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The Impact of Physical Activity during Pregnancy on Weight Gain and Delivery Outcomes

El impacto de la actividad física durante el embarazo en el aumento de peso y los resultados del parto

Marta Gimunová[1], Martin Zvonař[2], Jan Švancara[3,4] and Lubomír Kukla[3]

1 Masaryk University, Brno (Czech Republic).
2 Faculty of Sports Studies, Masaryk University, Brno, (Czech Republic).
3 Research Centre for Toxic Compounds in the Environment, Faculty of Science, Masaryk University, Brno, (Czech Republic).
4 Institute of Biostatistics and Analyses, Faculty of Medicine, Masaryk University, Brno, (Czech Republic).

Abstract: Background: Regular physical activity during pregnancy has been previously associated with preventing delivery complications; however, the current evidence is inconsistent. Therefore, this study analyzes how physical activity affects pre-term birth, Apgar score in the first minute, birth weight, induction of labor, cesarean section, use of analgesia and anesthesia, duration of the second stage of labor and pregnancy weight gain.
Methods: The study population, selected from European Longitudinal Study of Pregnancy and Childhood consisted of 2,921 women. Physical activity data were obtained via questionnaires self-administered during the second trimester, while data associated with delivery were obtained via questionnaires administrated by health care professionals. A univariate analysis was used to evaluate the influence of physical activity on delivery complications. The effect of physical activity on weight gain during pregnancy and the second stage of labor duration were tested using a Mann-Whitney test and a one-sample t-test, respectively.
Results: Analyzed delivery outcomes were found to be affected by maternal age, pre-pregnancy body mass and the number of previous live births. Neither particular physical activities nor their volume were found to influence delivery complications or the duration of the second stage of labor. However, physical activities such as aerobics, keep fit exercise, swimming, weight training and cycling were found to affect weight gain during pregnancy.
Conclusions: Results of this study confirms that current physical activity recommendations for healthy pregnant women are linked to no negative effects on either the delivery or the unborn baby.
Keywords: pregnancy, physical activity, delivery, weight gain, duration of labor, ELSPAC
Resumen: Introducción: La actividad física regular durante el embarazo se ha asociado previamente con la prevención de complicaciones del parto; sin embargo, la evidencia actual es inconsistente. Por lo tanto, este estudio analiza cómo la actividad física afecta el nacimiento prematuro, puntaje de Apgar en el primer minuto, peso al nacer, inducción del parto, cesárea, uso de analgesia y anestesia, duración de la segunda etapa del parto y aumento de peso durante el embarazo.
Métodos: Participaron en el estudio 2.921 mujeres, seleccionadas del Estudio Longitudinal Europeo de Embarazo e Infancia (ELSPAC), que se inició en la República Checa a principios de la década de 1990. Los datos de actividad física se obtuvieron a través de cuestionarios autoadministrados durante el segundo trimestre del embarazo, mientras que los datos asociados con el parto se obtuvieron a través de cuestionarios administrados por profesionales de la salud. Se utilizó un análisis univariado para evaluar la influencia de la actividad física en las complicaciones del parto. El efecto de la actividad física sobre el aumento de peso durante el embarazo y la duración de la segunda etapa del trabajo de parto se analizaron mediante una prueba de Mann-Whitney y una prueba t de una muestra, respectivamente.
Resultados: Los resultados del parto analizados se encontraron afectados por la edad materna, la masa corporal previa al embarazo y el número de hijos nacidos vivos previos. Ni las actividades físicas particulares ni su volumen influyeron en las complicaciones del parto ni en la duración de la segunda etapa del parto. Sin embargo, se descubrió que las actividades físicas como aeróbicos, keep fit ejercicio, nadar, entrenar con pesas y andar en bicicleta afectan el aumento de peso durante el embarazo. Además, el 34.9% de las mujeres embarazadas analizadas no alcanzaron la actividad física mínima recomendada.
Conclusiones: La actividad física entre las mujeres embarazadas se ha establecido como beneficiosa; este estudio también confirma que las recomendaciones actuales de actividad física para mujeres embarazadas sanas no tienen efectos negativos en el parto ni en el bebé nonato.
Palabras clave: embarazo, actividad física, parto, aumento de peso, duración del parto, ELSPAC.

Background

Regular physical activity (PA) is beneficial for pregnant women in the same way as for non-pregnant subjects improving physiological, metabolic and psychological parameters (Melzer et al., 2010a; Vespalec, Pavlík, Zvonař, & Zeman, 2016). Furthermore, regular PA during pregnancy has been associated with prevention from complications such as preterm birth, gestational diabetes, pre-eclampsia, low back pain and excessive weight gain (Hegaard et al., 2011). In addition previous studies show that regular PA and the consequent reduction in weight gain during pregnancy result in reduced risk of caesarean section explained partly by the correlation of caesarean delivery with increased BMI (Domenjoz

Dirección para correspondencia [Correspodence address]: Marta Gimunová. Masaryk University, Brno (Czech Republic). E-mail: gimunova@fsps.muni.cz

et al., 2014) and in reduced risk of perineal tear as a higher incidence of perineal tear has been associated with maternal excessive pregnancy weight gain or obesity and consequent fetal macrosomia (Kobayashi& Lim, 2015). Besides, a shorter labor was found in female athletes and recreational exercisers compared to inactive women (Clapp, 1990; Melzer et al., 2010). Better fitness may help especially during the second stage of labor, when pushing efforts are applied (Melzer et al., 2010). However, some of the previous studies have shown no significant difference in labor length when recreational exercisers, athletes and inactive women were compared (Penttinen&Erkkola, 1997; Barakat et al., 2009). The evidence on the effect of PA during pregnancy on instrumental delivery, epidural anesthesia and induction of labor is also inconsistent (Liu et al., 2011; Domenjoz et al., 2014).

Current recommendation of American College of Obstetricians and Gynecologists in the absence of medical or obstetric contraindication advises at least 20-30 minutes of moderate exercise a day on most, if not all, days of the week (ACOG, 2015). According to Physical Activity Guidelines for Americans by Office of Disease Prevention and Health Promotion (ODPHP, 2008) even vigorous-intensity level of PA is recommendable for healthy pregnant women if they were habitually vigorously active before pregnancy (ODPHP, 2008). Still, most women tend to reduce their PA during pregnancy (Hegaard et al., 2011; Liu et al., 2011). Up to 80 % of women intend to stay active during pregnancy; however, only 29 % achieve at least 150 min of PA per week (Mudd et al., 2009). Major reasons why pregnant women avoid PA are the fear of harming themselves or their unborn baby (Hegaard et al., 2010; Mudd et al., 2009; Connolly, Feltz&Pivarnik, 2014) as the balance and foot loading are altered during pregnancy (Gimunová et al., 2015) and a general lack of energy and fatigue (Hegaard et al., 2010).

Using the above recommendations as a benchmark, this study based on a large cohort (ELSPAC, launched in 1991 and 1992) aim to analyze the impact of PA on pregnancy weight gain and delivery complications and outcomes. The objectives of this study were to analyzed the effect of different types of PAs on (i) pre-term birth, Apgar score in the first minute, low birth weight, induction of labor, cesarean section, use of analgesia or anesthesia; (ii)duration of second stage of labor; and (iii) weight gain during pregnancy.

Methods

Study population data were obtained from European Longitudinal Study of Pregnancy and Childhood (ELSPAC) initiated in 1980s by the World Health Organization. In the Czech Republic the ELSPAC study has followed up 5,738 children in Brno and 1,851 children in Znojmo, both groups born in 1991 or 1992. ELSPAC, Czech Republic, data collection of 7,589 subjects enables investigating environmental, biological, social, economic and psychological influence on the health of children and adolescents. First data were obtained via questionnaires from their parents before the birth of followed up children. The study itself is described in the study of Pilar et al. (2016) and on the study website (http://www.elspac.cz/index-en.php).

All pregnant women living in Brno and Znojmo and expecting the delivery date between 1 March 1991 and 30 June 1992 were asked to take part in the study. From 5,354 women who agreed with participation in the study before the delivery we excluded 2,433 who did not respond to the questionnaires before giving the birth or had missing answers about PA. The final sample consisted of 2,921 women, 1,470 of them were nulliparous. Their mean age, height, pre-pregnancy body mass and weight gain during pregnancy are shown inTable 1.

Table 1. Characteristics of study participants.

	mean	**SD**
Age at delivery (years)	25.7	4.9
Hight (cm)	166.6	6.0
Pre-pregnancy body mass (kg)	60.8	9.7
Pregnancyweightgain (kg)	12.4	4.6

Data of women's weight before pregnancy and PA during pregnancy were collected via self-administrated questionnaires during the second trimester. Women were asked to answer in which kind of PA there were participating nowadays. They could choose from jogging, aerobics, ante-natal exercise, keep fit exercise, yoga, volleyball, handball, tennis, badminton, swimming, brisk walking, weight training, cycling or indicate other PA. In their answer they also indicated for each type of PA how many hours per week they were participating in the particular PA: not at all, less than 1 hour per week, 2-6 hours per week, or more than 7 hours per week.

Data about the weight gain during pregnancy and description of delivery were obtained via questionnaires administrated by health care professionals. Data about deliverywere reduced into pre-term birth (before 36 gestational week), induction of labor, cesarean section, Apgar score in the first minute (7 and less), low birth weight (2,500 g and less), duration of second stage of labor and the use of analgesia or anesthesia. Due to an increased application of episiotomy (up to 75 %), episiotomy and perineal tear were not included in the following analysis.

An informed written consent was obtained from all participants. Before data collection Scientific Council of Pediatric Research Institute in Brno, Czech Republic, approved ethical standards of the study. In 2002, the study was moved to Masaryk University and approved by its Ethical Council.

Statistical analysis

A univariate analysis was used to evaluate the relationship of PA during pregnancy and pre-term birth, induction of labor, cesarean section, low Apgar score in the first minute, low birth weight and the use of analgesia or anesthesia. The resulting risk factor is expressed by the odds ratio and the 95 % confidence interval, significance was tested using the Wald test. The effect of PA on weight gain during pregnancy was tested using the Mann-Whitney test. A one-sample t-test was used to test the effect of PA on the duration of the second stage of labor. The analysis was conducted using SPSS-22 (IBM, USA), and statistical significance was set at $p \leq 0.05$.

Results

The statistical analyses revealed no adverse effect of PA on pregnancy weight gain or delivery. Descriptive statistics of PA engagement and delivery description are show in Tables 2 and 3. Table 4 shows the effect of particular PAs on weight gain and Table 5 reveals factors affecting the odds of pre-term birth, low Apgar score in the first minute, low birth weight, induction of labor, cesarean section and use of analgesia or anesthesia.

The most commonly reported physical activities during the second trimester of pregnancy were brisk walking (< 1 h/week: 13.8 %, > 2 h/week: 26.4 %), ante-natal exercise (< 1 h/week: 14.4 %, > 2 h/week: 12.2 %) and swimming (< 1 h/week: 10.2 %, > 2 h/week: 3.8 %). No engagement in PA was reported by 27.1 % of this study population, 7.8 % reported less than 2 h per week, 41.1 % reported over 2 h and 8.2 % reported over 7 h per week. In 15.8 % of all cases the total volume of PA is unknown. A summary of reported PA engagement is shown in Table 2.

Table 2. Types of PA and self-reported engagement in them.

Activity	≥ 7 h/week	2 - 6 h/week	< 1 h/week	never	missing
Jogging	10 (0.3 %)	3 (0.1 %)	50 (1.7 %)	2,650 (90.7 %)	208 (7.1 %)
Aerobics	9 (0.3 %)	35 (1.2 %)	102 (3.5 %)	2,569 (87.9 %)	206 (7.1 %)
Ante-natal exercise	27 (0.9 %)	357 (12.2 %)	421 (14.4 %)	1,917 (65.6 %)	199 (6.8 %)
Keep fit exercise	10 (0.3 %)	88 (3.0 %)	195 (6.7 %)	2,422 (82.9 %)	206 (7.1 %)
Yoga	12 (0.4 %)	25 (0.9 %)	57 (2.0 %)	2,619 (89.7 %)	208 (7.1 %)
Handball, volleyball	7 (0.2 %)	3 (0.1 %)	13 (0.4 %)	2,690 (92.1 %)	208 (7.1 %)
Tennis, badminton	10 (0.3 %)	12 (0.4 %)	48 (1.6 %)	2,643 (90.5 %)	208 (7.1 %)
Swimming	17 (0.6 %)	111 (3.8 %)	299 (10.2 %)	2,283 (78.2 %)	211 (7.2 %)
Brisk walking	266 (9.1 %)	772 (26.4 %)	403 (13.8 %)	1,327 (45.4 %)	153 (5.2 %)
Weight training	13 (0.4 %)	32 (1.1 %)	99 (3.4 %)	2,571 (88.0 %)	206 (7.1 %)
Cycling	15 (0.5 %)	61 (2.1 %)	145 (5.0 %)	2,488 (85.2 %)	212 (7.3 %)
Other exercise	70 (2.4 %)	105 (3.6 %)	47 (1.6 %)	2,296 (78.6 %)	403 (13.8 %)

Of the 2,921 pregnancies and consequent deliveries, delivery complications were observed in 807 cases (27.6 %). These included pre-term birth, induction of labor, cesarean section, low Apgar score in the first minute, low birth weight or use of analgesia and anesthesia. The most commonly reported type of labor was spontaneous vaginal delivery (84.1 %). Data are shown in Table 3.

Table 3. Delivery description.

		N (%)
Fertility treatment		96 (3.3 %)
Gestational age	≤ 36 weeks	62 (2.1 %)
	37 – 42 weeks	2,843 (97.3 %)
	> 42 weeks	16 (0.5 %)
Low birth weight (< 2,500 g)		102 (3.5 %)
APGAR score 1 min	10 – 8	2,617 (89.6 %)
	7 – 5	264 (9.0 %)
	4 – 0	40 (1.4 %)
APGAR score 5 min	10 – 8	2,815 (96.4 %)
	7 – 5	96 (3.3 %)
	4 – 0	10 (0.3 %)
Delivery	Spontaneous vaginal labor	2,457 (84.1 %)
	Induced vaginal labor	203 (6.9 %)
	Primary indicated cesarean section	132 (4.5 %)
	Emergency cesarean section	115 (3.9 %)
	Other	2 (0.1 %)
Analgesia/ anesthesia		374 (12.8 %)
Episiotomy		2,172 (74.4 %)
Perineal tear	first degree	109 (3.7 %)
	second degree	19 (0.7 %)
	third degree	31 (1.1 %)
	none	2,514 (86.1 %)
	other	235 (8.0 %)
	missing	8 (0.3 %)

Duration of the second stage of labor

The duration of the second stage of labor, tested by one-sample t-test, was not affected by any PA during the second trimester.

Weight gain during pregnancy

PAs which were found to affect weight gain during pregnancy included aerobics, keep fit exercise, swimming, weight training and cycling. Statistical analysis results are shown in Table 5. Brisk walking and ante-natal exercise, i.e. the most commonly reported PA types alongside swimming, show no effect on weight gain during pregnancy.

Table 4. Effect of PA on weight gain [kg] during pregnancy.

		Mean (95 % CI)	p
Jogging	No	11.5 (11.4; 11.7)	0.113
	Yes	10.7 (9.6; 11.7)	
Aerobics	No	11.5 (11.4; 11.7)	**0.019**
	Yes	10.9 (10.2; 11.6)	
Ante-natal exercise	No	11.6 (11.4; 11.7)	0.247
	Yes	11.4 (11.1; 11.6)	
Keep fit exercise	No	11.6 (11.4; 11.7)	**<0.001**
	Yes	10.8 (10.3; 11.2)	
Yoga	No	11.5 (11.3; 11.7)	0.569
	Yes	11.6 (10.7; 12.4)	
Handball, volleyball	No	11.5 (11.3; 11.7)	0.669
	Yes	11.8 (9.7; 13.8)	
Tennis, badminton	No	11.5 (11.4; 11.7)	0.337
	Yes	10.8 (9.7; 11.8)	
Swimming	No	11.6 (11.4; 11.7)	**0.048**
	Yes	11.2 (10.8; 11.6)	
Brisk walking	No	11.6 (11.3; 11.8)	0.113
	Yes	11.4 (11.2; 11.6)	
Weight training	No	11.5 (11.4; 11.7)	**0.016**
	Yes	11.0 (10.2; 11.7)	
Cycling	No	11.5 (11.4; 11.7)	**0.015**
	Yes	10.9 (10.2; 11.5)	
Other	No	11.5 (11.4; 11.7)	0.136
	Yes	11.2 (10.7; 11.8)	

Risk factors for delivery complications

Univariate analysis results (Table 4) show risk factors expressed by odds ratios and 95 % confidence intervals for the following delivery complications: pre-term birth, induction of labor, cesarean section, low Apgar score in the first minute, low birth weight, and the use of analgesia and anesthesia. Factors affecting delivery complications and outcomes found in this study were maternal age, overweight and the number of previous births. None of the analyzed PAs or the total volume of PA show any effect on delivery complications.

Table 5. Risk factor of delivery complication (univariate analysis). * Reference category.

	OR (95 % CI)	p
Mother's age (years)	1.020 (1.003; 1.036)	**0.021**
Underweight (<18.5)	1.125 (0.826; 1.533)	0.455
Normal weight (18.5-24.9)*		
Overweight (30.0-39.9)	1.450 (1.119; 1.879)	**0.005**
Obesity (40+)	1.563 (0.897; 2.722)	0.115
Second child and more	0.631 (0.535; 0.743)	**< 0.001**

	OR (95 % CI)	p
Fertility treatment	0.908 (0.538; 1.532)	0.719
Jogging	1.340 (0.788; 2.279)	0.279
Aerobics	0.768 (0.516; 1.142)	0.192
Ante-natal exercise	0.872 (0.723; 1.052)	0.153
Keep fit exercise	0.922 (0.699; 1.214)	0.562
Yoga	1.071 (0.680; 1.688)	0.767
Handball, volleyball	0.559 (0.190; 1.648)	0.292
Tennis, badminton	0.919 (0.534; 1.582)	0.761
Swimming	0.910 (0.719; 1.152)	0.435
Brisk walking	0.870 (0.736; 1.028)	0.102
Weight training	0.913 (0.622; 1.341)	0.644
Cycling	1.290 (0.959; 1.734)	0.092
Other	1.204 (0.892; 1.625)	0.225
Do no exercise	1.026 (0.841; 1.251)	0.803
Do exercise less than 2 hours per week*	0.767 (0.550; 1.069)	0.117
Do exercise more than 7 hours per week	1.064 (0.785; 1.442)	0.690

Discussion

The purpose of this study was to analyze the impact of PA during pregnancy on the duration of the second stage of labor, weight gain during pregnancy and delivery complications and outcomes. Delivery complications, which can be potentially life-threatening for the newborn baby (Ghodsi&Asltoghiri, 2012) were found not to be affected by any kind or volume of PA in this study. However, this study found that – as previously observed by Straube et al. (2010) –biological factors including maternal age and overweightexerted a negative effect on preterm birth, induction of labor, cesarean section, Apgar score in the first minute, low birth weight, use of analgesia or anesthesia. On the other hand, the number of previous births (one or more) decreased the risk of delivery complications.

PA during pregnancy was previously reported to decrease or not affect the duration of the second stage of labor. In contrast to a previous study by Melzer et al. (2010b) who found the mean duration of the second stage of labor significantly shorter in women participating in PA, this study found that the duration of the second stage of labor was not affected (in accordance with Barakat et al. (2009) and Penttinen&Erkkola (1997)).

Weight gain during pregnancy has been associated with the health of both the mother and her offspring. Exposure to over-nutrition *in utero* as well as subsequent environmental exposure to the maternal obesogenic lifestyle has been observed to result in an increased risk of offspring obesity and consequent health-related problems (Adamo, Ferraro& Brett, 2012; Zvonar et al., 2016; Bebcakova et al., 2015). While in accordance with a previous study (Merkx et al., 2015), the promotion of PA has been recommended as a prevention of excessive weight gain during pregnancy and its implication for the health of the offspring, up to 35 % of pregnant women from our study population did not achieve the recommended amount of PA per week. While some cases may be attributed to pregnancy complications, this number is still considerably high and reflects the 31 % of world population which is not reaching the minimum recommendation for PA (Kohl et al., 2012).

The major strength of this study is the study population size. Data used in this study are part of ELSPAC (Czech Republic). From this study population consisting of 2,921 pregnant women, 49.3 % met the current recommendation and achieved at least 120 min of PA per week. The most commonly reported types of PA were brisk walking, ante-natal exercise and swimming. The same leisure-time activities were found to be most popular during pregnancy also in the Avon longitudinal study of parents and children (UK) launched in the same year as this study (Liu et al., 2011). Compared to nowadays an overall lower maternal age, number of caesarean sections, pregnancies induced by fertility treatment and an increased application of episiotomy were observed in this study cohort, which reflected the Czech population at the time of the study (Stepanikova, Kukla&Svancara 2016). All participants reported their current PA habits including the particular type and volume of exercise. Nevertheless, an unknown intensity of PA and its changes during the different stages of pregnancy are the limitations of this study. Future studies with more detailed observation of the intensity of PA are therefore required to explain the relationship of PA and pregnancy outcomes.

Conclusion

Factors affecting the risk for delivery complications found in this study population were overweight, maternal age and the number of previous live births. As expected, this study confirmed that PA primarily influenced weight gain during pregnancy. These results likewise confirm that current PA recommendations for healthy pregnant women are linked to no negative effects on either the delivery or the unborn baby.

List of abbreviations

PA physical activity

ELSPAC European Longitudinal Study of Pregnancy and Childhood

Declarations

Ethics approval and consent to participate

An informed written consent was obtained from all participants. Before data collection Scientific Council of Pediatric Research Institute in Brno, Czech Republic, approved ethical standards of the study. In 2002, the study was moved to Masaryk University and approved by its Ethical Council.

Consent for publication

An informed written consent for publication was obtained from all participants.

Availability of data and material

The datasets analyzed during the current study are available on request in the ELSPAC.CZ database, [http://www.elspac.cz/index-en.php?pg=professionals--topics].

Competing interest

The authors declare that they have no competing interests.

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