ORIGINAL ARTICLE

UDC: 618.2-055.26:613.72]:618.4
DOI: https://doi.org/10.2298/VSP200311080B

Effect of aerobic exercise on frequency of vaginal birth – A meta-analysis

Uticaj aerobnog fizičkog vežbanja na učestalost vaginalnog porođaja – meta analiza

Ksenija V. Bubnjević*, Marija Macura*, Aleksandra Jakovljević†, Aleksandar Borisavljević*, Novica Djoković‡

***University of Belgrade, Faculty of Sport and Physical Education, Belgrade, Serbia; Clinical Centre Kosovska Mitrovica, †Department of Internal Medicine, ‡Department of Gynecology and Obstetrics, Kosovska Mitrovica, Serbia**

Abstract

Background/Aim. Pregnancy is a state where different morphological and physiological changes occur in a pregnant woman's body. There are many factors that have an effect on maintaining a healthy pregnancy. Physical activity is one of the possible factors that can have an impact on the quality of life during pregnancy. Healthy pregnant women, without medical or obstetric complications, are advised to exercise in a moderate and proper manner. The aim of this meta-analysis was to evaluate the impact of continuous aerobic exercise on the frequency of vaginal birth in healthy pregnant women with normal body mass index (BMI) values. **Methods.** This meta-analysis was based on a systematic review and selection of randomized clinical trials. The affect of physical exercise was assessed using the "*RStudio*" programming language and environment. Heterogeneity of studies was assessed by Q statistics. Possible publication bias of studies was identified. The primary outcome analysis was related to the frequency of vaginal birth, while the secondary outcome analysis was related to BMI in the first measurement and total weight gain after the second measurement. The suitability of 10 individual studies is shown by graphical and statistical analysis of the extracted data. **Results.** Physically active pregnant women who exercised with light to moderate intensity 3 times a week (35–60 minutes), had a more frequent vaginal birth than sedentary pregnant women (67.4% vs. 60.5; relative risk (RR) 1.11, 95% confidence interval (CI), 1.04–1.18). RR was statistically significantly different from unit ($p = 0.002$). All pregnant women had optimal BMI values in the first measurement before intervention. Also, all pregnant women gained the recommended number of kilograms during pregnancy. **Conclusion.** Analysis of selected individual studies showed that continuous aerobic physical exercise during the second and third trimesters does not have a negative effect on measured outcome of pregnancy. Physically active pregnant women were more likely to give birth vaginally than sedentary pregnant women.

Key words:
delivery, obstetric; exercise; meta-analysis; pregnancy; pregnancy outcome.

Apstrakt

Uvod/Cilj. Trudnoća je stanje kada dolazi do različitih morfoloških i fizioloških promena u organizmu trudnice. Mnogi su faktori koji imaju uticaja, na održavanje zdrave trudnoće. Fizička aktivnost je jedan od mogućih faktora koji može imati uticaja na kvalitet života tokom trudnoće. Zdravim trudnicama, bez medicinskih ili akušerskih komplikacija, preporučuje se umereno i pravilno fizičko vežbanje. Cilj ove meta-analize je bio da proceni uticaj kontinuiranog aerobnog fizičkog vežbanja na učestalost vaginalnog porođaja kod zdravih trudnica sa normalnim vrednostima indeks telesne mase (ITM). **Metode.** Ova meta-analiza je bila zasnovana na sistematskom pregledu i selekciji randomizovanih kliničkih studija. Uticaj fizičkog vežbanja je procenjen pomoću "RStudio" programskog jezika i okruženja. Heterogenost studija je procenjena Q statistikom. Utvrđena je moguća publikaciona pristrasnost studija. Analiza primarnih ishoda odnosila se na učestalost vaginalnog porođaja, dok se analiza sekundarnih ishoda odnosila na ITM u prvom merenju i ukupnom dobitku telesne mase nakon drugog merenja. Podobnost 10 individualnih studija prikazana je grafičkom i statistčkom analizom ekstrahovanih podataka. **Rezultati.** Fizički aktivne trudnice, koje su vežbale lakim do umerenim intenzitetom 3 puta nedeljno (35–60 minuta), imale su češće vaginalni porođaj u odnosu na sedentarne trudnice [67,4% prema 60.5%, relativni rizik (RR) 1.11, 95% indeks poverenja:

Correspondence to: Ksenija V. Bubnjević, Rajka Mamuzića 40, 21 000 Novi Sad, Serbia. E-mail: xenrun@gmail.com

1.04–1.18]. RR je bio statistički značajno različit od jedinice ($p = 0{,}002$). Sve trudnice su imale optimalne vrednosti ITM u prvom merenju pre intervencije. Takođe, sve trudnice su dobile preporučen broj kilograma tokom trudnoće. **Zaključak.** Analiza odabranih individualnih studija pokazala je da kontinuirano aerobno fizičko vežbanje, tokom drugog i trećeg trimestra, nema negativan uticaj na mereni ishod trudnoće. Fizički aktivne trudnice su se češće imale vaginalni porođaj u odnosu na sedentarne trudnice.

Ključne reči:
porođaj; vežbanje; meta-analiza; trudnoća; trudnoća, ishod.

Introduction

Pregnancy is a period of life when a woman's body undergoes various morphological and physiological changes. There are various factors that can affect the course and outcome of the pregnancy. It is believed that weight gain can have both positive and negative impact [1]. Maintaining optimal weight, in addition to affecting the prevention of pregnancy problems and the most common diseases, also affects the sense of self-esteem and, consequently, a better quality of life during pregnancy [2]. Also, weight gain can have an impact on method of giving birth. Studies show that more obese women are more likely to give birth by caesarean section [3.] One way to reduce obesity and maintain optimal body weight is through regular physical activity, both before and during pregnancy. Controlled aerobic physical exercise is recommended for healthy pregnant women, while increased physical activity is not recommended for pregnant women who have any medical complications [4].

A positive pregnancy outcome comes down to having a healthy newborn. Childbirth can be carried out in many ways and it may depend on the health of the pregnant woman, the growth and development of the fetus. It is expected that every pregnant woman will expect "natural" and as painless childbirth as possible, so fear of potential delivery by caesarean section may occur. In this meta-analysis, an estimate of the incidence of childbirth occuring exclusively vaginally was performed. It is believed that certain factors, such as daily physical activity, can have an impact on the outcome of pregnancy itself as it relates to the way of delivery.

Many healthy pregnant women do not meet the recommended minimum for physical exercise (at least 3 times a week for at least 20–30 minutes a day) [4]. Due to different research results, it remains unclear how continuous aerobic exercise can have an impact on childbirth. This meta-analysis investigated the impact of identical exercise way on the frequency of vaginal birth in healthy and pre-sedentary pregnant women with normal body weight.

Methods

Search method

Searching the literature and selecting the right references was implemented in accordance with the Preferred Reporting Items for Systematic reviews and meta-Analyses (PRISMA) rules and recommendations [5]. The research protocol included a systematic review of the scientific literature, selection of individual studies according to set criteria, as well as extraction and analysis of primary and secondary outcomes. Selection of scientific studies was performed using two bibliographic databases ("PubMed" and "Scopus"). The search was enabled with the help of selected keywords: "Aerobic exercise", "Pregnancy", defined type of publication ("Randomized control or Clinical trial"), without time limit and with concluding research period until the end of 2018.

Literature selection

A detailed selection of scientific studies is presented in the “Flow diagram” (Figure 1). Duplicate studies, studies with inappropriate design, exercise and measured outcomes were excluded from the study, as well as studies indicating that pregnant women had a risky or a complicated pregnancy. For further research, high quality published scientific studies that meet the set criteria were singled out. Only randomized clinical studies (RCTs) were selected for this meta-analysis.

Participants

The criterion for the selection of participants included exclusively healthy pregnant women with a single fetus pregnancy (27.6–33.8 years of age). Pregnant women were randomized into two research groups. The experimental group consisted of physically active pregnant women (PAPW) who exercised during the second and third trimesters (at the earliest from the 12th and at the latest until the 39th gestational week), while the control group consisted of sedentary pregnant women (SPW) who did not exercise during pregnancy. All pregnant women received regular prenatal care. Pregnant women were previously physically inactive or sedentary and had normal body mass index (BMI) values (18.5–24.9 kg/m^2).

Intervention

Meta-analysis included RCTs that in detail described the phases of physical exercise (introductory part – warm-up, main part – development of endurance and strength, final part – relaxation and stretching) and exercise load (frequency, volume, intensity, manner and type of physical exercise). The intensity of the aerobic exercise method was controlled by a pulsometer or a Borg scale for self-assessment. All studies provide recommendations and guidelines for proper exercise during pregnancy [4, 6, 7] The studies described aerobic exercises (types of aerobics, water

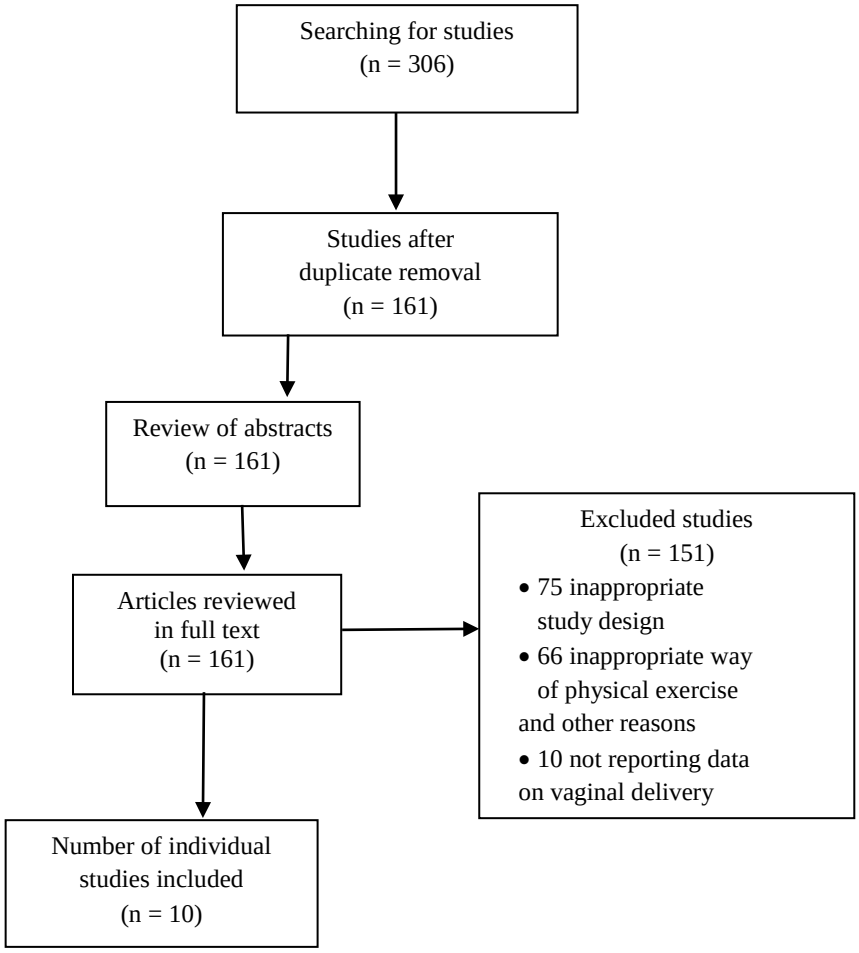

Fig. 1 – Flow diagram of studies selection.

aerobics, dancing, swimming, brisk walking and riding a stationary bike).

Outcome measurement

Primary (vaginal birth) and secondary (BMI and total body weight gain) measurements of pregnancy outcomes were measured. Secondary outcomes were measured before (about the 12th gestational week) and after the intervention (around the 37th gestational week), that is, continuous aerobic physical exercise. BMI was calculated using the following formula (kg/m^2), while the total body weight gained during pregnancy was calculated as the difference in kilograms between prenatal (first) and last measurement. A second weight measurement was usually done at the end of the third trimester. Workout sessions were regularly recorded in the diary.

Data extraction and risk of bias

Assessing the risk of bias in selected individual studies is essential to assessing the reliability of the meta-analysis itself [8]. The assessment of data quality (data inclusion, risk of bias, data extraction, and final analysis) was performed by two independent authors (AB and AJ). If there was disagreement when analyzing the extracted data, the final decision was resolved by discussion between the reviewer and the third author (KB). Table 1 shows the extracted data included into the analysis.

Data analysis

The meta-analysis unit was an individual scientific study. The unification of the results that determine the frequency of the primary outcome was done by determining the Relative risk (RR), while determining the secondary outcomes was done by determining the standardized differences in the means of numeric outcomes. The heterogeneity of the studies was determined graphically using the "Forest" and "L'Abbels" plots, and heterogeneity analysis was performed by calculating Q statistics. A fixed-effect model or a random-effect model was applied depending on the homogeneity of the studies, while adjustments of methods were made according to the DerSimonian and Laird [9] method. Publication bias was evaluated based on the funnel diagram, while testing was performed using the Egger test [10]. The obtained results of the analysis were tested at statistical significance level (alpha level) of 0.05. Data analysis was performed in R programming language and environment using "metafor" [11] and "meta" [12] packages for R.

Table 1

Outline of extracted data from individual studies for meta-analysis

Individual studies	Started analysis		Age (years)		BMI – Baseline (kg/m^2)		MWG (kg)	
	PAPW (n)	SPW (n)	PAPW (mean ± SD)	SPW (mean ± SD)	PAPW (mean ± SD)	SPW (mean ± SD)	PAPW (mean ± SD)	SPW (mean ± SD)
Barakat et al. [9]	138	152	31.4 ± 3.2	31.7 ± 4.5	24.0 ± 4.3	23.6 ± 4.0	11.9±3.7	13.7±4.1
Barakat et al. [10]	40	43	32.0 ± 4.0	31.0 ± 3.0			12.5±3.2	13.8±3.1
Barakat et al. [11]	382	383	31.6 ± 4.2	31.8 ± 4.5	23.6 ± 3.8	23.4 ± 4.2	12.1±3.7	12.9±4.5
Barakat et al. [12]	227	202	31.8 ± 4.6	31.3 ± 3.4	23.4 ± 3.7	23.7 ± 3.8	12.3±3.6	13.3±4.1
Barakat et al. [13]	33	32	33.1 ± 3.0	33.8 ± 2.0	24.1 ± 3.9	24.4 ± 6.0	10.9±2.7	11.8±4.8
Perales et al. [14]	90	77	31.1 ± 3.4	31.7 ± 3.9	23.5 ± 3.5	24.3 ± 4.4	11.9±4.2	13.9±10.2
Perales et al. [15]	52	54	31.0 ± 3.7	33.4 ± 4.0	27.9 ± 3.1	28.0 ± 2.6		
Perales et al. [16]	38	25	32.0 ± 3.5	31.8 ± 2.8	23.4 ± 4.2	23.1 ± 3.1	11.4±3.6	15.4±4.4
Perales et al. [17]	120	121	31.0 ± 4.0	31.0 ± 4.0				
Price et al. [18]	31	31	30.5 ± 5.0	27.6 ± 7.3	26.6 ± 3.1	27.8 ± 5.4	12.4±3.9	10.5±4.9

BMI – body mass index; PAPW – physically active pregnant women; SPW – sedentary pregnant women; MWG – maternal weight gain; SD – standard deviation.

Results

Out of total number of female participants from selected individual studies (n = 3,747), 69% of pregnant women were randomized, of whom 88% (n = 2,271) began the analysis and 80% (n = 2,067) had completed the analysis. A total of 92% of physically active and 90% of sedentary pregnant women completed the analysis. Weighted values indicated the similar age of all pregnant women who started the analysis (PAPW 31.6 ± 4.0 years; SPW: 31.6 ± 4.2 years).

Analysis of the extracted data describing the manner of exercise in individual studies highlighted the following common values. PAPW exercised about 3 times a week for 35–60 minutes. The training phases were described in eight studies: the introductory phase or warm-up lasted 5–12 minutes, the main part of the workout or the development phase of endurance and strength lasted 20–30 minutes, while the last phase of exercise or relaxation lasted 5–12 minutes. The main part of the workout included aerobic exercise in the form of various types of aerobics (dance or step). Exercise intensity was monitored by heart rate control with the help of pulsometer (55–60 beats per minute) and a Borg scale for self-assessment (10–14 or "medium difficult"). Table 2 shows the data from individual studies describing characteristics of exercise [13–22].

Out of total of 10 studies, the obtained weighted values showed that all pregnant women had optimal BMI values in the first measurement (PAPW: 23.9 ± 3.8 kg/m^2; SPW: 24.0 ± 4.1 kg/m^2), with no statistically significant difference between PAPW and SPW ($p = 0.650$). However, there was a statistically significant difference between the groups ($p < 0.001$) after the second measurement. Out of total of 10 studies, the weighted values of the extracted data indicated that physically active pregnant women gained slightly less weight during pregnancy (PAPW: 12 ± 3.7 kg/m^2; SPW: 13.2 ± 5.1 kg/m^2).

Selected individual studies did not have a high risk of bias (Figure 2), so they were not excluded from further analysis. Accordingly, a total of 10 individual studies were included in the meta-analysis.

Standardized mean of the incidence of vaginal birth was calculated from 10 individual studies, accounting for 3.3% of the total number of scientific studies reviewed (n = 306). The

Table 2

Description of continuous aerobic physical exercise in individual studies by frequency, duration, intensity of exercise and workout stages

Individual studies	Duration of aerobic exercise		Intensity of aerobic exercise		Duration of training phases in minutes (min–max)			
	number of training sessions (weekly)	training time (minutes)	heart rate (%)	Borg scale (9–20)	warm up	aerobic endurance	power	relaxation
Barakat et al. [13]	3	40–45	< 70		7–8	25		7–8
Barakat et al. [14]	3	35–45	< 70		7	25		7–8
Barakat et al. [15]	3	50–55	< 70	12–14	10–12	25–30		10–12
Barakat et al. [16]	3	55–60	< 70	12–14				
Barakat et al. [17]	3	55–60	55–60	10–12	10–12	20–25		10–12
Perales et al. [18]	3	55–60	55–60		5–8	25	20	5–8
Perales et al. [19]	3	55–60	55–60	10–12	5	20	10	5–10
Perales et al. [20]	3	55–60	55–60		7–8	25–30	10	7–8
Perales et al. [21]	3	55–60	55–60		5–7	25–30		5–10
Price et al. [22]	4	45–60		12–14				5–10

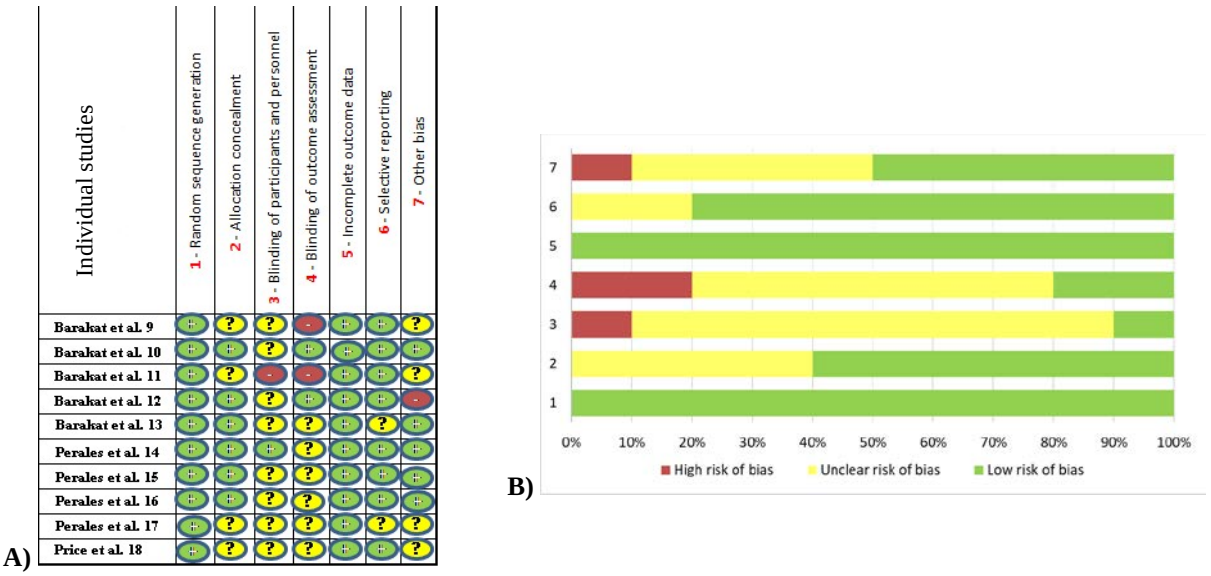

Fig. 2 – Assessment of risk of bias: A) Summary of risk of bias for each trial; B) Risk of bias graph about each risk of bias item presented as percentages across all included studies.

results of the meta-analysis showed that the incidence of vaginal birth was higher in pregnant women who were physically active during the second and third trimesters (PAPW: 67.4%; SPW: 60.5%) (Figure 3).

The combined RR value from the fixed effects model was 1.11 [95% confidence interval (CI) 1.04; 1.18]. Relative risk was statistically significantly different from unit ($p = 0.002$). The combined value of the results of individual studies showed that physically active pregnant women had a higher incidence of vaginal birth than sedentary pregnant women. The data were not statistically significantly heterogeneous ($p = 0.243$; I^2=22%; $\tau^2 = 0.003$), as can be seen in the L'Abbe plot. No publication bias was detected, as can be seen on the funnel graph that is symmetrical (0.69) (Figure 4).

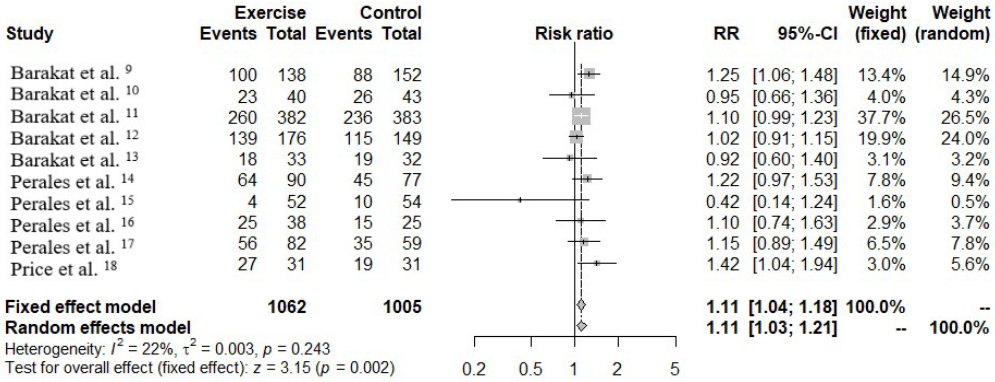

Fig. 3 – Outline of individual results and combined value of relative risk (RR) of vaginal birth efficiency. Data are presented as number in the experimental group (physically active pregnant women) vs. number in the control group (sedentary pregnant women).

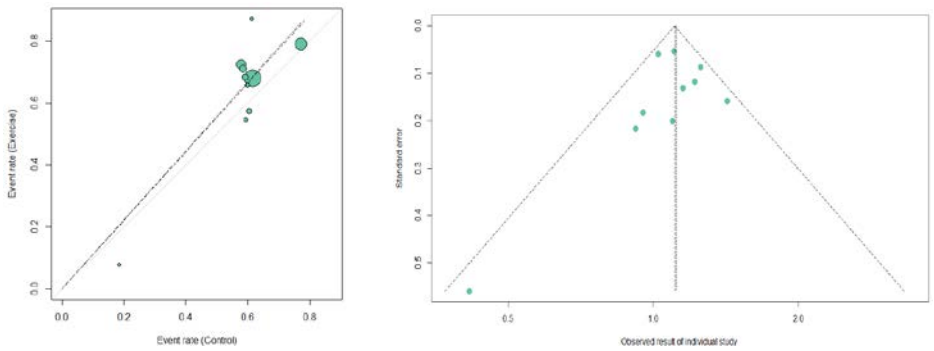

Fig. 4 – Demonstration of heterogeneity (left) and publication bias (right) of relative risk efficiency of vaginal delivery.

Discussion

The positive effects of daily physical activity during pregnancy are being mentioned more often nowadays. Continuous aerobic physical exercise is recommended if the pregnant woman is healthy [23, 24], whereas increased physical activity is not recommended if there is a medical or obstetric problem [4, 6]. Although more and more authors are addressing this problem today, the impact of different exercise intensities remains to be fully investigated [25]. It also raises the question of whether sufficient information is provided to pregnant women about the possible negative and positive effects of proper exercise during pregnancy [26–28]. Physically active pregnant women have been shown to have a better quality of life [2] less likely to suffer from common pregnancy problems [29], and less likely to suffer from certain pregnancy diseases [3].

Obesity is thought to be increasing among pregnant women. Being overweight has an effect on metabolism, and therefore can have an effect on pregnancy outcome [30]. Obese pregnant women are more likely to suffer from gestational diabetes mellitus. Also, obese pregnant women are more likely to give birth prematurely or by cesarean section [3]. Starting BMI values dictate how many kilograms a pregnant woman needs to gain in order to maintain a healthy pregnancy [31]. Therefore, it is assumed that the total body weight a pregnant woman should gain (10–12 kg) largely depends on the initial morphological values. In this meta-analysis, pregnant women who started the analysis had similar BMI values in the first measurement before intervention (PAPW: 23.9 ± 3.8 kg/m^2; SPW: 24.0 ± 4.1 kg/m^2). It is expected that physically active pregnant women will ingest more nutrients since increased physical activity and pregnancy development lead to increased caloric consumption in the body. The data were statistically significant ($p < 0.001$) even though physically active pregnant women gained about 1 kg less than sedentary pregnant women during pregnancy.

It is believed that age can also have an impact on the positive pregnancy outcome in addition to body weight [32]. In this study, all pregnant women were of similar age (PAPW: 31.6 ± 4.0 years; SPW: 31.6 ± 4.2 years). The homogeneity of the study groups was observed, which had a positive effect on the reached conclusions regarding the described continuous aerobic physical exercise during the second and third trimesters of pregnancy.

In meta-analysis where pregnant women underwent a change in diet and increased physical activity, the results of the study showed a positive effect of the intervention on weight regulation, as well as a decrease in the incidence of birth by cesarean section [18]. Some studies have come up with reports that physically active pregnant women had an easier birth than sedentary ones, and that the most common birth was "natural" or vaginal [9, 33]. Water is thought to have a beneficial effect, so swimming and exercising in water can have a positive effect during childbirth [34]. It is often stated that pregnant women who exercised during pregnancy had a more frequent vaginal delivery (PAPW: 73.6%; SPW: 67.5%; RR = 1.09, 95% CI = 1.04–1.15), as well as less frequent cesarean delivery [12]. In this meta-analytic study, the result confirmed the positive impact of daily exercise, that is, stated that physically active pregnant women had a more frequent vaginal delivery than sedentary pregnant women (67.4% vs. 60.5%; RR = 1.11, 95% CI = 1.04–1.18).

Full term birth, especially “natural” or vaginal, can certainly be considered a positive pregnancy outcome. Therefore, it is necessary to continue to monitor and investigate the various possible factors that could affect mother’s health and the birth of a healthy newborn.

Conclusion

The result of this meta-analysis, showed that physically active pregnant women had a higher frequency of vaginal birth than sedentary ones. On the other words, in previously physically inactive or sedentary pregnant women who were physically active during the second and third trimesters (different types of aerobics, 3 times a week for 35–60 minutes), no negative impact of continuous aerobic physical exercise was observed.

REFERENCES

1. *Seneviratne SN, Jiang Y, Derraik JGB, McCowan LME, Parry GK, Biggs JB,* et al. Effects of antenatal exercise in overweight and obese pregnant women on maternal and perinatal outcomes: a randomised controlled trial. BJOG: 2016 Mar; 123(4): 588–97.
2. *Dotlić JR.* Study of determinants of Health status and Quality of Life in Pregnancy; (Doctoral dissertation). Belgrade: University of Belgrade, Medical Faculty 2013. (Serbian)
3. *Artal R, O'toole M.* Guidelines of the American College of Obstetricians and Gynecologists for exercise during pregnancy and the postpartum period. Br J Sports Med 2003; 37(1): 6–12.
4. ACOG Committee Opinion No. 650: Physical activity and exercise during pregnancy and the postpartum period. Obstet Gynecol 2015; 126(6) e135–42.
5. *Moher D, Liberati A, Tetzlaff J, Altman DG.* Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. BMJ 2009; 339: b2535.
6. *ACOG* Committee on Obstetric Practice. ACOG Committee opinion. Number 267; January 2002: exercise during pregnancy and the postpartum period. Obstet Gynecol 2002; 99(1): 171–3.
7. *Wolfe LA, Davies GA.* Canadian guidelines for exercise in pregnancy. Clin Obstet Gynecol 2003; 46(2): 488–95.
8. *Magro-Malosso ER, Saccone G, Di Tommaso M, Roman A, Berghella V.* Exercise during pregnancy and risk of gestational hypertensive disorders: a systematic review and meta-analysis. Acta Obstet Gynecol Scand 2017; 96(8): 921–31.
9. *DerSimonian R, Laird N.* Meta-analysis in clinical trials. Control Clin Trials 1986; 7(3): 177–88.
10. *Egger M, Smith GD, Schneider M, Minder C.* Bias in meta-analysis detected by a simple, graphical test. BMJ 1997; 315(7109): 629–34.
11. *Viechtbauer W.* Conducting meta-analyses in R with the metafor package. JSS J Stat Software 2010; 36(3): 1–48.

12. *Schwarzer G, Carpenter JR, Rücker G.* Meta-Analysis with R (Use-R!). Switzerland, Cham: Springer International Publishing; 2015.
13. *Barakat R, Cordero Y, Coteron J, Luaces M, Montejo R.* Exercise during pregnancy improves maternal glucose screen at 24–28 weeks: a randomised controlled trial. Br J Sports Med 2012; 46(9): 656–61.
14. *Barakat R, Pelaez M, Lopez C, Montejo R, Coteron J.* Exercise during pregnancy reduces the rate of cesarean and instrumental deliveries: results of a randomized controlled trial. J Matern Fetal Neonatal Med 2012; 25(11): 2372–6.
15. *Barakat R, Pelaez M, Cordero Y, Perales M, Lopez C, Coteron J,* et al. Exercise during pregnancy protects against hypertension and macrosomia: randomized clinical trial. Am J Obstet Gynecol 2016; 214(5): 649.e1–8.
16. *Barakat R, Franco E, Perales M, López C, Mottola MF.* Exercise during pregnancy is associated with a shorter duration of labor. A randomized clinical trial. Eur J Obstet Gynecol Reprod Biol 2018; 224: 33–40.
17. *Barakat R, Vargas M, Brik M, Fernandez I, Gil J, Coteron J,* et al. Does exercise during pregnancy affect placental weight?: a randomized clinical trial. Eval Health Prof 2018; 41(3): 400–14.
18. *Perales M, Refoyo I, Coteron J, Bacchi M, Barakat R.* Exercise during pregnancy attenuates prenatal depression: a randomized controlled trial. Eval Health Prof 2015; 38(1): 59–72.
19. *Perales M, Cordero Y, Vargas M, Lucia A, Barakat R.* Exercise and depression in overweight and obese pregnant women: a randomised controlled trial. Arch Med Deporte 2015;32(3): 70–7.
20. *Perales M, Mateos S, Vargas M, Sanz I, Lucia A, Barakat R.* Fetal and maternal heart rate responses to exercise in pregnant women. A randomized Controlled Trial. Arch Med Deporte 2015; 32(6): 361–7.
21. *Perales M, Santos-Lozano A, Sanchis-Gomar F, Luaces M, Pareja-Galeano H, Garatachea N,* et al. Maternal Cardiac Adaptations to a Physical Exercise Program during Pregnancy. Med Sci Sports Exerc 2016; 48(5): 896–906.
22. *Price BB, Amini SB, Kappeler K.* Exercise in pregnancy: effect on fitness and obstetric outcomes-a randomized trial. Med Sci Sports Exerc 2012; 44(12): 2263–9.
23. *Bubnjević K, Ugarković D.* Aerobic physical exercise in the third trimester in pregnant woman with Hashimoto's thyroiditis: A case report. Vojnosanit Pregl 2017; 74(7): 687–92. (Serbian)
24. *Sanabria-Martínez G, Poyatos-León R, Notario-Pacheco B, Álvarez-Bueno C, Cavero-Redondo I, Martinez-Vizcaino V.* Effects of physical exercise during pregnancy on mothers' and neonates' health: a protocol for an umbrella review of systematic reviews and meta-analysis of randomised controlled trials. BMJ Open 2019; 9(9): e030162.
25. *Alvis ML, Morris CE, Garrard TL, Hughes AG, Hunt L, Koester MM,* et al. Educational Brochures Influence Beliefs and Knowledge Regarding Exercise during Pregnancy: A Pilot Study. Int J Exerc Sci 2019; 12(3): 581–9.
26. *McGee LD, Cignetti CA, Sutton A, Harper L, Dubose C, Gould S.* Exercise during pregnancy: Obstetricians' beliefs and recommendations compared to American congress of obstetricians and gynecologists' 2015 guidelines. Cureus 2018; 10(8): e3204.
27. *Hayman M, Reaburn P, Alley S, Cannon S, Short C.* What exercise advice are women receiving from their healthcare practitioners during pregnancy? Women Birth 2020; 33(4): e357–62.
28. *Pavelić D.* Endangered pregnancy. Sarajevo (BIH): "Svjetlost"; 1991. (Bosnian)
29. *Nelson SM, Matthews P, Poston L.* Maternal metabolism and obesity: modifiable determinants of pregnancy outcome. Hum Reprod Update 2010; 16(3): 255–75.
30. *Research Council (US) Committee to Reexamine IOM Pregnancy Weight Guidelines. Rasmussen KM, Yaktine AL.* Weight Gain During Pregnancy: Reexamining the Guidelines. Washington (DC): National Academies Press (US); 2009.
31. *Plećaš D, Stanimirović B, Stanković A, Vasiljević M, Šulović V.* Gynecology and Obstetrics. Belgrade: University of Belgrade, Faculty of Medicine; 2006. (Serbian)
32. *International Weight Management in Pregnancy (i-WIP) Collaborative Group.* Effect of diet and physical activity based interventions in pregnancy on gestational weight gain and pregnancy outcomes: meta-analysis of individual participant data from randomised trials. BMJ 2017; 358: j3991.
33. *Rodríguez-Blanque R, Sánchez-García JC, Sánchez-López AM, Aguilar-Cordero MJ.* Physical activity during pregnancy and its influence on delivery time: a randomized clinical trial. PeerJ 2019; 7: e6370.
34. *Di Mascio D, Magro-Malosso ER, Saccone G, Marhefka GD, Berghella V.* Exercise during pregnancy in normal-weight women and risk of preterm birth: a systematic review and meta-analysis of randomized controlled trials. Am J Obstet Gynecol 2016; 215(5): 561–71.

Received on March 11, 2020
Revised on August 5, 2020
Accepted on August 5, 2020
Online First August, 2020