| Wang et al. (2016) | -0.32 | -0.55 | -0.10 |
| Garnaes et al. (2016) | -0.19 | -0.61 | 0.23 |
| Simmons et al. (2016) | -0.20 | -0.37 | -0.03 |
| Daly et al. (2017) | -0.48 | -0.90 | -0.06 |

The result of the overall assessment of the quality of the study showed a low risk of bias in Figure 3. Overall, all studies showed a low risk of bias, especially in random sequence generation and allocation con-

cealment. However, blinding of participants and personnel, and blinding of outcome assessment have a higher risk of bias than other assessments. Two studies had the incomplete outcome.

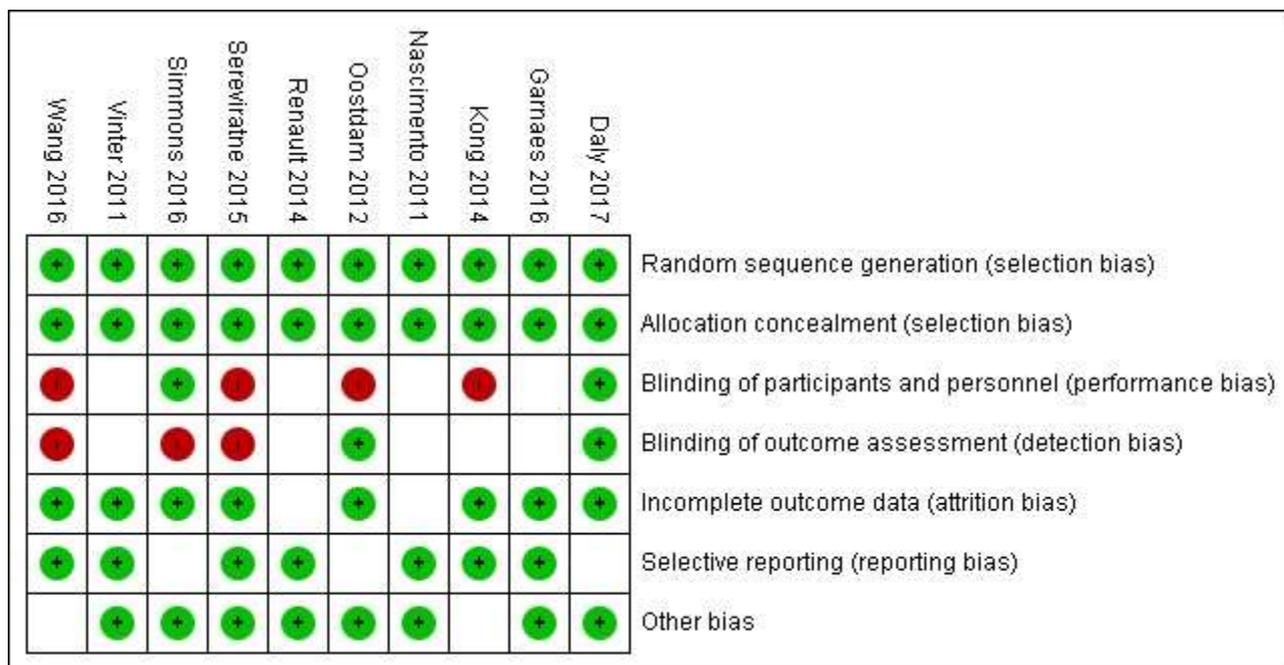


Figure 3. Assessment of the Study Quality for Each Article

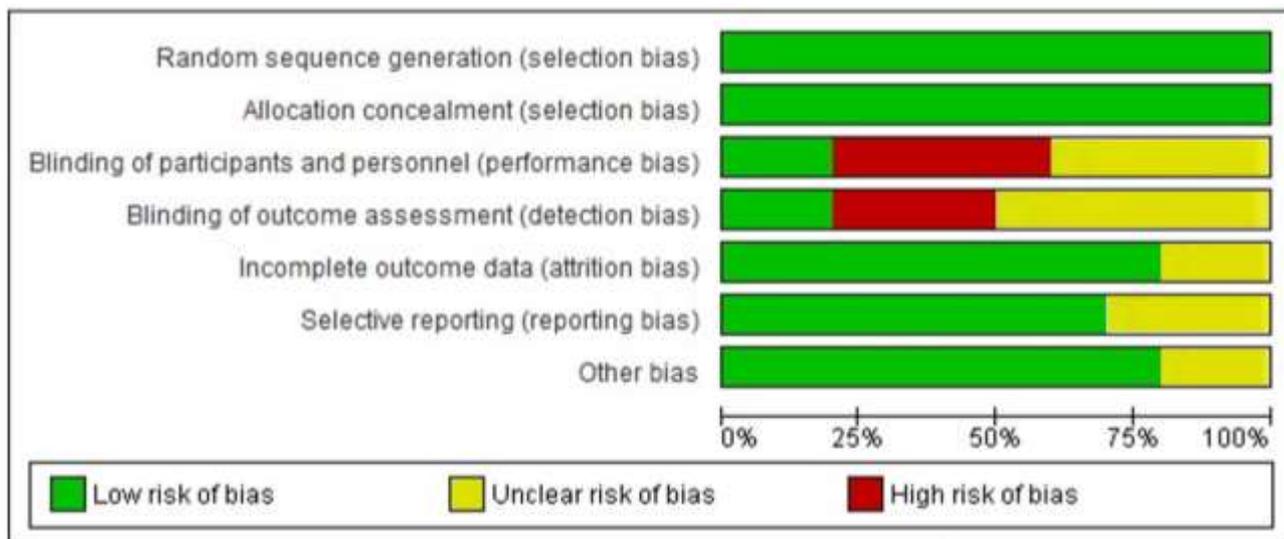


Figure 4. Percentage of the Study Quality Assessment of each of Bias

Assessment on random sequence generation and allocation concealment items had low bias values for all studies. It indicated all RCT studies carried out a random

recruitment for the study sample. Although some studies did not specifically elaborate on their randomization technique, whether using the random-number table or a

computerized random number generator, the process significantly reduced the study bias. Moreover, the allocation concealment had a low value for the bias assessment. It means all processes concealed the sequence of the study samples until the intervention was administered.

In the outcome of excessive gestational weight gain, 8 RCT articles were analyzed. Based on the Forest plot in Figure 5, measured physical activity intervention had no effect on excessive gestational weight gain. Pregnant women who were overweight and obese who conducted measured physical activity did not experience weight change

compared to those who did not engage in measured physical activity (SMD= 0.03; CI 95%= 0.17 to 0.73; p= 0.770). The forest plot showed a high heterogeneity of effect estimates ($I^2=69%$; $p= 0.002$), thus the data calculation of effect estimates was conducted using a random effect model approach.

The Funnel plot results in Figure 6 shows that the distributions of effect estimates across studies were relatively symmetrical between the distributions on the left and the right of the average vertical line of the effect estimates. Thus, this funnel plot showed no publication bias.

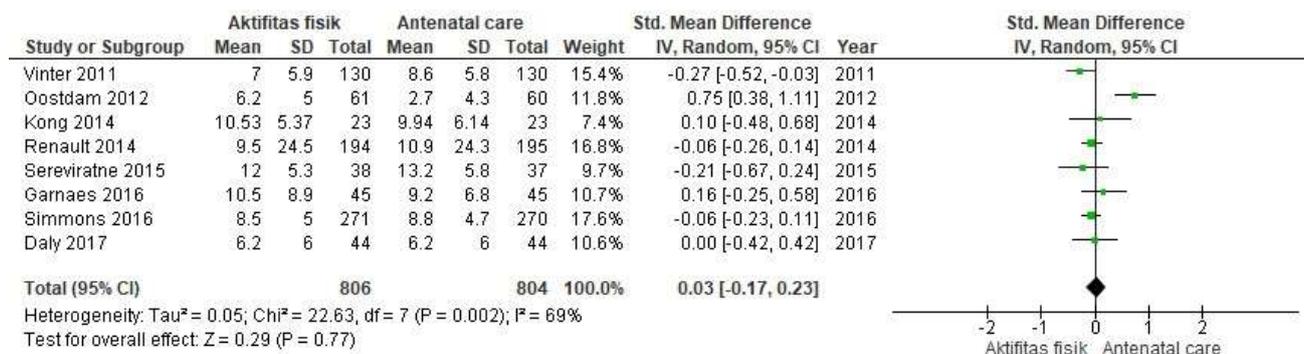


Figure 5. Forest plot of physical activity effect to reduce excessive gestational weight gain in overweight and obese pregnant women

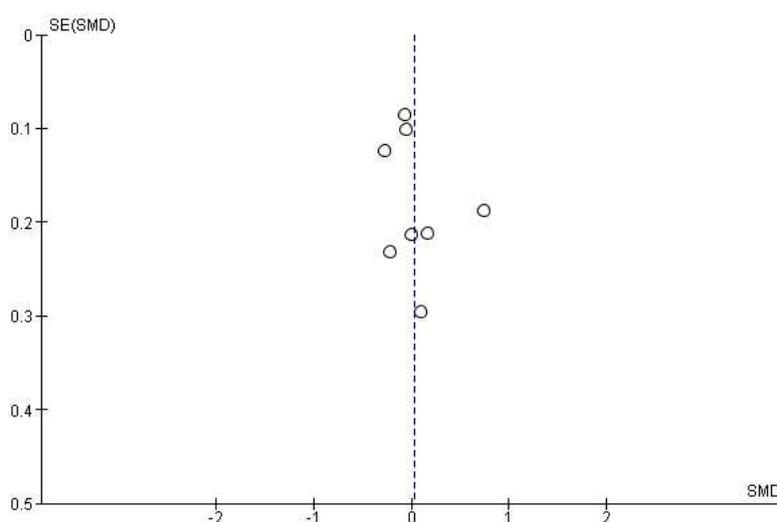


Figure 6. Funnel plot of physical activity effect to reduce excessive gestational weight gain in overweight and obese pregnant women

In the outcome of gestational diabetes mellitus, 7 RCT articles were analyzed. Based on the forest plot in Figure 6, measured physical activity intervention had an effect on gestational diabetes mellitus. Overweight and obese pregnant women who performed measured physical activity experienced changes in fasting glucose levels compared to those who did not perform unmeasured physical activity (SMD=0.20; CI 95% = 0.30 to 0.10; p=0.001). The forest plot showed a

low heterogeneity of effect estimates ($I^2=29\%$; $p=0.220$), thus the data calculation of effect estimates was carried out with a fixed effect model approach.

The Funnel plot results in Figure 8 shows that the distributions of effect estimates across studies were relatively symmetrical between the distributions on the left and the right of the average vertical line of the effect estimates. Thus, this funnel plot showed no publication bias.

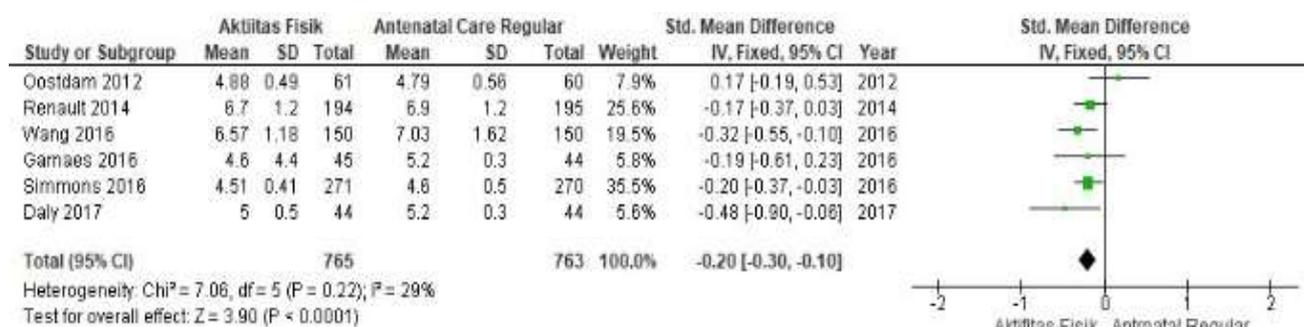


Figure 7. Forest plot of physical activity effect to reduce gestational diabetes mellitus in overweight and obese pregnant women

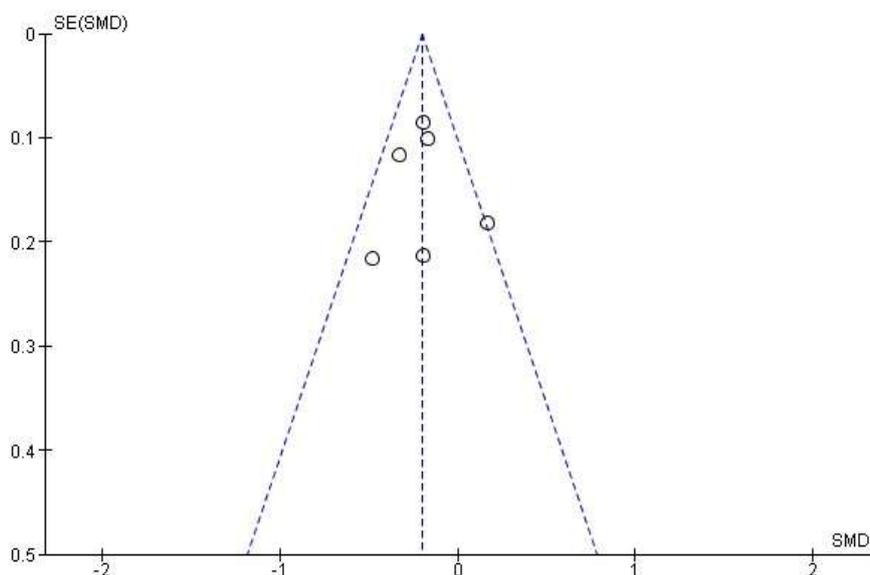


Figure 8. Funnel plot of physical activity effect to reduce gestational diabetes mellitus in overweight and obese pregnant women

DISCUSSION

The meta-analysis synthesized 10 studies with RCT design from 4 continents namely America (2 articles), Europe (6 articles),

Asia (1 article), and Australia (1 article). Excessive gestational weight gain. Overweight and obese pregnant women who performed measured physical activity did

not experience weight changes compared to those who did not perform physical activity (SMD= 0.03; CI 95%= 0.17 to 0.73; p= 0.770). These results are inversely proportional to 2 recent meta-analysis studies which stated that interventions in the form of physical activity accompanied by dietary regulation had been proven to be effective in reducing gestational weight gain (Agha et al., 2014; Muktabhant et al., 2015).

Therefore, the author could make a conclusion that physical activity cannot stand alone as a solitary intervention, rather it should be accompanied by dietary regulation to obtain a significant result. However, the measured physical activity intervention had an effect on gestational diabetes mellitus.

Overweight and obese pregnant women who performed measured physical activity experienced changes in fasting glucose levels compared to those who did not perform measured physical activity (SMD= 0.20; CI95%= 0.30 to 0.10; p= 0.001).

AUTHOR CONTRIBUTION

HC was the main researcher in the study who contributed to selecting the topic, exploring, collecting, and analyzing the data. BM and DGT contributed to interpreting the result of data analysis.

FUNDING AND SPONSORSHIP

The study was self-funded.

CONFLICT OF INTERESTS

There was no conflict of interest in the study.

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