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Masters Program in Public Health, Universitas Sebelas Maret
Meta-Analysis

Excess Weight Gain in Pregnant Women and Prematurity: A Meta-Analysis

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ABSTRACT

Background: Premature birth as a cause of morbidity and mortality in neonates. Excessive weight gain in pregnant women is considered a risk factor for adverse pregnancy outcomes including preterm birth. This study aims to analyze the effect of excess weight gain in pregnant women on premature birth.
Subjects and Method: This research is a systematic review and meta-analysis. Article searches were conducted using electronic databases such as Google Scholar, PubMed, Science Direct and Springerlink. The articles used are articles published from 2011-2021. The keywords to search for articles were: "gestational weight gain" AND "pregnancy" AND ("preterm birth" OR "premature birth") AND "cohort study" AND "adjusted odds ratio". The inclusion criteria used were full text articles in English with a cohort study design, multivariate analysis with Adjusted Odds Ratios (aOR), research subjects were pregnant women, intervention was excessive weight gain, comparison was normal weight gain (adequate). , the study outcome was preterm delivery (<37 weeks). The article search results are listed in the PRISMA diagram and analyzed using the Review Manager 5.3 application.
Results: A total of 10 cohort study articles from China, Indonesia, Canada, Korea, Mexico, Puerto Rico, Saudi Arabia, and Taiwan were selected for systematic review and meta-analysis. The results showed that excess weight gain in pregnant women increased the risk of preterm birth and was statistically significant (aOR= 1.23; 95% CI= 1.01 to 1.48; p= 0.030).
Conclusion: Excess weight gain in pregnant women increases the risk of premature birth.

Keywords: excess weight gain, premature birth, meta-analysis.

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BACKGROUND

Premature birth is still a worldwide epidemic with a global incidence of 15 million births per year (Purisch and Gyamfi-Bannerman, 2017; WHO, 2018). Globally, premature birth is the leading cause of death in children under the age of 5 years (Walani, 2020). Based on data in several countries, the number of premature births has increased. According to WHO, it is estimated that around 1 million children die every year due to complications of premature birth (WHO, 2018).

Premature birth is not only a major cause of morbidity and mortality in neonates, but also an emotional burden and an

economic burden on society (Purisch and Gyamfi-Bannerman, 2017). According to WHO, more than 60% of premature births occur in Africa and South Asia, but premature birth remains a global problem worldwide. In low-income countries, an average of 12% of babies are born earlier than in high-income countries, which is 9% (WHO, 2018).

Quality prenatal care before, between and during pregnancy (Wang et al., 2019) will ensure all women have a positive pregnancy experience. Weight gain during pregnancy is an adverse risk factor and can be reduced by providing nutritional or exercise interventions during pregnancy (Kominiarek and Peaceman, 2017). Weight control is thought to be more likely during pregnancy than before conception, so in recent years there has been an association between weight gain and preterm birth. Mother's weight before pregnancy and weight gain during pregnancy will affect the growth of the fetus. Other studies have also shown that maternal overweight and obesity are risk factors that have the potential to cause preterm birth (Cnattingius et al., 2014; Guo et al., 2020; Shaw et al., 2014), so interventions can also be given. in the preconception period (Dönmez and Güner, 2017).

Several other studies have also shown that the risk of preterm birth increases with excess weight gain (Faucher et al., 2016) and obesity (Cnattingius et al., 2014). However, several studies have reported an association between lower excess weight gain and preterm birth (Chowdhury et al., 2021; Mamun et al., 2011; Wise et al., 2011). Low weight gain is associated with micronutrient and macronutrient deficiencies that will increase the risk of preterm birth, while excess weight gain is also associated with the risk of preterm birth, but the relationship is not consistent and population-specific (Eick et al., 2020).

Large population-based studies are needed to estimate the effect of excess weight gain in pregnant women on preterm birth. On this basis, researchers are interested in conducting a study using a systematic review and meta-analysis approach to investigate relevant epidemiological studies to assess the effect of excess weight gain in pregnant women on preterm birth.

SUBJECTS AND METHOD

1. Study Design

This study uses a systematic review and meta-analysis. Article searches were conducted using electronic databases such as Google Scholar, PubMed, Science Direct and Springerlink. The articles used are articles published from 2011-2021. The keywords to search for articles were: “gestational weight gain” AND “pregnancy” AND (“preterm birth” OR “premature birth”) AND “cohort study” AND “adjusted odds ratio”. The article search results are listed in the PRISMA diagram and analyzed using the Review Manager 5.3 application.

2. Inclusion Criteria

Full paper article with a cohort study, multivariate analysis with adjusted Odd Ratio (aOR) to measure the estimated effect, study subjects were pregnant women with singleton pregnancies, comparisons were pregnant women with normal weight gain (adequate), the study outcome was premature birth.

3. Exclusion Criteria

Articles published in languages other than English, statistical results reported in the form of bivariate analysis, articles prior to 2011.

4. Operational Definition of Variable

In formulating research problems PICO is used. Population = pregnant women with singleton pregnancies. Intervention= excess weight gain. Comparison = normal weight gain. end result = premature birth.

Excessive weight gain during pregnancy is the difference in the weight of pregnant women measured before delivery minus the weight of the mother in early pregnancy which shows more than the International standard of Medicine, 2009. (BMI <18.5 recommended increase 12.5-18 kg; BMI 18.5-24.9 recommended increase 11.5-16 kg; BMI 25-29.9 recommended increase 7.0-11.5 kg; BMI 30 recommended increase 5-9 kg)

Premature birth is the birth of a live baby before 37 weeks of gestation

5. Data Analysis

Articles were collected using PRISMA diagrams and 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

The article search process is carried out by searching electronic databases through Google Scholar, PubMed, Science Direct and Springerlink. Article search results are listed in the PRISMA diagram in Figure 1**.**

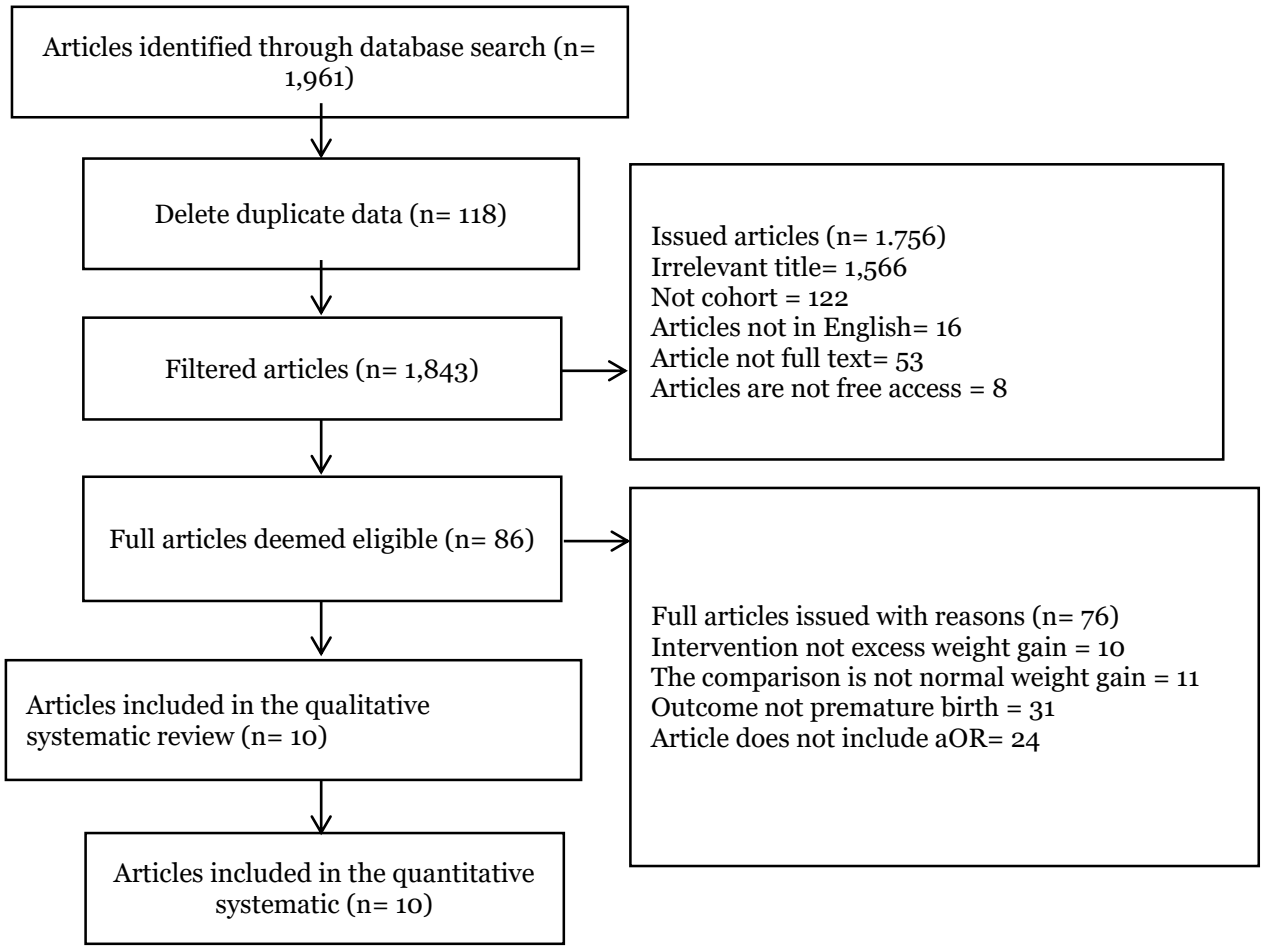

Figure 1. Results of PRISMA Flow Diagrams

Figure 2. Research Research Map

A total of 1,961 articles were identified after removing duplications, 1,843 articles were screened. Of these, 86 articles were assessed for eligibility. The following reasons are given for full-text articles that meet the exclusion criteria: Articles report only (ORs) resulting from bivariate analysis. Articles reporting outcomes other than preterm delivery, the effect size used is aRR/aHR, not aOR.

A total of 10 articles that met the quality assessment were included in the quantitative synthesis using a meta-analysis. Research from the primary study related to the effect of overweight pregnant women on premature birth can be seen in Figure 2 consisting of 10 articles from 7 studies from the Asian continent (China, Taiwan, Indonesia, Saudi Arabia, and Korea) and 3 studies from the Americas (Canada, Mexico, and Puerto Rico).

Research Quality Assessment

Quality assessment in this study uses the Cohort Study Checklist published by the Critical Appraisal Skills Program (CASP, 2018).

This assessment criteria consists of twelve criteria, with each measure given a score of 2 = if you answered yes, 1 = if you answered you don't know, and 0 = if you answered no. The following are the assessment criteria from the Cohort Study Checklist published by CASP (Critical Appraisal Skills Program), including:

1. Does the cohort study clearly address the research problem?
2. Was the group recruited in an acceptable way?
3. Is excess weight gain accurately measured to prevent or minimize bias?
4. Is the outcome (preterm delivery) measured accurately to prevent minimizing bias?
5. Did the researcher identify all the important confounding factors? Did the researcher control for important confounding factors in the design and/or analysis phase of the data?
6. Did the research subject complete the research time in full? Was the follow-up of the subject long enough?
7. Are the results of this study reported in

the 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. What are the implications of this research for practice?

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.

Table 1. Quality Assessment of Cohort Studies

Primary Study	Criteria												Total
	1	2	3	4	5	6	7	8	9	10	11	12	
Chen et al. (2020)	2	2	2	2	2	2	2	2	2	2	2	2	24
Choi et al. (2021)	2	2	2	2	2	2	2	2	2	2	2	2	24
Dzakpasu et al. (2015)	2	2	2	2	2	2	2	2	2	2	2	2	24
Eick et al. (2020)	2	2	2	2	2	2	2	2	2	2	2	2	24
Hassan et al. (2020)	2	2	2	2	2	2	2	2	2	2	2	2	24
Hu et al. (2020)	2	2	2	2	2	2	2	2	2	2	2	2	24
Huang et al. (2016)	2	2	2	2	2	2	2	2	2	2	2	2	24
Liu et al. (2015)	2	2	2	2	2	2	2	2	2	2	2	2	24
Samano et al. (2018)	2	2	2	2	2	2	2	2	2	2	2	2	24
Soltani et al. (2017)	2	2	2	2	2	2	2	2	2	2	2	2	24

Table 1 shows the assessment of study quality using the study cohort checklist published by CASP (Critical Appraisal Skills Program). Table 2 shows a description of the primary studies included in the meta-analysis.

Based on the forest plot in Figure 3 shows that the effect of excess weight gain (excessive) in pregnant women on premature birth is 1.23 times than pregnant women who have normal weight gain (adequate) during pregnancy (aOR= 1.23; 95% CI= 1.01 to 1.48; p= 0.030). Statistical heterogeneity between studies was I2= 94% indicating that the data distribution was heterogeneous so the analysis used the Random Effect Model (REM).

Based on Figure 4, the funnel plot shows an over-estimated publication bias. The distribution of the plots is not symmetrical and there is an imbalance in the distance between studies on the right and left sides of the funnel plot. The plot on the left is 4 with a standard error between 0 and 1, while the plot on the right is 6 with a standard error between 0 and 1.

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

Author (Year)	Country	Study Design	Sample Size		P (Population)	I (Intervention)	C (Comparison)	O (Outcome)	aOR (CI 95%)
			Total	Sample					
Chen *et al.* (2020)	Taiwan	Prospective Cohort	19,052	5,620	Primiparous and multiparous pregnant women	Excessive weight gain	Normal weight gain (adequate)	Premature Birth (<37 weeks)	0.80 (0.69 to 0.94)
Choi *et al.* (2021)	Korea	Prospective Cohort	3,454	785	Pregnant women mean age 33.3 years	Excessive weight gain	Normal weight gain (adequate)	Premature Birth (<37 weeks)	0.85 (0.15 to 4.68)
Dzakpasu *et al.* (2015)	Canada	Retrospective Cohort	5,930	3,499	Primiparous and multiparous pregnant women	Excessive weight gain	Normal weight gain (adequate)	Premature Birth (<37 weeks)	1.45 (1.06 to 1.98)
Eick *et al.* (2020)	Puerto Rico	Retrospective Cohort	320,695	130,030	Pregnant mother	Excessive weight gain	Normal weight gain (adequate)	Premature Birth (<37 weeks)	0.99 (0.97 to 1.02)
Hassan *et al.* (2021)	Saudi Arabia	Retrospective Cohort	14,364	7,326	Pregnant women mean 29.2 years old	Excessive weight gain	Normal weight gain (adequate)	Premature Birth (<37 weeks)	1.06 (0.91 to 1.21)
Hu *et al.* (2020)	China	Retrospective Cohort	88,297	17,152	Pregnant women mean age 30.0 years	Excessive weight gain	Normal weight gain (adequate)	Premature Birth (<37 weeks)	1.48 (1.38 to 1.58)
Huang *et al.* (2016)	China	Retrospective Cohort	17, 475	10,123	Pregnant women mean age 26.7 years	Excessive weight gain	Normal weight gain (adequate)	Premature Birth (<37 weeks)	1.48 (1.38 to 1.58)
Liu *et al.* (2015)	China	Retrospective Cohort	2,973	1,600	nulliparous pregnant women	Excessive weight gain	Normal weight gain (adequate)	Premature Birth (<37 weeks)	1.48 (1.05 to 2.71)
Samano *et al.* (2018)	Mexico	Prospective Cohort	601	137	Pregnant women teens average age 16.0 years	Excessive weight gain	Normal weight gain (adequate)	Premature Birth (<37 weeks)	2.61 (1.10 to 6.19)
Soltani *et al.* (2017)	Indonesia	Cohort	529	62	nulliparous pregnant women	Excessive weight gain	Normal weight gain (adequate)	Premature Birth (<37 weeks)	2.76 (0.55 to 13.69)

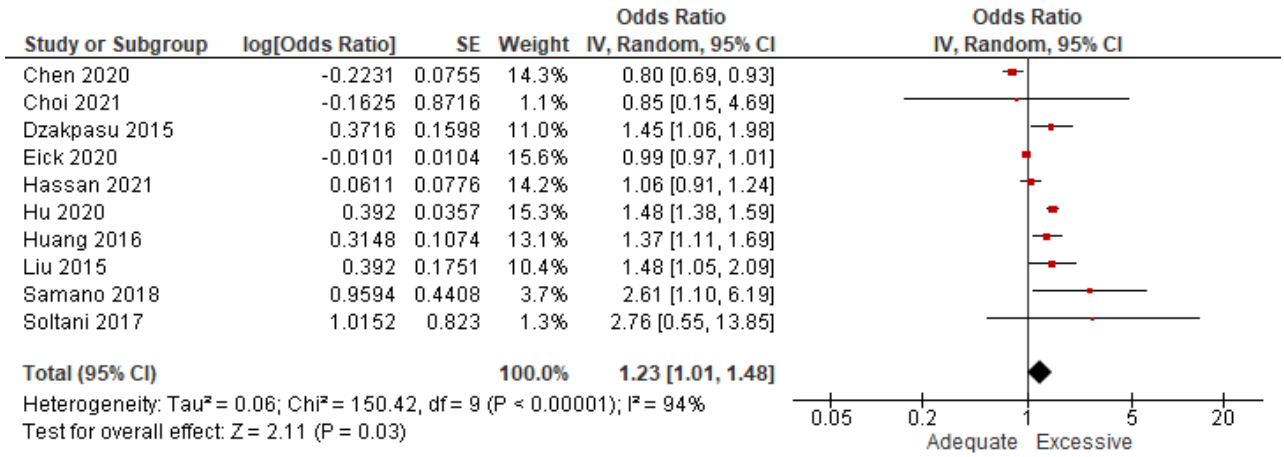

Figure 3. Forest Plot Effect of Excessive Weight Gain on Premature Birth

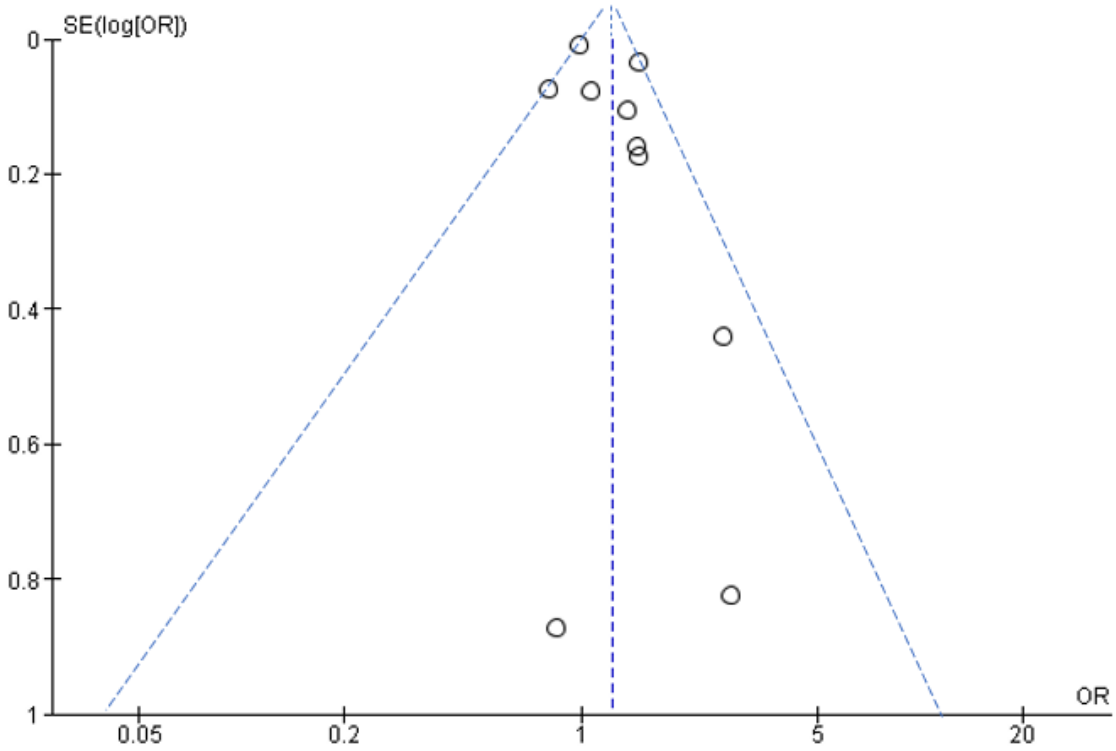

Figure 4. Funnel plot Effect of Excessive Weight Gain against premature birth

DISCUSSION

Pregnancy is a time when women have significant changes, including weight gain. 30% increase in gestational weight consists of increased fetal, amniotic fluid and placenta, while the remaining 70% occurs due to expansion of uterine and breast tissue, an increase in blood volume, fat stores and extra-cellular fluids, some of which will increase maternal weight. during pregnancy (Santos, et al in Sonia, 2021).

Weight gain during pregnancy is influenced by several factors, namely Body Mass Index before pregnancy, parity, increased fat mass, food consumption, physical activity and examinations to health care facilities (Asefa and Nemomsa, 2016). Body Mass Index before pregnancy is one of the important factors that affect the prognosis of pregnancy. High or low Body Mass Index

is associated with antenatal, intrapartum, and postpartum complications such as preeclampsia, gestational diabetes, premature birth, and postpartum hemorrhage (Tommys, 2018).

A study of 11,323 pregnant women found that inadequate weight gain and excessive weight gain were independent risk factors for preterm birth compared with normal weight gain during pregnancy (Dönmez and Güner, 2017; Wise et al., 2011; Zhang et al., 2016).

This meta-analysis study investigated the effect of excess weight gain in pregnant women on preterm birth. The independent variable is excess weight gain and the dependent variable is premature birth. The subjects in this study were pregnant women with singleton pregnancies. The intervention given was excess weight gain compared to normal weight gain during pregnancy. Research that discusses premature birth is considered important because premature birth is still a problem which can increase morbidity and mortality in newborns. This meta-analysis included 453,872 pregnant women from ten cohort studies conducted in China, Indonesia, Canada, Korea, Mexico, Puerto Rico, Saudi Arabia, and Taiwan. Studies were identified from 2011 to 2021, with each article having an aOR statistical outcome. This study explains that the effect of excess weight gain (excessive) of pregnant women on premature birth is 1.23 times that of pregnant women with normal weight gain (ade-quate) (aOR= 1.23; 95% CI= 1.01 to 1.48; p= 0.030). This meta-analysis study provides evidence that there is an effect that excess weight gain during pregnancy will increase the risk of preterm birth. In this study, there is a tendency for publication bias which is indicated by the funnel plot with an asymmetric distribution of plots.

The weight gain of pregnant women is based on the Body Mass Index before pregnancy if more than the IOM recommendation is categorized as excess weight gain compared to normal weight gain during pregnancy. Research on the relationship between pre-pregnancy weight gain and weight gain during pregnancy is still quite limited, but several studies have reported that obesity, being overweight or underweight increases the risk of preterm delivery (Dönmez and Güner, 2017). Obesity before pregnancy is associated with the presence of proinflammatory cytokines and adipokines as well as changes in the hypothalamic, pituitary, and adrenal corticotrophin releasing hormones. If this happens, there will be risk factors for adverse pregnancy outcomes such as premature rupture of membranes, eclampsia, gestational hypertension, including premature birth (Wang et al., 2021).

The results of this study are in line with studies reporting that excessive pregnancy weight gain among underweight pregnant women, insufficient gestational weight gain among obese pregnant women and excessive pregnancy weight gain in the last trimester increase the risk of preterm delivery (Huang et al., 2016). Excess weight gain during pregnancy is associated with a risk of gestational hypertension and gestational diabetes leading to a higher risk of preterm delivery (Faucher et al., 2016).

This study is in line with research conducted in Tanzania, which found that excessive weight gain was relatively high in healthy pregnancies. Excess weight gain was associated with adverse pregnancy outcomes including preterm delivery (RR= 1.59; 95% CI= 1.03 to 2.44) (Yang et al., 2021).

The results of this study are similar to a study conducted in Bangladesh which explained the relationship between the rate of weight gain in the second and third tri-

mesters of 1,569 pregnant women with 19.9% having weight gain above the recommendation during the second and third trimesters that there is a relationship between weight gain. and excess during pregnancy with preterm delivery (aOR= 2.2; 95% CI= 1.1 to 4.4; p= 0.023) (Hasan et al., 2021). Another study conducted also explained that there was a relationship between excess weight gain during pregnancy and premature birth in obese pregnant women (aOR = 1.56; 95% CI = 0.93 to 2.62; p= 0.007) (Faucher et al., 2016).

This study contradicts a study conducted in China on 552 pregnant women, stating that there is an association between underweight gain during pregnancy and an increased risk of preterm birth (OR= 2.80; 95% CI= 1.71 to 6.78; p= 0.021) and weight gain. overweight was not associated with preterm birth (OR= 0.42; 95% CI= 0.13 to 1.42; p= 0.166) (Wang et al., 2021). Another similar study conducted said that excess weight gain during pregnancy would reduce the risk of preterm delivery (aOR= 0.80; 95% CI= 0.52 to 1.22) (Su et al., 2019). Another study with similar results found that weight gain during pregnancy was negatively correlated with preterm delivery (OR=0.770; 95% CI= 0.64 to 0.91; p= 0.003) (Yang et al., 2017).

Efforts to prevent death and complications from premature birth can start with a healthy pregnancy. Quality prenatal care before, between and during pregnancy (Wang et al., 2019) will ensure all women have a positive pregnancy experience. Antenatal care guidelines can be carried out by providing interventions such as counseling on a healthy diet and optimal nutrition, use of tobacco substances, measurement of the fetus with ultrasound to determine gestational age and detect multiple pregnancies, conduct Antenatal Care (ANC) visits during pregnancy to identify other risk factors such as infection, and increasing access to contraceptive use (WHO, 2018).

The long-term impact of preterm birth has physical, neurodevelopmental/ behavioral effects (specific learning disorders, dyslexia, global development delay), and family, economic and social effects (March of Dimes, PMNCH, Save the Children, 2012). Giving early intervention on excess weight gain during pregnancy, especially in pregnancies at risk can be done as an effort to prevent adverse pregnancy outcomes, including premature birth (Swamy et al., 2008; Svedenkrans et al., 2013; Luu et al., 2017; Ou-Yang et al., 2020; de Gamarra-Oca et al., 2021).

The limitations of this study are that there is a language bias because it only uses English articles, a publication bias shown in the funnel plot results, and a search bias because it only uses four databases.

AUTHORS CONTRIBUTIONS

We declare that all authors contributed significantly to the work reported, whether it was in the conception, study design, execution, data acquisition, analysis, and interpretation, or all of these areas; took part in drafting, revising, or critically reviewing the article; gave final approval of the version to be published; agreed on the journal to which the article was submitted; and agreed to abide by the journal's policies.

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CONFLICT OF INTEREST

There are no conflicts of interest.

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