The effect of maternal exercise on maternal and foetal health in obese pregnant women

Učinek telesne dejavnosti pri nosečnicah z debelostjo na zdravje nosečnice in novorojenčka

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Abstract

Background: Obesity during pregnancy represents a global problem and is a major risk factor for complications during pregnancy and labour. Emerging evidence suggests that physical activity during pregnancy might be beneficial for both maternal and foetal health without side effects. The purpose of this systematic review was to review trials evaluating the effect of physical activity on maternal and foetal health in obese pregnant women.

Methods: PRISMA guidelines were followed. We searched for randomized controlled trials published until June 2018 on the PubMed, PEDro and CENTRAL databases. We included articles that had a well described physical activity intervention and studied obese pregnant women with BMI > 30 kg/m^2.

Results: Ten articles were included in the review. All articles included a physical activity intervention, seven articles included also a dietary intervention. Four articles included a pedometer--based intervention, six articles opted for a supervised physical activity intervention. Physical activity with or without dietary intervention had no effect on lowering the risk for gestational diabetes mellitus or improving neonatal or other maternal outcomes. There were mixed results in gestational weight gain and mode of delivery.

Conclusion: We can conclude that physical activity during pregnancy has mixed results on maternal and foetal health in obese pregnant women. There is no evidence from randomized controlled trials that PA during pregnancy in obese women improves maternal or neonatal outcomes, and therefore no clear statements on beneficial effects of PA in this population can currently be made.

Izvleček

Izhodišče: Debelost med nosečnostjo je svetovni problem in velik dejavnik tveganja za nastanek zapletov med nosečnotjo in porodom. Nova dognanja trdijo, da je telesna dejavnost med nosečnostjo koristna za mater in novorojenčka. Namen sistematičnega pregleda literature je seznanitev z randomiziranimi kontroliranimi raziskavami o učinkih telesne dejavnosti na zdravje matere in ploda pri nosečnicah z debelostjo.

Metode: Iskali smo randomizirane kontrolirane raziskave, objavljene do junija 2018, na spletnih podatkovnih bazah PubMed, CINAHL, PEDro, CENTRAL ali Medline. Vključili smo raziskave, ki so imele natančno opisan ukrep za telesno dejavnost in so vključile nosečnice z debelostjo, ki so imele indeks telesne mase (ITM) > 30 kg/m^2.

Rezultati: V pregled je bilo vključenih 6 raziskav, ki so telesno dejavnost kombinirale s svetovanjem o zdravi prehrani. Telesna dejavnost s prehranskim svetovanjem ali brez njega ni učinkovita pri zmanjšanju tveganja za nastanek sladkorne bolezni med nosečnostjo ali izboljšanje zdravja novorojenčka. Učinek telesne dejavnosti na gestacijsko telesno težo pa ni jasen. Samo ena vključena raziskava je vključila nadzorovano telesno dejavnost, medtem ko so ostale vključevale zgolj svetovanje in spodbujanje k povečanju količine hoje dnevno s pedometrom.

Zaključek: Zaključimo lahko, da učinki telesne dejavnosti pri nosečnicah z debelostjo niso jasni. Na podlagi randomiziranih kontroliranih poskusov ne moremo trditi, da telesna dejavnost nosečnic z debelostjo izboljša zdravje matere ali otroka.

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1 Introduction

Obesity in pregnancy is usually defined as a body mass index (BMI) of 30 kg/m^2 or more at the first antenatal consultation (1). It represents a global problem and is a major risk factor for complications during pregnancy and labour (2,3). Approximately half of women in their reproductive stage are either overweight (BMI 25 to 30), or are obese (BMI 30 or above) (4,5). Obesity during pregnancy is associated with higher risk of pre-term delivery (6), birth-asphyxia-related complications (7), pre-eclampsia, gestational diabetes mellitus (GDM), prolonged second stage of labour, delivery by caesarean section, wound infection, postpartum haemorrhage, early neonatal death or neonatal admission to intensive care (8-11) and infant mortality (12). Because of these associations maternal obesity has become one of the most challenging health care problems in the 21st century obstetrics (2,13).

Emerging evidence suggests that physical activity (PA) during pregnancy might be beneficial for both maternal and foetal health without side effects (14,15). Findings in the literature also suggest that increasing PA levels during pregnancy is effective in the prevention of GDM, hypertension, dyspnoea, excessive gestational weight gain (GWG), and high birth weight, among others (16-23). In a population based cohort study that included 98,820 women who delivered in Slovenia, the authors concluded that excessive GWG is a significant risk factor for pre-eclampsia, while low GWG is an important protective factor against PE in obese women (24). Maternal exercise may have benefits for the new born, such as higher neurodevelopment (25,26), better heart function, improved heart rate variability (27) and lower body fat (25). Exercise may improve the pregnant women's quality of life and reduce stress (15,28-30), which might protect the foetus (31). A recent meta-analysis that included obese and overweight pregnant women concluded that exercise interventions reduced GWG and the risk for GDM. No evidence was found with respect to benefits of exercise during pregnancy for infants (32). Another recent systematic review found that 30 to 60 minutes of aerobic exercise performed three to seven times per week during pregnancy is associated with a reduction in the incidence of preterm birth in overweight and obese pregnant women (33). However, no literature review was performed in obese pregnant women only.

Obese pregnant women should be encouraged to engage in healthy lifestyle modification in pregnancy, which includes physical activities and judicious diets. Obese women should start with low-

-intensity, short periods of exercise and gradually increase as able (34). Literature suggests that obese pregnant women should engage in PA for 3 to 5 times per week or on most days of the week. Each PA session should last between 20 to 30 minutes (35,36). The Slovenian recommendations on PA during pregnancy state that pregnant women should exercise every day of the week for at least 30 minutes at moderate intensity (37). All-though most guidelines for exercise intensity can be used in women who are pregnant and obese, the results from several randomized controlled trials suggested that light to moderate intensity activity may be best for women who are pregnant and obese. The perceived exertion should be evaluated during PA using the Borg scale. A personalized exercise programme including personal goals should be formed (36). In women who are pregnant and overweight or obese, a variety of exercise programmes have been implemented and proven to be safe and effective. These programmes include resistance training (23,38), stationary cycling (39,40), aerobics classes (41) and walking (42,43).

There are many new published trials evaluating the effects of PA on maternal health in obese pregnant women, but so far no systematic review has focused only on obese pregnant women. Previous reviews focused on overweight and obese women together (32,33,36,39,44,45,46). Overweight women with a BMI below 30 may also benefit from the particular recommendation, however, the chosen BMI cut-offs reflect careful consideration given to the balance of medical intervention versus risk, differences in local prevalence of maternal obesity, and resource implications for local healthcare organisations (1). The purpose of this systematic review was to review trials evaluating the effect of PA in obese pregnant women and, based on the results, evaluate the optimal exercise programme to diminish the risks associated with obesity and pregnancy.

2 Methods

The PRISMA guidelines were followed. Literature search was conducted on the following databases: PubMed, CENTRAL and PEDro. The search was conducted until the end of June 2018. A combination of the following search terms was used: 'obese' OR 'obesity' AND 'pregnant' OR 'pregnancy' AND 'physical activity' OR 'exercise' AND 'health'. Filters were applied to include only English language and human studies. The trials included needed to be randomized controlled trials that evaluated the effect of PA on maternal health or maternal and foetal health in obese pregnant women. They could be either combined with a dietary intervention or not. The included articles needed to have a specific and described exercise programme and should include only pregnant women with BMI score 30.0 kg/m^2 or above. All included women needed to be without exercise contraindications. Only articles written in English were included. We excluded articles that examined the effect of PA on postpartum depression or mental health only and articles that measured the effect of PA on urinary incontinence.

All articles were reviewed by one researcher. After removing duplications, articles were reviewed by titles and abstracts by the same researcher and discussed with the senior author. Articles that met the inclusion criteria in abstract and title review were assessed for eligibility in full text.

Primary outcomes were maternal and neonatal outcomes. For maternal outcomes we included relative risk for

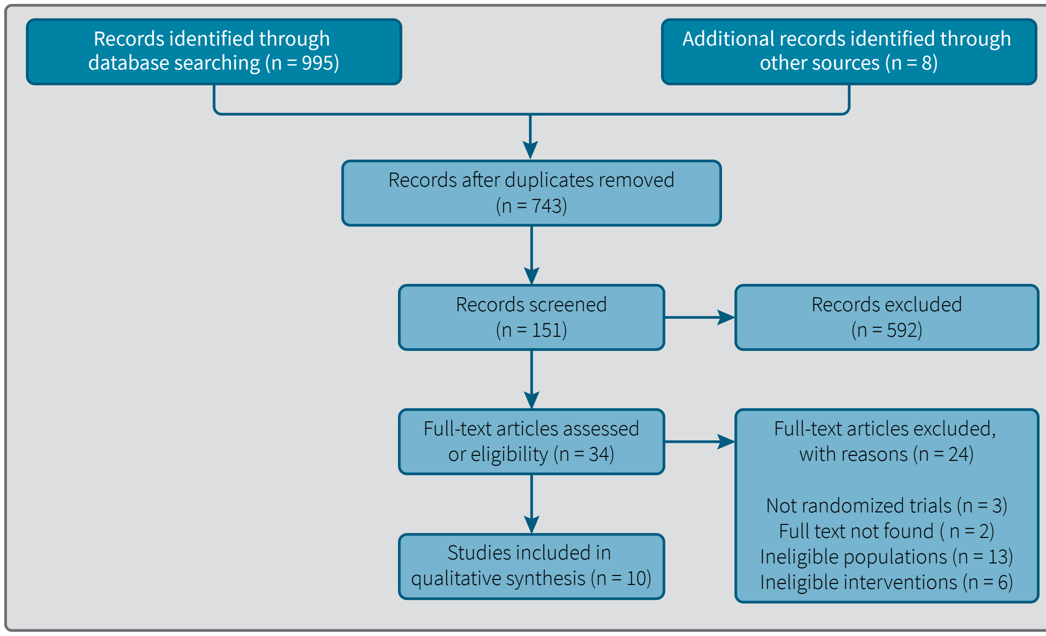

Figure 1: PRISMA diagram.

GDM and GWG. For neonatal outcomes we decided to include birth weight, gestational age at delivery and large for gestational age, as they most frequently appear in the literature. Secondary outcomes included fasting insulin levels, pre-eclampsia, systolic and diastolic maternal blood pressure, delivery by caesarean section and fasting HDL and LDL levels. Outcomes and characteristics were extracted from each of the included studies.

3 Results

Our search yielded 151 publications eligible for screening. After title and abstract screening, 34 articles were included for full text review. Ten of these met our inclusion criteria. The search and screening process are presented in Figure 1.

Table 1 presents the methodological approaches used in the included studies. Six articles (42,43,49,50,52,54) included a dietary intervention or some information on healthy eating that aimed at a health gestational weight gain of less than 5 kg that is linked with fewer complications during pregnancy and delivery. All obese pregnant women allocated to the control groups received standard prenatal care.

The diagnosis of GDM was based on a 75 g, 2-hour oral glucose tolerance test that was conducted between 24 and 28 weeks of gestation, with the diagnosis being based on the International Association of Diabetes in Pregnancy Studies Group criteria. Gestational weight gain was calculated as the weight measured at a visit during gestational weeks 36 to 37 minus the self-reported or measured pre-pregnancy weight.

Exercise has no effect on GDM in all of the included articles as shown in Table 2. There were mixed results regarding the effect of exercise on GWG. Five articles reported a significant result (42,43,49,51,54) and three articles reported an insignificant result (47,52,53). Renault and colleagues (54) found that gestational weight gain was significantly lower in the PA and dietary intervention as well as in the PA only group compared to the control group ($p = 0.008$), but

Table 1: Methodological approaches used in the studies.

Authors	N	Intervention period	Intervention	PA	Outcomes measured
Ong et al., 2009 (47)	12	18–28 wk of gestation	PA, C	Home based supervised exercise performed on an upright stationary cycle ergometer, 3x per week, 25 to 45 min	GDM, GWG, maternal aerobic fitness, self reported physical activity
Callaway et al., 2010 (48)	50	12 wk of gestation to delivery	PA, C	Individualized exercise plan, regular exercise advice, paper based diaries	GDM, fasting insulin, fasting glucose, MET h/week, >900 kcal/week
Vinter et al., 2011 (49)	304	10 to 14wk of gestation to 36 wk of gestation	PA and DI, C	encouragement to be active for 30 to 60 min daily, pedometer, free full-time membership to a fitness centre for 6 months with closed training with PT for 1 h per week, group sessions for 4 to 6 times during pregnancy	GWG, systolic and diastolic blood pressure, VO_2 max, GDM, caesarean section, pre-eclampsia, neonatal outcomes
Poston et al., 2013 (50)	183	15 to 17 wk of gestation to delivery	PA and DI, C	individual session with health trainer followed by 8 group sessions, advice on increasing step count monitored by pedometer, DVD of specifically devised pregnancy exercise regime	GDM, neonatal outcomes, GWG, mode of delivery, pre-eclampsia, blood loss at delivery, inpatient nights, blood pressure, neonatal outcomes
Renault el al., 2014 (43)	283	11 to 16 wk of gestation to delivery	PA and DI, PA, C	A daily step count of 11000, assessed by pedometers	GWG, systolic blood pressure, diastolic blood pressure, hypertension, pre-eclampsia, induction of labour, caesarean section, neonatal outcomes, gestational hypertension
Bisson et al., 2015 (51)	50	11 to 36 wk of gestation	PA, C	1 hour long sessions, stationary cycling (5 to 10 min), treadmill walk (15 to 30 min), muscle exercise (20 min), cool down period, three times per week	GWG, caesarean delivery, GDM, gestational hypertension, neonatal outcomes
Dekker Nitert et al., 2015 (52)	50	12 to 36 wk of gestation	PA and DI, C	individualized exercise plan meeting specific energy expenditure based on personal preferences and ability, monthly advice by physiotherapist, paper based diaries and self-monitoring	GWG, weight, BMI, systolic and diastolic blood pressure, fasting glucose, fasting insulin, fasting cholesterol, fasting HDL, fasting LDL, neonatal outcomes
Poston et al., 2015 (42)	1555	15 wk of gestation to delivery	PA and DI, C	individual interview, 8 individual or group sessions of 1 h for 8 weeks, DVD of exercise regimen, incremental increase of walking from a pedometer assessed baseline	GDM, GWG, maternal anthropometric measurements, fasting plasma insulin, insulin resistance, fasting trygcerides, LDL and HDL cholesterol, pre-eclampsia, systolic and diastolic blood pressure, mode of delivery, induction of labour, blood loss at delivery, inpatient nights, neonatal outcomes

Authors	N	Intervention period	Intervention	PA	Outcomes measured
Daly et al., 2017 (53)	88	13 wk of gestation to 6 wk postpartum	PA, C	3 PT supervised exercise classes per week during pregnancy and 6 weeks postpartum, 50–60 minutes	GDM, GWG, induction of labour, mode of delivery, length of labour, neonatal outcomes, postpartum weight retention
Renault et al., 2017 (54)	389	11 to 14	PA and DI, PA, C	encouragement to increase to 11000 steps per day, monitored by pedometer	GWG, fasting HDL, fasting LDL, cholesterol, fasting triglycerides, fasting insulin, C-peptide, leptin, GDM

Legend: N – number of participants; PA – physical activity; DI – dietary intervention; C – control; SC – standard prenatal care; GWG – gestational weight gain; GDM – gestational diabetes mellitus; PT – physiotherapist; HDL – high density lipoprotein; LDL – low density lipoprotein.

there were no significant differences found between the two intervention groups (p = 0.57).

Four articles, including 2044 women, measured the effect of PA on fasting insulin levels (42,45,52,54). No differences were seen among all four studies with p-values raging from 0.05 to 0.57. The highest difference was 5.7 mmol/L (47) between the control and intervention group, while other authors reported differences of between -0.1 mmol/L (52), 1.6 mmol/L (54) and 0.7 mmol/L (42). Three articles including 1994 women (42,52,54) assessed the effect of maternal PA on HDL and LDL levels. Again, no difference was reported among the groups. P-values ranged from 0.50 to 0.93 for HDL cholesterol and from 0.27 to 0.32 for LDL cholesterol levels. Two articles reported no difference in levels of HDL and LDL measured in mmol/L between the intervention and control group (42,54), while one article reported a difference of 0.2 mmol/L in HDL and 0.9 mmol/L in LDL measurements between the control and intervention group (52).Three articles including 687 women (43,49,52) reported the effect of PA on systolic with a difference of 1–2 mmol/L between the control and intervention group (43,49,52) and diastolic with a difference of 1 mmol/L (43,49,52) maternal blood pressure. There was no significant result reported. PA had no effect on the occurrence of pre-eclampsia as reported by two articles including 2142 women (42,43). Poston and colleagues (42) reported the occurrence of pre-eclampsia in 4 % of participants in both the intervention and control group. Renault and colleagues (43) reported that 1.5 % of women in the control and 2.2 % of women in the intervention group were diagnosed with pre-eclampsia. Five articles including 2463 women (44,49,51,53) reported that PA had no effect on elective or emergency caesarean section, with p-values raging from 0.16 to 0.79. The rate of caesarean section was between 20 % (53) and 37 % (43) in the control group and between 18 % (53) and 35 % (42) in the intervention group. Renault and colleagues (43) found an insignificant rate of deliveries by caesarean section (p = 0.16), but a significantly lower rate of emergency/unplanned caesarean section in the dietary and lifestyle counselling group (p = 0.015).

There were also no significant differences in neonatal outcomes in all of the included articles. Results are shown in Table 3.

Three articles (42,43,53) including 1926 women, examined the occurrence of pre-term birth. All articles reported an insignificant result with p-values greater than 0.05. In the control group pre-term birth occurred in 2 % (42,43,53), while in the intervention group it occurred in between 2 % (40) to 4 % (43,53). Four articles (43,43,51,53) including 1976 women, measured the outcome of small for gestational age.The p-values in all studies were greater than 0.05. In the control group there were between 5 % (43) to 16 % (53) and in the intervention group between 0 % (51) to 13 % (42) of infants small for gestational age.

4 Discussion

To our knowledge this is the first systematic review of articles that studied the effect of physical activity on maternal and neonatal health in obese pregnant women. The results from our systematic review show that no exercise or increasing habitual PA intervention is effective in improving neonatal outcomes and preventing GDM in obese pregnant women. Our results are consistent with recent systematic reviews that focused on obese and overweight women (32,33,36,39,44,45,46). Major differences can be seen in the methodological approaches used in the studies.

Table 2: Results of the included studies on GDM, GWG.

Authors	GDM		GWG	
	Intervention	Control	Intervention	Control
Ong et al., 2009 (47)	/	/	3.7 (3.4) p:0.155	5.2 (1.3)
Callaway et al., 2010 (48)	3 (16 %) p:0.57	5 (23 %)	/	/
Vinter et al., 2011 (49)	9 (6 %) p:0.76	8 (5.2 %)	7.0 p:0.014*	8.6
Poston et al., 2013 (50)	22 p:0.574	24	/	/
Renault et al., 2014 (43)	6 (5.8 %)	7 (5.2 %)	8.6 p:0.024*	10.9
Bisson et al., 2015 (51)	3 p:0.60	5	12.3 (5.9) p:0.03*	12.2 (5.9)
Dekker Nitert et al., 2015 (52)	/	/	7.87 (4.00) p:0,81	8.28 (6.10)
Poston et al., 2015 (42)	160 (25 %) p:0.68	172 (26 %)	7.19 (4.6) p:0.041*	7.76 (4.6)
Daly et al., 2017 (53)	25 (58.1 %) p:0.51	21 (48.8 %)	6.2 (6.0) p:0.15	7.89 (4.8)
Renault et al., 2017 (54)	/	/	8.7 p:0.02*	10.7

Data are mean (SD) or number of women (%); Legend: GDM – gestational diabetes mellitus (number of pregnant women diagnosed); GWG – gestational weight gain(kg); *- statistically significant result.

There were differences in dosage of exercise duration and timing. All included articles started the PA intervention in the second trimester or towards the end of the first trimester. Women are encouraged to start PA as soon as possible in pregnancy or continue with PA from before pregnancy (55,55). Seven articles included a supervised PA intervention that differed in frequency and duration (42,47,48,49,51-53). In three articles the PA intervention was delivered 3 times per week (44,51,53), one article included supervised PA 4 to 6 times per week (49) and one article only once a week (42). Two articles included an individualised plan (48,52). In four articles the duration of each session was 1 hour (42,51,53), whereas in one article the duration was between 25 to 45 minutes (47). Literature suggests that obese pregnant women should engage in PA for 3 to 5 times per week or on most days of the week. Each PA session should last between 20 to 30 minutes (35,36,37).

Five articles opted for a pedometer approach (42,43,49,50,54). The pedometer intervention has many limitations. Pedometers measure only ambulatory activity, cannot provide an accurate estimate of PA energy expenditure and have limited accuracy when measuring physical activity at slower or faster speeds (57). Another limitation of a pedometer based intervention is the lack of measuring activity in water. As swimming is a popular PA among pregnant women, this can be considered as a major limitation of the studies. Another major concern is that there is no medical supervision. As a new form of PA can be hard to incorporate in the daily routine without medical advice and a specific, personalised programme, we consider this a major limitation of the study. On the other hand, there are also some positive characteristics of a pedometer approach.

Table 3: Results of the included studies on neonatal outcomes.

Authors	Birth weight (g)		GA		LGA	
	Intervention	Control	Intervention	Control	Intervention	Control
Vinter et al., 2011 (49)	3742 p:0.039	3593	40 p:0.952	40	23 (15.4 %) p:0.340	18 (11.7 %)
Poston et al., 2013 (50)	/	/	/	/	7 (8 %) p:0.982	7 (8 %)
Renault et al., 2014 (43)	3605 p:0.08*	3641	278 (11) p:>0.05	278 (12)	9 (6.9 %) p:>0.05	9 (6.7 %)
Bisson et al., 2015 (51)	3575 (425) p:0.30	3455 (368)	39 (1) p:>0.05	39 (1)	4 (17 %) p:>0.05	3 (13 %)
Dekker Nitert et al., 2015 (52)	3548 (459) p:0.12	3597 (304)	39 p:>0.05	39	/	/
Poston et al., 2015 (42)	3420 (580) p:0.37	3450 (580)	39.5 (2.0) p:0.89	39.5 (2.4)	71 (9 %) p:0.40	61 (8 %)
Daly et al., 2017 (53)	3532 (477.1) p:0.99	3534 (552.3)	39.6 (1,8) p:0.32	39,2 (1.6)	3 (6.8 %) p:0.51	2 (4.6 %)

Data are mean (SD) or number of infants (%); Legend: GA – gestational age (weeks); LGA – large for gestational age (number of infants); *- significant result.

This intervention is inexpensive and can easily be implemented into daily clinical practice. Pedometers are user-friendly and commonly known. They are usually small and worn on the waist or wrist.

Our results show that no intervention was successful in preventing GDM. Reasons for this limitation can be explained by the fact that all of the included studies started with the intervention in the second trimester. Starting exercise in the second trimester can be practical for the researches and easier as the first trimester pregnancy symptoms, including nausea, vomiting and extreme fatigue, stop (55,56). Since many women already start gaining weight in the first trimester (58), exercise interventions likely need to begin very early in the pregnancy or perhaps already in the pre-pregnancy period to achieve maximal effects. With an early intervention we could achieve more, since with the progression of the pregnancy exercise becomes harder to accomplish.

Another possible explanation for non-significant differences between intervention and control groups is that the PA was not of appropriate intensity. The incremental rise in PA intensity achieved with the type of interventions, used in the included studies, is inadequate for improving glucose tolerance. A minimum of 16 MET/h per week of PA is suggested to be needed to reduce the risk of GDM (59). This is equivalent to 40 min/day of walking. No article included in our review met the minimum amount of exercise needed to reduce the risk of GDM. It is possible that women allocated to the control group also increased their level of PA, which further reduces the power of the studies to detect differences.

The results show that exercise interventions have a mixed effect on GWG. Five articles concluded that a PA intervention is effective. Other recent studies, conducted in normal weight pregnant women, also report mixed effects (58,59,61). More studies are needed to establish the conclusive effect of PA on GWG. In a systematic review of the effects of PA and PA plus diet interventions on body weight in overweight or obese pregnant women the authors concluded that supervised PA programmes or personalised prescription are needed to prevent excessive weight gain for overweight and obese pregnant women (35).

To increase knowledge about the effects of PA in pregnancy on delivery, neonatal outcomes and maternal health in obese pregnant women longitudinal prospective studies with detailed descriptions of different types of dietary interventions and PA are needed. Different types of PA should be investigated to establish the least and most effective type of PA. For future studies, we recommend an early intervention with a personalized intervention programme. A major limitation of the studies included was the lack of guidance and control over PA. Since obesity requires a medical intervention, we recommend that physiotherapists or appropriately trained health trainers guide and provide advice to pregnant women.

5 Conclusion

This systematic review has shown that PA is not an effective intervention for lowering the risk of GDM or improving neonatal outcomes. There were also mixed results regarding the effect of PA on gestation weight gain and delivery mode. There are many limitations of the included studies that could explain the inconclusive results. Further high quality and large studies are needed to determine the effectiveness of a PA intervention with and without a dietary intervention. Future studies should investigate the difference between various PA interventions that should be personalized and started as soon as possible, ideally before the pregnancy. There is no evidence from randomized controlled trials that PA during pregnancy in obese women improves maternal or neonatal outcomes, no clear statements on beneficial effects of PA in this population can currently be made.

6 Declaration

Conflicts of interest: The authors declare that no conflicts of interest exist.

Funding: The study was not founded.

Ethical approval: There was no ethical approval needed since this is a systematic review.

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